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MOTIVE POWER OF MOTOR CARS.

During the past decade there have been great developments in methods of transportation and in these developments the internal combustion engine has played an important part, the most conspicuous example of which is its application to the automobile. The introduction of electric street and interurban lines has accustomed people to a frequent and rapid means of transportation between local points and this has often resulted in a call upon the railroads for the same sort of service. So the past few years have seen the use of the internal combustion engine extended successfully to heavy touring cars, freight trucks, railroad inspection cars and railroad motor cars capable of carrying from ten to fifty passengers. During the past two years the motor car has been placed in service on a number of roads, for giving stations off the main line more frequent train service and doing away with the necessity of running an engine and coach, and mixed trains. In many cases their use has proved very successful; in fact a motor car running in California was recently taken off and a train put on because the motor car had developed more traffic than it could carry. At present many different designs of motor cars are being experimented with but the three distinct types are the gasoline, gas-electric and the steam car. Two of these are primarily gasoline cars and they are somewhat more in favor than the steam car in this country at least, due to the compactness and efficiency of the gasoline engine. The gasoline car has in its favor also a low fuel cost per mile, low cost of operation and the ability to carry plenty of fuel. However, the gasoline engine cannot be said to have reached the stage where it can run 365 days in the year without any care as seems to be the opinion of some. The motor car should daily be given as much attention and care as the locomotive. More or less trouble has been experienced in arriving at a satisfactory method of transmitting the power to the drivers and also in the designing of a car which can be operated from either end, obviating the use of a turntable or Y. The gas-electric car is an effort in this direction, but is not as compact and efficient as the direct gasoline. The system of power transmission on the gasoline car through gears or a combination of friction clutch and gears also has its disadvantages, such as less flexibility in speed regulation and more or less noise caused by the wearing of the gears. A recently designed car which uses friction transmission for all speeds as well as for reversing would seem to be an effort in the right direction if a large amount of power can be transmitted in this way. Very little has been done towards the development of gas producers for motor car work, but with the increasing use of gasoline and a probable increase in its cost, it would seem that the combination of gas producer and engine might prove economical and feasible. The gasoline engine is undoubtedly the most acceptable and efficient source of power for the motor car if it can be applied in such a way as to give the flexibility of operation of steam.

In a future issue we expect to publish a very thorough discussion on the railroad motor car question by F. W. Lane. It is interesting to note the caution with which all authorities treat the subject of motive power for railroad motor cars. Mr. Lane's conclusions are somewhat indefinite. The nearest he gets to a direct recommendation is that cars of less than eighty horse power will show a smaller cost of operation where the internal combustion engine is used. This statement is qualified, however, by another which takes up the question of flexibility and ease of operation as well as reliability and cost of maintenance. The fact that interest in this subject is increasing on every side and that different railroads continue to experiment along the same general line, is encouraging for the future of the motor car whatever the power. The question of expense, first cost of repairs and depreciation cannot be satisfactorily determined by the performance of isolated cars operating under different weather and physical conditions where fuel prices vary. For this reason the prospective users among the railroads will have to carry on their own experiments using data secured by others in so far as it is applicable to individual conditions. The amount at stake is so large that a continued study of the subject seems strongly warranted and circumstances appear to justify the belief that the use of this class of rolling equipment is the sole solution of the problem of protecting steam road local passenger service from the depredations of the paralleling electric lines.

HOME MADE SHOP APPLIANCES.

Before piece work became an established method of computing fair compensation for shop labor, the incentives for the invention of labor saving machines and devices were small as far as the shop men themselves were concerned. If the original piece work rate has been carefully computed and the men are given to understand that it will not be changed, labor saving devices will soon make themselves evident about the shop. The railroads can well afford to provide material and even time for the construction of devices which will lessen the cost of production of some article or class of article in common use. It is curious fact that when the idea of the individual value of homemade appliances is once started in a large shop, the kinks and devices will come out on every hand. The man who has never been sufficiently interested heretofore to do any thinking outside of his simple line of duty, becomes enthused with the importance of the subject, with the result of increasing his own machine efficiency to the advantage of both the company and himself.

On another page of this issue we are publishing illustrations of a number of shop kinks taken from drawings made at the Beech Grove shops of the Cleveland, Cincinnati, Chicago & St. Louis Ry. It will be remembered that considerable trouble followed the first attempt to incorporate the piece work system in this shop. Since it has been adopted, however, the flow of new ideas for labor saving devices has been surprising, to say the least. Men, who at first were barely able to make their former daily wages under piece work coupled with old methods, began to think along new lines, and meeting every encouragement, they soon put their ideas into effect with the assistance of the superintendent and the draughtsmen. The latter, by the way, are the apprentices, at Beech Grove.

It is notable that the invention and use of homemade appliances in the railroad shop runs in what might be called, for lack of a better word, epidemics. It is not always the shop which is poorly equipped with factory made machinery which has in use to best advantages these labor savers. As is many such cases the men appear disheartened. Neither is it always the case that the shop, which is the most efficiently equipped with modern machine tools, is the user to best advantage of these kinks. It appears, however, that the latter class of railroad shop is usually the one where the atmosphere is the most encouraging and the one in which the men are most willing to exert themselves for mutual benefit.

TERMINAL FACILITIES AND NEW POWER.

Pity the mechanical head who is allowed appropriations for new power without proper facilities for taking care of the engines in the way of shopping and housing! There are a number of railroads which have recently placed orders for the heavier class of locomotives, including Mallets, without seeming to have considered the question of taking care of this power after it has been delivered. At this time the rule rather than the exception seems to be the overcrowding of repair shops with rolling stock of all kinds which is badly needed in service. With the advent of the large articulated compounds, these conditions are aggravated to the extent, in some cases, of necessitating the contracting of repair work in outside shops, with a resultant delay and congestion. The head of the mechanical department of any railroad naturally wishes to make a showing equal to, or better, than others using the same class of power, and when his facilities are so limited, he is sure to fall far below the average. This fact will tend to place the very heavy classes of engines in ill repute wholly undeserved. Short turntables, short pits, and other terminal equipment of small capacity will offset to a more or less degree all of the advantages of the large and expensive articulated power. Appropriations for a corresponding increase of shop and terminal capacities should accompany the appropriations for larger locomotives, if there are any benefits to accrue.

In a paper recently read before the Canadian Railway Club, Mr. C. Kyle, general master mechanic of the Canadian Pacific Ry., emphasizes the necessity for larger terminal capacity as follows: "To my mind there is no department connected with railway operation upon which so much depends as that charged with the despatching of locomotives. The roundhouse is the most important of all the departments, for no matter what figuring and calculating is done elsewhere, or what business may be secured, if, from various causes, the roundhouse fails in prompt and reliable despatching, thus causing detentions, etc., the business will eventually fall off."

The turntable should be looked upon as the key to the situation, and should be of such construction as will enable it to hold up against the weight of the heaviest locomotive in service; it should be preferably power driven. There should be one person specially appointed to take care of its inspection and oiling, and it should be his duty to know, beyond doubt, that it is always in satisfactory condition. At the principal shops that are responsible for the upkeep of locomotives, there should be provided tracks of sufficient capacity to take care of locomotives out of service on account of waiting repairs, traffic conditions, etc., and also wheel tracks sufficient to take care of new and old wheels kept in stock. There should be both driving and truck wheel pits, and all pits should be provided for loading and unloading wheels, suitable lorrie tracks for trucking heavy materials, up-to-date boiler tester and hot-water washing-out plant, with pits specially alloted and constructed for this purpose, special care being given to bad water districts. There should be sufficient modern machinery to take care of the proper maintenance of tire work, driving boxes and wedges, pistons, valves, and motion, and rod work, also a proper blacksmith and boilermakers' equipment; all obsolete tools originally used for repairs to the small power should either be disposed of or scrapped.

Mallet Articulated Locomotives, Southern Pacific Co.

The Baldwin Locomotive Works have recently completed 21 consolidation Mallet type locomotives for the "Associated Lines." These are part of an order for 105 engines, placed with this company by the "Associated Lines" in the spring of 1909. The heavy Mallet engines have been assigned as follows: Three coal burners for the Union Pacific R. R., three for the Oregon Railroad & Navigation Co., and fifteen oil burners for the Southern Pacific Co. Apart from modifications necessary because of the change of fuel, the six coal burners are practically duplicates of Southern Pacific locomotives Nos. 4000 and 4001, which were built by the Baldwin Locomotive Works early in 1909. Experience gained in operating these engines through tunnels and snow sheds has proved the desirability of placing the engine crew where a better view of the track can be obtained. Accordingly the new Southern Pacific locomotives are designed to run with the fire-box end first, and the tender back of the smoke box. With a coal burning locomotive such a plan would of course be impracticable, but no difficulty need be anticipated when using oil as fuel.

In the new design the cab is entered through side doorways, reached by suitable ladders. An unobstructed view of the track is obtained through the front windows. The cab fittings are conveniently located within easy reach of the engineman, who occupies the right hand side when looking ahead. The Ragonnet power gear is employed, and its cylinder is located as on the previous locomotives. It has therefore been necessary to run a shaft across the boiler back-head in order to make connection with the operating lever. This arrangement, however, in no way interferes with the convenience of the cab fittings.

The main frames are securely braced, under the cab, by a steel casting to which the bumper is bolted. The latter supports a stub pilot. The bumper is placed well forward to protect the occupants of the cab from buffing and collision shocks.

The deck plates at the smoke box end of the locomotive is of cast steel, and is provided with a chafing block and a suitable pocket by the tender draw-bar. The tender is of the Associated Lines standard design with rectangular tank, as equipped for oil-burning locomotives.

As far as the boiler, cylinders, machinery and running gear of this locomotive are concerned, the design practically duplicates that of Southern Pacific engine No. 4000. The latter engine has now been in service a sufficient length of time to demonstrate its value; and the fact that twenty-one additional locomotives of the same type have been built for the Associated Lines, proves that the performance of these great engines has been fully up to expectations.

On account of the similarity of design detween these locomotives and that of the No. 4000, which was fully illustrated on page 150 of the May, 1909, issue of the Railway Master Mechanic, the drawings are not reprinted herewith.

The principal weights, dimensions, etc., are as follows:

Gauge	4 ft. 8½ ins.
Cylinders	26 ins. and 40x30 ins.
Valves	Balanced Piston

Boiler.

Type	Straight
Material	Steel
Diameter	84 ins.
Thickness of sheets	$\frac{13}{16}$ in. and $\frac{27}{32}$ in.
Working pressure	200 lbs.
Fuel	Oil
Staying	L crown bars

Fire-Box.

Material	Steel
Length	126 ins.
Width	78¼ ins.
Depth, front	75½ ins.
Depth, back	70½ ins.
Thickness of sheets, sides	⅜ in.
Thickness of sheets, back	⅜ in.
Thickness of sheets, crown	⅜ in.
Thickness of sheets, tube	½ in.

Southern Pacific Articulated Locomotive, Built to Run Cab First.

Water Space.

Front	5 ins.
Sides	5 ins.
Back	5 ins.

Fire-Tubes.

Material	Steel
Thickness	0.125 in.
Number	401
Diameter	2¼ ins.
Length	21 ft.

Feed-Water Heater Tubes.

Number	401
Diameter	2¼ ins.
Length	5 ft. 3 ins.

Heating Surface.

Fire-box	232 sq. ft.
Fire-tubes	4941 sq. ft.

Feed-Water Heater.

Tubes	1220 sq. ft.
Total	6393 sq. ft.
Grate area	68.4 sq. ft.

Driving Wheels.

Diameter, outside	57 ins.
Diameter, center	50 ins.
Journals, main	11x12 ins.
Journals, others	10x12 ins.

Engine Truck Wheels.

Diameter, front	30½ ins.
Journals	6x10 ins.

Southern Pacific Locomotive, Cab End.

Diameter, back	30½ ins.
Journals	6x10 ins.
Wheel Base.	
Driving	39 ft. 4 ins.
Rigid	15 ft.
Total engine	56 ft. 7 ins.
Total engine and tender	83 ft. 3 ins.
Weight.	
On driving wheels	394,700 lbs.
On truck, front	22,100 lbs.
On truck, back	20,200 lbs.
On trailing wheels	
Total engine	437,000 lbs.
Total engine and tender, about	610,000 lbs.
Tender.	
Wheels, number	8
Wheels, diameter	33 ins.
Journals	6x11 ins.
Tank capacity	9,000 gals. water
Fuel capacity	3,150 gals. oil
Service	Freight

Engine equipped with Baldwin Smoke-Box Superheater.

Superheating surface	655 sq. ft

Romance of the Rail

A contributer submits the following:

'Tain't our wives that we're thinkin' of—away up back—
While we rastle two thousand tons over the track;
'Tisn't danger that's givin' us tempers vile;
No! It's cuttin' down the cost o' the car-ton-mile.

Its the oil we dont use for each car-ton-mile,
Its the waste we don't draw that makes life worth while;
For the yachtsmen and the magnates—all that bunch o' chivalry—
Are needin' all the coin that they can get. D'ye see?

We're studyin' the almanac, night and noon,
For we don't use the headlight when it says, "Full Moon."
Never look at an order—just feel out our way,
As they've found that lights in the cab don't pay.

Oh! the engine is a-poppin', saying "car-ton-mile,"
While we feel around the roadbed for a broken file;
Then we stop and pick some cat-tails—at the river bank—
To use instead o' torches at the water tank.

S'pose that when we're sent to glory by a rotten rail;
When the boys chip in for flowers—in an old tin pail—
St. Peter will ask, with a cynical smile:
"How much were you saving per car-ton-mile?"

—W. Edson Smith.

The Assembling of Draft Gears

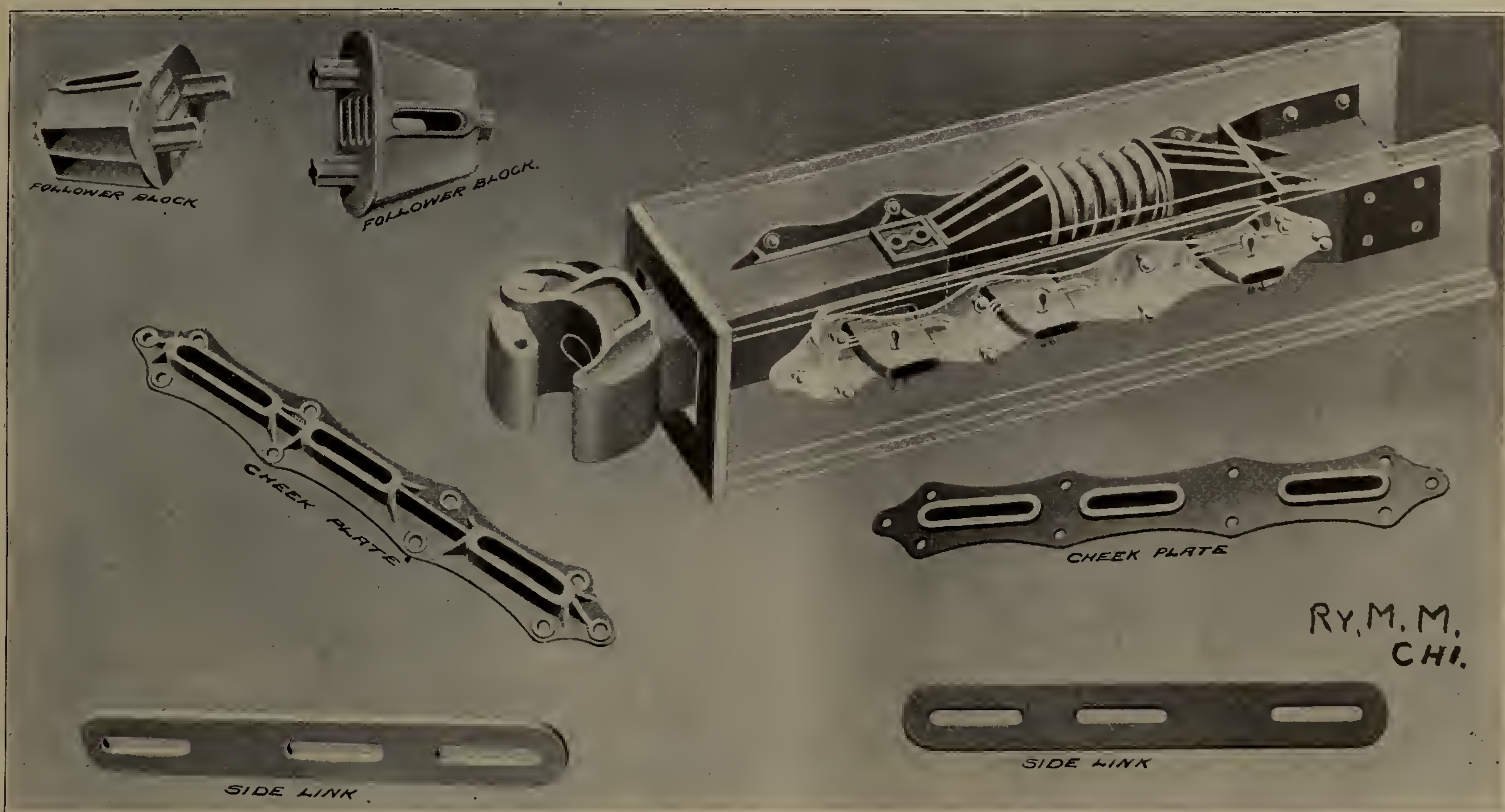
NOTE—It is our intention to bring out in pamphlet form, in the near future, the matter contained in this and later articles. This pamphlet will be distributed among railway car men and their officials with the expectation that the information will be of considerable benefit in the repairing, assembling and inspecting of draft gear and appurtenances.—Editors.

FARLOW DRAFT GEAR.

The photographic reproduction shows the Farlow draft gear assembled and in its separate component parts.

GOULD FRICTION DRAFT GEAR.

The photographic reproductions show the assembling of the Gould friction draft gear in consecutive operations. With this gear, after it has been in service for a considerable length of time and the wedges and shoes have become loose with wear, the full capacity can be regained by inserting a flat plate shim between the center springs, the plate, of course, being of proper thickness to take the slack occasioned by wear. It has been demonstrated many times, by using gears which have been in



Farlow Draft Gear.

Following is the order and method of assembling as furnished by the manufacturers:

1. The cheek plates are riveted to the center channels or sills of the car, the longest slot being placed at the front end of the car.

2. The filler casting or rear support for the entire gear is then riveted between the sills as is shown on the drawing.

3. One of the draft keys, of which there are three, is put in the rear slot next to the filler block; then one of the side links is placed in position; then the rear follower block; then the other side link. After this is done the rear key is driven entirely through the gear.

4. The twin springs are then placed upon the lugs of the rear follower block.

5. The front follower block is then placed against the springs with the lugs projecting into same, and another draft key is driven through the center slot of the cheek plates, links and follower blocks.

6. The coupler is then placed in position and the third or front key is driven through the cheek plates, links and coupler.

7. The cotter pins are then placed in the ends of the keys on either side and then opened to prevent the keys working out of the slots.

It is expected that this work can be done by one man wherever the car is located without the aid of shop tools or shop labor.

service two or three years, that a shim ⅛ in. to 3/16 in. thick placed between the center springs restored the gear to its original capacity.

In the illustration the barrel has been cut in half to show the insertion of parts and the operations are marked from the first to the last operation.

HARVEY FRICTION DRAFT SPRING.

The Harvey friction draft spring is similar in its application to the old practice of applying ordinary springs. The accompanying illustrations show the applications of the springs in connection with the Miner tandem an dthe single pocket styles of draft rigging. The weights and dimensions are as follows:

Pieces.	Name.	Weight. Lbs.	Total Wt. Lbs.
	Springs.		
2	Harvey Friction Draft Springs, Class G........	104	
2	8x8-in. M. C. B. Coil Springs, Class G..........	110	
	Total Weight Springs..........................		214
	Malleables.		
4	Miner Draft Plates, D 234.......................		
2	Miner Vertical Thimbles, D 107.................		
	Estimated Total Weight Malleables............		415.00
	Cast Iron.		
2	Yoke Fillers	90	
	Total Weight Cast Iron.........................		90
	Wrought Iron.		
2	Yokes, 1¼x5x6 ft. 8 in..........................	283.3	
4	Guides, ⅝x2x2 ft. 7⅝ in........................	44.	
8	Followers, 1½x8x9¼ in..........................	251.3	
2	Sill Ties, ¾x3x2 ft. 0 in........................	30.6	
	Total Weight Wrought Iron		609.2

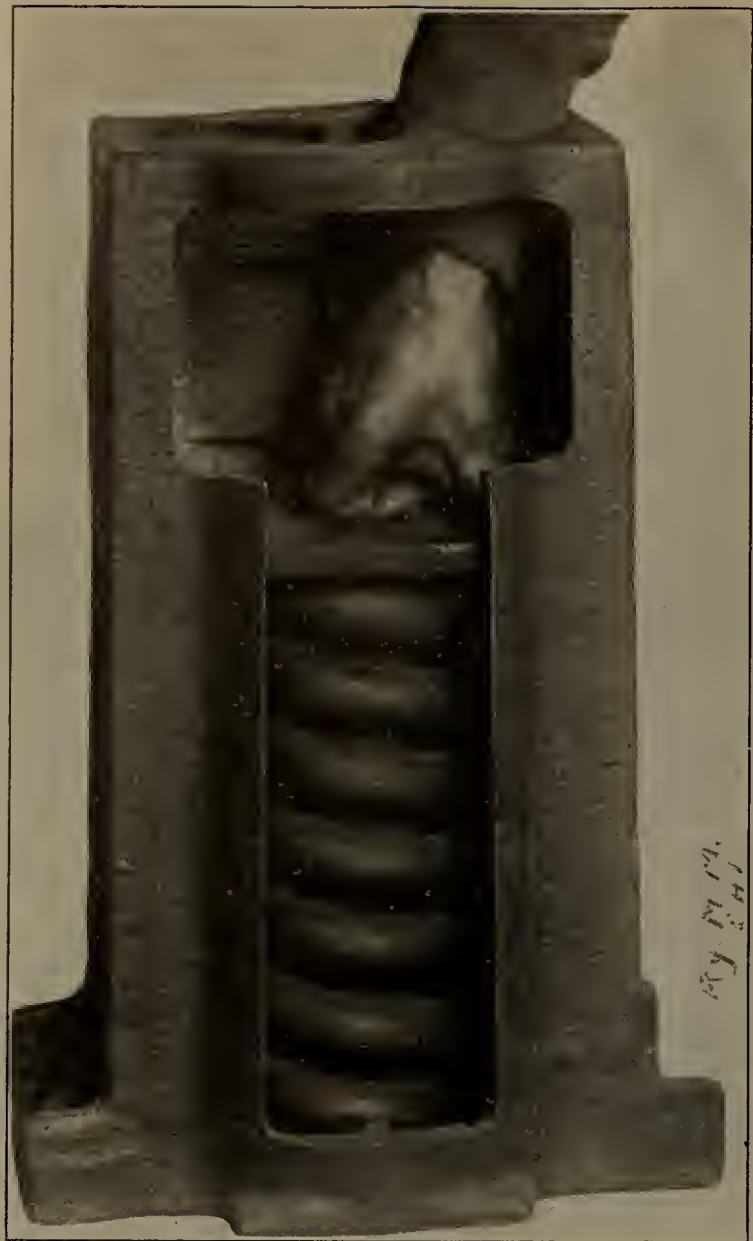


Fig. 1.—Inserting Coil Release Spring, Gould Draft Gear.

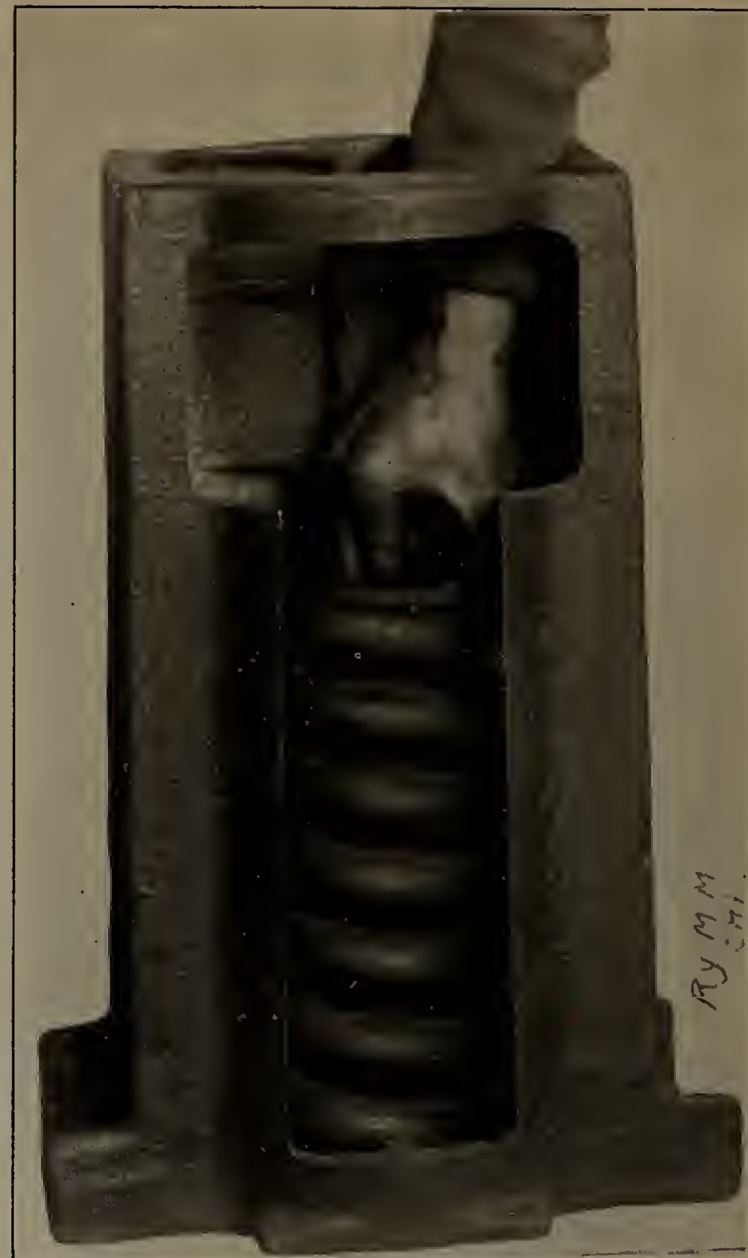
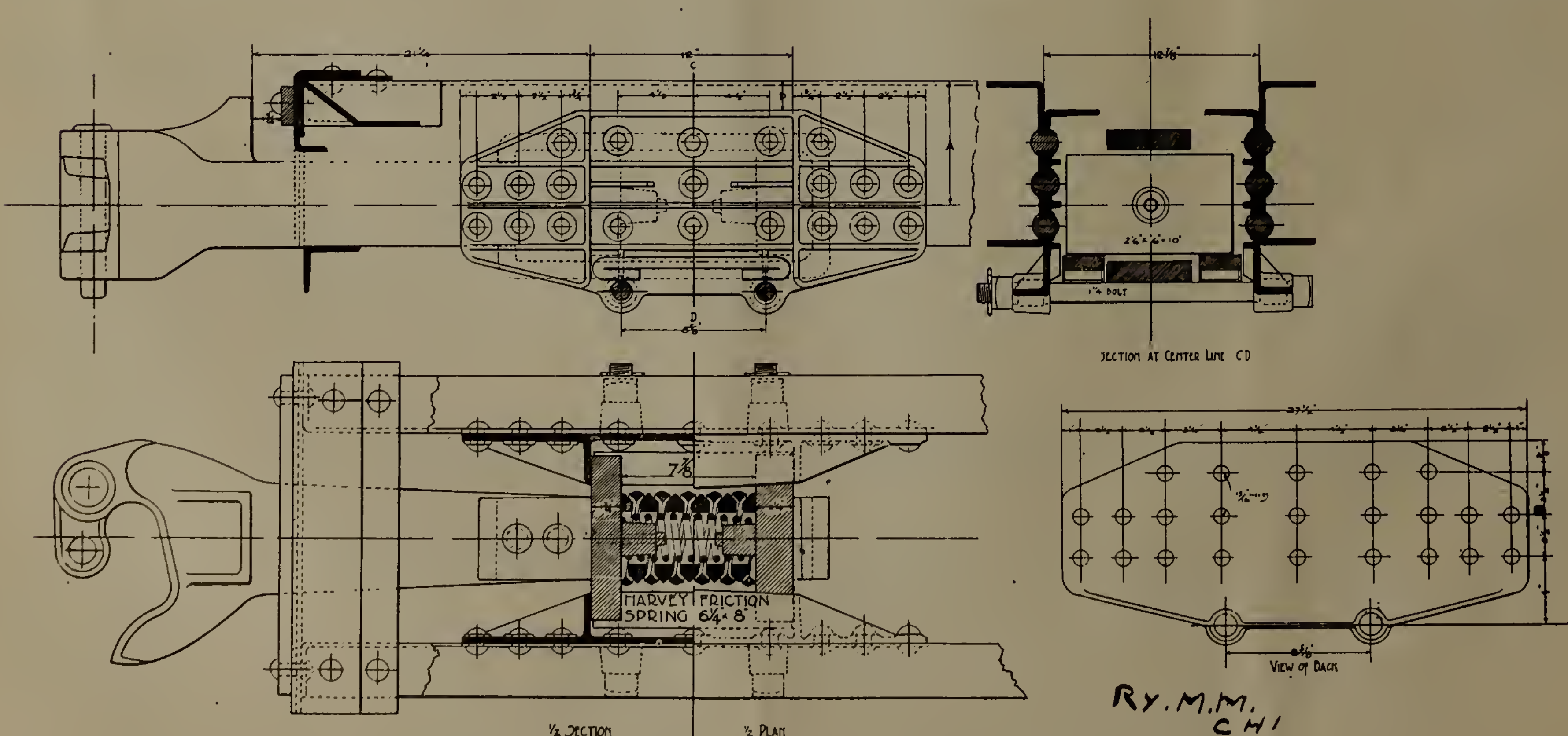


Fig. 2.—Placing Follower on End of Release Spring, Gould Draft Gear.

	Rivets.		
8	Yoke Rivets, 1¼x12¾ in.	42.2	
2	Yoke End, ¾x6½ in.	1.9	
56	Draft Plate, ⅞x2½ in.	36.4	
	Total Weight		81.5
	Bolts.		
12	Guide Bolts, ⅞x2⅜ in.	14	
2	Tie Strap, ⅞x3 in.	2.5	
	Total Weight Bolts		16.5
	Grips.		
14	⅞-in. Grip Nuts	1	
	Total Weight Grip Nuts		1.
	Total Weight		1427.2



Harvey Draft Gear Spring With Belle City Plates and Steel Sills.

McCORD DRAFT GEAR.

In the McCord draft gear, the casing is formed by two malleable iron side frames, in which are pivoted cast steel levers which press against the malleable iron spring cap and compress the spring. The pivot bearings of the levers are cored with a ⅞-in. hole. Two of the ¾-in. rivets holding the malleable iron sides together pass through these holes, and it should be particularly noticed that the bearings of the levers are not on the rivets, but are in sockets in the malleable iron sides.

The spring is a double coil spring, 6¼x16, 20,000 lbs. capacity at four inches compression, maximum compression 4¼ ins. The shoulders on the side frames also serve the purpose of a rear follower. In a buffing shock the coupler forces

Harvey Draft Gear Spring.

Fig. 3.—Inserting Wedge Plates on Both Sides of Barrel, Gould Draft Gear.

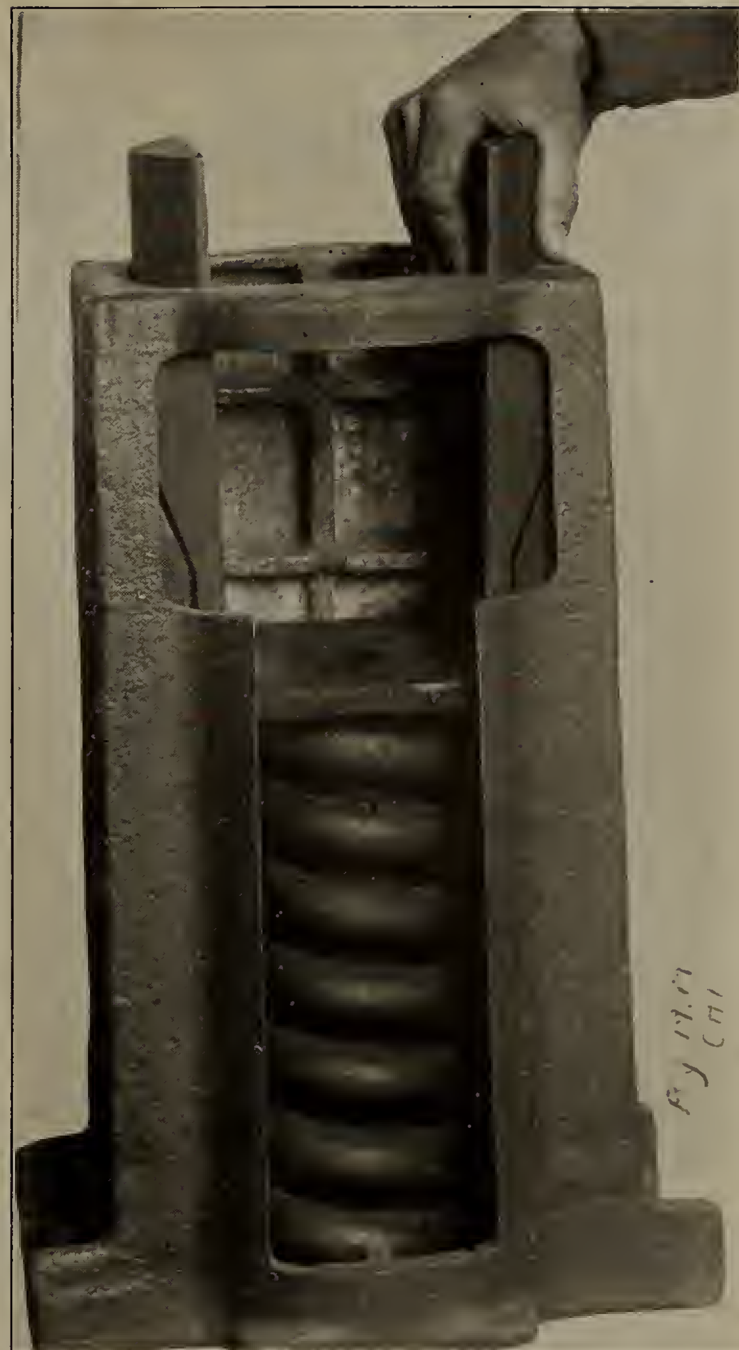


Fig. 4.—Friction Wedges in Place Against Wedge Plates, Gould Draft Gear.

the front follower against the levers, which, as the coupler moves, rotate in their bearings and transfer their motion to the spring. In a pulling strain, the yoke passing around the draft gear forces it against the front follower, and the load is transferred to the spring through the levers in the same way. The draft gear is assembled in the yoke with the spring under ½-in. compression, to insure close contact between all parts. It will be noticed that the spring is compressed 4 ins., while the drawbar travels only 2⅛ ins., and when the draft gear itself is solid there is ¼-in. compression left in the spring, so that there is no possibility of any shock being delivered to the solid spring—the most frequent cause of springs breaking in service. The difference between the travel of the drawbar and the total compression of the spring is equalized by the shape of the levers. The total weight of the gear, including followers and springs, is 595 lbs. per car.

The method of assembling will be understood after reading the features of operation and looking over the illustrations.

WESTINGHOUSE FRICTION DRAFT GEAR.

The illustrations show this gear assembled and dissembled very clearly. The manufacturers arrange their instructions for its application under two heads according to the class of service. Their suggestions are as follows:

Freight Service.

Couplers: We recommend the back end of the coupler to be 9⅛-in., with rivet holes suitable for 1¼-in. rivets. The back

Fig. 5.—Inserting Flat Springs Between Friction Plates, Gould Draft Gear.

McCord Draft Gear in Yoke, Showing Relative Position of Parts.

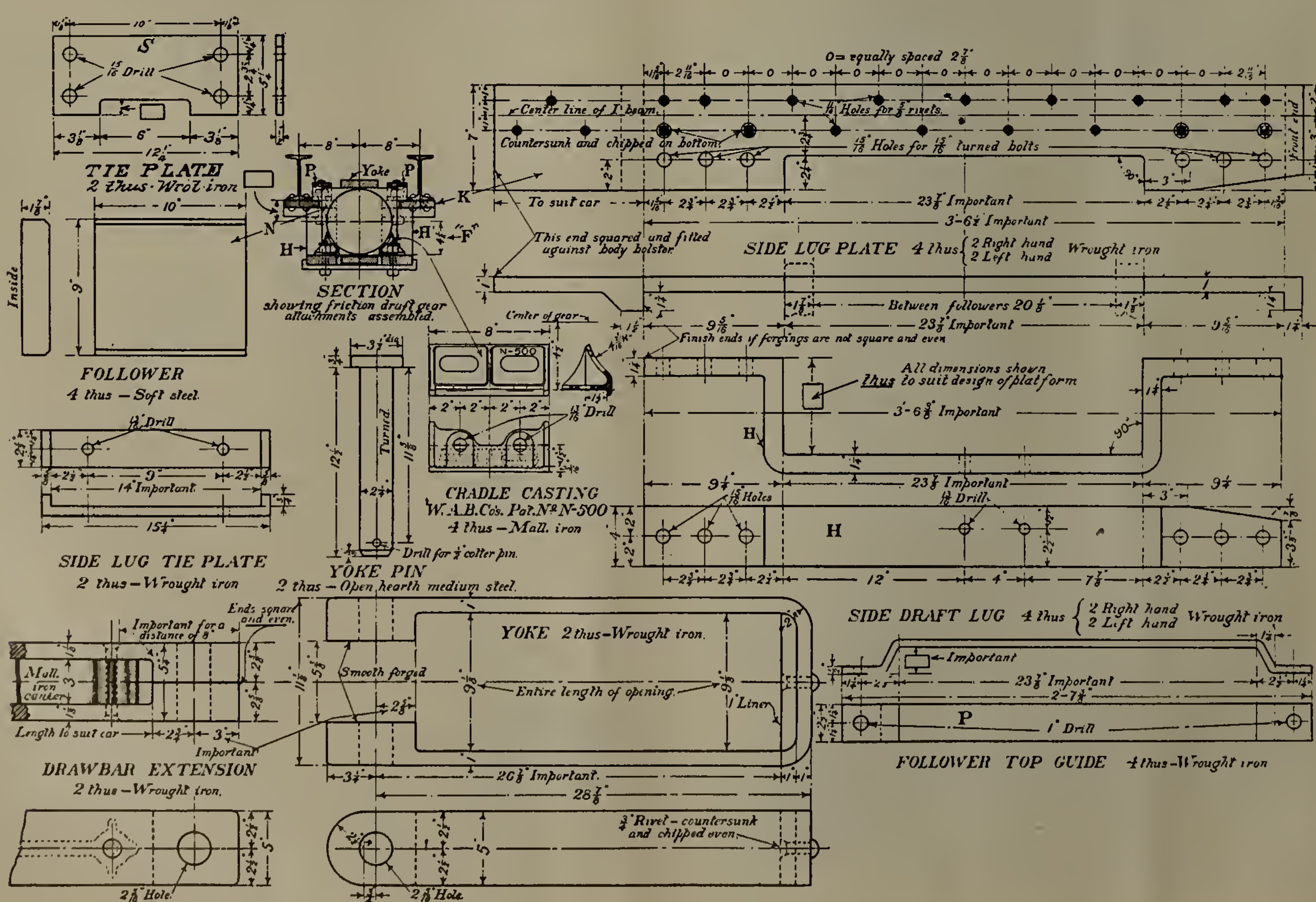
end of the coupler to be free from excessive draft and ground smooth so as to have an even bearing upon the follower.

Yoke: We recommend the draft gear yoke to be made of 5x1¼-in. wrought iron, or soft steel, with the lips of the front end properly fitted to the shoulders of the coupler and the back end of yoke reinforced with a liner secured to the yoke with a ¾-in. counter-sunk head rivet and the coupler rivet holes spaced to suit M. C. B. standards and drilled 1 5-16-in. diameter for 1¼-in. rivets. The opening of the yoke to be 9⅛ ins. its full length and the length from the back end of the coupler to the inside of the liner to be the same as the distance between the draft lugs, which should be 20⅛ ins. (total length of Westinghouse friction gear installation) plus the thickness of the two followers.

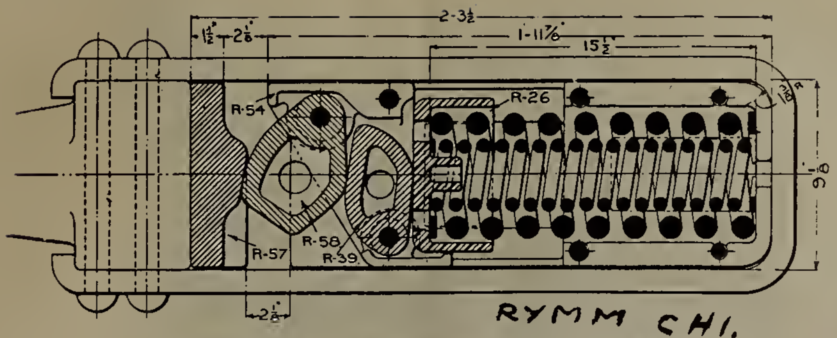
Followers: The followers to be of wrought iron or flanged steel 8¾ ins. wide (not to exceed 9 ins.), and of an even thickness of 2¼ ins.

Draft Lugs: The follower bearing surfaces of the draft lugs should be at right angles to the center line of draft, vertically and horizontally. The front draft lugs to be located at the proper distance from the end sill to give the required coupler horn clearance and the back lugs, so that the distance between the inside faces of the followers is 20 1-8 ins., which necessitates compressing the Westinghouse friction gear 1-8 in. when placing it in position.

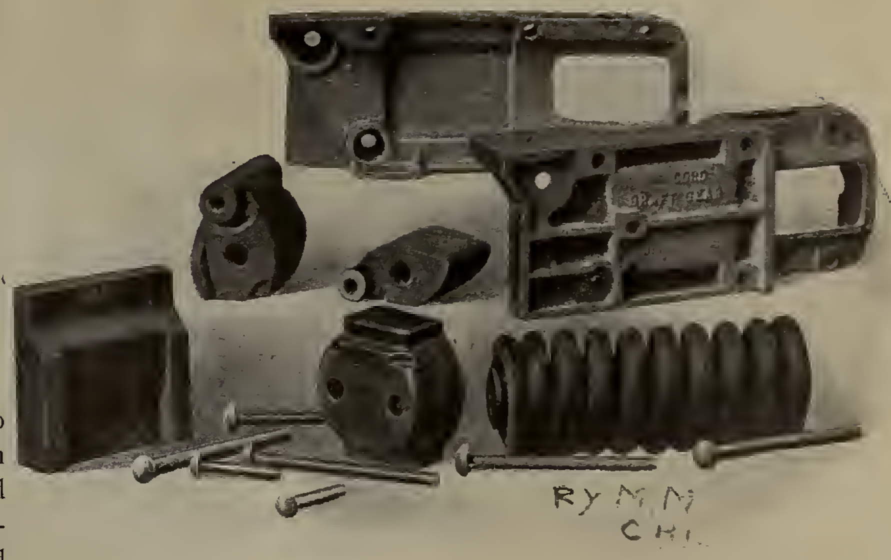
Coupler Horn Clearance: The total movement of draft gear is 2 7-16 ins. when installed. When applying the friction



Detail Drawing of Westinghouse Gear.



Sectional Drawing of McCord Gear.

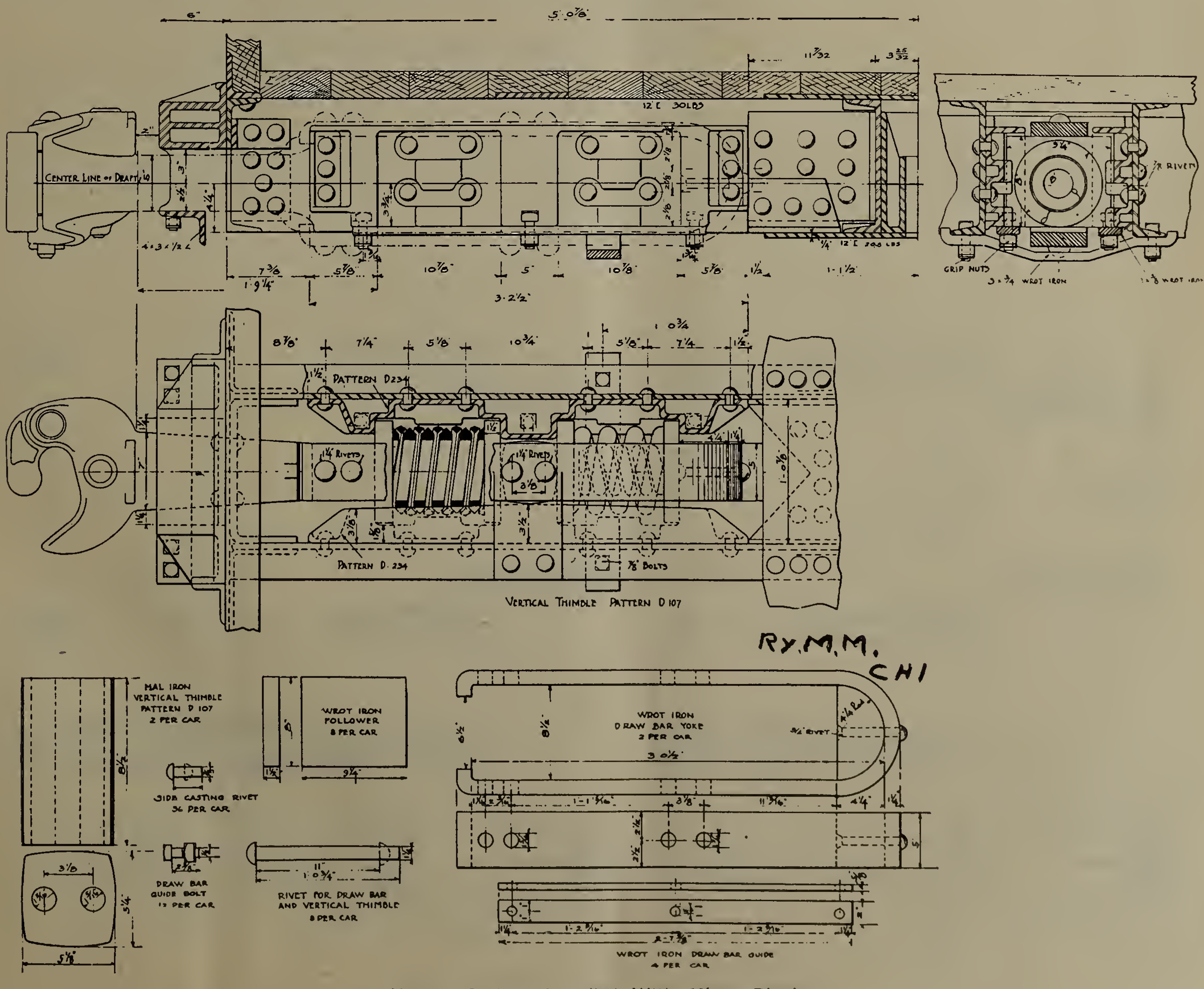


Parts of McCord Draft Gear.

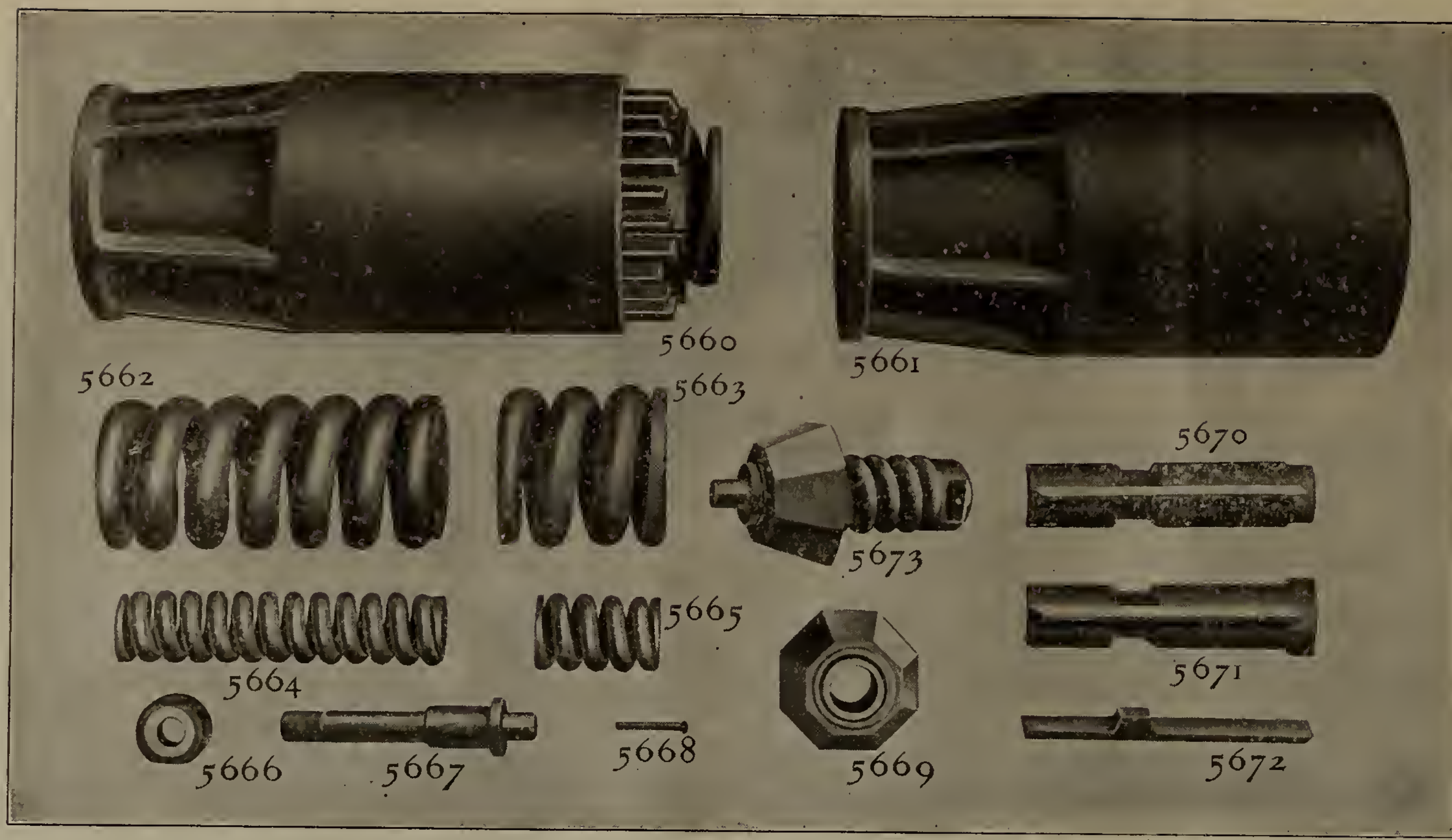
draft gear to equipment with end sills of sufficient strength to receive the final blow in buffing, Plate II, the distance between the horn of the coupler and the end sill striking plate should be 2 5-16 ins., after all loose slack is taken up in the draft rigging by compression. This clearance may also be allowed on wooden cars with metal frames and cast steel end sills of specially strong construction in which the center sills are close together. Whenever possible, we recommend the final blow to be taken upon the end sill of the car and not upon the rear draft lugs, as cars are often designed with light pressed steel center sills with no tie plate connection at the bottom near the rear draft lugs. When applying the friction draft gear to steel freight cars of pressed steel, or light structural iron design of end sills, not designed to receive the final blow of the coupler horn, the coupler horn clearance would be 2¾ ins. after the slack is taken up in the draft rigging by compression.

Erecting: When placing the friction draft gear in the yoke, it is important that the opening of the latter allows it to pass through freely. We recommend the open, or preliminary spring end of the draft gear, should point toward the end of the car upon which it is located, so that the initial movement of the coupler in buffing will be directly upon the preliminary spring. Use a block of wood for forcing the gear into place between the followers, but do not strike sufficiently hard to distort the cylinders, as damage to the draft gear will result.

If when placing the draft gear upon the car, it is necessary to give additional compression to the preliminary spring, so as



Harvey Springs Installed With Miner Rigging.



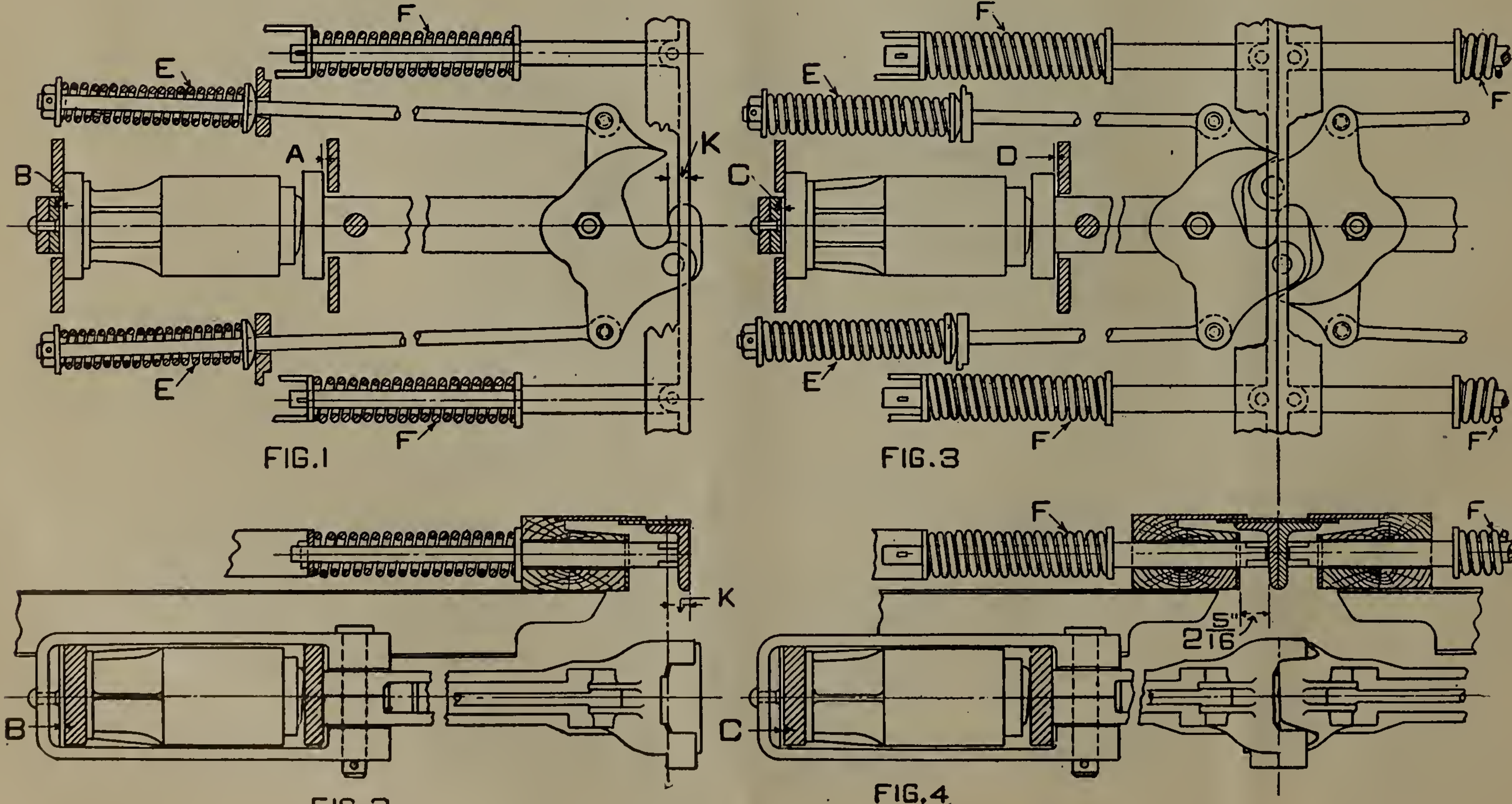
Parts of Westinghouse Gear.

to allow the followers to pass between the draft lugs, use a wedge between the inside follower and the yoke. This wedge must always be removed after the draft gear is in position. Do not use a nut or any small piece of metal for this purpose. When applying the draft gear to steel freight cars, note that the cylinder rests upon the rounded surface of the supporting plate and the yoke on the top of the followers, while the bottoms of the followers rest upon the surface of the supporting plate, which is secured at the ends for that purpose.

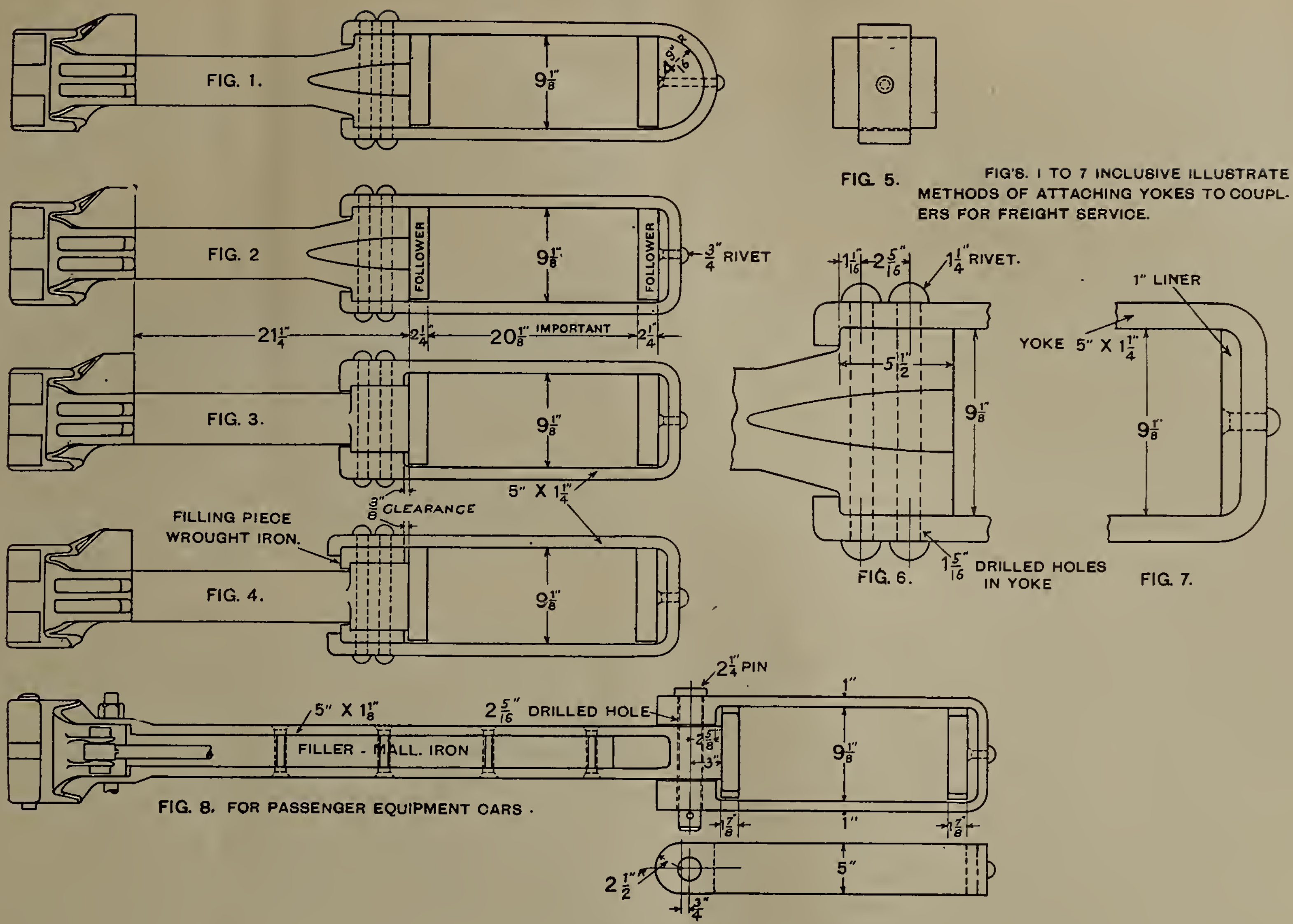
Before placing the supporting plate in position, it should be checked with a template and straightened, if necessary. Before fastening the bolts, note that there should not be less than 1¼ ins. clearance between the bottom of the yoke and the supporting plate and 3-8 ins. between the top of the yoke and the tie plate connecting the top of the sills.

Passenger Service.

When applying the Westinghouse friction draft gear to passenger equipment cars with forged attachments, we recommend the yoke to be 5x1-in. wrot iron, back end reinforced with liner 1 in. thick, opening of yoke 9 1-8 ins. its entire length, diameter of draft pin 2¼ ins., and coupler extension of 5x1 1-8-in. wrot iron with ends forged and draft pin hole drilled 2 5-16 ins.; also the rear end of side draft lug to be fitted against body bolster.



Westinghouse Draft Gear in Different Positions.



Details of Westinghouse Draft Gear.

Three Stem Couplers: When applying the Westinghouse Friction Draft Gear to passenger equipment cars equipped with three-stem couplers, it is important that side stem springs should have the proper action and capacity and be given only sufficient initial compression to equal the preliminary compression given the draft gear when applying it between the followers. If the initial compression to the side stem springs exceeds the force exerted by the draft gear in release position, the front follower will be forced away from its stop and the back end of the yoke the same distance away from the back of the rear follower, resulting in the car inspectors thinking the lost motion is caused by thin followers which, in several cases, we have known them to replace with followers thicker than standard, which they have not been able to apply on account of the extra preliminary compression the gear required to put the thickened followers in place, and when this has been accomplished, it does not help the matter by giving the gear the extra amount of preliminary compression, the excessive preliminary compression to the side stem springs being the primal cause of the trouble.

The above conditions exist with any type of spring, or friction gear, and we call attention to this fact only that the matter may be made clear to inspectors who often order a passenger equipment car to the shop unnecessarily, thinking the lost motion between the followers and the stops is caused by the former being too thin, the trouble always being either that the side stem springs are of too high capacity or are given too much initial compression.

Lubrication of Railway Equipment*

By William J. Walsh.

It might be well at the outset to say that lubricating companies make oils to suit each class of service. The impression is common, however, among some railroad men that there is no difference in Galena oils for freight and for passenger lubrication; this impression is incorrect. Taking into consideration the temperature of the journals of a slow-moving freight train, and the temperature of the journals of a fast-moving passenger train, you will find there is a decided difference therein, and that different oils should be used. To illustrate: The average running temperature of freight trains is considered to be 80 degrees, and the average running temperature of passenger trains 125 degrees. We learn from experience that the proper gravity of oil for the lubrication of all trains should be about 30 degrees, and as one degree of gravity is lost at every ten degrees advance in heat, it is plain to be seen that should we supply an oil for the lubrication of a freight train at 80 degrees, with a gravity of 30 degrees, and the same lubricant is used on a fast-moving passenger train at 125 degrees, the gravity of the lubricant would be reduced about 5 degrees; or, to explain further, if this lubricant at 30 degrees gravity is dense enough to carry the load at 80 degrees running temperature, it would not be dense enough to carry it at 125 degrees running temperature. It is for this reason that the Galena-Signal Oil Company always recommends the use of what is known as Galena coach oil for passenger-train service.

It has always been my aim, in my years of experience looking after lubrication matters for our company, to endeavor to educate the men in car yards and engine houses by demonstrating to them the very best way to do the work. I find that the extravagant use of oil on the railroads is due to lack of knowl-

*From a paper read before the New England Railroad Club.

edge on the part of the men using the oil. I well remember my own ignorance on the lubrication question, and it has always been my idea that others were probably as ignorant on the subject as I was, and with that in mind I adopted the educational system on the railways I have been assigned to; therefore my paper to-night will present to you the methods I have followed to secure the best results in lubrication lines, during my connection with the Galena-Signal Oil Co.

The most important feature of the lubrication system consists of the systematic repacking of journal boxes. As cars pass over the repair tracks, or stand on loading, unloading or storage tracks, the packing should be removed from all of the boxes and replaced with fresh packing. This work should be done at least once a year, and journal boxes should be stenciled with the date the boxes are repacked, so that the work may be continued in a systematic manner. The old packing removed from the journal boxes should be put into a vat of hot oil, and thoroughly washed, and cleansed of all impurities. It should then be thrown up on a screen and the surplus oil drained off, so that after being shaken out and handled again by hand it is ready for use again. This renovating process removes all the sand, cinders, heavy grease, babbitt and all foreign matter from the waste, changing it from a heavy, soggy mass to a light, fluffy condition. This work is all done by a man with a hay fork.

The device I am describing is a hot oil soaking vat, or waste cleaning machine, now in general use on two of the leading railways in the West. It consists simply of a metal vat resting upon, or completely surrounded by, steam or hot-water pipes, with the drain pans kept hot by the pipes. Under no circumstances should the steam or hot-water pipes be placed inside of this vat, on account of the heat from the pipes evaporating the lighter parts of the oils. This vat is quite inexpensive.

It is very necessary for the packing in a box to be light, on account of the wearing of the journals and the bearings. With every mile that the car runs the bearing and the journal wear slightly, and in the course of many miles this wear causes the packing to separate from the journal, unless the packing is elastic. When a car has traveled any considerable distance without any attention being given the journal boxes, the trainmen or car repairers bring the waste up in contact with the journal by means of the packing iron, and the oil in the box again reaches the journal.

There is a limit to the amount of oil which can be absorbed by the waste in the journal box. Careful experiment has shown that one pound of waste will absorb and hold four pints of oil. Any amount in excess of this will not remain in the waste, but will run down through it into the bottom of the box. Waste which has all the oil that it can hold, namely, four pints to the pound, is called saturated packing. To illustrate this more clearly: Go out into the rain without an umbrella. For the first few minutes that you are out the rain will strike your clothes, and will soak into the cloth, and you will not feel the water. Remain out in the rain long enough, however, and your clothes will become saturated; and then every drop of rain that strikes your clothes thereafter will pass through, and will run down your body. Your clothes have absorbed all the water they will hold.

The mistake made in the past in oiling with the use of an oil can, has been that the oiler attempted to fill the box with oil up to the level of the opening in the front, and while he was doing this the oil ran out of the back of the box, until the level of the oil adjusted itself to the height of the back wall, which runs about two inches above the bottom. It is impossible to put enough oil into a journal so that the journal will run in the oil, and the lubrication of the journal must be accomplished by means of packing thoroughly saturated in oil, which is put in so as to come in contact with the bottom half of the journal.

The proper method of packing boxes is as follows: Take a large wad of saturated packing, twist it up and squeeze out all the surplus oil, until you have a long roll of packing, sufficient to go about two-thirds of the way around the journal; shove this back to the rear end of the journal, and let it come up around to form a dust guard in the rear of the box. This wad of packing is not intended for lubricating the journal, but merely to prevent dust from getting into the box and coming in contact with the journal. Then take a piece of packing that has been thoroughly loosened and shaken out, and put it into the box, under the journal, bringing it up around the sides, not higher than the center line of the journal. As many pieces of this packing should be put in as are necessary to fill the space between the collars of the journal, but they should not be allowed to project beyond the outside collar of the journal. Care should be taken to get this packing in so that the space is entirely filled, and yet it should not be rammed in so tight that the oil is squeezed out of it. The space between the outside collar and the opening of the journal box should be filled with one large wad of packing, similar to that placed in the back end of the box, but not twisted—merely wrapped up in a wad.

A "hot box" is caused by excessive friction, and lubrication is the overcoming of friction. Friction is the resistance to movement, caused by the contact of two surfaces. There is no such thing as a perfectly smooth surface. The most highly polished journal, when examined under a microscope, will resemble a rough casting, and will be full of ridges and holes. The same is true of a journal bearing. When these two surfaces come together, and are moved by each other, resistance, or friction, occurs, and to overcome this friction the two surfaces must be separated from each other sufficiently to allow the uneven surfaces to pass by each other. Ordinarily oil is used for this purpose, and when spread on the surfaces which come in contact it fills out the uneven spots and separates the two surfaces with a very thin film; the surfaces then pass by each other with greatly reduced resistance. To illustrate: Let us take two large, heavy slabs of stone, weighing two or three tons each, lay one on top of the other, and then try to move the top one. The two surfaces are so rough that it is almost impossible. Take a pinch bar and raise one end of the top stone, and slip a piece of pipe between the stones, and then you will find that the top stone moves very freely. We have separated the two rough surfaces by means of the pipe, and have accomplished the same result as we do by putting oil between the journal and the journal bearing of a car. A round roller made of hard wood would answer the same purpose as the iron pipe, but if a piece of soft wood is used, it would be crushed under the weight of the stone. Therefore, the medium for overcoming the friction must be of sufficient strength to hold the two surfaces apart, and in the case of the journal and the journal bearing this medium is the lubricating oil. This is what distinguishes a good quality of oil from a poor quality.

The quantity of oil which passes between the journal and the journal bearings is, of course, very small. This is due to the immense weight which is pressing the bearing in contact with the journal. To illustrate this: Take a 60,000-pound-capacity loaded car, and the weight on each journal would be about 12,000 pounds. The amount of oil which can pass between the journal and the journal bearing, with 12,000 pounds on top of it, is the quantity that lubricates the journal, and it matters not how much oil may be in the box or around the journal; only a very small quantity can possibly remain under this great weight.

One great cause of "hot boxes" where "shell-filled" bearings are in use, has been the wearing out and the cracking of the babbitt liner of this journal bearing. The "shell-filled" bearing has the babbitt liner cast into the shell in such a manner that when the babbitt wears out the rough bearing comes in contact with the journal, and when this lining cracks it leaves a knife-edge that shaves the oil from the journal. This trouble does not occur where a good solid bearing that has been bored out and well tinned before relining is in use.

One source of annoyance to trainmen is to have a hot box on a car that has just come from the repair track, after going a few miles out on the road. Trainmen invariably attribute this trouble to a lack of proper workmanship on the part of the car repairers. I will explain how this occurs, and show you that it comes about in a very natural way; the remedy for it is very simple, but it cannot be prevented by the car repairers who make the repairs.

Journals are made large enough so that they can run for a long time, and wear down in size, and still be strong enough to carry the proper load. A 60,000-pound-capacity journal is 4¼ inches in diameter when it is new, and all 60,000-pound-capacity bearings are made so that the inside circle of the brass is 1/16 inch larger than 4¼ inches in diameter, and will fit properly on a new journal, with a slight opening on each side. This journal, which is 4¼ inches in diameter when new, after many miles of service wears down, and is turned down until the limit of wear permitted by the Master Car Builders' rules is reached, which is 3¾ inches in diameter, or ½ inch less than its original size.

Suppose a 60,000-pound-capacity car comes on the repair track for a new pair of wheels. The old wheels are removed and a new pair put in, with a journal which is, say, 4 inches in diameter. The standard 60,000-pound-capacity bearing, which measures slightly over 4¼ inches in diameter, is placed on this 4-inch journal, and owing to the difference in size of the brass and the journal the bearing is only on the top. The box is packed with good, oily packing, and everything is done by the car repairer to put the car in first-class shape. The weight of the car on the journal being carried only on a narrow strip on the top of bearing, the result is excessive friction at that point, and the journal wearing up into the bearing generates a good deal of heat in the first few miles. To illustrate: Supposing the journal to be ¼ or ⅜ inch smaller than the original size of 4¼ inches, one can plainly see that the bearing would have, say, ⅛-inch contact in its crown, which would give about one square inch of bearing surface, the bearing being about 8 inches in length, to carry the immense load of 12,000 pounds. In computing the approximate contact surface of the bearing, the diameter by the length would give 34 square inches, with a full-sized axle; figuring the bearing surface in the same way on a worn axle, we would have about one square inch of bearing surface to carry this great weight, 12,000 pounds. It may be information to you, gentlemen, that oil has never been known to flow between two surfaces where the pressure exceeds 900 pounds per square inch. Furthermore, as the journal wears up into the brass to form its bearing, the box drops, causing the packing to separate from the journal. Nine out of ten new bearings put in on old journals will have to go through this experience, and it is very essential that trainmen should give attention to new bearings at the very first stop after leaving the terminal, and in most cases all that is necessary is to take the packing iron and work the waste up in contact with the journal.

The bearing soon becomes large enough to carry the load without excessive heating, but the waste is away from the journal, and undess it is pushed up in contact with the journal the box will continue to run hot. If caught in time, and treated with the packing iron so that the journal receives lubrication, it will cool off. Of all tools carried in the caboose or baggage car, a packing iron, of proper dimensions, is the most important, and nine out of ten hot boxes will respond to proper treatment with a packing iron, if not neglected too long.

The same sysetm I have just explained can be applied to locomotives with excellent results, but to get a satisfactory cost on locomotives as compared with cars it would be necessary for each engineman to thoroughly understand the question of lubrication, it would be necessary for the engineer to apply the lubricating oils judiciously, and it would be absolutely necessary for him to keep his cylinder lubricator in first-class condition, to keep the water low in his boilers, so that he would not wash the oil off his valves, and at the beginning of his trip to set the feeds of the cylinder lubricator by his watch to feed only drops enough per minute so that only enough oil will be fed to lubricate the valves, the cylinders and the air pump, and only oil enough fed through his guides and piston cups to lubricate that part of his engine; further, a tremendous amount of rod cup grease is wasted to-day by the enginemen in too frequent screwing down of their grease cups, and too much rod cup grease is being given to trainmen to-day by the enginemen for the cure of hot boxes on cars.

Shop Kinks at Beech Grove Shops, C., C., C., & St. L. Ry.

The Beech Grove shops of the Cleveland, Cincinnati, Chicago & St. Louis Ry. were opened in June, 1908. Almost immediately the piece work system was installed as the most modern method of computing remuneration. As the employees were, for the greater part, old men in the employ of the railroad at the other shops where they had had little or no experience with piece work, some trouble resulted. Piece work has since been applied to almost every operation and the original prejudice has practically disappeared. With renewed interest the machinists have devoted themselves to the development of ideas for the promotion of labor-saving devices with the result of increasing their efficiency with respect to both the company's and their own interest.

We publish herewith several photographs, taken recently, which will give an idea of the machine arrangement and the attention given the apprenticeship system. A short description of the erecting shops is as follows:

The machine and erecting shop is 309 ft. wide, 578 ft. long, and belongs to what has been aptly named the double banked transverse type. Two erecting shops, 69 ft. wide and 50 ft. 3 in. high, are served by one 120-ton electric traveling crane, and one 10-ton messenger crane below. There are two interior bays, each 65 ft. wide, for machine tools and material, and one central bay 40 ft. wide, with a balcony; the latter is occupied by the tin and copper smith shops, air-brake repairs and brass finishers, and the large hot blast fans, lavatories and lockers.

There are 52 erecting pits divided equally between the two outside bays. Four pits, on through tracks, are for wheeling and unwheeling locomotives, leaving 48 for locomotive repairs On the basis of 48 pits, there is about 1,100 sq. ft. of floor space for machine tools for each erecting pit. The machine floor occupies the central section, extending 15 ft. outside the columns of the middle bay, and this portion, which is served by the 10-ton traveling cranes, is occupied by the larger machine tools. These cranes are also available for handling material to platforms extending beyond the balcony. The columns of the central bay and the girders connecting them transversely are made use of to support electric motors, line shafts and counter shafts. Every alternate column of this bay is also fitted with bracket cranes with air cylinder hoists for handling material to the machine tools. These cranes were supplied by the Whiting Foundry Equipment Co., Harvey, Ill., which also furnished the jib and bracket cranes for the smith shop and boiler shop. The tools directly under the balcony are served by a small traveling crane fitted with a Harrington block. The large locomotive traveling cranes in the locomotive shop, smith shop and boiler shop were all made by the Niles-Bement-Pond Company.

The tool room is located near the center of the building and under the balcony. It is equipped with two 16-in. engine lathes, one 24-in. shaper and No. 4 Universal miller, one Sellers tool grinder, one twist drill grinder, two 24-in. x 3-in. safety emery grinders, one No. 2 reamer and cutter grinder and one 20-in.

Boiler Shop, Beech Grove, C., C., C. & St. L. Ry.

Forge Shop, Beech Grove, C., C., C. & St. L. Ry.

drill. Directly south of the tool room are the machine tools for finishing main rods and side rods, and adjacent to it under the balcony is a space for hand finishing rods. The rods of large locomotives are so heavy that it was thought advisable to provide convenient means for lifting them in the rod gang and to the various tools. This department is therefore served by a light traveling crane with a Harrington block.

Following are the descriptions of a number of practical and useful shop kinks. We acknowledge the extreme courtesies of Mr. Wm. Garstang, superintendent of motive power, and Mr. M. J. McCarthy, shop superintendent, in assisting in the preparation of this article. The publication of the photographs is by courtesy of Mr. A. F. Taylor, chief clerk at the shops.

Figure 1 illustrates a pneumatic drill press clamp which may be used on machines with fixed tables. The air cylinder has a long stroke which allows of a large range of work. The time saving is at once evident as all clamping by means of bolts is obviated. The device was originated by C. L. Thomson, machine foreman.

Figure 2 illustrates a device built to facilitate the application of tires to wheel centers. It can be built in any weight suitable for the easiest handling of different classes of work. This appliance was designed by W. J. Woffatt, tin shop foreman.

Figure 3 shows a stay bolt clutch, the application of which

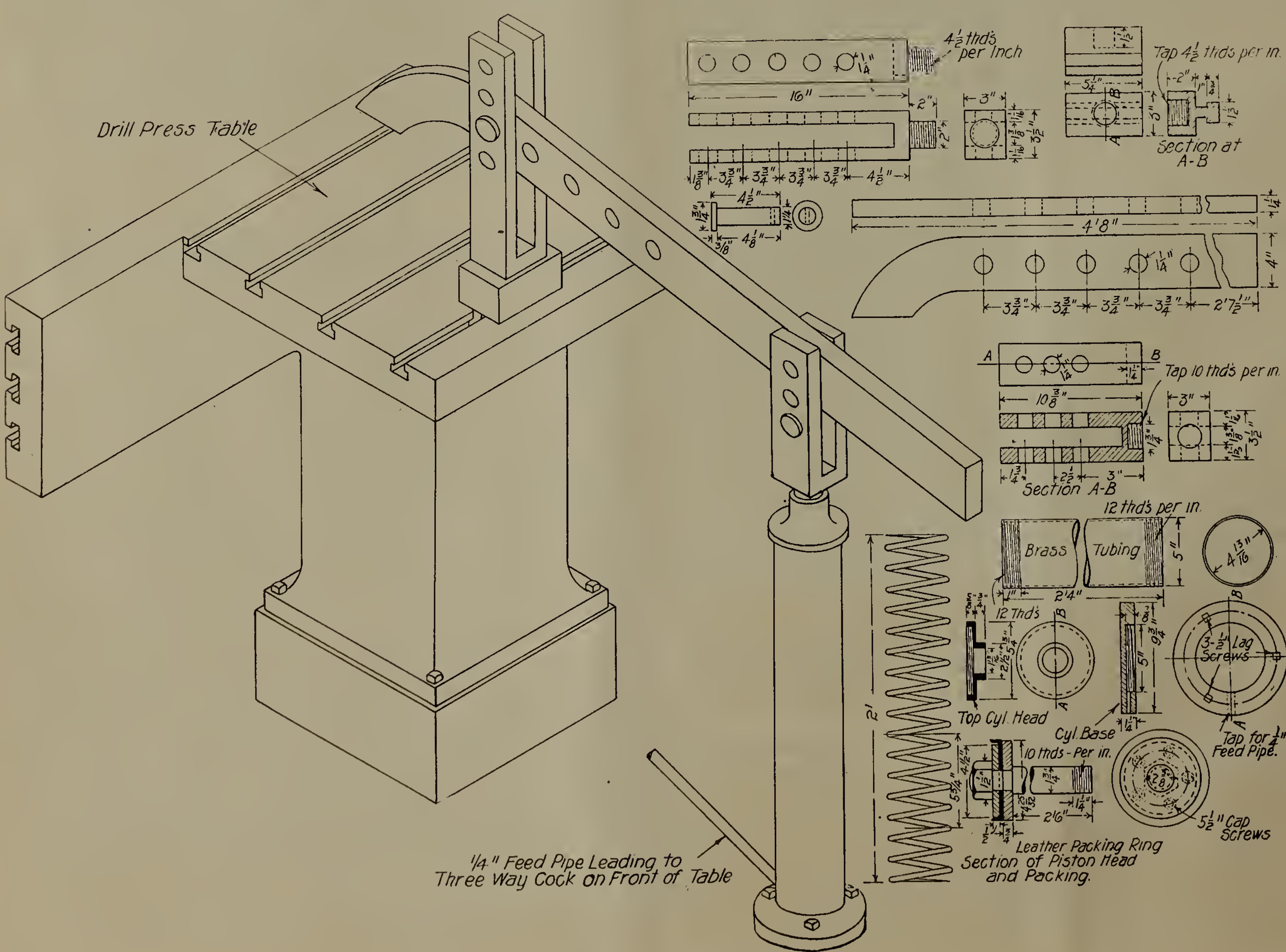


Fig. 1.—Pneumatic Drill Press Clamp.

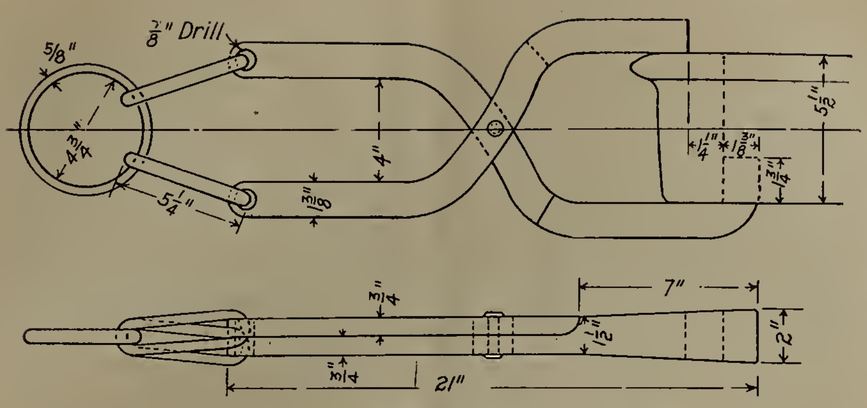


Fig. 2.—Tire Clamp for Applying Tires.

is at once evident. The parts are made of soft steel and all case hardened except the chuck itself. This device was designed by John H. Filcer, boiler shop foreman.

Figure 4 shows a wagon or truck built to carry portable vise stands. These portable vises are used to eliminate the usual benches about the erecting shop. Each machinist has the use of a portable vise stand which he can bring to the work. This wagon was originated by C. L. Thomson, machine foreman.

Figure 5 is the drawing of a former for shaping grease blocks to fit driving boxes. One operation of the air cylinder piston does the work, while the extracting is quickly done by the lower cylinder. This device is the idea of C. L. Thomson, machine foreman.

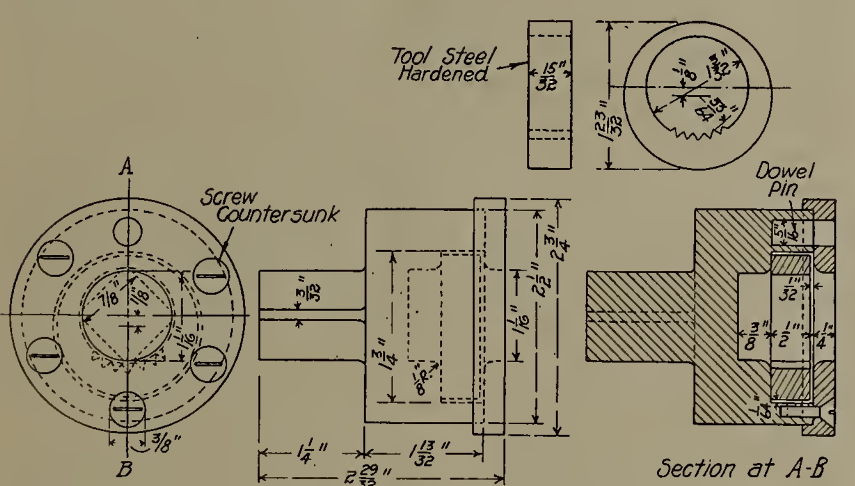


Fig. 3.—Stay Bolt Clutch.

Figure 6 is the representation of a tire clamp which gives the crane a quickly secured and solid hold on any tire. This clamp was originated by Robert Bruce, machinist.

Figure 7 is a tool stand used on the New York Central lines for the purpose of furnishing the mechanists with the substitute for a permanently located bench.

Figure 8 is a shoe and wedge mandrel the purpose of which is quite evident. This device in one form or another is practically a necessity. The design was originated in the Chicago shops of the Chicago & Northwestern Ry.

Figure 9 is the drawing of a rotary schedule holder for holding in ready access the piece work schedule sheets. These holders are located in convenient places about the shop for ready reference. The device was designed by J. T. Remley, piece work inspector.

East Bay of Erecting Shop, Beech Grove.

Apprentice School, Beech Grove.

Figure 10 shows an adjustible trestle with a set of jacks for locomotive pit work. This device is a time saver in jacking up locomotives over the pit. The jacks can be shifted to best advantage and the engine jacked up without the necessity of inconvenient blocking.

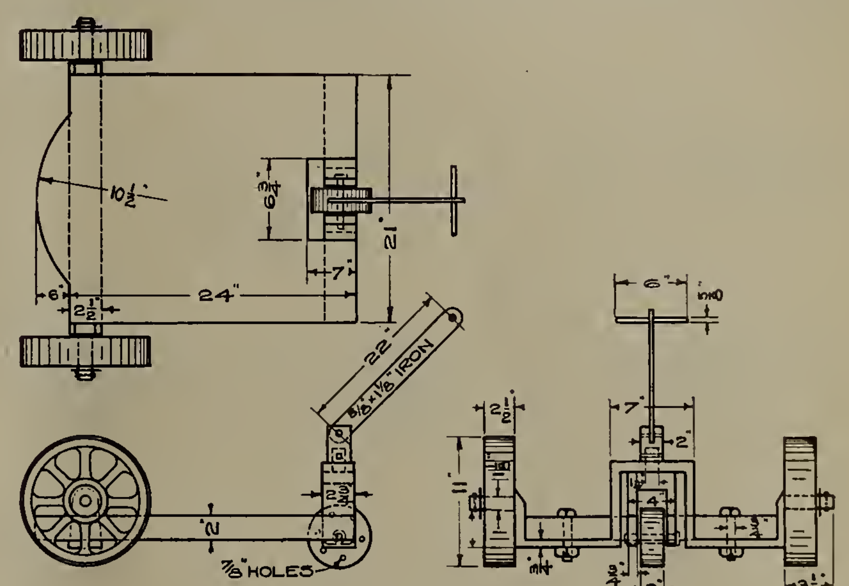


Fig. 4.—Wagon for Portable Vise.

Figure 11 shows a portable vise stand which carries out the idea of the avoidance of permanently located work benches. This vise stand is mounted on the truck described above and is wheeled about the shop. The facilities are thus carried to the work instead of carrying the work to a bench.

(To be continued)

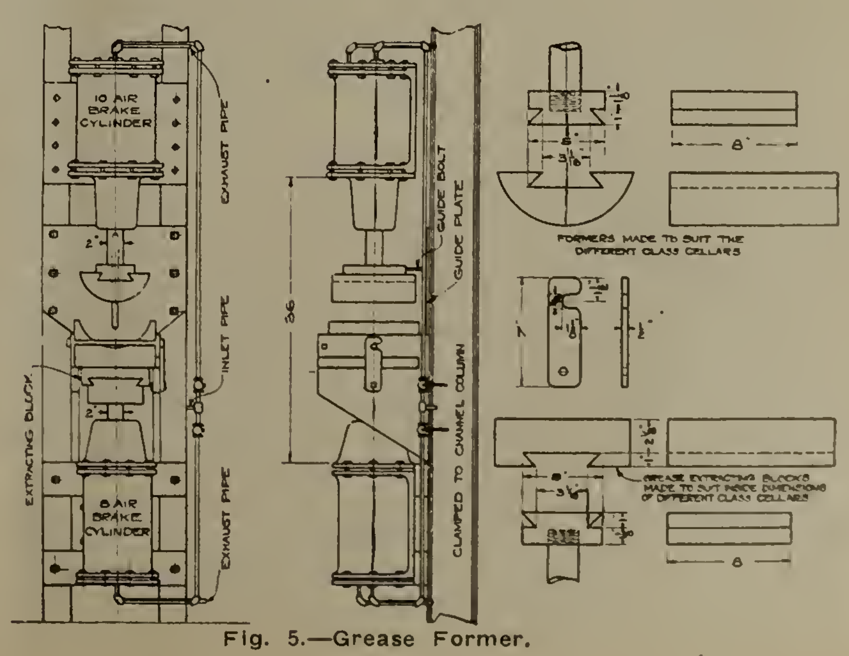


Fig. 5.—Grease Former.

Impact of Elastic Solid Bodies

When one solid body comes into violent collision with another one, so that the motion of either (or both) is checked or reversed, a shock is experienced by both bodies. This is familiarly illustrated in the striking of a nail by a hammer, and in many other experiences of everyday life. But in order to calculate the magnitude of the shock or blow, we have to proceed with some consideration and care, or we shall be led into absurd results.

The phenomenon that occurs when two solid bodies collide in this way is known, in theoretical mechanics, as "impact." Immediately upon their coming into contact, a pressure is produced at the point or region where they first touch. If they were both absolutely rigid, so as to be incapable of undergoing even a slight local flattening in this region of contact, the pressure between them would at once become infinitely great, so that both bodies would be instantly shattered to pieces; and this would be the case, no matter how slowly they were moving when they came together. In nature, however, there is no such thing as an absolutely rigid body, for every body yields somewhat to the action of a force exerted upon it. The bodies that we call "rigid," in nature, are merely bodies in which the alteration of form is very slight, when any ordinary force is exerted upon them,—so slight, perhaps, that it cannot be detected without the use of refined scientific instruments.

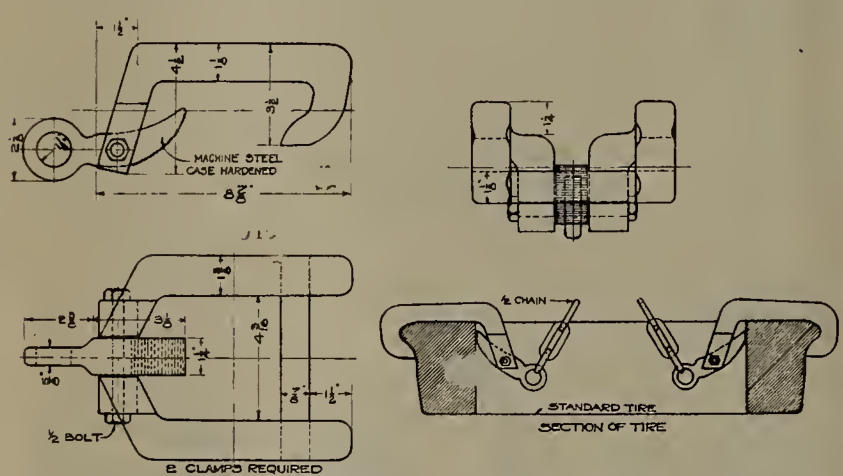


Fig. 6.—Tire Clamp for Crane Carrying.

When two actual solid bodies collide, the total duration of contact may be very short indeed, and we are in the habit of thinking of the impact, in a case such as is exemplified by the collision of a pair of billiard balls, as being instantaneous. It never really is instantaneous, however; and we must think of the bodies as being in contact for a period which, though it may be very short, is nevertheless real, and quite capable of being measured, if we go about it in the right way.

Even after contact has actually occurred, the more remote parts of the bodies continue moving towards each other on account of the momentum they had before the impact began; and it is plain that this cannot be the case without the bodies becoming deformed. In the vicinity of the region of contact there is a local flattening or compression, and the bodies are both thrown into a state of stress in this neighborhood, while, at the same time, the velocity with which their remoter parts continue to approach each other grows less. After a certain interval the bodies will reach their maximum deformation and at the same instant they will cease to approach each other.

If the bodies are perfectly plastic, like soft putty, the impact is now complete, and nothing further happens, the energy of motion that they had, before the collision, being irrevocably dissipated in the form of heat. If, however, they are both perfectly elastic, so that when deformed they tend to spring back again into their original shape, and to regain that shape perfectly, then the impact is by no means over. The energy that they possessed in virtue of their original velocity, in that case, has not been dissipated in the form of heat, but has become stored up within them, just as the work we do in straining a spring is stored up within the spring, ready to be given out again as soon as the spring is allowed to regain its original form. The elastc bodies continue to press against each other, and, once their speed of approach has been annulled, the pressure between the two begins to make them move apart, and the separation continues to increase until they are again free from contact with each other. The impact is then terminated.

To speak of the "force of a blow in pounds," when we regard the impact as being absolutely instantaneous, is manifestly illogical, but it is plain that such an expression is quite accurate when we regard the impact as of finite, though very short, duration, for then it signifies the maximum value of the pressure that exists between the bodies during this short interval.

We ordinarily think of an "elastic body" as being one which, like india rubber, yields in shape very readily under the action of a relatively small force, resuming its shape as soon as the force is removed. In theoretical mechanics, however, it is the fact that the body tends to come back to its original size and shape, when the force is removed, which constitutes the real test of elasticity, rather than the readiness with which the shape or volume of the body yields when a given force is applied to it. The amount by which the size or shape changes under the action of a given force is expressed by stating what is called the "modulus of elasticity" of the body, with respect to a change of the proposed character; "modulus" being a Latin word signifying "measure," so that the rather forbidding-looking expression "modulus of elasticity" merely means a number which serves to measure the amount of force which must be applied to the body in order to change its form or bulk to a given extent. Thus the modulus of elasticity of a steel bar, with respect to endwise compression, is the compressive force which would have to be applied to a bar of the same material, one square inch in sectional area, in order to shorten the bar by its entire length, if the compressibility of the bar, during all this change in form, followed the same law that holds true for very slight changes in the length. Of course it would be absurd to suppose that the law for small changes would hold true for enormous ones, or that the bar could be compressed to a zero length by any force whatever; but it is found to be convenient to measure the compressibility by means of a "modulus" as thus defined, it being understood that the modulus is to be employed only in computing very small changes in length, and that it ceases to be of use as soon as the bar has been strained beyond its elastic limit, so as to take a permanent set.

In order to calculate the force, or maximum momentary pressure, that is exerted between two bodies that come into collision, we have to take into account the nature of the bodies, since the pressure that will be produced by the impact will differ accordingly as they are plastic, or perfectly elastic, or intermediate between these states.

According to Newton's view, two perfectly elastic bodies, when they collide, undergo deformation as a whole, and then,

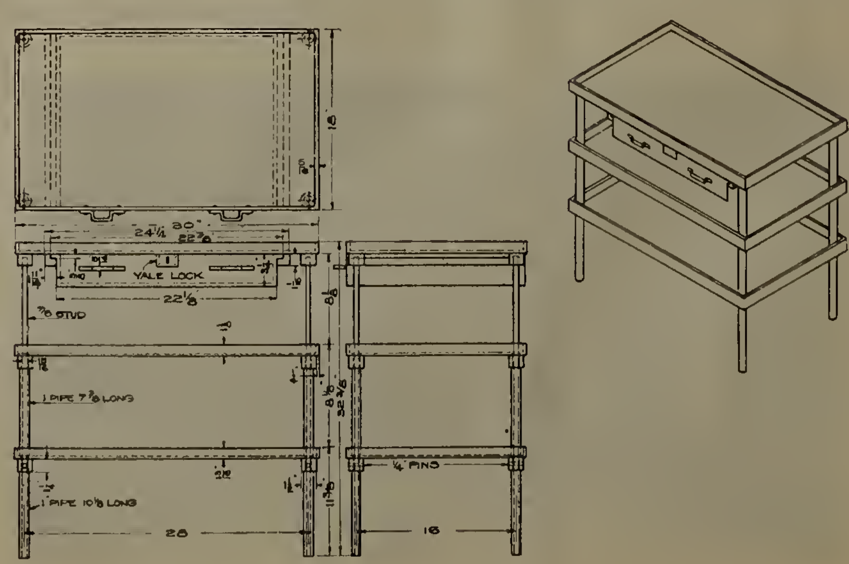


Fig. 7.—Tool Stand.

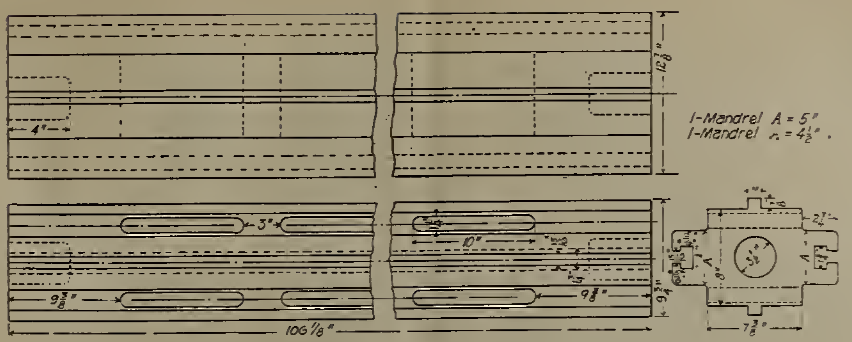


Fig. 8.—Shoe and Wedge Mandrel.

when the deformation has attained its maximum value, they spring back again from each other in such a way that all the successive states that occurred during the first half of the impact are repeated again, but in exactly the reverse order. Newton, therefore, does not take into account the possible production of internal vibrations, persisting in the bodies after the impact is completed and the bodies have separated.

Saint-Venant, the great French authority on the theory of elasticity, made highly important contributions to the theory of impact, and gave what was believed to be a far more accurate theory of the subject than Newton's. He took account of the fact that when elastic bodies collide, the impact produces not only a pressure at the region of contact of the two, but also (save when certain special conditions are fulfilled) internal vibratory motions, so that when the bodies have rebounded from each other, each is, in general, in a state of vibration, as well as being in motion as a whole. Nothing is more certain than that this state of internal vibration exists in many cases. For example, when a bell that is suspended by a cord is struck by a hammer, the bell begins to swing on the cord, and at the same time it emits a musical note by reason of the vibrations that are set up within it. In the same way, a bar of steel, when caused to strike endwise upon an anvil, rebounds into the air, and, if the experiment is suitably conducted, also emits a musical note, showing that the bar as well as the bell has been thrown into a state of vibration. Saint-Venant's theory, in which full account is taken, mathematically, of such vibrations, appears, upon the face of it, to yield results of a higher order of precision; but when tested by experiment it is found to be quite unsatisfactory. In the case of two elastic bars colliding endwise, for example, Hamburger found that the actual duration of the contact was several times as long as the duration calculated by Saint-Venant's method.

Voigt, too, has tested Saint-Venant's theory, by causing two elastic bars of the same material and the same cross section to collide endwise, one of them being twice as long as the other. The velocities of the bars, as measured after the impact, were found to differ widely from the velocities calculated by Saint-Venant's theory, but to be in good accord with the older and presumably far less perfect theory of Newton. The order of

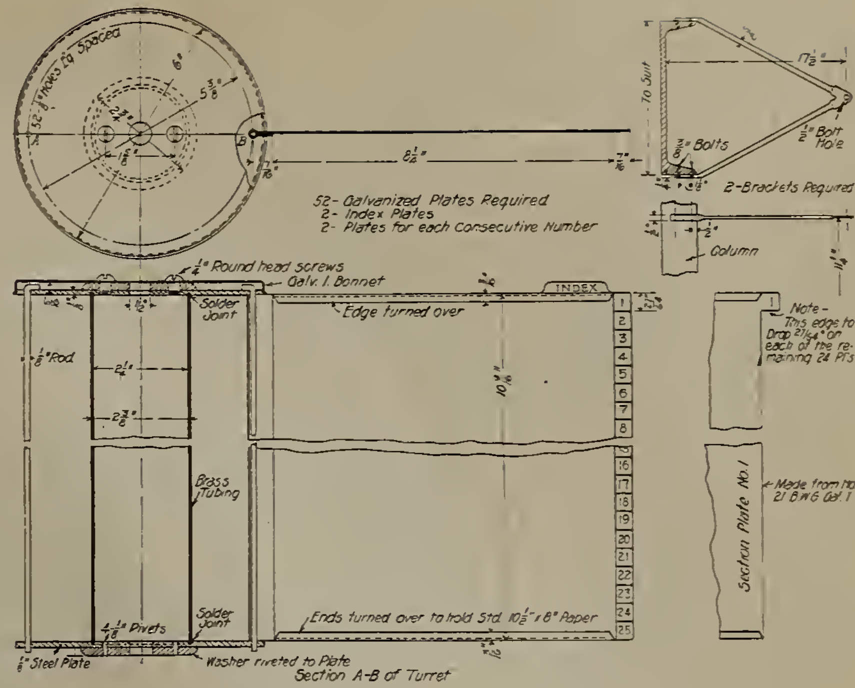


Fig. 9.—Rotary Schedule Holder.

the agreement and disagreement may be illustrated by the following single example: The longer bar being at rest, the shorter one, moving with the speed of 80.4 ins. per second, was allowed to strike against it endwise. According to Newton, the short bar ought to bound back from the long one with a speed of 26.8 ins. per second, and the long one, after the impact, ought to be moving ahead (that is, in the direction of the original motion of the short one) with a velocity of 53.6 ins. per second. In the actual experiment, the velocities were found to be in the directions indicated by the Newtonian theory, and to have the respective magnitudes 21.6 ins. per second, and 51.4 ins. per second. The agreement here is very fair. On the other hand, the "improved" theory of Saint-Venant, when applied to this case, predicts that after the impact the long bar will be moving forward with a velocity of 40.2 ins. per second, instead of 51.4 ins. per second, as observed, and that the short one will be stationary. The disagreement between Saint-Venant's theoretical results and the actual facts is manifestly great, and the reason for the difference is not known. His theory evidently assigns too much energy to the vibrations of the colliding bars, for in the case cited above the actual amount of vibratory energy that existed in the two bars together, after the impact, was something like 11 per cent of the energy of motion that the system possessed before the collision, while according to Saint-Venant's theory it should have been 50 per

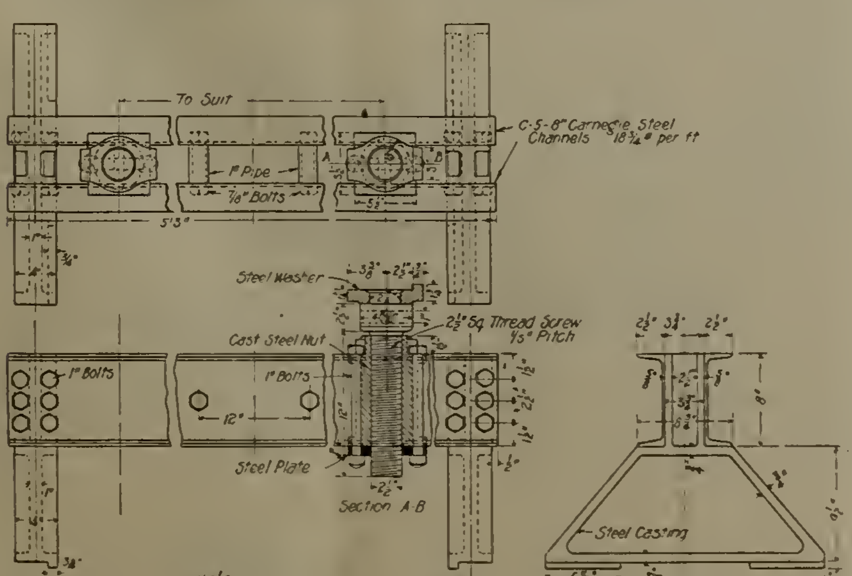


Fig. 10.—Adjustable Locomotive Pit Trestle.

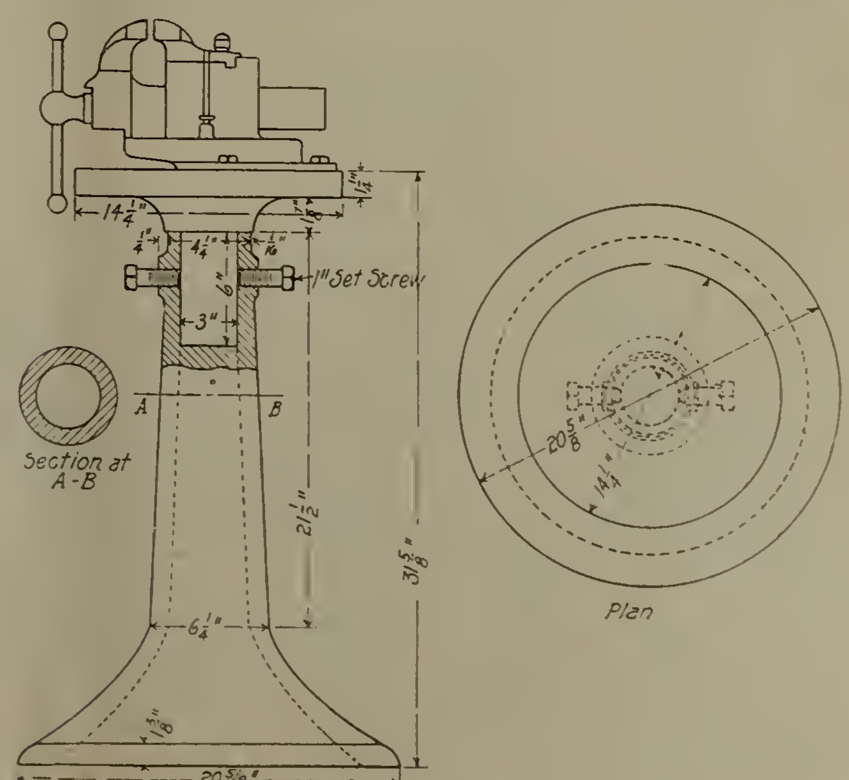


Fig. 11.—Portable Vise Stand.

cent. Newton's theory disregards the vibratory energy altogether, and proceeds as though there were no such energy present.

As a result of the experimental investigations mentioned above. Professor Voigt proposed a new theory of impact, which was intended to be intermediate, in a sense, between that of Newton and that of Saint-Venant. Voigt's fundamental assumption is that the skin, or superficial layer, of the metal differs in its properties from the rest of the bar, and his theory can be made to degenerate into that of Newton, on the one hand. or that of Saint-Venant, on the other, by varying the constants that are assumed to characterize the "skin." It might be supposed that a theory with such a wide range of adaptability could be made to yield entirely satisfactory results, but such is not the case, for Hausmaninger found that when the constants of the theory are selected so as to make the calculated velocities of the bars agree well with experiment, the calculated duration of contact is much shorter than the actual duration as found by experiment.

Hertz gave yet another theory of impact, which agrees with experiment much better than either Saint-Venant's or Voigt's, but which, unfortunately, is not well adapted to the problem we have in hand, being especially designed for the attack of problems in which the collision is between two solids that are bounded by curved surfaces, like a pair of spheres. Like Newton, Hertz takes no account of the internal vibrations that may be set up within the colliding bodies by the impact.

From what has been said before, it will be plain that we are in no position to calculate, with any considerable degree of precision, the force that one elastic body exerts when it collides with another body that is either elastic or rigid. The ignoring of the residual internal vibrations in the colliding elastic solids must be regarded as a temporary expedient, to be adopted only until someone finds out how to take these vibrations properly into account; for nothing is more certain than that such vibrations do occur, except under special conditions. Theories which, like Hertz's, omit them from consideration, may give accurate results under the conditions in which such vibrations do not occur, or in which their energy is negligible, but in other cases they can never be in truly close accord with experience.

Mr. C. E. Stromeyer, in his papers on water-hammer action in steam pipes, adopts a Newtonian form of impact theory which is probably accurate enough for the ultimate purpose he has in view,—namely, for calculating the pressure due to the impact of water against a steam pipe or its fittings. We shall explain the theory, here, in the form it would have when applied to a solid elastic body. its application to the impact of water-masses being given in the preceding article on water-hammer action.

In his first paper, Mr. Stromeyer deals with the case in which an elastic bar strikes, endwise, against a non-yielding, rigid body, which we may call the "anvil," and he treats the impact as though it occurred in the following manner: First. when the contact between the two is primarily established, there is a pressure produced between the bar and the anvil, and this pressure is supposed to remain constant as long as the contact continues. The bar being suddenly stopped at its front end, the back parts continue to press forward, as we have previously described, and the result is that layer after layer of the bar, beginning at the front end and passing backward towards the tail end, come successively to rest, a pressure, equal to the pressure that is prevailing all this time at the front end, being developed in each layer as it comes to rest. Finally, after the lapse of a short but quite definite time, the whole bar is stationary, and all in a condition of uniform compression, from one end to the other. The next instant the bar begins to spring back again, just as a spiral spring would, if it were released from a state of compression at one end, while fixed at the outer end. The very outermost layer at the free end begins to move first; and if the bar is perfectly elastic, so that none of its energy is dissipated in the form of heat or otherwise, the velocity with which the first layer starts off will be equal and opposite to the velocity that it had when the bar first struck the anvil. Simultaneously with the starting off of the outermost layer of the bar, the stress in this layer disappears. The next layer at the free end of the bar then undergoes a like transformation, taking up its original velocity, but in a reverse direction, and simultaneously losing its stress, and so on, until finally the last layer of the bar, which has all this time been at rest and in contact with the anvil, begins to move with the same velocity, and loses its state of stress. The whole bar is then in the act of leaving the anvil, and is again in motion, in the free air, with a velocity equal and opposite to that which it had before it came into contact with the anvil in the first place.

This view assumes that there are no vibrations in the bar when it is again free; and while we know that this cannot be accurately true, we know, also, from experiments, that the amount of energy that is present in the vibratory form is quite small, and hence, so far as this circumstance is concerned, Stromeyer's treatment of the elastic impact is admissible as an approximation.

To calculate, by this method, the duration of the impact, it may be assumed that the bar transmits the wave of compression with the same velocity that a wave of sound would have in the material of the bar, sound consisting merely in a succession of similar waves. Between the instant when the bar and the anvil first come into collision, and the instant when they are again separate, the compressive wave has traveled from the head end of the bar to the tail end, and back again to the head end. The total distance that it has traversed, therefore, is equal to twice the length of the bar. Hence the total duration of the impact, multiplied by the velocity of sound in the bar, must be equal to twice the length of the bar, and so we have the following rule:

Rule 1.—To find the duration, in seconds, of the impact between the bar and a perfectly rigid anvil, multiply the length of the bar, in inches, by two. and divide the product by the velocity of sound in the material of the bar, in inches per second.

To find the pressure exerted by the bar upon the anvil, we may proceed thus: By the definition of the modulus of elasticity, given above, we know that the total length of the bar is to the shortening of the bar under impact, as the modulus of elasticity is to the total actual maximum stress in the bar, per square inch of its sectional area. Now the shortening experienced by the bar is equal to the distance that its tail end travels in half of the duration of the collision,—that is, in the time required for a sound-wave to travel through the bar from one end to the other. From these two facts we may deduce the following:

Rule 2—To find the pressure due to the impact of the bar against the rigid anvil, in pounds per square inch of the cross-section of the bar, multiply the velocity of the bar before impact, expressed in inches per second, by the modulus of elasticity of the material of the bar, in pounds per square inch, and divide the product by the velocity of sound in the material of the bar, in inches per second.

All this supposes that the body against which the bar collides is rigid and unyielding. The calculation could easily be modified to fit the case in which two elastic bars collide endwise, but the case here considered is sufficient for our present purpose,—namely, for investigating the intensity of water-hammer action in steam pipes.

To illustrate the two rules given above, let us take the following numerical example, given by Stromeyer: A bar of steel 1 ft. long is dropped upon a rigid and unyielding anvil, so that it strikes endwise on the anvil, with a velocity of 10 ft.

Emergency Treatment for the Injured. See Editorial—Page 428, November, 1909, Issue.

per second. What will be the duration of its contact with the anvil, and what will be the "force of the blow,"—that is, what will be the pressure that the bar will exert against the anvil, per square inch of the bar's cross-section, during the period of contact?

The modulus of elasticity of steel may be taken at 30,000,000 lbs. per square inch, and the velocity of sound-waves in steel may be taken at 17,000 ft. per second.

First, as to the duration of the impact. The velocity of sound in the steel being 17,000 ft. (or 204,000 ins.) per second, and the length of the bar being 12 ins., we proceed by Rule 1 thus: 12×2=24, and 24÷204,000=0.0001176 seconds, or about the 8,500th part of a second, which is the duration of the contact.

Second, as to the force of the blow, or the pressure that the bar exerts upon the anvil, during the short period of its contact therewith. The velocity of the bar, before impact, being 10 ft. (or 120 ins.) per second, the modulus of elasticity of steel being 30,000,000 lbs. per square inch, and the velocity of sound in steel being 17,000 ft. (or 204,000 ins.) per second, we proceed by Rule 2 thus: 120×30,000,000=3,600,000,000, and 3,600,000,000÷204,000=17,647 lbs. per square inch. The "force of the blow," or the pressure exerted by the bar against the anvil while the two are in contact, is, therefore, about 17,600 lbs. per square inch of the cross-section of the bar.

It is to be especially noted, in connection with these rules, (1) that the duration of the collision does not depend at all upon the velocity of the bar previous to the collision; the greater speed of the bar, when it is moving faster, being exactly compensated for by the greater amount of the corresponding compression. And (2) that the pressure produced by the bar against the anvil does not depend at all upon the length of the bar. This last-mentioned result is one to which criticism would probably be directed, by a critically-minded person. As we have indicated at much length, however, this whole subject is still in an unsettled state, and there is no known formula which gives results that are beyond all cavil.—The Locomotive.

Calculation of Electric Locomotive Capacity

The determination of the weight of train which an electric locomotive should, under given conditions, be expected to haul, resolves itself into two parts, namely, the pull or tractive effort the locomotive can exert, and the weight of train which a tractive effort of this magnitude will haul.

If, as is usually the case in electric locomotives, the motors are sufficiently powerful to slip the wheels, the tractive effort for short periods is limited only by the adhesion of the locomotive to the rails. For pulls of longer duration, the heating of the motors must be taken into account and the duty of the locomotive limited so as to keep the temperature of the motors within a safe limit. The maximum tractive effort is the product of the weight on drivers, multiplied by the coefficient of adhesion. The Standard Handbook for Electrical Engineers, page 809, gives the following values for this coefficient: On clean dry rail, 30 per cent; on wet rail, without sand, 18 per cent; wet rail sanded, 22 per cent. A safe value is 20 per cent.

The tractive effort of a locomotive is used to overcome three principal opposing forces, of which two are capable of exact determination. (1) The grade resistance of a train is equal to its weight multiplied by the decimal representing the grade. Thus the grade resistance per ton on a 1¾ per cent grade is 2,000×.0175=35 lb. per ton. (2) The tractive effort required for acceleration, per ton of train, is equal to the rate of acceleration expressed in miles per hour per second, multiplied by the constant 91.3. Thus the tractive effort required for acceleration at the rate of one-eighth of 1 m. p. h. per second is ⅛×91.3=11.4 lb. per ton. (3) Train resistance is made up of the various frictions, wind resistance, etc. There are many formulas in use, giving widely diverse results. We may without serious error take a value of 5 lb. per ton for low speeds. For starting cars from a state of rest, three times this value may be required. The weight of train which can be hauled is obviously the quotient obtained by dividing the tractive effort of the locomotive by the amount of tractive effort required per ton of train, the sum of the three values found as just described.

We can now apply the principles outlined above to our correspondent's first case, a 57-ton locomotive on a 1¾-per cent grade. The tractive effort at the slipping point of the drivers is 57×2,000×.20=22,800 lbs. Assuming that the train is required to accelerate at the rate of one-eighth of 1 m. p. h. per second, the tractive effort required per ton is 35+11.4+5=51.4 lb. per ton, and the weight of train, including locomotive, is 22,800÷51.4=444 tons. Similarly, on the 1 per cent grade the tractive effort required per ton is 20+11.4+5=36.4 lb. per ton, and the weight of train 22,800÷36.0=6626 tons. On level track the grade resistance becomes zero, the tractive effort 16.4 lb. per ton and the train weight 1,390 tons.

Up to this point we have not considered the capacity of the motors. By reference to the characteristic curves supplied by the manufacturers of the motors, we may ascertain the amount of current taken when the motor is exerting any given tractive effort. The curves as issued apply to only one particular wheel diameter and gear ratio, and care must be taken to make the necessary changes in the curves before applying them to other wheel and gear conditions. These current values for the three trains, whose weights were calculated in the preceding paragraph, are tabulated below (lettered A, B and C, to correspond with the three parts of question 1). Trains A and B, the maximum trains which the locomotive can haul on the given grades, require much less current after passing off of the grades onto the level track, and these values are also given.

	Lbs. per Ton.	Tons.	T. E.	Amps.
Train A (Maximum train on 1¾ per cent grade)	51.4	444	22,800	1,560
Train B (Maximum train on 1 per cent grade)	36.4	626	22,800	1,560
Train B on level	16.4	626	10,280	850
Train C (Maximum train on level)	16.4	1,390	22,800	1,560

Considering, now, the values in the ampere column, and comparing them with the one-hour rated current as given by our correspondent, it will be seen that train A, when accelerating on the grade, takes a current 45 per cent in excess of the rated current. If already heated to a normal service temperature, the motors will take a current of this magnitude for only a very few minutes without injurious overheating. The ascent of the one-mile grade, starting from rest at the bottom and accelerating at the rate specified, will take about five minutes. Unless the ascent is to be followed very shortly by a long stop or by a period of coasting, affording the motors an opportunity to cool, a train of this weight should not be hauled on the 1¾ per cent grade. Train B takes the same current on the grade as train A, and the reduction in current when it runs onto level track is less than in the case of A. It will require either a reduction in weight or a period of rest after ascending the grade. If the locomotive in either of these cases starts with its motors cool, their temperature after the ascent will be such as to allow a long period of level-track running without overheating; but this condition of starting cool is one which can occur only a very few times in a day, and cannot in most cases be counted upon. In the case of train C, the only reduction in current will be due to increase of speed and the ending of acceleration, after about three minutes. If the train resistance at the maximum speed be taken as 8 lb. per ton, the total tractive effort will then be 8×1,390×11,120 lb., and the current will be about 900 amp., 83 per cent of rated current. This is too high for continuous running, though even when the motor has become heated from previous service it may be continued for probably half an hour before reaching the maximum permissible temperature.

It will be apparent from the foregoing that the schedule—the degree of continuity of service and the frequency and duration of opportunities for cooling—are of the greatest importance in determining the loads a locomotive can handle, or the adequacy of a given motor equipment for any given service. Our correspondent has furnished us no data in this direction, and, accordingly, no more definite answer can be made to his questions.

The remaining questions can be answered very briefly:

(2) It has been shown that the 600-h. p. locomotive has sufficient weight to develop a tractive effort which taxes its motors (assuming a schedule of only average severity) to their capacity. A proportionate weight for the 800-h. p. locomotive would accordingly be very ample.

(3) If the weight is proportionate to that of the 600-h. p. locomotive and the motors have similar characteristics, the train weights also will be proportionate.

(4) "Pulling power" or tractive effort is found as already explained, by multiplying the weight on drivers by the coefficient of adhesion. It should be noted that "tractive effort" and "drawbar pull" are not synonymous terms. Tractive effort includes the effort used in propelling the locomotive itself, and train weights obtained by the use of the value of tractive effort include the weight of the locomotive, whereas drawbar pull is the force applied to the cars alone.—Electric Railway Journal.

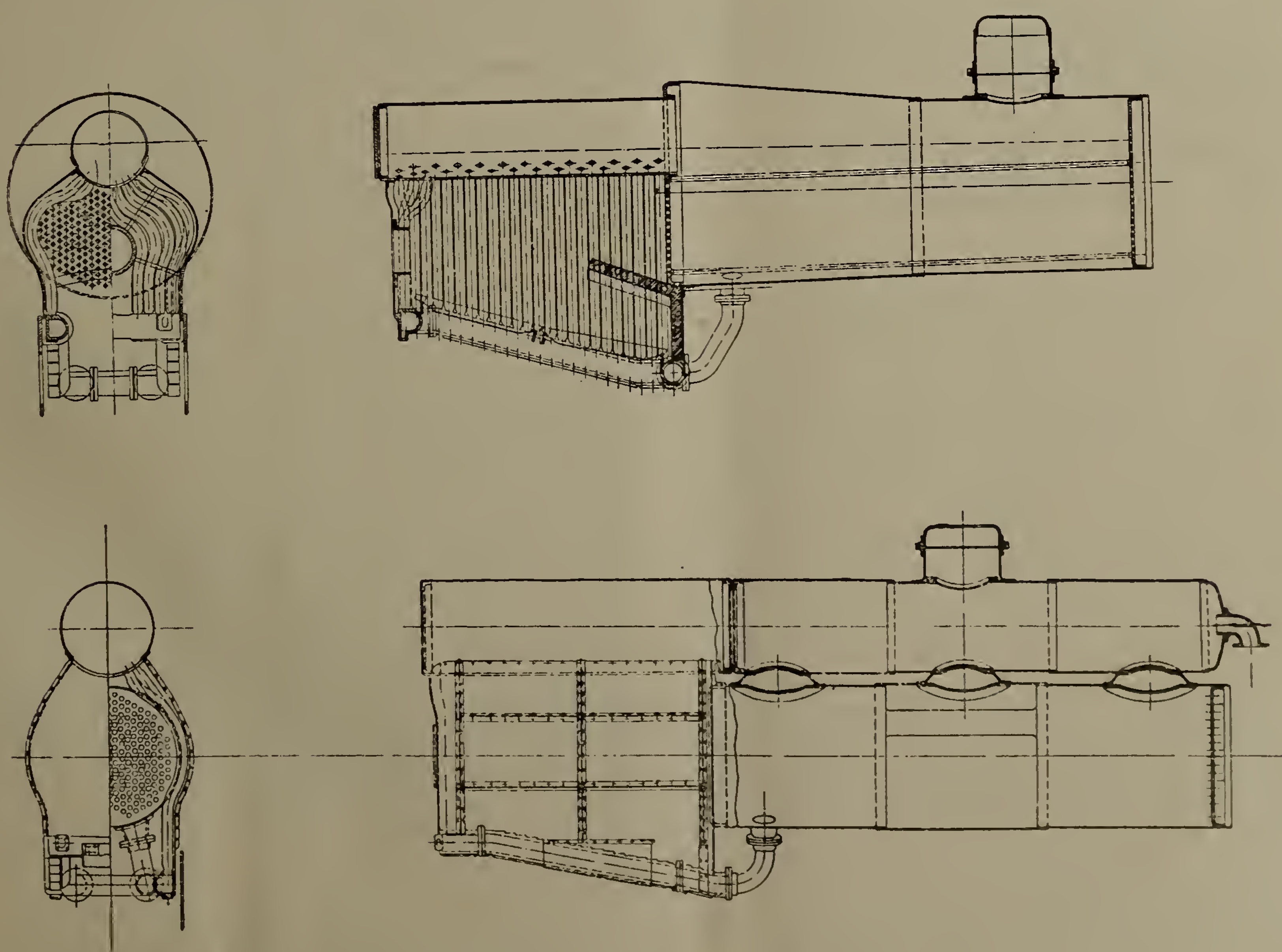
Brotan Locomotive with Water-Tube Firebox

The October Bulletin of the International Railway Congress contains a description of a locomotive boiler which is reported to have performed very satisfactory service in England.

This boiler, which is illustrated herewith, is described as follows:

The boiler is equipped with the usual fire-tubes running through the barrel, but the fire-box, instead of having plain sides surrounded by a water-space, is formed by a series of tubes arranged as shown in the drawing, which rise up the sides of the "box," and then arch over to meet a steam collector which runs for the whole length of the fire-box and boiler. In the earlier form, a steam dome was fixed on this collector at the smokebox end, but in a more recent design the collector terminates at the front end of the fire-box where it enters the boiler barrel. In addition to the collector it is necessary that the full complement of fire-tubes shall be fitted, as these must all enter the tube-plate. To make this possible, the barrel is coned as shown. As will be seen, the fire-box water-tubes surround the sides and back of the box, but on the front side they curve round the firebox tube-plate and thus make the fire-tubes readily accessible. At their upper ends, the water-tubes are expanded into a one-inch plate, forming the bottom plate of the box at the back and sides. This pipe carries the fire-bars and forms a connection for the water passing from the barrel through the quadrant-shaped connecting pipes shown, to the water-tubes. On its lower side are 2-in. holes placed opposite to the water-tubes, thus making it possible to expand these into position with a tube-expander.

The water-tubes are held together by several bands which radiate from the frame of the fire-door, bend round and pass



Brotan Locomotive Boiler.

thence to the shell-plates to which they are secured. The fire-door frame is fastened by means of a turn-buckle placed between it and the cast steel pipe, previously mentioned as running round the fire-box bottom. The whole of the fire-box is covered by an outside casing, and the space between the casing-plate and the water-tubes is filled up with a plastic composition, made of asbestos scrap mixed with fossil meal.

The general level for the water is about the center of the collector drum, the highest and lowest levels varying about 4 ins. on either side of this mean level.

The advantages claimed by the inventor for the Brotan boiler are as follows:

There are not any riveted parts exposed to the fire, nor flat fire-box walls that would require strengthening by stay and anchor bolts. Therefore, many of the defects of the ordinary locomotive fire-box are avoided.

The system of the upright water-tubes with the water supply at the bottom creates an active circulation of the water, facilitates the rapid rising of vesicles, and transmits the heat in a very effective way through the walls, which are only 5-16 in. thick. Quick steaming is thus secured.

The active circulation of water renders formation of scale, especially in the water-tubes, almost impossible; besides this, the tubes may be easily and thoroughly cleaned, both from above and below, with wire brushes, which enhances the safety in working.

Although its diameter is smaller than that of the ordinary boiler, a greater number of fire-tubes can be fitted in. Furthermore, the direct heating surface, which is far more effective, is 50 per cent greater than in the ordinary boiler. The Brotan boiler as, therefore, a greater heating surface without increasing the weight or the fire grate area, thus securing better combustion and larger capacity.

The cost of manufacture is about 20 per cent less than that of the ordinary boiler. Tubes can be quickly replaced from the interior of the fire-box. The necessity of replacing all of the tubes has not become evident in five years' service, but if the bent tubes are kept in stock, the old ones may be removed and new ones substituted within a period of about fourteen days.

Changes at Gorgona and Empire Shops, Panama

The transfer of Empire shops from the Mechanical Division to the Central Division of the Panama canal zone, for the repair of all steam shovels and the manufacture and repair of steam shovel parts, was effected October 1. In addition to the force already maintained by the Central Division at its field repair shop at Cunette, near Empire, the following force has been transferred from the Mechanical Division and will remain at the Empire shops: One general foreman, 5 fortmen, 1 assistant to foreman, 2 draftsmen, 1 shop electrician, 84 machinists, 21 boilermakers, 18 blacksmiths, 2 electric crane operators, 9 carpenters, 1 pipefitter, 2 machinists' helpers.

For the present the headquarters of the Superintendent of Motive Power and Machinery, of the Mechanical Engineer, and the boiler inspector, will remain at Culebra, but the office and drafting forces will be transferred to Gorgona shops, as soon as the new building being erected there for their accommodation is completed. The approved organization of Gorgona shops, under the Electrical Engineer and Master Mechanic, provides at present for 652 gold employes and 980 silver employes, in all 1,632 men, distributed as follows:

Office Force—Chief clerk and 25 men, chief draftsman and 15 men, electrical accountant.

Car and Foundry Department—General foreman of the car and foundry department and 533 men. To this department has been added the steel car repair work with 112 men transferred from Empire shops.

Electrical Subdivision—Foreman of construction, Colon to Balboa, and 121 men.

Locomotive Department—General foreman and 388 men. This department includes the machine and erecting shop, pipe and copper shop, boiler shop, blacksmith shop, paint shop, power plant, and night force.

Engine Houses and Air Compressors—Superintendent of engine houses and air compressor plants at outside points, and 451 men. The former master mechanic at Empire shops has been assigned to this work. He has under his direction the hostling at Empire, Bas Obispo, and Balboa; the engine house and repair shops at San Pablo and Caimito, Tabernilla, and Las Cascadas; the car shop engine house, coal chute, and cable splicing forces at Pedro Miguel; the car inspection and repairing at Balboa; the air compressors at Rio Grande, Empire, Las Cascadas; the foreman mason, and the foreman of the air pipe lines.

Master Car Builder—The former master car builder at Empire shops will have under him the field force engaged in car repairs at Las Cascadas, Bas Obispo and in Culebra Cut, in all 68 men.

The foreman in charge of the scapping of old French materials will report direct to the Electrical Engineer and Master Mechanic of Gorgona shops.—Canal Record.

Education in Engineering*

President Lowell, of Harvard, in his recent remarkable inaugural address, gave this as his conclusion: "The best type of liberal education in our complex modern world aims at producing men who know a little of everything and something well." If that conclusion be true of the liberal education leading to the learned profession of the law or medicine or theology, why is it not also true of a scientific education leading to the learned profession of engineering? If preponderance be given to one part of President Lowell's conclusion over the other part, certainly knowing "a little of everything" leads to superficiality; while just as surely knowing but one thing well leads to narrowness. There would seem to be a happy mean between these two extremities, in the education of the engineer.

The engineer capable of being at the head of the larger engineering works must know something of many things, several things well and one thing profoundly. The engineer president of a great railway system, for example, must know something of the alignment and gradients of the permanent way, its construction and maintenance; something of the proper location of sidings and stations; something of the system of signals, of the various kinds of cars, of the quality of water for the locomotives, of the heating and lighting of cars, and many other things. He must know well that the bridges have been designed for safety and endurance and that they have been properly constructed. He must know well that the tunnels are safely protected against external pressure and falling rocks. He must know well that the locomotives for drawing the high-speed trains, as well as those for the heavy freight trains, are of the very best design and capable of performing their duty with efficiency, economy and endurance. He must know well how to manage the traffic and keep the accounts. He must know profoundly how to co-ordinate all the different parts of this complex organization so that each part will perform its proper and full function, to the end that passengers and freight will be carried safely, surely, quickly and cheaply, and also that dividends will be paid to the shareholders.

*From "The Profession of Engineering," in the Engineering Record.

The Galveston, Houston & Henderson is building a 14-stall reinforced concrete roundhouse at Galveston, Tex., and expects to build a 50-ft. x 120-ft. machine shop soon.

High Pressure Gas for Transport

Recent experimental research made by the Pintsch Compressing Co., has brought out the fact that dry Pintsch gas such as is obtained by the regular Pintsch process, is suitable for transportation under a pressure of 100 atmospheres or over. For this purpose Pintsch gas, from which all liquid hydrocarbons have been removed while under the pressure of 14 atmospheres is used, and the dry gas is compressed directly into steel flasks at high pressure. Under this high pressure a partial condensation of the gas takes place, which, however, disappears as soon as the pressure is reduced, the gas presenting again its original dryness and other characteristics with but an inappreciable loss in candle power.

A steel flask of 3.75 cubic feet capacity and weighing about 330 lbs., will, when charged to a pressure of 100 lbs., yield about 500 cubic feet of gas at atmospheric pressure. From this it is seen that the gas under these high pressures deviates considerably from Boyle's law, in accordance with which the flask would be expected to yield but 375 cubic feet of gas at atmospheric pressure. The deviation from Boyle's law at a pressure of 100 atms. amounts to about 33 per cent., the flask containing a correspondingly larger quantity of gas. This departure combined with the fact that small seamless flasks can be constructed of an extremely high tensile strength steel, render it possible to reduce the weight of the transport holder for a given quantity of gas carried by over 50 per cent. of the former weight of transport holders used. The space or volume occupied by the high pressure holders is at the same time nearly ten times less than that of the holders used in transporting gas at a pressure of 14 atms.

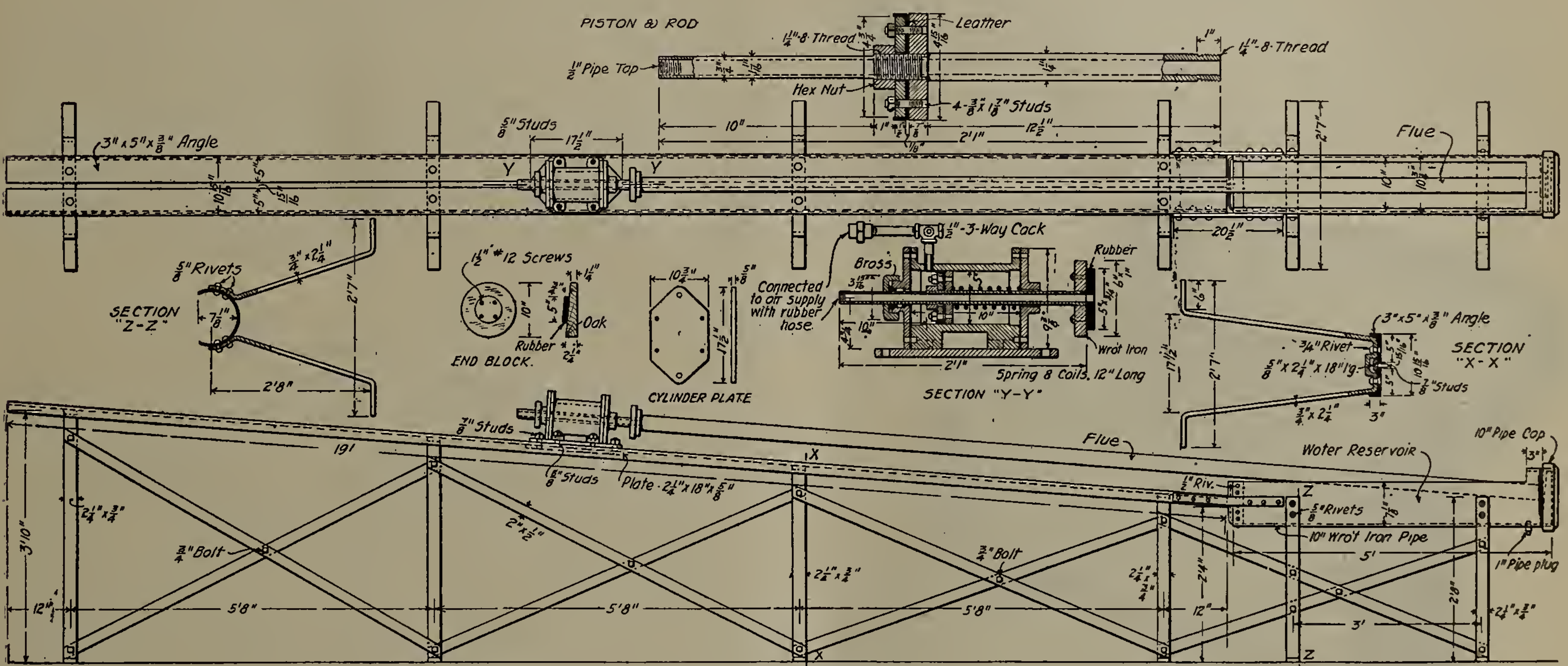
The true value of the high pressure transportation becomes, however, most apparent in cases where no compressing facilities are available at the point of distribution to transfer the gas from the transport holder to buoys or cars; where in other words, filling can only be accomplished by equalizing the pressure. In such cases but about 30 per cent of the gas carried in transport holders at a pressure of 14 atms. is available for filling and the remainder of the gas returns to the supply station unused.

In the case of high pressure transportation, however, fully 90 per cent of the gas transported becomes available for filling, and under these circumstances the reduction in weight of the transport holders for a given quantity of gas filled to buoys or cars is about six times less and the volume about 30 times less than that of the transport holders used by the former method.

There exists a distinct difference between high pressure Pintsch gas and the so-called Blau gas. The former is a dry gas, possessing all the well-known characteristics of regular Pintsch gas, great care being taken in the process of manufacture to remove from the gas all liquid hydrocarbons.

The same liquid hydrocarbons are retained in the Blau gas and others added to exert a solving influence upon the remaining dry constituents of the gas and thus effect a reduction in volume. The presence of these hydrocarbon liquids are direct cause of difficulties experienced in connection with Blau gas due to accumulation of liquid in the regulating devices at the point of consumption and due to freezing up in cold weather.

The Virginia & Truckee Ry., Carson City, Nev., is changing several of its coal burning locomotives from coal to oil. The work is being done in the road's shops.



Flue Testing Machine Used in Burnside Shops, Illinois Central Ry.

For etching aluminum the following formula can be used: Alcohol, 4 oz.; acetic acid, 6 oz.; butter of antimony (antimony chloride). 4 oz.; water, 40 oz.

The following is a useful glue for fastening leather to iron: Best ground glue 2 parts and acetic acid 1 part. Glue dissolves when acid is heated. Mix well together and apply.

The Union Pacific has authorized the building of an office building, at Omaha, Neb., to be 97 ft. x 177 ft. and 12 stories high. The city ticket offices will occupy the first floor and the remaining floors will be used for the general offices. Jarvis Hunt, Chicago and New York, is the architect, and the building is estimated to cost $1,000,000.

Wanted.—Copies of the Railway Master Mechanic of the issue for January, 1909, including index for 1908. Payment will be in the nature of an extension of subscription for one year.

Maintenance Regulation Cards*

By Mr. R. W. Burnett, General Master Car Builder, Canadian Pacific Railway, Montreal.

In the operation of a railway one matter of prime importance in all departments is the issuing of instructions in such a clear and concise manner that there will be no misinterpretation by those who have to be guided by them, and to the extent that they are clearly understood largely depends the efficiency of any department. Instructions as to maintenance of equipment, standards, shop practice, etc., have been issued in various ways. The M. C. B. Book of Rules, for what it is intended, is complete and indispensable.

Instructions on certain subjects, such as air brakes, steam heat, etc., are to a large extent issued in book form. Other instructions are contained in blue prints. Aside from the instructions issued by the methods above mentioned, there is a field which has to be covered in a more direct way, and in the past this has largely been done by circular letters.

The preparation of circular letters consumes a great amount of time and study, to prevent conflicting instructions being issued. This time is consumed by the head of the department or most valuable members of the staff, in reading former instructions and checking the various points covered to make certain that the letter to be issued covers the subject in a clear manner, and that all letters issued, subsequent to the original,

Card File for Equipment Instructions.

modifying or cancelling portions thereof, are taken into consideration. This is sometimes impossible by reason of the number of former issues and multipicity of duties of the person who has the responsibility. This naturally results in letters being hurriedly prepared partially covering a subject, with the feeling that omissions or inaccuracies can be corrected by subsequent letters.

These are also often issued to persons not in active touch with details, and to persons in other departments who should have the information, but who do not have the time or the assistance available to go through the file and arrive at what the present practices are. They therefore do not constitute the ready reference which such persons should have.

I might at this point mention some of the difficulties met with in depending too much on blue prints for every-day reference. A station of sufficient importance to warrant an office staff, that can keep the prints properly filed, may keep them in reasonably good shape, but there are a large number of men whose facilities for filing prints is limited by the available wall space for framing and hanging.

Furthermore, blue prints or folios of pattern numbers contain a vast amount of information which is useful only as a matter of record. What the man doing the work requires is condensed information relative to parts liable to failure, instructions as to how, and under what conditions, repairs or betterments are to be made, materials to be used, and drawings to be followed.

The filing of circular letters is a dicult problem. In an office where there is a sufficient staff to properly attend to the filing any letter may be located quickly, but with the foremen and inspectors, who are the men depended upon to make daily use of the instructions and for whom they are really intended, it is different.

Some men may place them in books or in files that may be provided, others will place them in the most convenient drawer, or on hooks, but, in search of information, we have too often discovered that there are missing links.

Even with the most modern filing systems, a considerable time is often necessary to arrive at a correct understanding of what constitutes the up-to-date instructions on any one subject. It is often impossible to ascertain this in any reasonable time, owing to overlapping, conflicting, or apparently conflicting, letters having been previously issued. This may result in arguments between various persons as to the proper interpretation, or they are left in doubt for indefinite periods as to the meaning intended, the result being different practices at different points.

As a substitute for and improvement on the circular letter system, we have instituted a system of issuing instructions by cards, which we call "Maintenance Regulation Cards." To distinguish between the car and locomotive department, those pertaining to car work are called "C. R." cards, meaning "Car Regulation," and those pertaining to motive power "M. R.," meaning "Motive Power Regulation."

The use of these cards has been developed by evolution. In the earlier stages they were used only to give direct instructions relative to standards, materials to be used (such as paint for the various classes of freight equipment), giving drawing numbers, or such instructions as pressures to be used in mounting various sizes of wheels, etc. But, as the cards were issued, the possibilities of the scope for which they could be used became more and more apparent. In a short time cards were prepared giving in detail instructions covering certain subjects, containing drawing, pattern, and form numbers, stating under what conditions betterments could be made, naming stations that would do the work, and the amount of work expected at various stations, and in many cases saying what not to do and advising how report of work should be made.

The method of preparing these cards varies. The usual procedure is to originate them in the general office, by making a preliminary draft of the proposed card, covering the subject as completely as possible, and giving copies to one or more members of the staff, or to foremen particularly interested, for criticisms and suggestions, after which all papers are turned over to one of the staff to compare with previous instructions and rewrite. The card is then given to the chief draughtsman to be checked for accuracy as to drawing, pattern, and form numbers and dimensions. Copies are then sent to the heads of the departments interested, who in turn refer them to their staff for suggestions and criticisms. The card is then finally approved and proof-printed, proof is checked up, and necessary number printed. If necessary, extracts of the proposed card are sent out for the guidance of the foremen, pending the final approval and issuing of the card.

The chief draughtsman is asked to prepare cards which consist principally of data that would be furnished by the drawing-room. Various other members of the staff are called upon to

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*From a paper read before the Canadian Railway Club, November, 1909.

make drafts of proposed cards on subjects with which they are in close touch. In some cases a local foreman may be asked to prepare a card on some practice that he has developed, or which has necessarily been carried on more largely at his station than at other points. It does not necessarily follow, however, that it is always advisable to assign the preparing of cards to the persons most intimately acquainted with the subject, as some men, owing to close application to other duties, may get out of touch with a certain subject, but when it is necessary for them to prepare a card on same they are forced to familiarize themselves with all the details in a way not likely to be forgotten.

Considering the manner in which these cards are prepared, and should they be short of any, they are supplied upon request.

In the beginning we had a mailing list, each person on the list receiving a copy of each card printed. Some of the persons on this mailing list received a stated number of each card printed, to supply their different foremen. We have since found it necessary to issue in a different manner, and one card is printed on which the persons to whom certain cards are to be furnished are designated by symbol letters, as it has been found that, instead of confusing the foreman with a large number of cards on subjects in which he is not interested, he should receive only such as pertains to the work that he handles.

Heads of departments on this list receive a copy of each card issued, and are designated by symbol letter "A"; others, such

13 M R 1.

Issue to a b c

CANADIAN PACIFIC RAILWAY. ALL LINES. MOTIVE POWER DEPARTMENT	MAINTENANCE REGULATION 13 M R 1 BOILER, INSPECTION AND TESTING NO. 3 AUGUST 14. 1800

1. Boilers must be tested by hydraulic pressure when engine is in shop for No. 1 or 2 machinery repairs, after any repairs have been affected to the boiler and in the case of boilers over 10 years old, at intervals of service not exceeding 12 months
2. The temperature of the water used in filling and testing must not be less than 100 degrees, the test pressure must equal 25 per cent in excess of the authorised working pressure and must be indicated by a standard test gauge
3. Jacket must be sufficiently removed to allow any leaks or weaknesses to be detected, especially those which may occur around the bottom of the barrel
4. The test is to be reported on Form M P 18, and date of test filled in on Form 181 in cab of engine
5. Boilers under 10 years old must be inspected internally the first time flues are removed after 2 years from the date of last inspection, and when over 10 years old within 2 years service from date of last inspection
6. Inside of boiler to be thoroughly cleaned, edges of all joints scraped, careful examination made for grooving and pitting, longitudinal braces, dome and belly stays thoroughly examined and hammer tested, and thorough examination made for any weakness or defect.
7. All defects discovered must be marked by the inspector for repairs and reported on Form M P 18 Fireboxes must be inspected when engine is in shop for No. 1 or 2 machinery repairs
8. Inspectors will be held responsible for reporting all defects and calling attention to those caused by improper maintenance or construction
9. Locomotive Foremen will be held responsible for tests being carried out and properly entered and reported
10. See 13 M R 2 for additional inspection required for special classes

5 C R 6

CANADIAN PACIFIC RAILWAY. OFFICE OF THE MASTER CAR BUILDER CAR REGULATION 5 C. R 6 ISSUE NO. 1 APRIL 10, 1908	MOUNTING OF STEEL TYRED WHEELS

1. **WHEELS HAVING TYRES WITH REINFORCED FLANGES** -- i. e. tyres having 5 5-8" total width of tread and flange -- must be mated on the same axles.
2. **WHEELS OF THE SAME DIAMETER ON TREAD** must be mounted together
3. **WHEN ENTERING AXLES IN WHEEL BORE,** care must be taken not to damage the journal - after entering the first wheel on axle, journal can be protected by using wooden wedge or brass lining between the wheel bore and the journal
4. **WHEEL PRESS SHOULD BE FITTED** so that either wheel can be pressed on without having to turn wheels and axles.
5. **WHEN MOUNTING STEEL TYRED WHEELS COMPLETE** press on both wheels together, using centre Gauge --as shown on Drawing No. 4471 1-4 -- on the wheel farthest advanced - when end of gauge reaches centre mark on axle, stop pressing this wheel and do all further pressing on the other wheel, using Standard Reference Gauge --"as used for mounting" -- and as shown on M C B Sheet No. 12, afterwards checking wheels -- at 3 equidistant points on the circumference -- by the other side of the gauge --"as used for inspecting" -- Use check gauge for discs of steel tyred wheels --as shown on Drawing 4471 1-4-- measuring from the two farthest sides of the inside retaining rings of the two wheels. If this does not check up, then examine tyre to see if it has been correctly turned See Car Regulation 5 C R 10

LENGTHS OF CENTRE GAUGES SHOULD BE AS FOLLOWS:-

For wheels 5 5-8" wide over tread and flange. 2' 2 9-16"

For wheels 5 1-2" wide over tread and flange. 2' 2 11-16"

LENGTHS OF CHECK GAUGES SHOULD BE AS FOLLOWS:-

For 36 1-4" wheels .. .. .. 4' 7 1-4"

For 34" and 40" wheels .. .. .. 4' 7 1-2"

6. **WHEN MOUNTING CENTRES OR DISCS NOT FITTED WITH TYRES** press both on together using Centre Gauge --as shown on Drawing No. 4471 1-4-- on the disc farthest advanced - When end of gauge reaches centre mark on axle, stop pressing this disc and do all further pressing on the other one, using Check Gauge for Discs of Steel Tired Wheels --as shown on Drawing No. 4471 1-4-- at 3 equidistant points in the circumference

LENGTHS OF CENTRE GAUGES SHOULD BE AS FOLLOWS:-

For discs for 36 1-4" wheels - 2' 3 5-8"

For discs for 34 and 40" wheels - 2' 3 3-4"

LENGTHS OF CHECK GAUGES SHOULD BE AS FOLLOWS.-

For discs for 36 1-4" wheels - 4' 7 1-4"

For discs for 34 and 40" wheels - 4' 7 1-2"

OVER.

53 M. R. 8.

Issue to a. b. d. e

CANADIAN PACIFIC RAILWAY. ALL LINES MOTIVE POWER DEPARTMENT	MAINTENANCE REGULATION 53 M R 8 SHIPPING DEAD ENGINES ISSUE NO 2. SEPTEMBER 18. 1909

1 When dead engines are being moved in trains it is advisable that they be placed in the front portion. In case two or more are together they must be separated, but not more than three cars apart. All brakes must be cut in and operative and the following precautions taken to prevent skidding of drivers due to boilers being empty, application of new brake shoes or tyres new or newly turned

a. Cut out cock under the engineer's brake valve must be closed and wired in this position

b. Driver brake piston travel must be lengthened a sufficient distance so that when brakes are applied fully by a 20 lb reduction, not more than 35 lbs will be shown on the gauge registering driver brake cylinder pressure

2 Main rods are to be taken off, put together complete with straps and brasses and placed on the tender, side rods must not be removed unless necessary and a speed of 20 miles must not be exceeded at any point. If the side rods are removed the maximum speed will be reduced to 10 miles per hour

3 When an engine thus shipped is equipped with an engine truck brake the piston travel must be increased to at least two-thirds of the TOTAL TRAVEL

4 On tenders handled empty without coal and water the tender piston travel must not be less than 9 inches When fitted with slack adjusters they must be released sufficiently to insure 9 piston travel and their automatic operation prevented by removing the pipe connected with the brake cylinder and plugging the hole

5. A competent man must be sent in charge of the dead engine or engines handled in any train

6 The boilers and tenders should be emptied before the dead engines are put in the train and all superheater pipes, cylinders and W A B pumps thoroughly drained

7 Wrecked engine rods to be taken care of as stated in Clause 2 If the engine truck is destroyed or broken on 8 wheel, Mogul or Ten Wheel Engines they should not be hauled past the first siding until a temporary truck is put under, and the weight of the engine distributed as well as circumstances will permit, the speed under those conditions must be limited to 10 miles per hour

8 If the tyre is off any wheel on an engine or tender that wheel must be blocked up clear of the rail, under no circumstance must the wheel center be allowed to run on the rail

9 Locomotives being shipped dead to Angus Shops must have such loose or easily removable parts as engine tools, signal lamps, oil cans etc placed in the smoke box and smoke box door fastened in usual manner

Car replacers to be placed in the tool boxes under tender frames and sealed up on tenders not so equipped they are to be placed in tool box on the front of the tender

67 C. R. 1.

CANADIAN PACIFIC RAILWAY. OFFICE OF THE GENERAL MASTER CAR BUILDER CAR REGULATION 67 C R 1 ISSUE NO 1, SEPTEMBER 6, 1909	INSTRUCTIONS GOVERNING THE REPORTING, REPAIRING, CONDEMNING ETC., OF CARS DAMAGED IN WRECKS, OR GENERAL DELAPIDATED CONDITION DUE TO AGE, WEAR AND TEAR ETC

1 As soon as possible after arriving at wreck the foreman in charge will wire the Gen M C B Gen Supt and such other officials as he requires, giving initial number or name of each car damaged, with estimated cost to repair and cause of wreck

2 When wreck has been picked up the foreman in charge will fill out and send to the Gen M C B at Montreal on first train Form M C B 89 The estimate on this form may vary from the telegraph report as more complete inspection may make necessary

3 Divisional Car Foremen in all cases must be notified by wire of wrecks and should make every effort to get to serious wrecks to take general charge and prevent unnecessary damage to equipment

4 Precautions must be taken in lifting or rolling passenger cars to prevent damage to the frame roof or sheathing by crushing or twisting, or slipping of ropes or cables due to improper hitching

5 (a) Wooden flat, Ballast, or Coal cars of 30 ton capacity or over must not be burned or otherwise destroyed under any circumstances, but when badly damaged loaded on flat cars and shipped to point designated by the M C B for repairs

(b) Wooden cars of 30-ton capacity and over other than flat or coal should not be burned unless the car is in two pieces and can not be picked up and run on trucks, and then should be burned only with the consent of the Divisional Car Foreman, who should make every effort to make personal inspection

(c) Cars of less than 30 ton capacity may be destroyed when damaged to the extent of $100.00 or more unless equipped with metal roofs in which case they should be treated as cars of higher capacity

(d) Steel cars, or cars with steel underframes must never be reported as destroyed except on authority from the Gen M C B

6 No cars will be condemned other than cars destroyed in wreck as covered by paragraph No 5 without submitting Form 25 and receiving authority from the Gen M C B

7 All cars destroyed must be reported to the Gen M C B on Form M C B No 16

8 (a) Cars taken from revenue service to use as boarding cars must be selected by the Divisional Car Foreman and approved by the Gen M C B

(b) Cars must not be taken for boarding car service that are equipped with metal roofs

9 Cars that are to be burned at wreck or when otherwise condemned that are equipped with metal roofs must have serviceable roofs or parts of roof carefully removed and kept for further use, and when destroyed at repair points purlines carlines rafters etc should be kept as far as practicable, to avoid using new material

10 All cars that are burned should first have couplers springs air brake equipment and serviceable side doors removed

File Cards for Shop Instructions.

which gives so many of the staff an opportunity to make suggestions and criticisms, it may be said that, to a large extent, foremen are carrying out their own instructions. We invite suggestions as to the subjects that should be covered by cards, and at divisional car foremen's meetings the drafts of the proposed cards are criticised and suggestions considered, also propositions are made as to the issuing of cards on subjects requiring definite instructions, sometimes accompanied by draft of proposed card. This combines the practical side of the subject, as seen by the men actually handling the work, with such necessary data and further instructions as may be furnished by the office.

The cards are given the same index number used for correspondence. The index number of wheels, tires, and trucks is 5, and the first card on any of these subjects would be 5-C. R. 1, and the second 5-C. R. 2. One card has been issued showing the index numbers and the subjects they cover. A card is issued quarterly showing the active cards, giving the index number of each, subject covered, issue number and date, by which all on the mailing list are enabled to check their file, as assistant foremen, receive only such as pertain to their work. The symbol indicating to whom they will be sent is printed on the card. The cards pertaining to wheel-mounting, tire-turning, etc., are mounted in a frame and placed in a conspicuous place in the wheel shop. Cards pertaining to air brake work are mounted in a frame and placed in a conspicuous place in the air brake room.

To file the cards a box, which is illustrated herewith, is furnished, and it is expected that in a short time it will amount to a text book, covering the maintenance of our equipment, at all times revised to date. It has been found that to a large extent it is advisable to eliminate parts of the contents of instruction books and issue on cards, as it is easily seen that any part of the subject can be revised and reissued much more easily and cheaply than by reprinting an entire book. The result is that they are revised, where a book would not be.

The difficulty of filing circular letters was explained earlier in this paper. In contrast with this there is only one manner of filing these cards, which is instantly apparent to any man of ordinary intelligence. The subjects are numbered in numerical order. The first in the file is the index card; the second is the card issued quarterly showing the active cards. The writer has sometimes visited points where the cards were not properly filed through carelessness, and has properly filed and checked them, to see if the file was complete, within five minutes' time, which could not be accomplished with any circular letter system he has seen, regardless of time.

Such assistant foremen, leading hands, and inspectors as do not have a place in which to keep a file of cards, not only have access to the regular office file, but it is insisted that they read the cards and familiarize themselves with up-to-date instructions.

It is of course necessary to occasionally revise the cards to take care of new developments, such as a change in shop practice or the alteration of drawings that would affect the subject covered. When this is done the card retains its index number, but is given a new issue number corresponding with the number of times it has been issued, and is also given the last date of issue. When a revised card is issued, the card which it supersedes is returned to the office. It has not been found necessary to revise many cards. The cards that have been revised were those issued before the present more thorough system of preparing them was developed and the revisions have consisted principally in more thoroughly covering the subject. It has not been found necessary to make any extensive arrangement for revising, as, the correspondence having the same index number, it is an easy matter to run through a file and make note of developments subsequent to the last date of issue. This, however, we find can be more easily done by keeping one set of cards especially for revision purposes, and making notations on the cards in this file of anything affecting the subject they cover.

It is the intention to institute a system of examination of foremen and inspectors with regard to their familiarity with the cards coverng their work. This is carried on to some extent at present, although it is not perfected, but, with a properly arranged set of standard instructions and regulations, it is evidently a comparatively easy matter to establish a periodical examination of foremen and others, which will insure their familiarity and thorough understanding of the methods which they are expected to pursue in handling their work.

It should be understood that the development of this system has not been followed, regardless of expense, to the extent of obtaining an unnecessary degree of refinement, but on the contrary, in addition to the benefits derived by those to whom instructions are issued, through the saving of time, and their having a clear understanding of what is required, the amount of office work has been greatly reduced, with the result that more attention can be given to other things. When a card is once issued it furnishes a foundation upon which any changes or alterations can be made with comparatively little work, and avoids the reconsideration of any subject as a whole.

To a large extent, where explanatory correspondence was formerly used, where work had been neglected or information asked, it is only necessary to call attention to the card and insist on instructions being carried out.

Our set of cards is by no means complete, as we have not only not yet covered all the subjects we originally intended to cover, but we daily find an extended scope for their use beyond that originally anticipated. While the work of drafting and revising will never be complete, we expect that in a short time the main subjects will be so thoroughly covered that the work of preparing will be comparatively small.

One thing that has been learned in the development of this system is that, before the preparation of a card is commenced, it is best to sub-divide a subject, covering sub-divisions by separate cards. As an instance of this, the card covering gas equipment, 28-C. R. 1, gives full catalogue reference as to lamps, class of cars in which used, and where used in car, also catalogue reference of parts liable to failure. 28-C. R. 2 gives instructions regarding cleaning and testing of gas equipment both at terminals and shop. 28-C. R. 3 gives instructions regarding gas mantles, showing catalogue reference, stating where large and small mantels are used, how and in which cars extra mantles will be carried, and method of applying new mantles.

For electric train lighting equipment we have the cards subdivided into instructions for shops, originating terminals, and intermediate terminals, as we wish the men at intermediate terminals to have a clear understanding as to the extent to which they should attempt to make repairs to a car in transit, with brief instructions as to how to locate cause of trouble and make repairs quickly.

I will cite a few of the advantages we have found in using cards in place of circular letters. In the first place, they are prepared with more care and cover in detail all points of the subject referred to, while circular letters are more apt to be hastily prepared, and subsequent circular and other letters often give further instructions and modify or cancel portions of former issues. This is often confusing to the persons receiving such letters, causes extra work checking with previous letters, and also necessitates great care to avoid issuing contradictory instructions. With the card system all obsolete instructions are cancelled, but, when letters are depended upon, any prudent foreman can refer to some long-forgotten letter as authority for almost any practice that may be found at his station.

Another advantage is that, when a card is to be prepared, it is found that there are many points in connection with the subject that have not received the necessary amount of attention. Frequently parts have not been maintained as they should be and could have been without extra expense, and inexpensive alterations can be made and betterments applied. For example, in considering the maintenance of doors and door fixtures, we find that a 3-in. stop secured in a certain manner is necessary in place of a 2-in. stop, that the brackets should be riveted on (a plain, inexpensive bracket can be used for all wooden cars), that the hasp should be secured with a wrought staple instead of malleable, and malleable wedge applied to doors of old cars in place of wooden. All these changes were found advisable on going into the subject thoroughly, in order to avoid as far as possible any after-thoughts that would make it necessary to change instructions, and that when repairs or alterations were made they would all be considered at once and be cheaply done.

It might be said that this could have been done independently of the regulation card, which is of course true, but the fact remains, had the work been ordered in the usual way of circular letters, it is probable that first one item and then another would have been changed, and, in place of one clear, concise set of instructions on a single card, a series of letters would have been issued, which would have been far more difficult to follow up.

Another advantage that has been found is that some devices, having a number of parts with in many cases no established name for each part, have to some extent been ordered complete to get one part, the heavier and more expensive pieces being held indefinitely in stock, where they have little better than scrap value, owing to their freedom from failure. To overcome this we have issued cards on the various devices or specialties, with full information as to what parts have proven liable to failure, instructions as to what should be ordered, pattern numbers, stating which parts are interchangeable, and other necessary information, and coining a name where necessary. On the back of the card is printed a photograph of the device, showing number and name of each piece, which has promptly enabled the foreman to obtain the parts which he had difficulty in procuring before, and prevented the purchase of parts not required.

Another point of advantage in the card system, which also illustrates the disadvantages of depending on circular letters and blue prints, is found when an officer visits a station with limited time to check various subjects. He is often confronted by some subject on some points of which, on account of possible confusion, neither he nor the local man are entirely clear. They go to the office, and his time is consumed in looking over circular letters and correspondence pertaining to the subject, and drawing and pattern numbers, possibly having to follow the file through several years to determine what should be done on one subject, only to learn perhaps that a part of the instructions are missing, and at best having no assurance that the file is complete. His time should be used in looking at the actual work, assuring himself that proper shop practice is being followed and that maintenance of equipment is promptly and economically conducted.

In preparing these cards the difficulties often experienced by one of the staff most familiar with the subject,—in sorting out instructions, filing in proper position, eliminating obsolete instructions, filing in proper pattern or form numbers,—have brought us to a realization of what we have been expecting of our foremen in the way of memory and office work.

Economical Methods of Handling and Firing Bituminous Coal in Locomotives*

All theories agree that the period of coal formation was prior to the creation of man—they suppose a world surrounded with heavy carbonic acid gas, unfit for human beings; its crust fissured and cracked with gaping exits for volumes of vaporous gases from the flaming interior and the surrounding waters. In this congenial atmosphere vegetation flourished and grew with rank profusion.

Coal is a mineral which has resulted after the lapse of thousands and thousands of years from the accumulation of vegetable material, caused by the steady yearly shedding of leaves from trees, as well as the trees themselves and the stalks of vegetation of all kinds which were thrown together in vast layers on the ground of the forests, where they soon turned to a black pasty vegetable mass. The layer thus formed was regularly increased year after year by the continued accumulations of fresh carbonaceous matter and subjected to an ever-increasing pressure of accumulated strata above, compressing the whole mass, and the internal heat of the earth, which caused them to part to a varying degree with some of their component gases. In this manner what we know as coal today was formed. The particular kind depended entirely upon conditions that existed during its formation.

The first shipment of coal to London was made in the year 1240. In this country the earliest historic mention of coal is by the French Jesuit Missionary, Father Hennepin, who saw traces of bituminous coal in the banks of the Illinois river in 1679. In 1750 the Virginia bituminous mines, on the James river near Richmond, were opened and worked. Five years after the Virginia mines began operation coal was discovered in Ohio, following which, in 1760, anthracite coal was first discovered in Rhode Island. The next disclosure of coal was on the Wabash river. In 1766 anthracite coal was discovered in Wyoming Valley, Pa., and in 1770 in the middle portion of the present anthracite region. However, little mining was done until 1834. The first shipment of semi-bituminous coal from the now famous Cumberland region in Maryland was made by rail to Baltimore over the B. & O. R. R. in 1842.

Any manifestation of chemical energy attended by inflammableness and accompanied by production of much heat, strictly speaking, is an instance of combustion. In steam engineering it means the controlled chemical combination of the elements carbon and hydrogen in the fuel, with the oxygen of the atmosphere, by which an evolution of heat is secured and maintained in a suitably constructed furnace for the purpose of generating steam. The term "combustion" as commonly used, carries with it the idea of incandescence, or the glowing whiteness of a body, caused by intense heat, which is quite characteristic of burning carbon. All phenomena of burning are instances of combustion. In the great majority of cases they consist of the union of oxygen of the atmosphere with the substances which are being burnt, the visible signs of which are heat and light.

In this part of the country chiefly bituminous coal is used in generating steam. Chemically it occupies a place between lignite and anthracite coal, but the transition of lignite into bitumnous ocal was as gradual as the change of the latter into anthracite, so there is no precise line of demarcation between the classes of coal. The use of the term "bituminous" is a misleading one because none of the so-called bituminous coals in this country contain any bitumen in their composition. The true bitumen is destitute of organic structure. It appears to have arisen from coal or lignites by the action of subterranean heat and very closely represents some of the products yielded by the destructive distillation of those bodies. It is possible that its name has been applied to certain varieties of coal on account of a similarity between the burning of a coal rich in hydrocarbons and bitumen. All coals which contain as much or more than 18 per cent or 20 per cent of volatile combustible matter are quite indiscriminately classed among bituminous coals. Coal is mainly composed of two elements—carbon and hydrogen—both having affinities for oxygen; but before they will unite chemically to produce heat it is necessary that certain conditions be fulfilled. The first is that a considerable mass of the coal must be heated to the point of ignition, which is from 1,000 to 1,5000 degrees Fahrenheit, before the oxygen in the air will unite with it. An isolated piece of coal will not burn in the open air because the temperature will soon fall below the point of ignition, consequently chemical action will cease.

Heat is the source of power of all steam engines. The unit of heat is the amount required to raise the temperature of one pound of water 1 degree from 39 to 40 degrees Fahrenheit. One of the largest single items of expense entailed in the operation of railroads is the coal consumed by their locomotives.

A good fireman, by the economical use of coal, can save considerable money each month for the company that employs him; but, in order to make this possible the locomotive must be in good condition and free from leaks. It does not require any skill to shovel coal, but it does in order to fire a locomotive intelligently. The fireman must also have the co-operation of the engineer in working and pumping the engine. It will take at least two years' experience on the deck of a locomotive before any bright young man can become a fireman. To become proficient in that length of time he must have assistance from someone who has graduated in the business.

Good judgment is a fireman's most important qualification and he who desires to lessen his work should do his best to cultivate this, one of the first requisites of a good engineer. Willingness is another need of a successful fireman and is hardly less important than good judgment.

The principal work of a fireman is the proper feeding and management of the fire, so as to generate the needed amount of steam. The proper performance of this work requires some knowledge of the composition and combustion of coal, also the best methods of obtaining the greatest amount of heat with the

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*By Mr. C. F. Smith, Road Foreman of Engines, Terminal Railroad Association of St. Louis, before the St. Louis Railway Club.

least possible consumption of coal. It is important for him to know that air and coal can combine in different ways, upon which difference depends, in a great measure, the amount of heat that is given off.

The fire should be kept of equal thickness over all parts of the grates. Next in importance is the breaking up of the large lumps of coal into pieces about the size of a fist. During combustion the intensity of heat depends largely upon the rapidity with which it burns and that relies largely upon the surface of the coal exposed to the attacking atoms of air.

The grates should not be shaken when the engine is working hard as the exhaust is liable to pull holes in the fire and they should not be shaken at any other time, only enough to keep the dead ashes out from between grates and the live fire above, the amount of shaking required depending upon the kind of coal used. Before starting for a hard pull it is important that the fireman has a good bed of live coal over grates and fresh coal on top of it, so as to prevent the necessity of opening fire door until the reverse lever can be hooked up. Fire-box door should be opened and closed between each scoop of coal when engine is working, so as to prevent the cooling of the temperature of fire-box as much as possible.

By doing all that can be done to secure as perfect combustion as possible much less coal will be required and the fireman will save himself considerable unnecessary work, besides, knowing that he has performed his duties carefully and economically.

Coal should not be allowed to fall out of gangways, but should be kept back in coal pit of tank. Overloading of tanks is a wasteful practice. Attention should be given to tanks so as to make them ride as good as possible. Tanks that ride hard and bounce when running are wasteful of coal on account of its falling off and being lost along the right of way.

Instruct men that fire up engines with coal to be economical in its use. Also have men properly instructed that their duties require them to watch engines that are kept under steam to be careful in the use of coal.

It has been the fashion of many roads for a number of years past to economize on the oil supply for locomotives to such an extent as to create more friction between moving surfaces in contact than there would be if proper amount of lubricants were used, also cutting frictional surfaces. This has resulted in locomotives burning more coal than they would otherwise, and lying down with their tonnage rating at times, when, if properly lubricated, they would have handled same. This is a case of spending dollars in trying to save cents. The matter of oil allowance should be left entirely to a practical man, who is directly in charge of men and engines to be handled by him regardless of the prevailing fashion.

The proper drafting of locomotives is an important factor in conserving the coal and its supervision should be left to a man whose duties require him to ride engines. The front end should be kept as near air tight as possible; steam pipes free from leaks; and other pipes and draft riggings in proper position. The exhaust nozzle should be of such a size that when other conditions are favorable engines will steam freely. There is no economy in trying to run a larger nozzle than engine will steam freely with.

All economical methods mentioned herein are being carried out in practice, as all they require is proper and intelligent supervision. Roads that do not economize all that is possible in the use of coal are burning up a lot of good money unnecessarily.

Discussion by Mr. T. E. Adams, Supt. Motive Power, St. Louis-Southwestern Railway.

It is agreed that the coal bill is the largest single item in the cost of conducting railway transportation. Recognition of this fact by railway managements has long been evident in their efforts towards its reduction through a consistent policy of giving trial to practically every feature of locomotive design which gives promise of enabling increased economy of operation. Both money and time have been freely given to exhaustive trial of all ideas in boiler proportions, front end arrangements, compounding, superheating, etc., as well as to investments in fuel-handling plants seeking to cheapen the cost of placing the fuel on the tender.

But that part of the proposition which is perhaps the most important part yet to be considered, is what coal is and how to use it; this has never been given attention either by the managements of railroads or any of the mechanical associations or other societies whose efforts along the line of the economical operation of locomotives should have included this important question long ago.

To show the importance of this fact I wish to quote Mr. M. N. Forney, an eminent mechanical engineer, from a book published by him in 1875, during the time he was associate editor of the Railroad Gazette. On page 404, Question 406 is asked: "How can we determine the relative value of the different kinds of fuel for locomotive use?" And the answer is made: "This can only be determined satisfactorily by actual experiment. The chemical composition, excepting so far as it indicates deleterious substances, such as sulphur, ashes, clinkers, etc., affords but little assistance in determining the value of fuel. Nearly the same quantities of elements in different fuels may arrange themselves, before and during combustion, so as to produce very different series of compounds. It is true that the composition of coal gives us some indication of its heat-producing capacity, but the extent to which that capacity can be converted into actual steam in locomotive boilers depends to a very great extent upon the conditions under which the fuel is burned. It should also be remembered that the rapidity with which steam can be generated is a very important matter in locomotive practice."

I wish to call your attention to the fact that notwithstanding the years that have elapsed since these ideas were put into print by Mr. Forney, even at that time his belief was that the principal knowledge necessary to bring about the economical use of fuel was to be determined in the burning of it.

In Mr. C. F. Smith's paper it is suggested that it would take at least two years' experience on a locomotive before any bright young man could become a fireman. This is not in accordance with our experience, as we find that after young men have been promoted to firing from the roundhouse, and have gone through the proper course of instructions, they fire engines more economically than some firemen who have been employed for years; due to the fact that the young men are anxious to succeed and push forward on their merits, while older firemen fall into a rut and it is hard to get them out.

Teach young men at the cinder pit to observe the different fires they clean, the amount of fuel one fireman saves over another on the same run, with the same engine; then, when the time comes for them to make student trips, put the beginner with your best man and you will have made a start in the right direction.

Mr. Smith says that the principal work of a fireman is the proper feeding and management of the fire. In my opinion the engineman should be held equally responsible for the proper feeding and management of the fire, as it is a matter of such vast importance, and the conditions are so varying, that it requires the good judgment of both the engineer and fireman to determine what action should be taken to keep the fire in the best condition.

Again: "The fire should be kept an equal thickness over all parts of the grates." This is one of the most important features to be considered in the successful firing of locomotives, for the reason that if the fire on the grate surface is not of the proper depth, more especially along the side-sheets, corners and flue-sheet, a great amount of heat will be wasted, due to its absorption by the water-space of the firebox, and there is nothing that requires as much attention to have the engine steam freely as looking after the sides and corners of the firebox in firing.

Mr. Smith also says: "The grates should not be shaken when the engine is working hard, as the exhaust is liable to pull holes in the fire, and they should not be shaken at any other time only enough to keep the dead ashes out from between grates and the live fire above, the amount of shaking required depending upon the kind of coal used."

The recommended practice for shaking grates, in some cases, is as follows: That the different qualities of coal and the different makes of grates should govern; coal that fills up and clinkers requires more attention than a better grade; the object is to keep the grates free so the proper amount of air will be admitted. This we believe to be one of the most important details in the instructing of enginemen as to the manner of handling fuel intelligently and economically. There are more steam failures, more fires to clean and more delays occasioned from the course of instructions generally in vogue than from any other source.

To show what interest is taken by the enginemen after they have been instructed along this line, I will quote from a statement made by an engineer employed on the St. Louis Southwestern Railway, of his own free will, running in passenger service over a 152-mile division, with a 20x26-in. engine weighing 183,000 lbs., handling from 7 to 10 cars daily.

"I will give you cases, which I can recall, that came under my personal observation. In one case I kept account of the times grates were shaken. The run is 152 miles and we made 1,600 miles at 152 miles each day, and grates were not shaken or moved at any time on the road. In another case we made 2,100 miles and grates were not moved. The train, in both cases, consisted of seven coaches—steel underframe baggage, steel underframe mail, smoking car, two chair cars, sleeper and parlor car. Grade, 1 per cent. We had 200 lbs. of steam at all times. I have been running a locomotive for the past 22 years and I consider this a very good showing, especially as I said nothing to the fireman in either case with reference to moving grates, which shows that they had been previously instructed. We used mine-run coal from two different states, and the percentage of slack ran high most of the time. We did not have any clinkers in box, and firebox did not fill up. I find this method of handling coal saves labor, coal, and, to a great extent, prevents black smoke."

Again, in Mr. Smith's paper, we read: "By doing all that can be done to secure as perfect combustion as possible, much less coal will be required and fireman will save himself considerable unnecessary work, besides knowing that he has performed his duties carefully and economically." We believe the word "enginemen" should be inserted in place of "fireman," as the contents of this paragraph are the foundation on which the principles of the economical and intelligent use of fuel should be based.

In this connection I wish to give an idea of what some of the modern instructions to enginemen along this line consist of:

"Clinkers are the arch enemy of perfect combustion and economy, and they are formed by an accumulation of ash on the grates melting together. When clinkers form over the grates to an extent that the easy steaming of the engine is affected thereby, the earliest opportunity must be improved to either hook them or knock them out. Such opportunity exists whenever the train has to wait 10 or 15 minutes for orders, or for another train; also during runs down long descending grades, while the engine is not using steam. Fires should be cleaned where engines are long hours on the road. Make use of the first opportunity. You will get better results with less labor and coal and avoid leaky flues. Better clean out a small amount two or three times than not to clean at all."

The above quotations are not based on scientific methods and are of such a nature as to lead to the unnecessary cleaning of fires, resulting in the waste of fuel, rather than to be productive of good engine service. Were practices of this kind put into effect on the St. Louis Southwestern Railway, it would mean the employment of fire-cleaners, additional coal consumed, overtime paid crews, etc., to say nothing about trains being tied up between terminals on account of the 16-hour law, and delays to traffic.

The question might be asked: What suggestion would you make, or plan of operation would you recommend? Answer: That a general revision of the methods now in use, for the education of enginemen in the use of fuel, be made, substituting, first, What Coal Is and How to Use It: the necessity of considering the quality of the coal in establishing fires at terminals—that is, as regards the percentage of slack; depth of fire to be established on the grates: conditions of weather and train to be considered, and steps that should be taken in handling the fire, after engine leaves terminal, in case it does not steam freely, and to prevent fires clinkering.

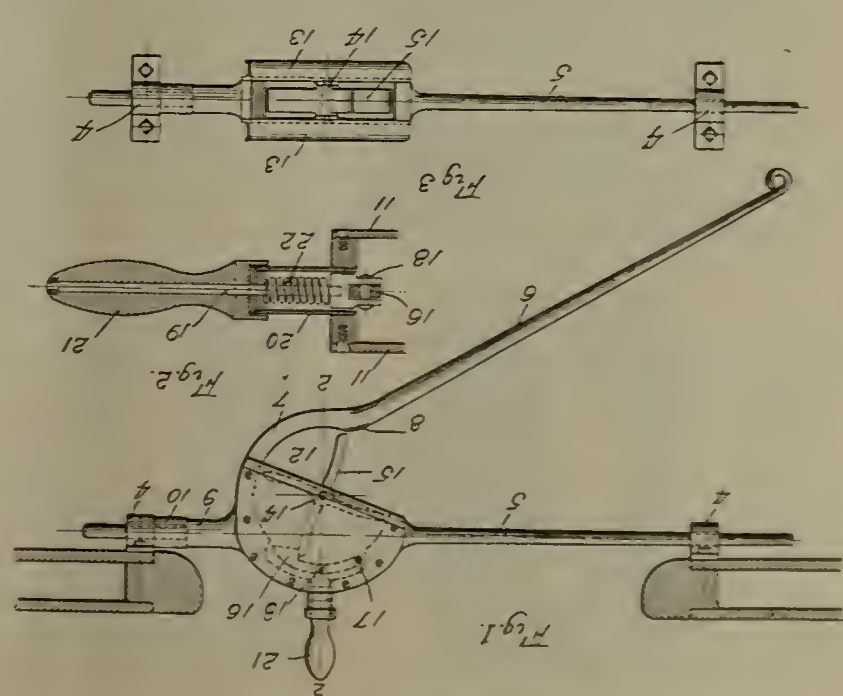
The need for such recommendations is substantiated by a circular to promote the comfort of passengers, recently issued by the Canadian Pacific Railway and published in the railroad items of the St. Louis Globe-Democrat, a portion of which reads as follows: "Some exceptionally good fuel records, equal to the average European railways, have recently been made by our engines, and if the average consumption of coal could be reduced to these special records, the electrification of railways would be indefinitely postponed, because there would be no smoke nuisance and the cost of operation by steam would be so low that the advantages of the electric railway would be removed. There is no trick in it. All that is necessary is to take full advantage of your knowledge of the district over which you are running, and of your engine."

I do not agree with that portion of the circular in which the statement is made, "There is no trick in it." Nothing in the past in the way of educating enginemen has brought about such results as instructions in the intelligent and economical use of fuel are destined to produce in future. In corroboration of this I wish to call attention to the fact that several different railroads are establishing educational bureaus for the education of employes in the various departments, and it will naturally follow that the education of enginemen in the economical and intelligent use of fuel will be one of the most important branches of instruction to be taken in consideration.

New Mail Bag Catcher

An improvement in mail bag catchers devised by A. C. Ergler, of Altoona, Pa., is shown in the accompanying diagram. The invention relates more particularly to the receiving and holding device carried by the car.

As is usual the device is held in a horizontal position by the handle grip. The arm engages the mail sack and directs it in the seat striking one of a series of revolving fingers. This causes another of the fingers to follow and hold the bag, a ratchet preventing a reverse of movement in the finger plate. The bag is readily detached by disengaging the ratchet latch.



New Mail Bag Catcher.

Ivorydale Engine House, C., H. & D. R. R., Equipped with Ritter Folding Doors.

Graphite Engine Front Finish

The ordinary and usual treatment of locomotive front ends has a number of unsatisfactory features. It requires frequent renewal, which means not only cost of material, but also cost of labor. Some of the material used is volatile, and when the engine is running and the front end becomes hot, offensive fumes come back to the cab. In aggravated cases these fumes fill the eyes of the engineer, almost blinding him for the moment, and makes it difficult to see the signals. For engine fronts the Joseph Dixon Crucible Co. recommends its graphite engine front finish, which is said to give a service of from six to nine weeks at each application. It provides the engine front with a durable and attractive coating. The value of this finish is due chiefly to the flake graphite which forms its base. As most of us know, flake graphite is unaffected by heat or cold; and it has, in addition, durable polishing properties. The Dixon company has recently issued a circular on its engine front finish for those interested.

Ritter Folding Door

The accompanying illustration shows an installation of a comparatively new idea in engine house or freight house doors. While the application of these doors is not limited to the two mentioned uses, it appears to particularly good advantage in this class of work. The photograph shows the doors in several positions and illustrates their adaptability for use as ventilators while still excluding rain or snow and diverting the wind.

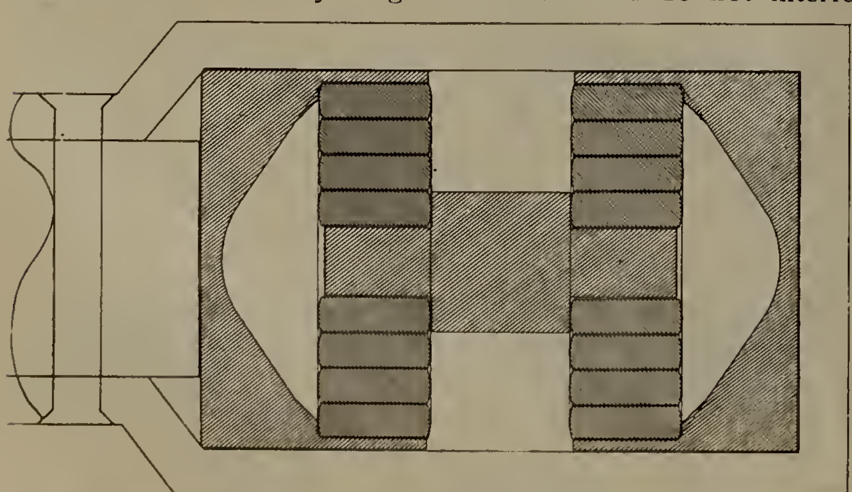
The doors are made of any desirable material to fit the various conditions. Corrugated steel, wood and glass are common materials in the doors installed. The doors may be raised with ease and locked at any height. The sections do not interfere or rub together and the absence of springs or gearing has special merit and contributes to the durability.

The Ritter Folding Door Co., of Cincinnati, Ohio, is the manufacturer and the company reports that some of the recent important installations are as follows: Central of Georgia, at Macon, Ga.; the Carolina, Chinchfield & Ohio, at Erwin, Tenn.; the Queen & Crescent Route, at Meridian, Miss.; the Richmond, Fredericksburg & Potomac, at Richmond, Va.; the Illinois Central, at Sioux City, Ia.

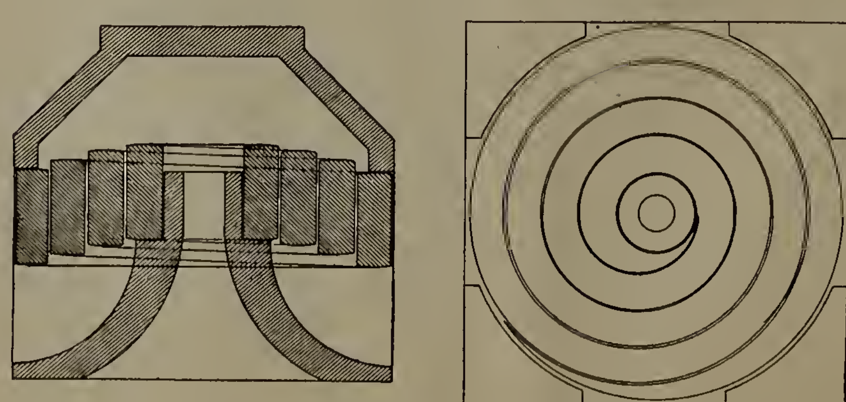
New Idea in Springs

The accompanying drawings illustrate a new idea in springs for general use, but particularly they were designed with a view to making simpler the absorption of heavy shocks, such as is required in draft gear and locomotive work.

Mr. Enoch Prouty, the inventor, has carried out in this spring the idea of arranging to absorb shocks by a gradual increase in the resistance without the necessity of providing a "dead point" of limit where the spring's influence is lost and an impact, between practically solid bodies, results. As will be noted by reference to the drawings, this spring is, at its neutral point, in the shape of a plane spiral. As it is extended by pressure it takes the shape of a conical spiral. To this arrangement is due the fact that as the pressure extends the spring, the resistance increases. It is not necessary that there be any dead point, and in case there is none the resistance of the spring becomes greater and greater until it reaches the limit of the strength of the materials, or until the pressure against it is balanced. An interesting feature rests in the fact that the spring works in either direction with the same efficiency. This is of particular value in draft gears.



Prouty Flat-Volute Spring for Draw Bars.



Prouty Spring Under Compression.

The principle which is involved by all spiral springs is evident after short study. Whether the stock used is square or round the spring effect is given by a twist of the material. By shortening the length of stock which is subjected to torsion the resistance becomes greater and, in this device, the cone shaped box holder is made to produce this effect.

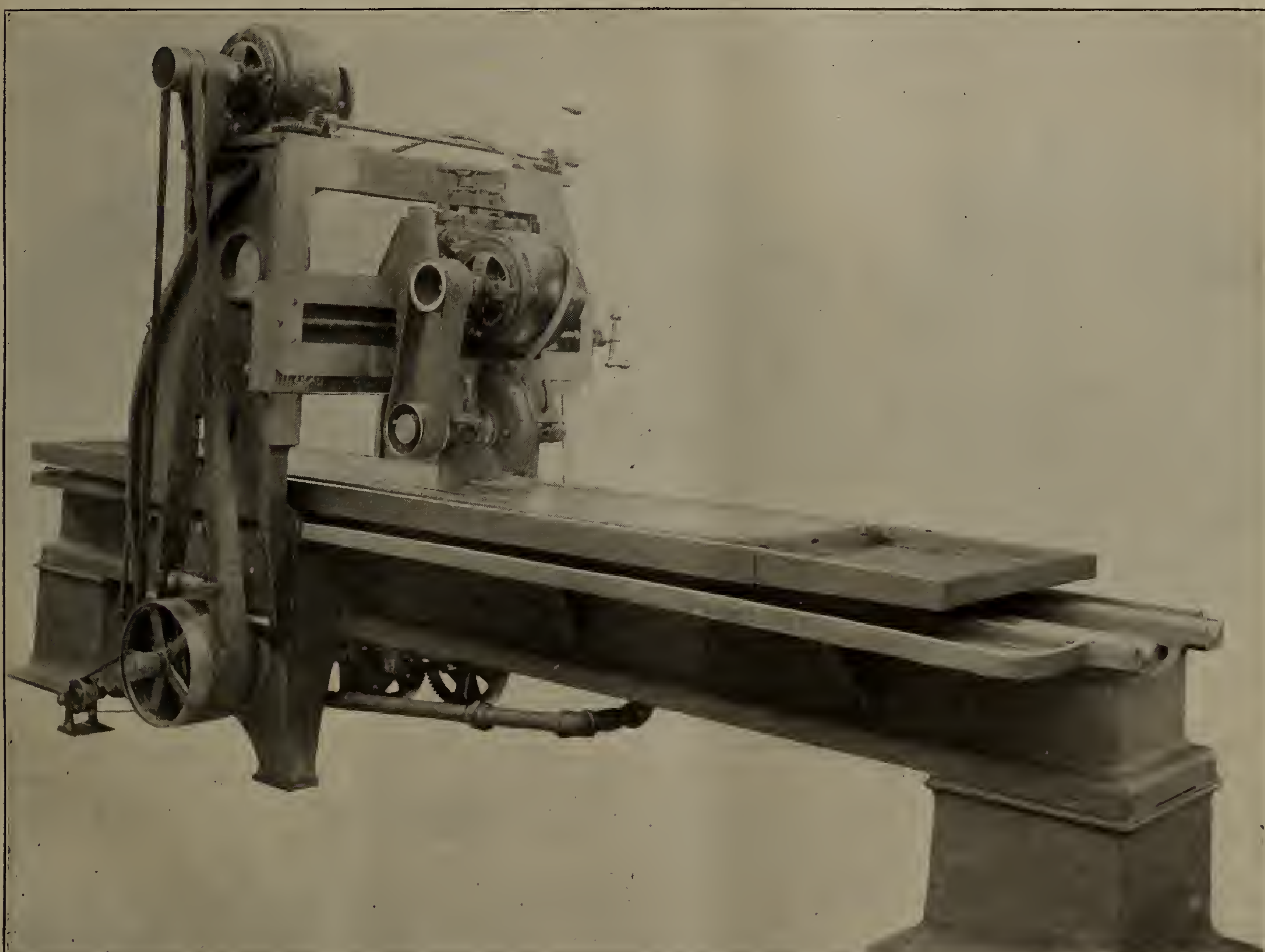
Olson Lubricator Guard

The "Olson Lubricator Guard" is a new invention designed to remedy an old evil. The inventor, Mr. P. G. Olson, St. Paul, Minn., known throughout the entire railroad fraternity of the northwest as "Pete" Olson, although young in years, has had long experience in an engine cab, and it dates back to the time when drivers were mere pygmies compared with the present day wheels, when wood firing was in vogue, and a hill was a mountain, and rails weighed a good deal less than 80 lbs. Mr. Olson is credited with knowing something about engines. When the "Master Builder of the West," Mr. J. J. Hill, takes a run to Seattle, it is Pete Olson who pulls the throttle.

Mr. Olson has long realized the necessity for a device that would protect in an effective manner, particularly the eye-sight of the engineer and fireman from the flying splinters of glass, when the engine lubricator bursts. Stress is laid upon the eyesight, as this is one of the great assets of the men in the engine. He, therefore, something over a year ago, designed what he calls the "Olson Lubricator Guard," a device, simple and effective. The guard is gotten up with a view to not only act as a protector, as stated above, but it is also further designed to cover the packing nuts, and prevent the expansion and contraction of same. This, in most cases, is the cause of the breakage. It is reported that in all cases, where the guards have been put into service, there has been no breakage of the glass. Presumably this is due to the fact that the packing nuts are so effectively protected. The guards have been adopted as standard by the Great Northern Railway system, and being now placed on the market, will undoubtedly appeal to the railway world as a valuable safety device wherever tubular lubricating glasses are in vogue.

Springfield Planer Surface Grinder

The Springfield Mfg. Co., of Bridgeport, Conn., has recently changed hands and is now under the management of Mr. H. F. Brandes as president and treasurer. This company has recently placed on the market a new automatic planer surfacer which is illustrated herewith.



Springfield Planer Surface Grinder.

The machine is motor driven and has a second motor mounted directly over the belt driven grinding wheel, the belt being kept under proper tension by means of a mechanical device as shown. The motor on the uprights drives the platen as well as the feeds, the whole machine being neatly and effectively arranged to take care of the cooling compounds which are usually used on machines of this type, this being supplied by a centrifugal pump operated from the lower driving shaft. The machine in question has a capacity to grind work 8 ft. long and 24 ins. wide, but of course it can be made for larger work in both length and width.

New Literature

THROUGH THE YUKON AND ALASKA. By T. A. Rickard; 384 pages, cloth, 6x9. Published by the Mining and Scientific Press, San Francisco.

A record of observations made in the course of the author's journey through this district during the summer of 1908. The evidence of a great deal of study is to be found among the pages of this book. An interesting history of Alaska's survey and accession by the United States and of the development of the resources of the country is included. Much attention, of course, is given to the discovery and mining of gold, but the other features are not neglected. The person who has considered the territory of Alaska to be capable of producing gold only, has a surprise in store for him when he reads this book. The author is prominent in mining circles, is an associate of the Royal School of Mines, and is the editor of both the Mining and Scientific Press and the Mining Magazine. He was formerly state geologist of Colorado. The manifest authority of his opinions makes his book of special value to the technical man, while the manner in which his subject is treated makes it of great interest to the layman. The book is very profusely illustrated with maps and photographic reproductions.

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UNIVERSAL DIRECTORY OF RAILROAD OFFICIALS. 560 pages, cloth, 5¼x8¼; published by the Directory Publishing Co., London; A. Fenton Walker, 143 Liberty St., New York, N. Y., sole representative for the United States. Price, $4.00.

In our review of this book in the December, 1909, issue, we neglected to state that the book is sold by A. Fenton Walker as the American representative as above.

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LOCOMOTIVE BREAKDOWNS. By G. L. Fowler and W. W. Wood; 294 pages, flexible cloth, 4½ by 6½; published by the Norman W. Henley Publishing Co., 132 Nassau St., New York City. Price, $1.00.

A pocket book of valuable information for the engine man or shop man, now in its sixth edition. This work has been kept closely up to date through its various editions. A feature, however, is the enlargement of the chapter on air brakes. The subject matter throughout the book is in the form of questions and answers, each subject being fully explained so that inexperienced as well as experienced men may obtain the maximum of information. The book is comprehensively illustrated with drawings and photographic reproductions, and tables and formulas of common use materially add to its value.

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A new and enlarged edition of "Feed Water Filtration" has been published by James Beggs & Co., 109 Liberty St., New York. It tells how water of condensation and returns from heating systems may safely be used to cut down the coal and water bills and it explains the advantages and disadvantages of various methods of filtration. The Blackburn-Smith Feed Water Filter and Great Extractor is described in detail.

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The "Ryerson Reference Book" for 1910 has just been issued by Joseph T. Ryerson & Son, of Chicago. This is to be issued from time to time in addition to the monthly stock list and is a complete list of the materials handled by this company. "Everything in Iron and Steel" is the foreword. It is of convenient pocket size and bound in an attractive paper cover.

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The T. H. Symington Co., of Baltimore, Md., has issued a leaflet announcing the purchase of the Farlow Draft Gear and giving other descriptive matter concerning it.

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The Ritter Folding Door Co., of Cincinnati, Ohio, has issued a booklet giving many illustrations of the different applications of their folding door to freight depots and round houses.

The Gisholt Machine Co., of Madison, has issued a leaflet on "Finishing Valve Bodies and Work of a Similar Nature."

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A very interesting booklet descriptive of the oxhydric process for cutting and welding of metals has been issued by the American Oxhydric Co., of Milwaukee, Wis.

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Every two or three years the Joseph Dixon Crucible Co., of Jersey City, N. J., republishes "Graphite as a Lubricant," which has become a standard work with them. The new edition is thoroughly revised and brought fully to date.

The Selling Side

The Springfield Mfg. Co., Bridgeport, Conn., announces a change of management. The business has been purchased from Mr. G. W. Jackman and is now under the management of Mr. H. F. Brandes, who for many years has served the Bullard Machine Tool Co., as its general superintendent.

G. E. Watts, Atlanta, Ga., has been appointed southern representative of the R. D. Nuttall Co., Pittsburgh, Pa.

J. W. Friend, vice-president of the Pressed Steel Car. Co., Pittsburgh, Pa., died on December 26 at the age of 65.

The Dearborn Drug & Chemical Works, Postal building, Chicago, manufacturers of boiler feed water treatment, advise that its business in 1909 has been the largest in the history of the company, having exceeded by a nice percentage the year 1907, which was the banner year in the history of the business up to this time. The big increase of business came during the last six months of 1909. and the indications for the coming year are exceedingly bright, as reported by the general offices of the company and their twenty selling branches.

Middendorf, Williams & Co., Baltimore, Md., dealers in bonds, announce that they have secured the services of Charles Turner Williams, who will be associated with the company after January 1.

The United Service Co., New York, has been incorporated with an authorized capital of $100,000. The company will deal in railway supplies of all kinds, both steam and electric. On January 1 it will take over the business of the Railway Equipment Co., S. J. Dill, president; Henry Morgan, vice-president; A. V. Wainright, secretary; W. D. Martin, treasurer; F. G. Robinson, purchasing agent. The entire stock of the United Service Co. is owned by the Susquehanna Railway Light & Power Co.

J. F. Wallace, chairman of the board of directors of Westinghouse, Church, Kerr & Co., New York, has been elected vice-president of the Kansas City, Mexico & Orient, to succeed the late George Crocker.

The Evens & Howard Fire Brick Co., St. Louis, Mo., is just completing two new kilns at its Gregg factory, which will increase the company's capacity about 350,000 brick per month. Two oblong down-draft kilns have also been added at the Howard plant to increase the capacity of the retort department and also to meet the increased business of the gas works division.

A double leaf bridge with 200 ft. clear span bascule over the Neva river was recently ordered by the city of St. Petersburg, Russia, of the Strauss Bascule & Concrete Bridge Co., Chicago.

The Chicago Bearing Metal Co. has been recently organized to manufacture locomotive and engine castings, journal bearings, brass and bronze castings and alloys of all kinds. C. A. Bickett is the president and Walter D. La Parle is the general sales agent. The plant is located at 45th street and Center avenue, Chicago. The railroad shipping facilities are excellent. The buildings are of fire proof construction and of large size, the main building is 210 feet long by 150 feet wide. All equipment is new and up-to-date.

Mr. La Parle, the general sales agent, is a native of Chicago. He has been in railway supply business for the past twenty years and has an extensive acquaintance among railroad officials in operative, maintenance and mechanical departments, being for 11 years connected with the Verona Tool Works, of Pittsburg, and was the organizer of the Solid Steel Tool Co., now the Western Tool & Forge Co., of Brackenridge, Pa.

J. D. Conway, who, as stated in these columns last month, has been appointed the secretary of the Railway Supply Manufacturers' Assn., was born in Beaver county, Pa., December 15, 1863. He learned telegraphy at Beaver, Pa., while in the service of the C. & P. Ry. In 1884 he became a telegraph operator on the Pittsburg & Lake Erie and has been with that company since that time, having held the position of assistant to L. H. Turner, superintendent of motive power, since 1891. Mr. Conway is closely identified with the Railway Club of Pittsburg, being the first secretary of that organization and having held the position for several years, when he resigned owing to the pressure of other duties. In 1906 he served a term as chairman of the National Association of Secretaries. Beginning January 1, 1910, he took up the duties of secretary of the Railway Supply Manufacturers' Association, with office at the German National Bank building, Sixth St., Pittsburg.

R. F. Kilpatrick.

J. D. Conway.

W. D. La Parle.

Personals

M. H. Haig has been appointed mechanical engineer of the Atchison, Topeka & Santa Fe, with office at Topeka, Kan. He succeeds W. L. Allison, who recently resigned to enter the service of the Franklin Railway Supply Co. Mr. Haig was formerly editor of the RAILWAY MASTER MECHANIC.

C. H. Kadie succeeds E. C. Sasser as the master mechanic of the Augusta Southern Ry.

G. H. Mathews succeeds M. S. Curley as the master mechanic of the Beaumont, Sour Lake & Western R. R.

R. Preston succeeds C. H. Temple as master mechanic of the central division, Canadian Pacific Ry. His office is at Winnipeg.

F. W. Bailey succeeds F. W. Sadlico as a master mechanic of the western division, Canadian Pacific Ry., with office at Moose Jaw, Sask.

T. L. Roberts succeeds S. Phipps as master mechanic of the Pacific division, Canadian Pacific Ry., with office at Vancouver, B. C.

J. Murrin has been appointed superintendent of the locomotive shops of the Chicago & Northwestern Ry. at Chicago.

N. J. Chapin succeeds W. P. Cunningham as the master mechanic of the Colorado South Eastern R. R., with office at Hastings, Colo.

H. R. Kimball has been appointed the master mechanic of the Duluth & Northern Minnesota Ry., with office at Knife River, Minn.

J. Stewart succeeds N. L. Rand as a division master mechanic of the Intercolonial Ry. at Moncton, N. B.

J. J. Thomas, Jr., succeeds Geo. S. McKee as superintendent of motive power and car equipment of the Mobile & Ohio R. R His office is located at Mobile, Ala.

D. R. MacBain has been appointed assistant superintendent of motive power of the New York Central & Hudson River R. R., with office at Albany, N. Y.

M. Hassett has been appointed a master mechanic on the New York Central & Hudson River R. R., with office at E. Buffalo, N. Y.

Thos. Ryan succeeds F. J. Lozo as a division master mechanic of the Intercolonial Ry. at River Du Loup, Que.

F. M. Steele, a master mechanic of the New York Central & Hudson River R. R., has been moved from East Buffalo, N. Y., to Rochester, N. Y.

G. Lennen has been appointed a master mechanic of the New York Central & Hudson River R. R., at New Durham, N. J.

L. H. Albers has been appointed supervisor of air brake equipment on the New York Central & Hudson River R. R., with office at West Albany, N. Y.

F. A. Linderman has been appointed supervisor of boilers on the New York Central & Hudson River R. R., with office at West Albany, N. Y.

R. F. Kilpatrick has been appointed superintendent of motive power of the Western Pacific Ry., with office at San Francisco.

Railway Mechanical Patents Issued During December

Automatic bleeder for air brake system, 940,676—Edward Van Hart Conley, Kearney, N. J.
Method of reworking worn car axles, 940,805 and 940,806—John M. Hansen, Pittsburg, Pa.
Brake hanger pin construction for car truck side frames, 940,865—Geo. G. Floyd, Granite City, Ill.
Dump car, 940,893—Jay B. Rhodes, Kalamazoo, Mich.
Car, 940,902—Walter H. Son, New York City.
Car window ventilator, 940,946—David W. Snow, Portland, Me.
Locomotive spark arrester, 940,955—Lewis A. Coleman, Norfolk, Va.
Coupling for train pipes, 941,066—Joseph E. Forsyth, Chicago, Ill.
Steel box car, 941,067—Robert E. Frame, St. Louis, and Clement G. Harrington, Maplewood, Mo.
Metallic door, 941,068—Robert E. Frame, St. Louis, and Clement G. Harrington, Maplewood, Mo.
Car door hanger, 941,069—Robert E. Frame, St. Louis, and Clement G. Harrington, Maplewood, Mo.
Brake shoe key, 941,107—Charles N. Smith, St. Thomas, Ont., Canada.
Brake operating mechanism, 941,219—Chas. A. Williamson, Jersey City, N. J.
Railway car, 941,249—Harry S. Hart, Chicago, Ill.
Combined signal and air brake, 941,259—Albert M. Jones, Hagerstown, Ind.
Ventilator for railway cars, 941,290—John E. Ward, New York City.
Car truck, 941,293—Charles W. Wodznski, Menominee, Mich.
Safety air brake appliance, 941,295—Thomas W. Ash, Sherman, Tex.
Automatic air brake coupling, 941,348—William E. Campbell and Howard T. Inghram, Fairfied, Iowa.
Dump car, 941,381—Spencer Otis, Chicago.
Car for transporting ore or other material, 941,405—William C. Carr, Buffalo, N. Y.
Locomotive track sander, 941,457—Henri L. Lambert, Rouen, France.
Car truck, 941,515—Charles B. Goodspeed, Chicago, Ill.
Air hose coupling, 941,652—Frederick W. Rock, Detroit, Mich.
Fluid pressure brake, 941,684—William P. A. Macfarlane, Chicago, Ill.
Car bolster, 941,691—Charles H. Anderson, Seattle, Wash.
Mechanical stoker for locomotives, 941,698—David F. Crawford, Pittsburg, Pa.
Passenger railway car, 941,807—Lewis E. Paden, Philadelphia, Pa.
Locomotive ash pan, 941,815—Frederic L. Roberts, Washington, D. C.
Car, 941,855—Ezra S. Bucknam, Philadelphia, Pa.
Valve replacing apparatus, 941,873—Edward W. Goodwin, Bensonhurst, N. Y.
Fluid pressure brake apparatus, 941,914—Murray Corrington, New York, N. Y.
Car coupling, 941,965—Charles H. Tomlinson, Mansfield, Ohio.
Car heater, 942,040—James McElroy, Albany, N. Y.
Car truck, 942,048—John C. Barber, Chicago, Ill.
Railway car truck, 942,096—Charles F. Murray, Chicago, Ill.
Car door mechanism, 942,108—Ralph V. Sage, Westmont, Pa.
Appliance for automatically and otherwise locking and unlocking railway car doors, 942,125—David Andrews and Charles Bickerton, Manchester, England.
Uncoupling chain for car couplings, 942,134—Geo. G. Davis, Indianapolis, Ind.
Automatic car coupling, 942,218—Otto F. Richter, Indianapolis, Ind.
Car construction, 942,224—John F. Streib, Avalon, Pa.
Car roof, 942,249—Edson C. Covert, New Kensington, Pa.
Nut-locking expansion bolt, 942,226—Charles D. Vernon and Jacob P. Morningstar, Wheeling, W. Va.
Door-operating mechanism, 942,234—Robert M. Zimmerman, Montreal, Quebec, Canada.
Passenger car, 942,265—Peter M. Kling, Pittsburg, Pa.
Car window, 942,270—Thomas A. Legge, Chicago, Ill.
Combined hanger and track for car doors, 942,324—Edward A. Hill, Chicago, Ill.
Brake shoe, 942,343—Charles B. McPhillips, Suffern, N. Y.
Forged steel car-wheel, 942,381—John M. Hansen, Pittsburg, Pa.
Pipe or rod carrier, 942,446—George Holt, Watervliet, N. Y.
Car ventilator, 942,451—Frank J. Linehan, Boston, Mass.
Making records for setting locomotive slide valves, 942,453—John B. Michael, Knoxville, Tenn.
Grain-car door, 942,551—Winfield S. Driskell, Gretna, Neb.
Arch for fireboxes of locomotives, etc., 942,575—John Loftus, Albany, N. Y.
Brake for railway cars, 942,684—Louis de Vito, Cleveland, O.
Car truck, 942,702—John C. Barber, Chicago, Ill.
Trap door for railway cars and similar structures, 942,711—Edward F. Chaffee, New York, N. Y.
Device for cleaning ashpans of locomotives, 942,737—Nels Olson, Birmingham, Ala.
Locomotive ashpan, 942,765—Timothy W. Anderson, Fort Smith, Ark.
Car door, 942,862—Francis X. Malocsay, Jersey City, N. J.
Draft gear, 942,948—Thomas H. Symington, Baltimore, Md.
Car sprinkler valve, 942,974—Edward C. Perry, Worcester, Mass.
Brake beam hanger, 942,985—Sidney S. Underwood, Montreal, Quebec, Canada.
Grain car door, 942,994—William H. Ascue, Kiowa, Kan.
Steel car construction, 942,997—William P. Bettendorf, Davenport, Iowa.
Brake beam, 943,021—Charles F. Huntoon, Chicago, Ill.
Car door bracket, 943,039—Joseph K. McGuire, Valley Junction, Iowa.
Car coupling, 943,079—James E. Hudler, Crumpler, N. C.
Automatic car coupling, 943,116—Henry Leslie, Birmingham, Ala.
Car coupling, 943,144—James F. Durbin and Votaw S. Durbin, Fort Scott, Kan.
Steel car, 943,213—Charles H. Anderson, Seattle, Wash.
Loading machine for box cars, 943,225—Albert J. Gurney, Sunnyside, Ill.
Dumping car, 943,259—Charles A. Lindstrom, Allegheny, Pa.
Friction draft gear, 943,314—Thomas L. McKeen, Scranton, Pa.
Car-moving device, 943,654—William H. Colyar, San Francisco, Cal.
Car truck, 943,666—Richard J. Edwards, Galena, Ill.
Railway car truck, 943,707—Willard F. Richards, Lancaster, N. Y.
Engine-moving brake lever, 943,715—James A. Taylor, Birmingham, Ala.
Brake shoe, 943,730—John F. Beatty, Morton, Pa.
Railway brake, 943,737—Charles E. Duffie, Omaha, Neb.
Wrench, 943,771—Arthur D. Davis and William A. Thompson, Cleveland, N. C.
Ash-pan for locomotives, 943,777—John H. Gee, Palestine, Tex.
Air brake adjusting device for loaded and empty cars, 943,778—Alva L. Goodknight, Mena, Ark.
Locomotive boiler furnace, 943,823—Frederick F. Gaines, Savannah, Ga.
Metallic rod packing, 943,835—George B. Maltby, Cleveland, Ohio.
Car truck, 943,853—John C. Whitridge and Charles B. Goodspeed, Columbus, Ohio.
Brake equalizing mechanism, 944,058—Frank D. Thomason, Chicago, Ill.
Swing-motion truck for cars, 944,165—Charles D. Young, Columbus, Ohio.
Car truck, 944,202—Albert J. McCauley, St. Louis, Mo.
Spark arrester and extinguisher, 944,237—Andrew W. Graham, Bradford, Pa.

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ESTIMATING LOCOMOTIVE SPEEDS.

The result of accurate registration of train speeds, particularly unusual speeds, is nearly always a source of surprise to officials as well to enginemen. Certain high speed trains have been supposed to be making upwards of eighty miles per hour, but when accurately recorded by some instrument, it has been found that the actual speeds were greatly over estimated. The occasions for the proper estimation of speed are very frequent, especially during the run of a limited passenger train. Municipalities are in the habit of passing ordinances fixing the speed of trains within certain limits, stretches of track undergoing reconstruction are protected by slow orders, railway rules prohibit running across facing switch points at more than a fixed slow rate of speed. All these instances and many more are reasons of daily occurrence which would seem to bring out the necessity for the accurate estimation of speed by the engineer. Several railroads have equipped their locomotives with speed recording devices which operate with more or less accuracy. That their application is not more general seems to be principally due to the fact that their performance has not been all that it should be. In tracing the responsibility for more or less serious accidents, speeds enter into the case quite frequently. Were it possible to refer to an accurate record, beyond the power of the engineer to control, such investigations would often be greatly simplified. Primarily however, the field of the recording speed indicator should be in the prevention of accidents by assisting the engineer in obeying the speed regulations of the section of track over which he may be operating. Whether or not there is, at present on the market, an instrument which will satisfactorily perform these duties is a matter which could well be decided by experiment and test.

THE UNIT SYSTEM OF ORGANIZATION.

The strength of any organization depends to a great extent on the strength of its members, and the unit system of organization as originated by Major Hine, is an effort to enlarge the scope of certain members of a railroad organization and thus make them of more value to the road and to themselves. The system has been extended during the past year to twenty-one divisions on the Harriman lines, carrying with it the title of assistant superintendent to the master mechanic, trainmaster, division engineer, traveling engineer, and chief dispatcher, together with a cosolidation of their offices and files. Some men have not welcomed the change, claiming that the absence of a distinct title designating their particular field of endeavor was a loss rather than a gain. We think, however, that most officials look upon it as a broadening movement rather than a narrowing one. The organization of a large railway has become very complex and the master mechanic's field, for instance, has become widened and broadened to such an extent that its organization is sometimes as large as that of the whole road in the past. A change to the title of assistant superintendent then is a promotion, recognizing as it does, the importance of having a certain number of officials placed in a sphere of greater activity and authority. One objection to the system has been that there may be a possible conflict of authorities, such as the former division engineer out on the road ordering an engine shopped while the ex-master mechanic, being at the time the senior assistant at the office, has ordered differently. This is a weak point in the system, but the scheme allows of much elasticity in the details and this may be worked out in time. Much depends on the superintendent, for if he be a strong tactful man, friction of this sort will be avoided. In applying the system to the entire organization of a railroad there are many questions yet to be solved however. Such as the provision for the mechanical engineer—could he properly be included in the scheme as an assistant general manager and if not, what would be his position? It is understood that Mayor Hine considers such an official a specialist; his position being analogous to that of a staff officer in the army, who acts in an advisory capacity while the line officer has charge of the men at the front. All changes in title have been made at the old salaries and Major Hine has stated that ultimately the purpose is to fix a certain salary for each position so that a man may know what to expect at his next promotion. This is not as it should be; the good of a road often makes it necessary to retain a certain man even at a higher salary than that of his predecessor and this would not be possible unless some modification is made to the fixed salary plan. Any worthy effort looking towards the betterment of organized endeavor should be commended however, and the Hine plan has so far proved itself worthy. The fact that it is being installed on the Harriman lines is of itself in its favor and with time to work out the details, we believe that the effort will result in a better organization.

EUROPEAN LOCOMOTIVE NOTES.

Recent experiments in Italy have revived interest in high temperature superheating for locomotives. This has been for many years in abeyance, althought in certain cases it was found that locomotive super heating effected a saving of about twenty per cent in coal. Still greater economy was claimed on certain German railways, but these claims were not always given credence there. On the Italian lines 2-6-0 locomotives fitted with the newest style of Schmidt superheater have been used in regular service for hauling passenger trains of an average weight of 206 tons at an average speed of about 45 miles per hour over level and undulating lines. The coal consumption per 100 ton miles run (computed) amounts to 8.68 pounds. Contrasted with this is the experience of simple saturated steam locomotives which handled the same service on the same lines, but whose average load was 180 tons behind the tender and whose coal consumption was 11.32 pounds. The resulting economy in view of the superheated steam locomotive is therefore over 23 per cent. And there is more than this. In hauling train loads 12.6 per cent greater in weight, time was saved on the journey to the extent of 104 minutes to every one thousand kilometers run as against 94 minutes saved by the saturated engine, a relative time economy of 9.6 per cent. From the experiments on English railways, it is said that the coal economy of the superheated steam locomotive is attributable to the inefficiency of the saturated steam locomotive. The latter, on the contrary, are among the most efficient and economical of simple expansion engines known and compare most favorably with any English railway locomotive as regards fuel consumption. The superheater locomotives are built on precisely the same general conditions as those of the Schmidt system employed on the Lancashire and Yorkshire railway. Their superior economy must therefore be put down to methods of operation; in Italy these have received close and careful attention. A number of small two-cylinder compounds are employed in parallel service with the same trains on the Venice division, and although they have small boilers, without superheaters, and with 11 per cent less heating surface, they are identical in all principal conditions of design wtih the superheater locomotives. The object of adopting this similarity of design was to ascertan which is the more economical system. The coal consumption, on the bases previously indicated, and during the same quarter of the year, was 8.33 pounds for the small two-cylinder compounds; this, compared with the 11.32 pounds of the simple saturated engines, represents an economy of 26.4 per cent, and, compared with the 8.68 pounds of the superheater engines, an economy of about 4 per cent. Hauling trains of 250 tons average, or 28 per cent more than the saturated "simple" engines, and 17 per cent greater than the superheater engines, the compounds saved 149 minutes per 1,000 kilometers run; this, compared with the 94 minutes of the saturated simples, represents an economy of 37 per cent, and compared with the 104 minutes of the superheater engines, of 30 per cent. The oil saved by both classes of saturated steam locomotives amounted to between 20 and 40 per cent as compared with the superheater steam locomotives, for cylinders and valves only. Under usual working conditions, the steam cut-off in the cylinders of the compound is 35 to 45 per cent as compared with 14 per cent to 18 per cent in the saturated "simples," and with 30 to 40 per cent in the superheated "simples." The highest boiler steam pressures are:—For the superheaters, 165 pounds; for the saturated simples, 191 pounds; and for the compounds, 219 pounds; but, considering that compound engines work with nearly undiminished ecnomy at the same boiler pressures as competing "simples," the State Railways have ordered the safety-valve pressures of the compound engines to be lowered to those of their old simple-expansion locomotives, namely, 191 pounds *maximum*—which means a working average boiler pressure in service of about 175 pounds for the compounds. The economy due to the higher pressure of 219 pounds formerly employed was, by Goss's formula, 0.4 per cent. At present, with all the saturated engines working at equal pressures, the cost of boiler repairs in the compounds is greatly reduced, because the amount of coal burnt is reduced by over 25 per cent, and a corresponding reduction is effected in the water evaporated, with lessened costs of boiler cleaning on account of scale and deposit. The superheater engines benefit, of course, by almost equal economies in fuel; and altogether, averaging the whole of the engines at work, they are little inferior to the compounds except as regards time-saving and oil economies. Against high steam-temperatures of the superheater engines and the greater fluidity of the steam (which rather increases the difficulty of keeping pistons and valves steam-tight) the compound engines have a boiler pressure nominally 30 pounds higher, but this small difference has an immaterial influence on boiler repairs. Of far more importance is the degree of the hardness of water. On the English Great Western Railway, Mr. Churchward has found that the repairs are no greater with pressures of 225 pounds in simple engines using softened water than were the repairs with the lower pressures when the water was not treated. Thus in Italy, and also partially in Austria, the almost universal practice of working compound engines at the same pressures as simple engines, has now been renewed. But it does not appear that a return to the pressures of 150 pounds or 125 pounds for compound engines would be justified while the simple engines are still being worked at 190 pounds or even 225 pounds because low-pressure boilers must necessarily be of very great capacity, and this adds to the total weight. In Italy the Schmidt system has been applied tentatively to some compound engines, but the application is too recent to allow of the results being given. However, it appears that the economy effected will not differ appreciably from that obtained with the same system in France, *i.e.,* 12.5 to 15 per cent, or in Austria, *i.e.,* 14 to 15 per cent. These added economies represent a combined total of about 50 per cent as compared with saturated steam simple engines working the same trains.

Special attention is just now being paid to the design of rolling stock for smooth rail working on heavy gradients. There has been a rapid rise in the cost of haulage for gradients exceeding 4 per cent and for heavier gradients special devices have to be employed. F. W. Bach, talking to the Institution of Civil Engineers on January 11th, dealt with this problem in a very interesting fashion, taking gradients up to one in twenty-five. On account of the evenness of the torque of engines with three cylinders, which enabled a much better use to be made of their adhesive weight and also of their superior economy in fuel, he favored the adoption of three-cylinder engines for mountain service. He drew attention to the importance of questions associated with speed limits on both up and down gradients, of type and power of brake, of the limit of axle-load, and various details of practical construction. In connection with the design of passenger coaches and goods' wagons light tare was of economic importance. It was quite possible to combine modern luxury of passenger equipment with very light tare, the load being less than five tons per axle, and, similarly, freight equipment of high cubic capacity could be designed with low axle loads and as low a ratio of tare to total weight as one to four.

Motive Power of Motor Cars

By Francis W. Lane.

Whether or not the motor car ever assumes an important position as a part of the equipment of steam railroads, the experiments made in view of the possibility of such an outcome will at least have demonstrated the extent to which the means for the development of a considerable amount of power and adequate means of transmission may be compressed within a very small space. This statement is particularly applicable to such motor cars as have been designed for the use of steam power. With reference to such motor cars as are designed for the use of gasoline engine or gasoline-electric power, comparisons with what has been accomplished in the automobile industry are hardly applicable on account of the enormous difference in the inertia of weights dealt with, even when the comparison is between the heaviest of automobiles and the lightest of motor cars. High power in the case of an automobile is ordinarily for the purpose of enabling the car to develop a high rate of speed with a light load and for a short period of time, while in the case of the motor car on steam railroads, the requirement of high power is to enable the car to develop high speed under a sustained effort for a considerable period and with a comparatively heavy load. The forms of transmission that have proved successful in the automobile may therefore be unsuitable in the case of the railroad motor car, and the power required in the one may be a wholly inadequate index of the requirements of the other.

The limitations of space available in comparison with the amount of room seemingly required for the development and transmission of the necessary power are peculiarly apparent in the case of the steam motor car. In a few words, what is demanded is the equivalent of a locomotive of considerable capacity so compactly put together that it shall occupy only a small space in the front of the car body and yet be capable of developing and transmitting reliably a large percentage of the power developed by an independent locomotive occupying with its tender as much space as the motor and its passenger facilities together. Passenger facilities cannot be contracted beyond a well-fixed minimum and that had already been reached before the advent of the steam motor, carrying locomotive and passenger car on the same frame and under the same roof.

Steam Cars.

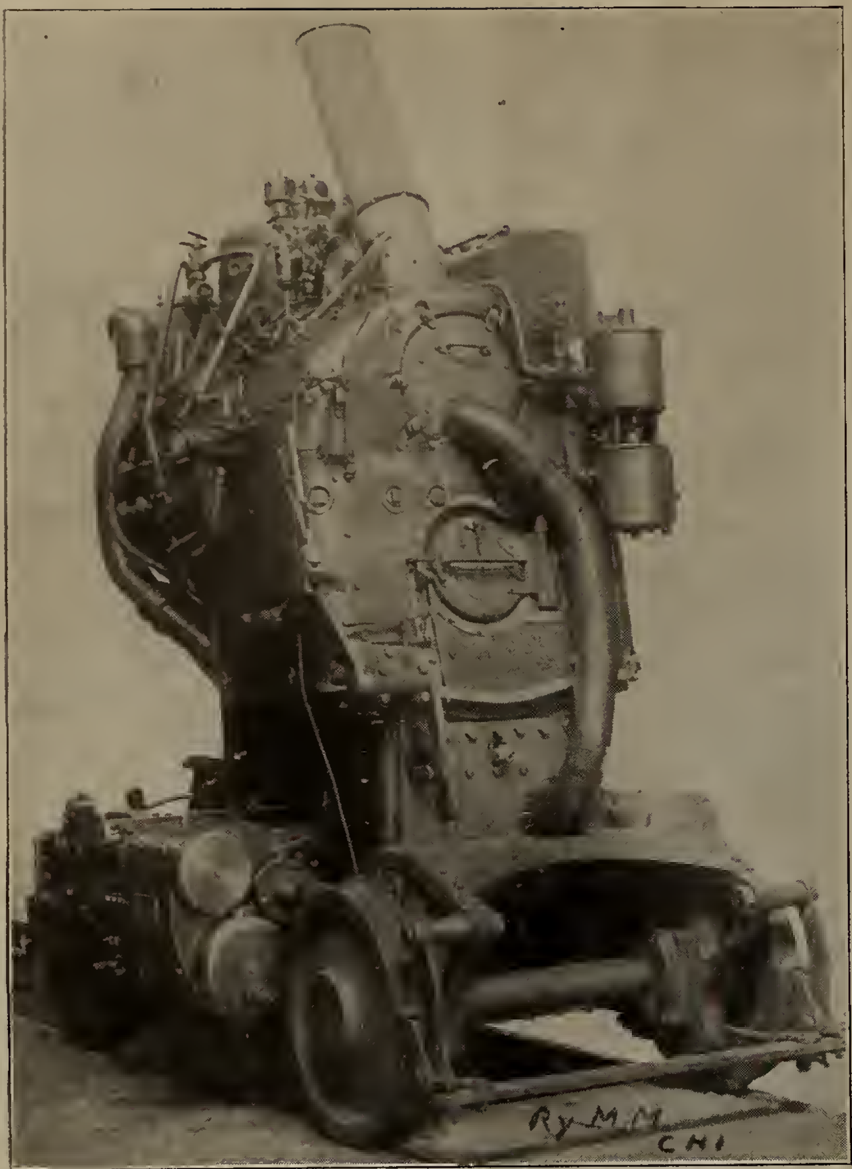
What has been done in reducing a fairly powerful locomotive into small compass for motor car purposes is strikingly shown in the accompanying illustrations of the motive power of some of the cars which are now in service on steam railroads. In the illustrations of the motive power apparatus of the steam motor car built by the American Locomotive Co., and which has been in service for some ten months on the Chicago, Rock Island & Pacific Ry., the entire locomotive engine is shown as detached from its car. For service purposes this locomotive is properly put in comparison with the smaller types of standard locomotives, such as are ordinarily used on branch lines, and while, of course, certain reductions have been made by lopping off waste space and consequently useless dead weight, this engine, with the car of which it forms a part, is, for operative purposes, the equivalent of the light locomotive mentioned, to which may be attached a passenger coach and at the least, a combined baggage and smoking car. The independent locomotive could haul a larger load than the motor car if the larger load were in existence. Ordinarily it is not, and herein consists the economic efficiency of the motor car.

In the car to which reference is made the entire engine and boiler are carried on the four-wheeled truck which is the forward truck of the car and of which the rear pair of wheels are the drivers. Of the total weight, 104,000 lbs., of the car, 64,000 lbs. are carried on this truck, and this comprises not only the weight of the boiler and engine but a certain proportion of the weight of the car body.

The engine is a two-cylinder cross-compound with cylinders 9¼ and 14½ ins. in diameter and 12 ins. stroke. Both high and low pressure cylinders are equipped with piston valves operated by Walschaert valve gear. The rear wheels, which are the driving wheels, are 38 ins. in diameter. Working compound, the engine will develop a theoretical maximum tractive power of 4,360 lbs.

Superheated steam at 250 lbs. boiler pressure is supplied to the cylinders from a horizontal boiler of the return tube type. In order to eliminate the necessity of flexible steam joints the boiler is mounted rigidly on the motor truck frame. By the use of the horizontal return tubular boiler, the problem of providing the largest amount of heating surface possible within the necessary limited space allowed was satisfactorily solved. The firebox is at the front end and the smoke box is directly above it. The gases of combustion pass through the tubes to the combustion chamber at the rear end of the boiler and thence forward through the return tubes to the smokebox.

The firebox is 33 ins. long and 43 ins. wide and is bricked



Power Truck of American Locomotive Motor Car, C., R. I. & P. Ry.

for burning oil as fuel. The barrel of the boiler is 45 ins. in diameter. At the combustion chamber end there are 214 fire tubes 1¼ ins. in diameter and 3 ft. 9 ins. long and an equal number of return tubes of the same diameter and 3 ft. 11½ ins. long. The total heating surface is 565.6 sq. ft., of which the tubes contribute 528 ft. and the firebox the remainder.

The boiler is fitted with a superheater located in the combustion chamber where the temperature of the gases is high. The superheater header is bolted to a cast steel saddle casting secured to the top of the boiler. This header is divided transversely into saturated and superheated steam compartments by means of a vertical partition and there are 16 superheater tubes bent into the shape of a double loop and extending down into the combustion chamber. Steam passes from the dome through a short dry-pipe to the superheater and through it to the high-pressure cylinder which is located on the right side of the truck.

The entire engine and boiler are contained within the wheel base of the truck, which is 8 ft. 4 ins. between wheel centers. As shown by the engravings, the locomotive is complete in every respect as to equipment of injectors, lubricators, gauges, air brake apparatus and controlling gear. The construction of the car framing is such that the locomotive part can be drawn away from the car body for purposes of general repair, though in its normal position it is entirely enclosed in the front compartment.

A motor car built by the Canadian Pacific Railway from designs of Mr. H. H. Vaughan, assistant to the vice-president, is somewhat similar as to compactness and capacity, though differing considerably in detail. In this case the drive is upon the forward wheels of the motor truck and the cylinders are located upon the motor truck frame in the rear of the trailing wheels and outside the frame. This location of the cylinders gives a very direct movement of the connecting rod from the cross-head to the driving wheels, avoiding the loss of power from angular distortion.

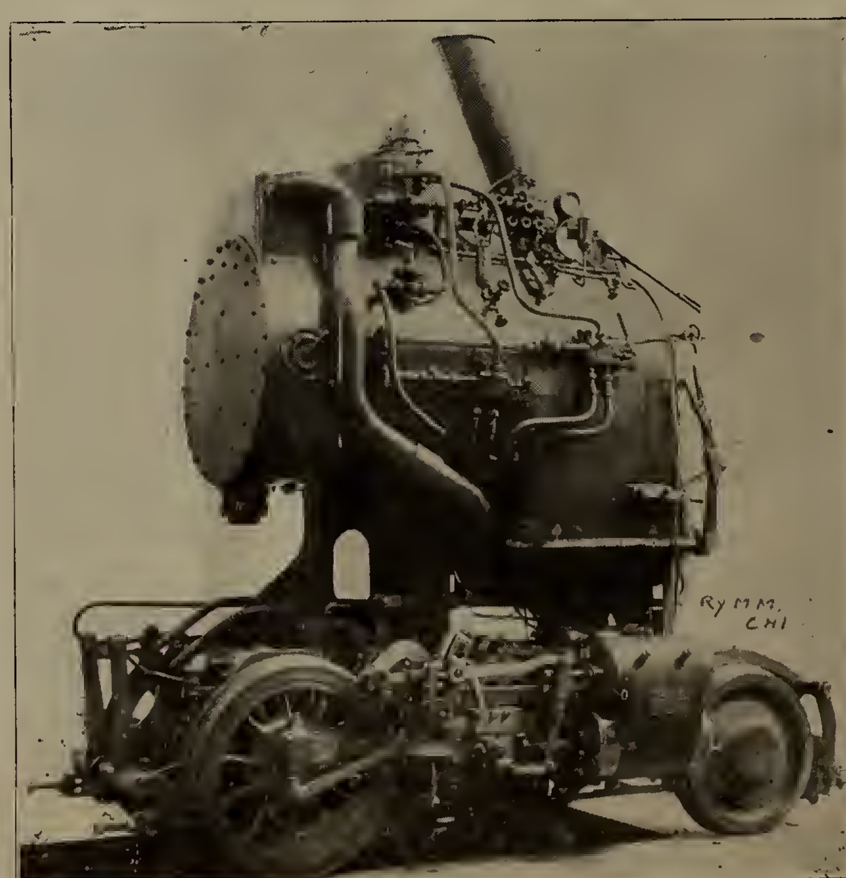
The cylinders are 10 by 15 ins., with inside admission piston valves actuated by Walschaert valve gear. The driving and trailing wheels are of cast steel centers, the former being 42 ins. in diameter on the tread and the latter 34 ins. The journals of both pairs of wheels are 8 by 12 ins. Of the total weight of the car, which is 72 ft. long, 136,620 lbs., 82,880 lbs. are carried by the motor truck, slightly more than half being on the driving wheels.

The boiler is of the return tube type, 4 ft. 6 ins. inside diameter and 7 ft. 11 ins. long between flue sheets. It contains one Morison corrugated furnace 32 ins. in diameter, and 95 tubes 1¾ ins. in diameter. The total heating surface is 536 sq. ft., of which 485 ft. are in the tubes and 51 ft. in the furnace. The superheater consists of 21 steel tubes 1¼ ins. in diameter and contains 52 sq. ft. of heating surface. The working pressure of the boiler is 180 lbs. and the steam is superheated to from 700 to 760 degs. F. before reaching the valve chest. The Morison corrugated flue is lined with firebrick and the boiler is equipped with a sand-blowing device for cleaning soot off the flues.

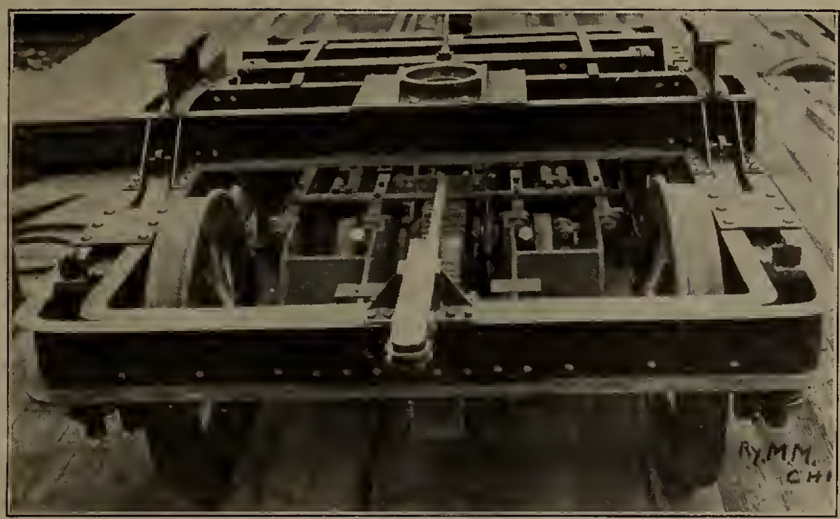
Water is fed to the boiler by two Hancock injectors and the equipment is otherwise substantially that of a large locomotive, including Westinghouse A. M. T. automatic brake system, which has a graduated release and is especially adapted to the class of service motor cars are intended to perform.

As originally built, this motor was intended to use oil as fuel, but this was found unsatisfactory and changes were made to burn coal. The engine compartment of the car, including coal bunkers, is 13 ft. 6 ins. The speed capacity is from 50 to 60 miles per hour.

In the Kobusch-Wagenhals steam motor car, the engine is carried between the wheels of the truck with gear connection to the driving axle and spring suspension at the other end, making virtually a three-point suspension. The cylinders are 7 by 8 ins. with American plug piston valves. The boiler is of the marine water-tube type, with a total heating surface of 450 sq. ft. The total weight of the car, including fuel and water supply, is 66,350 lbs. The fuel is crude oil. It is fired by a single burner carrying 10 lbs. pressure on the tank and operated by superheated steam under pressure of 60 lbs., this being reduced from the boiler pressure of 250 or 300 lbs. by a reducing valve. Steam is raised from cold water in 15 minutes.



Power Truck of American Locomotive Motor Car, C., R. I. & P. Ry.



Engine and Truck of Kobusch-Wagenhals Motor Car.

In the Ganz steam motor car, of which several have been used in this country and many in Central Europe, the motive power is two compound enclosed steam motors of 60 horsepower each. These are located on the forward truck and drive through gears upon the rear axle. The motors may be operated independently or together. The generator is 42 ins. in diameter and 48 ins. high and consists of four concentric cylinders held in place by bolts and with the two annular water spaces so formed connected by inclined steel tubes. Fuel is fed to the grate below through an inner tube after the manner of a base-burning coal stove. Movable gears on the drive shaft provide for changes of speed.

A motor car built by the Burlington from designs by Mr. Max Toltz, Chicago, is on a plan that has been followed to some extent in Europe. The motor truck is practically independent, except that it carries a bolster upon which the front end of the car body is supported. The boiler is vertical, with superheater, and is of 150 horsepower capacity. The cylinders are 13 by 17 ins., located on the outside of the truck frame, and are provided with piston valves actuated by Walschaert gear. The fuel is oil, delivered in a swirling spray.

The above descriptions cover all the types of steam motor car that have been used in this country up to date with the exception of two types which were built some 12 years ago and soon abandoned, and one which has just been put in experimental service upon the Santa Fe and other roads. The latter which was built by the Louisville & Nashville from designs of Mr. T. H. Curtis, superintendent of machinery, weighs 155,000 lbs., of which 50,000 lbs. are on the front or engine truck. The car was built for high speed. The boiler is of the return tubular type and in one test there was an average consumption of only 20 lbs. to the mile.

The car is built of steel and is 76 ft. 6½ ins. between the faces of the couplers. Of the interior a space 18 ft. 9 ins. is reserved for engine and boiler, the remaining space being devoted to passenger accommodation, the seating capacity being 72. The car hauls one trailer without apparent effort and has attained speeds up to 70 miles per hour. The water supply is 1,500 gals. carried in a tank under the middle of the car.

Gasoline Cars.

With the development and simplification of the internal combustion engine, producing in small space power both efficient and reliable, as illustrated by the now infrequent failures of the first class automobiles, naturally comes the thought of application to the motor car.

In 1904, the Union Pacific R. R. decided to experiment towards the development of a car using gasoline, which should meet the recognized requirements of a successful motor car. Since the completion of the first car in 1905, the same interests have continued experimenting, improving and building motor cars of this description, but the demand for the car soon required more space and attention than could be given in the regular shops of the Union Pacific and the superintendent of motive power of the company, Mr. W. R. McKeen, resigned from the service of the Union Pacific and organized a company with works at Omaha, Neb., for the exclusive building of equipment of this class.

Although several different types have been built in the last four years, they have simply shown the evolution of the original idea.

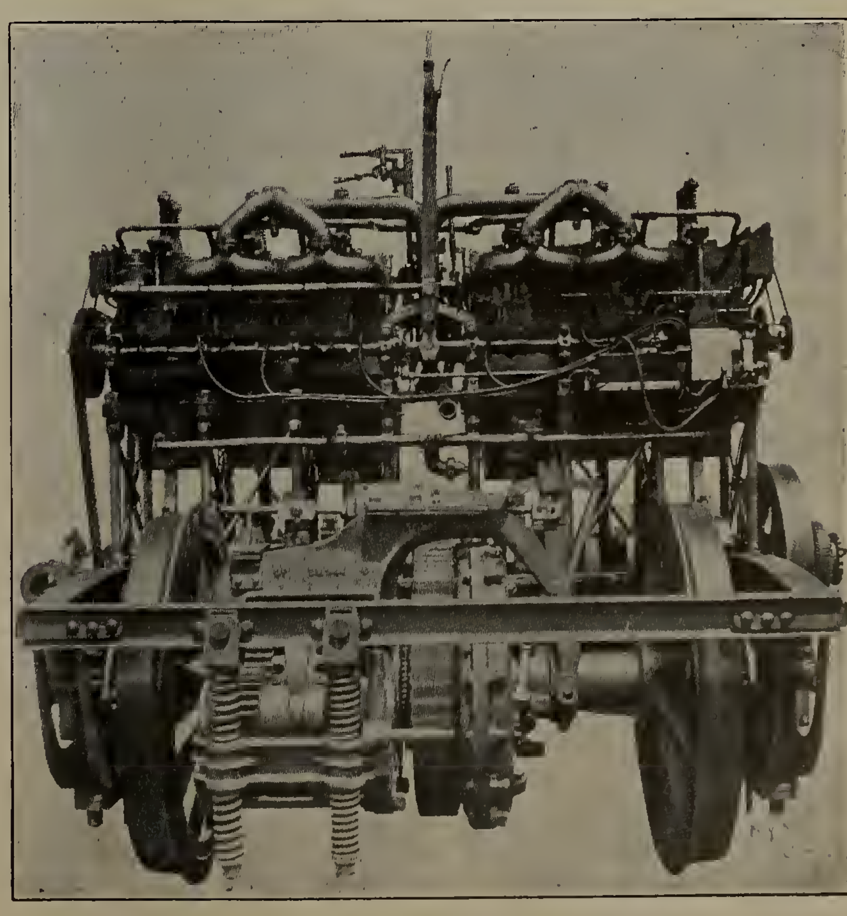
The cars now being built are 70 ft. in length with compartments for engine, baggage, railway post office, if desired, smoking compartment and passengers.

The shops fitted for the building of these cars have been provided with special machinery for the purpose of making parts interchangeable and by the most improved methods, so that by the use of the best material, failures and breakage upon the road shall be minimized.

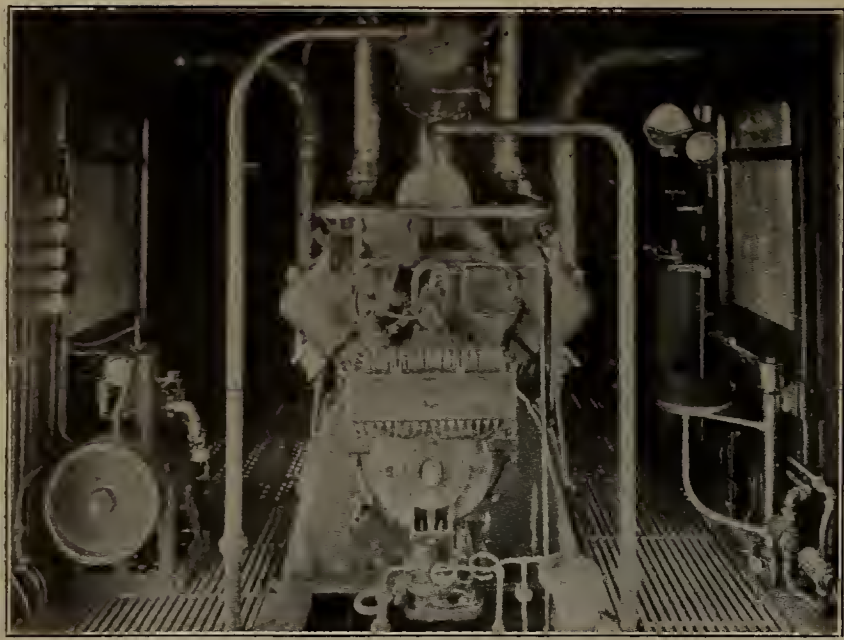
The fact that the entire works are given over to the manufacture of these cars has produced, in four years, improvements which could not have been expected in a much longer time, had the building of an occasional car been an incident in shops maintained for other classes of work.

The interior partitions are, of course, dependent upon the requirements of the service and locality. It is quite generally considered necessary to provide facilities for handling baggage with the passengers, so that practically all cars are equipped with baggage room, unless the amount of baggage and express justifies the hauling of a trailer, when the car itself can, of course, be devoted exclusively to the seating of passengers.

What appears as the accepted arrangement for motor cars is followed, the engineer and engine, occupying the front of the car, which is carried upon a four wheel truck as shown in one of the illustrations. The six vertical cylinders are placed over the center of the truck and drive a shaft located between and parallel to the axles of the front truck. Connection between the engine axle and the axle carrying the driving wheels is made by a 5-in. silent-running chain, plainly seen beside the friction clutch on center of front axle. Compressed air is used to start the large engine as well as for brakes, elevation of gasoline from tanks below the car to the engine, whistle, etc. The air is supplied by a small compact air compressor, which is started easily by hand. The stored air from the reservoir is admitted to the regular cylinders until the carbureter charges the engine sufficiently to commence explosions.



McKeen Motor Truck.



General Electric Motor Car Power Plant.

After the engine is started, the friction clutch working in connection with the counter shaft giving powerful low speed applies the power to start the car, after which the counter shaft is disconnected and speed manipulated by increasing or decreasing the supply of gasoline. This low speed connection is used only in starting and moving the car about its length. There are no gears in service except during this brief period. The six cylinders of the standard engine rated as 200 horsepower, are 10 ins. in diameter with 12-in. stroke. The cylinders have water jackets cored in the casting, the water being cooled by radiators under the car in hot weather and as much as may be desired used for heating the car in cold weather. One of the cars in switching service handled a 40-ton car of coal weighing 111,300 lbs., gross, upon a trestle up an 8 per cent grade, while upon level track, speed up to 79 miles an hour has been made.

The weight of this 70-ft. car in working order is 68,000 lbs., about 42,000 lbs. of which is upon the front truck and approximately 25,000 lbs. upon the 42-in. drivers, which are the lead wheels of the front truck.

The evident demand for satisfactory motor cars shown by the interest taken in all developments announced through the railroad journals, have enlisted the attention of the General Electric Company. It believes that the production of steam as a source of power is unnecessary and has adopted an 8-cylinder, 4 cycle gasoline engine of 125 horsepower at 550 revolutions per minute direct connected to an 8 pole 80 kilowatts 600 volts commutating pole generator and direct coupled with 3½ kilowatts 32 volts exciter, as shown in one of the illustrations.

The cylinders are 8 by 8 ins. with water jackets cored in close grained grey castings and are cooled by thermo siphon circulation, having radiation of 2,000 sq. ft. surface located on roof of car. The bearings throughout consist of bronze cages lined with babbitt. All valves are of nickel steel. Automatic force feed lubrication is applied to all wearing surfaces. Ignition is by high tension magneto and plugs, gasoline being supplied by a plunger pump directly driven by the engine. The gasoline is carried in a steel tank holding 90 gallons, located below the car floor and is filled from the outside. Power is applied to both pairs of wheels of the forward truck through two 600-volt 100 horsepower railway motors. A special controller is furnished by which the motors are placed progressively in series and parallel, and the voltage applied to them controlled by varying the strength of the generator field.

If desired, the car can be furnished with a trolley for city work, using the same motors. The car is finished with the usual equipment for controlling the air brakes, electric lights, whistle, gong, etc. Compressed air is used to start the main engine through admission to the main cylinders and is regularly furnished by a small 4 x 4 in. single cylinder pump driven from the main crank shaft. If the car stands long enough to lose its supply of stored air, it can be charged by a small independent pump.

The car can be started, stopped and reversed without stopping the engine, and by a simple arrangement of the circuits, the power furnished the motors is under such control that the greatest flexibility is obtained, such as might be obtained with an unlimited number of gears but without the objectionable jar frequently occurring when gears are changed.

The weight of the car exhibited at Atlantic City in June, 1909, which measures 50 ft. over all with steel body, is given as 70,000 lbs., of which about 45,000 is on the motor truck.

A different arrangement of the gasoline engine for electric production and application using accumulators is shown in the Strang gas-electric car. As a substitute for the mechanical transmission of power direct to the drivers, the Strang Gas-Electric Car Co., New York, has built four cars, each of which is furnished with a generator of about 150 horsepower at 425 revolutions per minute, furnishing electric power. A vertical 4-cycle type engine with six cylinders, 10½ x 9 ins., in connection with a generator of 85 kilowatts furnish direct current at 250 volts. This apparatus is also shown in one of the illustrations.

The power is applied to both axles of the front truck by 100 horsepower motors. When not in motion, any surplus current generated is stored in a battery of 112 cells, having a capacity of 300 ampere hours. High grade material has been utilized and all the main working parts are located in the crank case which is completely enclosed to retain oil and exclude dirt. The various bearings are oiled by means of a rotary gear pump. Ignition is of the high tension type. The cylinders are jacketed for water circulation connecting with radiators upon the roof which is designed so as to conceal them. The circulation is secured by a turbine pump driven by independent 2 horsepower motor, shown at right.

In general, relative to the mechanical construction and economy alone of motor cars, it seems fairly well conceded that for motor cars of 80 h. p. or over steam possesses a great number of advantages in the way of flexibility, reliability and cost of operation and maintenance. For cars of less than 80 h. p., the internal combustion motor shows a smaller cost of operation. There are, however, numerous other features which must be taken into consideration in determining the class of motor to be used in any particular case, but which are outside the field of the present consideration.

Strang Gasoline Electric Motor Car Power Plant.

Apprenticeship System of the Grand Trunk

The problem of effectually supplying the ever-increasing demand for skilled and thoroughly trained mechanics has been constantly in the foreground and for some years past has caused a great deal of anxiety to the heads of all large industrial corporations.

The Grand Trunk Railway some years ago pioneered a movement which has since occupied the attention, to a greater or lesser extent, of the officials of all the great railroads of Canada and the United States, as well as the largest manufacturing firms in both these countries, namely, the technical training of their apprentices.

The average boy, who from force of circumstances had to leave school in the early stages of his education and take up his life work, had little to look forward to in the matter of education, except by years of unremitting toil, unassisted, unrewarded, and finally arriving at a smattering of a few primary subjects imperfectly learned. Night schools filled some of the requirements, but attendance whilst beneficial was mostly drudgery, owing to the subjects taught not bearing directly on their daily work.

With this problem before them, the Grand Trunk Railway several years ago started a class for its apprentice boys, who were eager to learn; commenced to teach subjects which at once aroused interest among the boys, bearing as it did on the every-day needs of mechanics. In a surprisingly short time, the desire for knowledge being whetted, it was found necessary to increase the scope of the teaching, as the apprentice boy of the day saw within his grasp the very highest position of responsibility in the management and operation of the road. He realized that here was an opportunity to obtain an education little short of a college course, with a minimum exertion on his part and at the same time be independent and self-supporting.

From the commencement on a small scale, the system has grown until at the present time these technical schools are located at the important centers on Grand Trunk system and hundreds of scholars are enrolled, while every large railway system of this continent boasts several graduates of the G. T. training schools as their mechanical engineers, and more than one of our largest industrial concerns have graduates as their chief draughtsmen.

The subjects taught are graded to suit the student's ability and in dozens of cases boys who left school when in the second grade can now do problems which would tax the powers of a high school graduate. The subjects taught comprise everything from simple arithmetic to higher mathematics, mechanics, machine design and mechanical drawing.

Encouragement is given the boys to learn by a number of prizes donated annually, open to competition to all classes on the system, and include free scholarships in engineering at McGill University, as well as cash prizes. These prize competitions are held at different centers to which the best students at the several centers are invited. The appreciation of individual promotions forms one of the strongest features in the system and serves to keep alive the keenest interest in the classes, as the boys realize that as soon as they arrive at a certain standard of excellence, increased pay is their reward. Students of political economy see in this system, as it is being carried out, the future supply of skilled mechanics, master mechanics, superintendents, etc., being husbanded, and an effective solution to the labor problem, namely, the prompt recognition of individual merit.

For two evenings per week during the fall and winter months the apprentice must attend mechanical drawing classes, study of practical mechanics and elementary electricity, competent instructors being provided. On the staff

Grand Trunk Apprenticeship Diploma.

Cutting Flues, Grand Trunk Apprentices at Montreal.

are two graduates of American and Canadian engineering colleges, Purdue and McGill. The work in the drawing class is outlined in a special text book written by the company's chief draughtsman at Montreal, who is also the author of the book used on practical mechanics. During the term frequent examinations are held, and the points gained by each boy are posted so that they may all keep advised as to just what progress they are making, and thereby be able to brush up the weak spots that the examinations have disclosed.

The master mechanic is constantly in touch with each boy's progress and standing, and if necessary he frequently calls a boy up, and in a kindly manner points out to him the necessity of applying himself more consistently to bring his rating up to the required standard.

The annual competitive examination is always conducted by the company's chief draughtsman from Montreal. Prizes are awarded to the apprentices obtaining the highest average in their respective years. These prizes amount to $40 for each shop, and are distributed over the different years of apprenticeship, thus: the apprentice obtaining the highest average for his first year in mechanical drawing gets $4, and the one obtaining the highest in practical mechanics gets $4 also. Therefore, it is quite possible for one apprentice to obtain both prizes. A keen interest is taken in this examination, which takes the form of a contest between the various shops.

In addition to the prizes as stated above there is a capital prize offered of $25 for each subject. This is competed for by the apprentices obtaining the highest averages in drawing and practical mechanics at their respective stations. These apprentices are given a trip to some point on the system where the final examinations are held, and the one receiving the highest number of points in each subject receives the amount stated. This, in addition to what he has already received at his station, will make a total of $29, $33 or $58, if he has been successful in all subjects.

After the season has closed, the boys at some of the large shops hold what is termed "Apprentice Night." This is the social event of the season. Each one makes a drawing, which is neatly inked in. This is placed on exhibition, and the prizes are awarded for each year of apprenticeship. These prizes amount to $2.50 for the first prize, and $1.50 for the second prize. There are also prizes offered for special colored drawings amounting to $3 for first prize, and $1.50 for second prize. This may be competed for by any apprentice, irrespective of his year, and considerable interest is manifested by those of artistic ability.

The form of apprenticeship which has been adopted by the Grand Trunk Railway System has been in successful operation for a number of years and has been the means of supplying that company with skilled mechanics in satisfactory manner. All apprentices are indentured to the machinist's trade for five years, and to blacksmith's, boilermaker's or other trades for four years. Five cents per day is deducted from the wages of each apprentice, and the total amount is returned to him at the expiration of his apprenticeship, with an addition of $25 as a bonus if services have been entirely satisfactory.

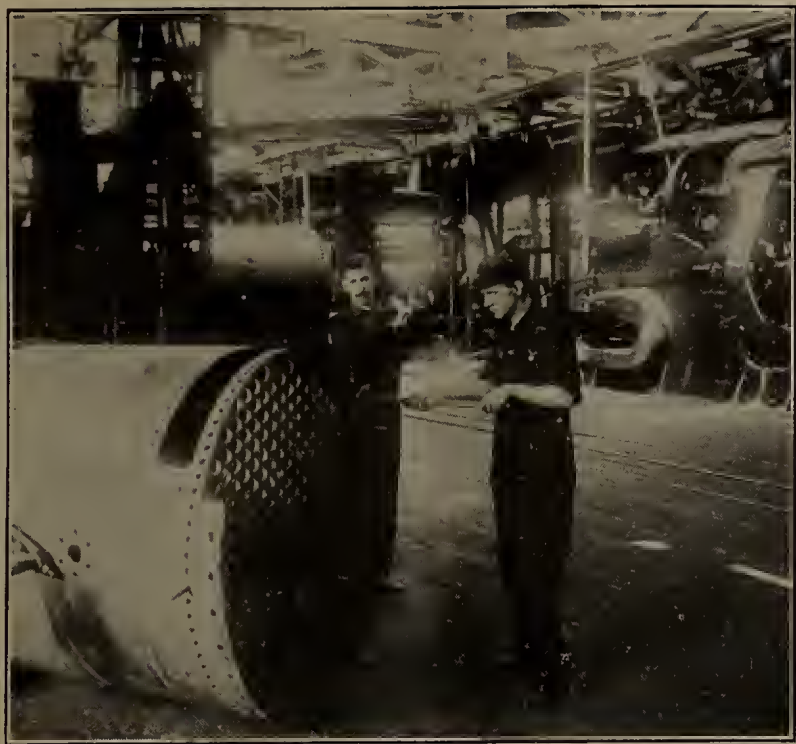
The first requisite in employing an apprentice is to know that he is morally, physically and mentally capable of filling the requirements of a mechanic. To ascertain this the apprentice is required to make his application direct to the master mechanic or the general foreman, and to be not under 15 or over 18 years of age. He is required to undergo a medical examination so as to assure the head of the department that he is healthy and likely to be able to follow up the trade after he has completed the term of apprenticeship. This information being satisfactory, he has to pass an examination in the master mechanic's or general foreman's office. This is usually conducted by the chief clerk or some person specially appointed for that purpose.

The apprentice after having passed a successful examination is provided with a text-book for his instruction and guidance. This book contains examinations for the apprentice for each promotion he takes while serving his apprenticeship, and if he fails in any of these examinations he is set back to his old position for another term and the next apprentice in turn is promoted ahead of him, provided the next apprentice passes a satisfactory examination. When another promotion is necessary the apprentice who failed is given another opportunity to qualify. If he fails the second time he is either dismissed from the service or given some minor position he is capable of filling outside of the trade, as it is concluded that he is either not sufficiently intelligent or too indifferent to make a mechanic.

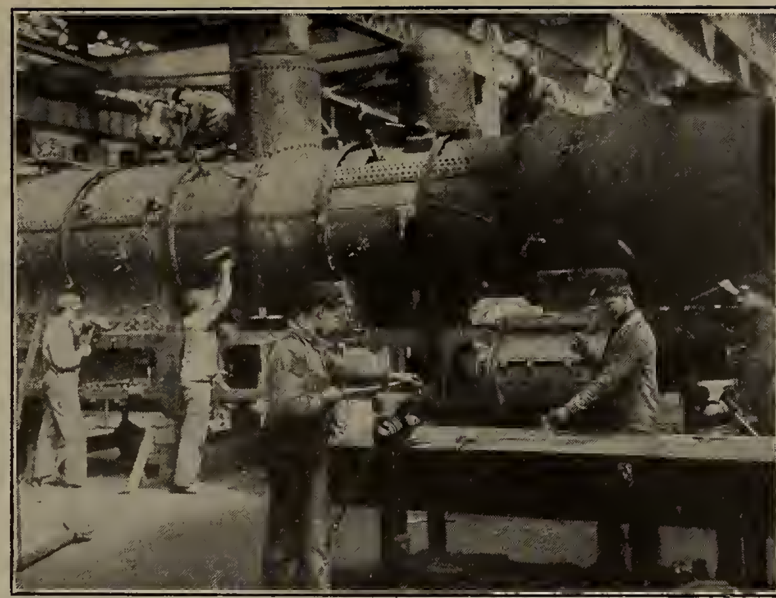
After passing the first or entrance examination in the master mechanic's or general foreman's office, the apprentice is sent out to the boiler, blacksmith or coppersmith shops, or other shop as may be required. He stays there from six to nine months, and is taught to be active and obedient, and to prepare himself for future promotions.

When a boy is to learn one branch of the business only, for instance, boilermaking, blacksmithing, steam-fitting, etc., he is only required to serve four years, but if he is to learn the machine work and fitting, he is required to serve five

Pattern Maker Apprentices.



Boiler Maker Apprentices at Montreal.



Apprentices in Charge of Recent Graduate, Stratford Shops.

years and all the machinists' apprentices are indentured for five years. In the case of any apprentice learning boiler-making or blacksmithing, he is required to pass an examination in the master mechanic's office and the first examination in the apprentices' rule book, as it is deemed necessary to have the information contained therein for any branch of the service, and in the case of these four-year apprentices being few in number after the first examination, in comparison to the machinist's apprentices, they are instructed in their business by the foreman in charge, and each year they are required to pass an examination in drawing before receiving their advance in wages, the same as machinists' apprentices.

The object of the text book is to have the boy theoretically conversant with the work that is going to be done by him after his next promotion. For instance, a boy going from the blacksmith to machine shop has to pass his examinations before he is accepted in the machine shop, which is called "Examination for promotion of apprentices from other shops to the machine shop." As he is usually put on a drill to commence with, by studying his text book, he learns considerable about it, and also the tools he is to use in connection with it. The same practice is followed throughout the whole term of apprenticeship, and while the apprentice is working at one machine he is studying as much as possible about the machine he is to go on next. One of the great advantages of this system is that it gets the apprentice thinking, and leads him to reading up in line with his work.

The indenture system has been found of great advantage, both to the company and the apprentice. It has a tendency to keep the apprentice satisfied and steady his energies along the required lines. It also prevents him from being tampered with by outside firms or corporations who desire to obtain the services of the boy as soon as he has become useful to the company who has instructed him. At the completion of his term each apprentice receives a certificate showing that he has served as an apprentice and as a mechanic in the branch of trade to which he was apprenticed.

An apprentice is required to serve five years at the following rates: 8c, 10c, 12c, 15c and 17c per hour. Before he is granted each years' advance he is required to pass a written examination on shop work, also make a drawing of some detail part of a locomotive, as specified in the apprenticeship book, which examination and drawing must have the approval of the master mechanic and the superintendent of motive power before his advance is allowed.

The above system insures thorough education in all details of the trade, and while some of the work may be specialized it is not done by the apprentice until he becomes a journeyman. For instance, the apprentice comes from the boiler shop to the machine shop, from the machine shop to motion bench, to the side rod bench to the axlebox gang, to the steam pipe gang, to the valve gang, and finally to the erecting gang, so that after an apprentice is out of his time he is a specialist in any one of these branches.

This system of apprenticeship on the Grand Trunk has also been found to be the means of parents giving their sons who desire to enter the service, a better education than formerly. Before its adoption the only requirements was that the boy had to be 15 years of age. It was found that parents took their boys away from school at 12 or 13

Apprentices at Stratford Shops.

Apprentices in Bolt Department, Stratford Shops.

years of age, and put them at some other work until old enough to enter the Grand Trunk shops. When the examinations were first inaugurated quite a number of the boys were turned down, and had to go back to school again before they could qualify to enter the service. This has not only resulted in prospective applicants getting a better education, but has elevated the moral standing of the apprentices' work, and made the system attractive to boys who have passed the high school entrance examination, and who, although well advanced along the lines of school education, adopt the mechanic's trade in preference to other pursuits.

The success of the apprenticeship system is imperatively dependent upon the careful management of the examinations, and the compulsory attendance at the classes provided by the company for their education. An apprenticeship record is also kept. This is filled out by the chargeman under whom the apprentice is working, is scrutinized by the foreman, and then forwarded to the master mechanic.

The Railway Business Association

It is now sixteen months since the manufacturers of equipment, material and supplies organized the Railway Business Association. With characteristic energy and enthusiasm, the members of this craft have responded to every call, and gone after the desired result with the same determination and optimism that they are accustomed to display in their business. The members of the general executive committee have given ungrudgingly of their time and thought for consultation, many of them having to travel long distances to attend the conferences. The plans mapped out by the committee and suggested to the membership have been eagerly seized and carried out in a way that makes success certain.

In view of the cordial reception accorded by the public and by legislative bodies, the question now most often asked is why this vast economic force did not sooner band together in its own interest. It has made men think, it has encouraged caution and wisdom both as to ways of regulating and as to ways of explaining proposed measures which those to be regulated may regard as unwise. All this the association has done without calling names or questioning motives. It has regarded its function as that of promoting good nature. Salesmen, it is pointed out, are trained in the art of friendliness. The Railway Business Association has endeavored to become a sort of "Smile Combine."

George A. Post.

The railway officials had nothing to do with forming the association and contribute nothing to its treasury or its management. They early appreciated that any influence which the supply craft might exert would depend upon maintaining entire independence of the railroads. The manufacturers have a different training from that of the railroad official, and have a point of view of their own derived from their commercial necessities and experience as to how difficulties are best met and overcome. They have gone right at the problem of railroad regulation just as they have been accustomed to encounter problems in their own business by going and seeing the other fellow, making his acquaintance, gaining his confidence and asking nothing that was not fair.

The technical discussion of specific bills they leave to the railroad managers. The manufacturers point out that there is a widespread and growing disposition of the carriers to acknowledge the desirability of regulation and a frank and open attitude in stating facts as to the probable effect of proposed restrictions. This attitude they ask the legislators to welcome, which they are doing; and, as a member of the association, would put it to "Find out whether the bill would reduce the ability of the railroad to buy our goods."

We present portraits of some of the gentlemen whose names appear on the following list of officers of the association:

President.

George A. Post, President, Standard Coupler Co., 2 Rector St., New York City.

Vice Presidents.

H. H. Westinghouse, V. P., Westinghouse Air Brake Co., 165 Broadway, New York City.

O. H. Cutler, Pres., American Brake Shoe & Fdy. Co., 32 Cortlandt St., New York City.

W. H. Marshall, Pres., American Locomotive Co., 30 Church St., New York City.

E. S. S. Keith, Pres., Keith Car & Mfg. Co., Sagamore, Mass.

A. H. Mulliken, Pres., Pettibone, Mulliken & Co., 725 Marquette Bldg., Chicago, Ill.

O. P. Letchworth, Pres., Pratt & Lechtworth Co., Buffalo, New York.

W. G. Pearce, V. P., Griffin Wheel Co., 600 West Union Bldg., Chicago, Ill.

Treasurer.

Charles A. Moore, Pres., Manning, Maxwell & Moore, Inc., 85 Liberty St., New York City.

Secretary.

Frank W. Noxon, 2 Rector St., New York City.

Executive Members.

Col. H. G. Prout, V. P., Union Switch & Signal Co., Swissvale, Pa.

J. S. Coffin, Pres., Franklin Railway Supply Co., 30 Church St., New York City.

E. L. Adreon, V. P., American Brake Co., St. Louis, Mo.

J. H. Schwacke, 1600 Hamilton St., Philadelphia, Pa.

A. M. Kittredge, Pres., Barney & Smith Car Co., Dayton, Ohio.

Major John F. Dickson, Pres., Dickson Car Wheel Co., Houston, Texas.

W. B. Leach, G. M. & Treas., Hunt-Spiller Manfg. Corp., 383 Dorchester Ave., Boston, Mass.

Alba B. Johnson, V. P. & Treas., Baldwin Locomotive Works, 500 No. Broad St., Philadelphia, Pa.

E. B. Leigh, Pres., Chicago Ry. Equipment Co., 46th St., Chicago, Ill.

James Viles, Treas., The Buda Company, 637 Ry. Exchange Bldg., Chicago.

W. E. Clow, Pres., James B. Clow & Son, 342 Franklin St., Chicago, Ill.

H. Elliot, Pres., Elliot Frog & Switch Co., East St. Louis, Ill.

W. O. Dodd, Pres., Natl. Lock Washer Co., Newark, New Jersey.

W. H. Whiteside, Pres., Allis-Chalmers Co., Milwaukee, Wis.

W. H. Miner, Pres., W. H. Miner Co., Chicago.

Oliver Crosby, Pres., American Hoist & Derrick Co., St. Paul, Minn.

W. P. Worth, Treas., Worth Brothers Co., Coatesville, Pa.

W. H. Marshall.

Frank W. Noxon.

O. H. Cutler.

We publish below a few short biographical sketches of those who have helped make the Railway Business Association what it is:

George A. Post, the president, is also president of the Standard Coupler Co. of New York. He was born Sept. 1, 1854, at Cuba, Allegheny county, N. Y. His youth was spent at Owego, Tioga county, N. Y., and his education obtained in the public schools, the Owego Academy and the Oswego Normal school. Removing to Susquehanna, Pa., at 18, he entered the freight service of the Erie R. R., subsequently becoming assistant to the superintendent of motive power. For about 10 years Mr. Post was actively identified with politics as a democrat. He was elected mayor of Susquehanna at 22, candidate for presidential elector at 26, and elected a member of the 48th Congress in 1882 at 28, being the youngest member of that body. While in the employ of the Erie R. R. he read law nights and was admitted to the bar of the Supreme Court of Pennsylvania. For several years he was a member of the democratic state committee and chairman of the Susquehanna county committee, was a delegate to the National convention of 1884 and chairman of the state convention of 1885. He was secretary of the democratic Congressional committee in 1886. Mr. Post was editor and part owner of the Democrat, published at Montrose, Pa., from 1883 to 1889, when he moved to New York, where for two years he was connected with the World. In 1892 he entered the railway supply business as vice-president of the Standard Coupler Co., of which since 1894 he has been president. After 10 years devoted wholly to business life, Mr. Post in 1904 was chairman of the Executive Committee of Railway Supply Manufacturers in connection with the conventions of the Master Car Builders and the Master Mechanics, and was active in effecting the permanent Railway Supply Manufacturers' Association in 1906. In 1905 he was chairman of the American Railway Appliance Exhibition in connection with the International Railway Congress at Washington, D. C., an event which made the railway supply craft more prominent than ever before. Mr. Post in 1908, together with Charles A. Moore, Otis H. Cutler and J. S. Coffin, signed the call which resulted in the formation of the Railway Business Association. He became its first president and is now serving his second term. He is vice-president of the Machinery Club of the city of New York, and a member of the Council of the Pennsylvania Society of New York. He lives at Orange, N. J.

Frank W. Noxon, the secretary, has had an extended experience in newspaper work, both as editor and special contributor. He has been engaged for about 15 years in newspaper work in

E. S. S. Keith.

A. H. Mulliken.

C. A. Moore.


O. P. Letchworth.


E. L. Adreon.


J. S. Coffin.

Boston, having been connected with the Advertiser, Traveler and Herald, where he did able and effective work in connection with public movements, on which he has won high encomiums from important people. He began writing for the Herald, in Syracuse, his birthplace, in 1892.

Alfred H. Mulliken, vice-president, was born in Augusta, Me. He came to Chicago and entered the service of Crerar, Adams & Co. as office boy in 1868. He started a railway supply business in 1880 which was sold to Crerar, Adams & Co. in 1885. Mr. Mulliken then engaged in the manufacture of track tools, frogs and switch material. His work since is well known history of the firm of Pettibone, Mulliken & Co. one of the largest manufacturers of frogs and switches in the world.

Charles A. Moore, treasurer, was born at West Sparta, N. Y. During the civil war he served in various capacities in the United States Navy, and later went to Boston, where he engaged in the business of selling engineering specialties. In 1880, having secured control of the business of the Ashcroft Manufacturing Co. and the Consolidated Safety Valve Co., he brought the business to New York, moving the factories to Bridgeport Conn., and combined these interests with those of H. S. Manning & Co., forming the well-known firm of Manning, Maxwell & Moore. In 1895 Mr. Maxwell died, and Mr. Manning having retired in 1905, Mr. Moore incorporated the business into a five-million-dollar corporation, Manning, Maxwell & Moore, Incorporated, of which he is president and controlling owner. The business of this company is the manufacturing and selling of machine tools, electric cranes, boiler fittings and supplies, with headquarters in New York City, and branches in fourteen principal cities in the United States, Mexico, Japan, China and the Philippine Islands. Mr. Moore has gained considerable prominence politically, and has been repeatedly offered nominations as mayor of the old city of Brooklyn (where he made his residence for many years) and of Greater New York. He was a warm friend of William McKinley and Mark Hanna, and was one of the two messengers who delivered the official vote of the State of New York at Washington, at the time of McKinley's first election. For nine years Mr. Moore has been president of the American Protective Tariff League.

Col. H. G. Prout, executive member, and vice-president of the Union Switch & Signal Co., was born in Fairfax county, Va. His early work was hard and when in 1863, he enlisted in a Massachusetts regiment, his constitution was well prepared to withstand the rigors of military service. He was mustered out in 1865 and entered the University of Michigan in 1867 which he left in the middle of his senior year. He was later given his degree as a civil engineer after several years of active life. He served as an engineer in the War Department of the United States and then went to Africa and there, during his stay of about five years, was advanced to the grade of colonel

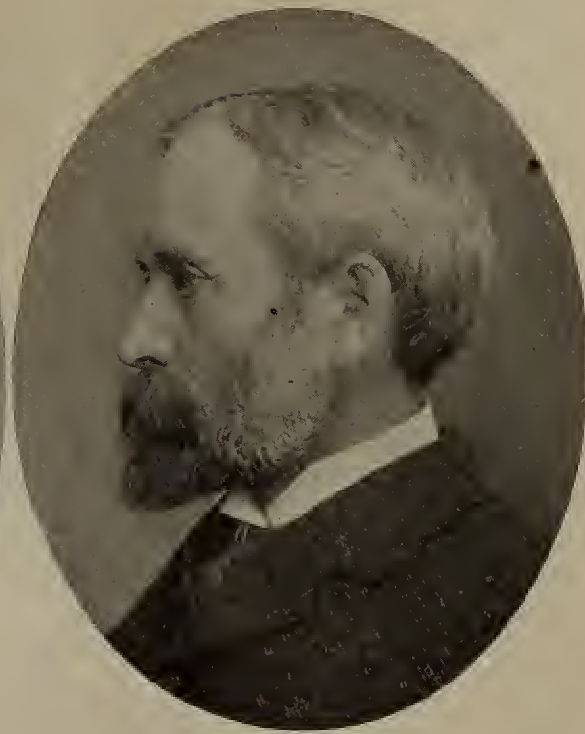

Oliver Crosby.


A. B. Johnson.


W. B. Leach.

A. M. Kittredge.

E. B. Leigh.



H. G. Prout.

in the General Staff of Khedive of Egypt. After his return to America he was, for a little over a year, signal engineer to a company out of which grew the Union Switch & Signal Co. He engaged for a few years in business in the city of New York and in 1887 became editor of the Railroad Gazette, which position he held for sixteen years. He left the Gazette in 1903 to become vice-president and general manager of the Union Switch & Signal Co., which position he has held to date. In the words of one of his assistants "Whatever Colonel Prout has done since 1903 is well known history of the Union Switch & Signal Co."

A. M. Kittredge, executive member, was born in Dayton, Ohio, in 1854. He became an apprentice in the sheet iron business at the age of 16, became foreman immediately upon the expiration of his apprenticeship and was later made superintendent of a large factory which position he held until 1877. After this until 1884 he covered the territory west of the Ohio and east of the Mississippi as a salesman for the H. W. Merriam Shoe Co. In 1884 he accepted a position with the Barney & Smith Car Co., became assistant superintendent of the plant in 1886, superintendent in 1888, vice-president in 1900 and president in November, 1908. During his connection with this plant the amount of business has increased its volume ten times. The Barney & Smith Car Co. now employs 3,500 men, and manufactures all classes of railroad cars from the most elaborate sleeper to the plainest freight car, in either wood or steel construction or composite construction.

Edward B. Leigh, executive member, is president and general manager of the Chicago Railway Equipment Co. He was born at Townsend, Mass., in 1853, and moved to St. Louis, where he secured his education at Washington University, in 1855. He was prominent in the grain elevator business in St. Louis in which he associated until 1882 when he became manager of the American Air Brake Co. He organized the National Hollow Brake Beam Co. of Chicago in 1888, of which he was manager until January, 1902, when he assisted in organizing the Chicago Railway Equipment Co. (which succeeded to the business of the National Hollow Brake Beam Co.) and has since been president, general manager and treasurer.

W. B. Leach, executive member, served an apprenticeship to the machinist's trade at the Old Colony railroad shops in South Boston, Mass. After working in various positions as machinist, assistant foreman, foreman, shop foreman with additional duties, for a couple of years as foreman in charge of wreck train, until 1896, he was offered a position as general foreman of the N. Y. N. E. shops at Norwood, this road two years later being absorbed by the N. Y. N. H. & H. R. R. R. He continued in that capacity until 1902 when he was offered and accepted a position on the Boston & Albany R. R. as master mechanic of the Albany division with headquarters at West Springfield, Mass., remaining there until January 1, 1904, just before which time he was offered the position of general manager and treasurer of the Hunt-Spiller Manufacturing Corporation, accepting the position on Feb. 1, 1904. Under his efficient management the business of this concern has steadily increased, until now its product, then little known, is used by railroads all over the country.

John F. Dickson, executive member, is president of the Dickson Car Wheel Co., of Houston, Texas. A detailed account of Mr. Dickson's services to conservatism in railroad regulation would make a long story. In brief by making the acquaintance of all the representatives and senators in the Texas legislature, by sending them circulars, cartoons and letters he exerted a great influence and was undoubtedly instrumental during 1909 in bringing about the celebrated series of adjournments without action in successful extra sessions called by the Governor expressly for the purpose of carrying through an elaborate anti-railroad campaign of legislation.

Edward L. Adreon, executive member, was born in St. Louis in 1847 and was educated in Wyman's St. Louis University. He entered the office of city comptroller of St. Louis in 1865 and remained there twenty years, the last eight as comptroller, to which position he was twice elected. Since April, 1887, he has been vice-president and general manager of the American Air Brake Co., St. Louis, and since August, 1888, southwestern manager of the Westinghouse Air Brake Co., and the Westinghouse Traction Brake Co. He is vice-president of the Broadway Savings Trust Co., secretary and treasurer of the Westinghouse Automatic Air & Steam Coupler Co., director of Adreon & Co. and of the Chicago Railway Equipment Co.

Alba B. Johnson, executive member, was born in Pittsburg, Pa., in 1858. He secured his education in the public schools of Philadelphia, graduating from Central High School in 1876. He entered the service of the Baldwin Locomotive Works the following year, and has been continuously identified with them since then, with the exception of about two years, 1878 and 1879, spent at the Edge Moor Iron Works, of Wilmington, Del. In 1896 Mr. Johnson entered the firm of Burnham, Williams & Co., successors to Burnham, Parry, Williams & Co. On July 1, 1909, the firm was incorporated as the Baldwin Locomotive Works, when Mr. Johnson became vice-president and treasurer. He is a director of the Standard Steel Works Co., of the Fourth

Street National Bank, and of the Pennsylvania Company for Insurance on Lives and Granting Annuities. He is also a trustee of Jefferson Medical College and Hospital.

Joel S. Coffin, executive member, was born in St. Clair county, Mich., in 1861. His business career began at a very early age and his first occupation was in the lumber woods of northern Michigan, where he learned the trade of blacksmith. In 1876 he entered the shops of the Chicago & West Michigan R. R. at Muskegon, Mich., as a machinist's apprentice. After completing his apprenticeship in 1880 he began firing a locomotive on the same road and in a short time thereafter was promoted to the position of engineer. Beginning in 1884 he ran an engine on the Wisconsin Central Ry. and in 1889 was promoted to the position of general road foreman of engines. In 1892 he entered the service of the mechanical department of the Galena-Signal Oil Co. and in 1897 was made manager of that department. In 1907 Mr. Coffin was elected vice-president of the Galena-Signal Oil Co., and in January, 1909, resigned that position to accept the vice-presidency of the American Brake Shoe & Foundry Co., which position he now holds. In addition to Mr. Coffin's connection with the American Brake Shoe & Foundry Co. he is president of the Venango Manufacturing Co. of Franklin, Pa., and the Franklin Railway Supply Co. of New York.

The Failure of Brass Locomotive Tubes*

Having exhausted all the usual methods of investigation into the cause of the frequent bursting of the brass locomotive tubes, which form the subject-matter of this paper, the engineer and managing director of the concern for which the investigation was made, considered that further enlightenment was necessary, and the author was instructed to endeavour to discover the cause of repeated disasters which ended in serious casualties and Government inquiries.

The first tube submitted to the author was received in two parts, the larger 3 ft. 5 in., and the other 2 in. over all. The pieces fitted one another along a line of fracture. The tube had been externally scraped and wiped, so that the metallic surface on the outside was exposed. A working pressure of 160 lb. per square inch was carried in the boiler in which the tube was fitted.

The outside of the tube in contact with the boiler water was quite free from corrosion of any kind. The inference is that the boiler water was free from substances capable of corroding the alloy (70/30 brass) of which the tube was composed.

No part of the exterior of the tube exhibited evidence of having been "burnt"—*i.e.,* over-heated and oxidised. The inside, however, was much corroded from end to end; the greatest corrosion had taken place near the fracture, which, in place, lay nearest the fire-box. The walls of the central and least-corroded portion of the tube were 0.1 in. thick. About the area of fracture the least measurement gave a thickness of only 0.038 in. The whole of the interior of the tube was coated with a lightish-green salt, practically insoluble in water, but easily in dilute sulphuric acid. A further investigation of this salt scraped from the interior led to the conclusion that it was mainly composed of mixed basic sulphates of copper and zinc. After removing the green coating by dilute sulphuric acid a dark-red "scale" appeared, formed of cuprous oxide. Examined under a high magnifying power, this layer of oxide was permeated with the light-green salt referred to.

So far it is reasonable to infer that the cause of fracture of the tube under working pressure was due to:—

1. Corrosion proceeding from the inside towards the outside of tube.
2. That the tube had not been "burnt"—*i.e.,* over-heated and oxidised, as cupric and zinc oxide were absent in the "scale" and salts.

After sawing the tube longitudinally and opening, it was observed that the corrosion was not continuous throughout the length of the tube, being more marked at the ends, and particularly at the fire-box ends, and on one-half of the inside circumference.

An exhaustive microscopical examination (1-in. lengths) of the tube, longitudinally and transversely, was made. The crystal grains were found to be larger at the ends than in the middle parts.

About the area of fracture the crystal size was equivalent to that produced by maintaining a 70/30 brass of equal dimensions at a temperature of 800 deg. Cent. for about ten minutes. The crystal size at the end farthest removed from the fracture was smaller, resembling that of an equal dimensioned piece of brass heated for ten minutes at 700 deg. Cent. The central portions of the tube were normal, both longitudinally and transversely, proving that one tube had been annealed at about 600 deg. Cent.

A peculiarity of the crystals at the seat of breakdown lay in the fact that they were uneven. Those nearest the fracture were much larger than in an area 90 deg. to 180 deg. from it. The boundaries of the largest crystals were corroded, and embraced intrusions of cuprous oxide. Obviously, then, the tube as supplied by the makers was passable as a commercial production. Slight over-heating had taken place at the ends of the tube, possibly for expanding purposes Abnormal over-heating, however, had occurred near the fracture, which, as explained above, abutted the fire-box.

As the temperature of the water due to the boiler pressure used was about 360 deg. Fahr., it might have been advisable to anneal the tube in process of manufacture at as low a temperature as possible. However, the manufacturer is not to blame here, as large crystal grains would have been formed in other portions of the tube had it been unevenly or over-annealed in the mill. The over-heating had taken place after the tube left the manufacturer.

A chemical examination of the coke used as fuel proved it to contain 0.89 per cent of volatile and 0.37 per cent. of sulphur fixed in the ash. Such a coke would supply all the sulphur necessary for bringing about the above results.

The inquest on the tube so far has shown that by over-heating of the ends of the tube, particularly the firebox end, the grain structure has been so enlarged that incipient disintegration has taken place—that is, the texture has been enlarged, and the crystal boundaries become permeated with films of lower oxides, thus undermining the strength of the alloy.

Can the abnormal corrosion be explained? A word or two anent the method of working the boiler. Steam blast was used for producing draught. As coke was the fuel, the interior of the tubes would be subjected to intermittent streams of hot gases containing gaseous sulphur compounds—carbon monoxide and dioxide. The proportion of the latter gases would depend on the size and volume of the fuel in the grate.

Two alternative explanations appear applicable.

The first may be called shortly a "low-temperature" theory.

Allowing the ends of the tube to have become over-heated—the evidence shows them to have attained a temperature much above the melting-point of zinc—it is reasonable to conclude that the zinc of the surface layers of the interior of the tube had evaporated.

A similar result is brought about when rolls of hard brass are subjected to a prolonged annealing in a reducing atmosphere at a temperature about the melting-point of zinc.

As the hot gases passing through the tubes consist chiefly of nitrogen—carbon dioxide and monoxide—the latter would tend at times to maintain a reducing atmosphere and cause cuprous oxide to be formed rather than the higher oxide. The joint

*From a paper by T. V. Hughes, read before the Institute of Metals, Jan. 18, 1910.

action of steam and sulphur dioxide, evolved when the fires were made in the morning or at intervals during the day, using damp coke, coming in contact with the cooled cuprous oxide-covered surface, condense and react, especially if a little cupric oxide was also formed. Thus arise the sulphates—basic in character, as the above investigation shows. The cuprous oxide layer being meshed suggests such formation as following evaporation of one constituent of a crystalline mass. The sulphates being once formed, repetition of the combined actions would cause the corrosion to continue until breakdown of the tube occurred at the firebox end, where the reactions would be most pronounced.

The second may be shortly referred to as a "high temperature" theory.

The evidence shows the tube in certain parts to have attained the temperature of about 800 deg. Cent. Interaction between the hot carbon monoxide, gaseous sulphur compounds, and the copper and zinc of the tube could take place. The tendency would be to form cuprous oxide in view of the metallurgical action of cupric oxide reducing gases and sulphur compounds under the conditions obtaining.

This cuprous oxide would appear to be a vanguard of the attack. The cooler and moist sulphurous gases generated after stoking wet fuel on to the grate would be the rearguard and form the sulphates referred to above. There was no evidence of carbonates in the green incrustation. The heating and cooling of the firegrate would take place several times a day under special conditions of traffic. This occurred regularly on two sections of the route in a fifteen minutes' service. At the top of two gradients of 1 in 17 to 20 the locomotives were brought to a standstill for steam-raising purposes. It appears to have been the habit of the stoker to charge damp coke on to the white-hot bed of fuel in the grate during these stoppages. Thus the cooling and formation of large volumes of carbon monoxide can be accounted for.

The evidence of the contemporary presence of the basic salts of copper and zinc, and particularly of the layer of cuprous oxide in contact with the tubes, negatives the theory that the bursts of the tube followed corrosion of the alloy by impacts of particles of coke and ash, induced by the steam-blast.

As stated above, the tube submitted for examination had been externally scraped and wiped.

On close inspection a chocolate-coloured film could be detected in places.

As the author was not satisfied with the cause of the overheating of the tubes—and as the ends presumably had been expanded in the cold, and no re-heating of any kind resorted to in the loco-shed when fixing new tubes in the boiler—he advised further investigation; and as a result several tubes from the same boiler were sent for examination. They were delivered to the author neither scraped nor wiped. The tubes were externally covered from end to end, where in contact with the boiler water with a chocolate deposit, even and bright. The average thickness of this covering was about 1-10 millimetre. In order to avoid contamination with iron, and to reduce as much as possible admixture of the scrapings with abrasions of the tube itself, a hard copper scraper was used. On scraping it was noticed that the deposit was formed in a series of layers. The innermost, or that nearest to the metal of the tubes, was almost black and very compact. In hardness the chocolate-coloured deposit resembled that of talc. The innermost layer required considerable force to remove it. In fact, it resembled, in general characteristics, a hard varnish. By scraping a large number of tubes, similar in all respects as to the amount and character of deposit, sufficient for a fairly exhaustive analysis was obtained.

A preliminary test proved that up to 100 deg. Cent. moisture only was dissipated from the material. Consequently the bulk was heated at 100 deg. Cent. until constant in weight. A portion of this was extracted with water. The extract yielded chloride and sulphate of lime only. The dried portion was extracted with alcohol. This rendered a soap containing iron, alumina, and magnesia as bases.

The residue after the alcoholic extraction was then extracted with dried ether. On evaporating, a grease, fluid at ordinary temperatures, was obtained. At a later date several pounds of this chocolate-coloured deposit were procured. On more extended investigation this grease proved to be a heavy mineral hydrocarbon. Such is used as a cylinder lubricant. The locomotives from which the tubes were removed were broken up a year or two ago. The author has recently been informed that a quantity of cylinder oil was found in the water-tank, having found its way there by the carelessness of the attendants. The doubly extracted dry residue was subjected to analysis.

In the first place it was incinerated in a stream of purified oxygen and air by the ordinary methods of organic analysis. Weights of carbon dioxide and water were obtained: the former calculated to carbon in carbonaceous matter (as there was not the slightest trace of carbon dioxide apparent on heating the dried substance with dilute acids); the latter assigned to combined water and hydrogen in combination with the carbon most probably.

The residue after combustion was submitted to analysis, with the results given below:—

	Per Cent.
Loss at 100 deg. Cent.—*i.e.,* moisture	2.80
Matter soluble in water (chloride and sulphate of lime)	1.65
Alcholic extract (a soap containing iron, alumina, and magnesia)	1.34
Ether extract (rendering a grease fluid at ordinary temperatures)	0.50
Carbon as carbonaceous matter	5.98
Combined water and hydrogen	15.59
Silica	19.21
Magnesia	16.77
Ferric oxide	13.23
Copper	8.18
Zinc	8.35
Alumina	2.41
Lime	2.45
Sulphuric acid (as SO_3)	1.85
Phosphoric acid (as P_2O_5)	0.32
Chlorides	trace
Alkalies	nil

A few observations on the above analysis are desirable. No salts of either copper or zinc were found in any of the extracts.

A proportion of zinc appears to have been present as basic sulphate. A proximate analysis on a very small quantity led to the conclusion that a portion of the copper found was present in the deposit as an oxide. The balance of the copper and zinc approached the composition of the tube (70/30 brass), indicating that scrapings of the tube itself had become admixed with the sample of "scale." The brass fittings on the boiler might account for some of the copper and zinc. The carbonaceous matter (5.98 per cent.) is apparently that derived from the carbon in the innermost varnish-like layer. There were no carbonates in the "scale," nor were there carbonates formed when the extracted deposit was calcined in the air. Over thirty measurements of the thickness of the "scale" were made. They gave an average of 0.09 millimetre—the maximum being 0.11 and the minimum 0.07 of a millimetre. It was thought that a measurement of the electrical resistance of this deposit would give some indication of its heat conductivity. Consequently the coating on a dry tube was subjected to an electromotive force of 250 volts.

The electrical resistance offered by this coating was 20 megohms. Several measurements were made before the tubes were scraped, with as nearly as possible the same result.

When the coating was damped by a drop of water, where one electrode touched it, the resistance fell to 150,000 ohms only.

The test is instructive as indicating that even when damp and cold, the coating forms an excellent non-conductor of electricity, and, we may reasonably conclude, of heat also.

Since the above investigation was completed several pounds of a chocolate-coloured frothy mass were obtained from stays and bracings in the same boiler. The stuff contained a total of 6 per cent of organic substances extracted by alcohol and rectified petrol.

The peculiar nature of the deposit on the tubes, the author believes, is sufficient to account for the overheating referred to in this paper, and for the corrosion ending in explosion. In this instance we have shown that the material has broken down in the hands of the user, and not by any aberration on the part of the maker. It is noteworthy that the boilers from which the tubes were taken, and others in which similar accidents occurred, were fed with the untreated water supplied under the Birmingham Welsh water scheme.

The author is informed that abnormal breakdowns in the loco-tubes did not occur when the old supply was used for feed-water.

The author does not present this paper to the Institute as a research undertaken in an establishment replete with every convenience and modern apparatus, expensive and otherwise. He therefore trusts it will be received as the outcome of work done in an ordinary laboratory designed to deal with routine investigations of a metallurgical and engineering character, and equipped at his own expense.

Gyroscope Claims Questioned

After a careful consideration of both the advantages and the disadvantages incidental to the use of a single-rail line of gyroscope cars, The Scientific American comes to the conclusion that the ingenious and scientifically sound as the system is, its success as a substitute for that which freight and passengers are now moved will probably be at best a limited one.

What the new cars, it says, would save as to weight, by decreased number of wheels they would lose by the enforced carrying of the gyroscope itself, and as the latter would have to be extremely well made, the cost of the cars would not be decreased. There would be a saving by the elimination of one line of rails, but the one remaining would probably be as expensive as two are now, and it would necessitate expensive changes in roadbed and bridges by the concentration of train weight that is now divided. So far as the passengers are concerned, their comfort, especially in going around curves, would be much increased by the change to the gyroscope cars, but that present speeds could be doubled with safety and economy The Scientific American much doubts.

The only immediate utility of the monorail, gyroscope railroad seen by this authority is for pioneer lines through undeveloped country, especially in mountainous and hilly regions, where many and sharp curves were necessary. These could be traversed with ease by the self-adjusting cars, and later, if the new type should demonstrate in service of this kind its commercial practicability, it might in time be extended to more important lines of travel and finally to the great trunk roads. In spite of its lack of enthusiasm for the gyroscope plan of railroading, The Scientific American disclaims all hostility to it, and expresses high appreciation of the knowledge and skill shown by both the English and the German inventors whose labors have synchronously led to curiously like results.—*Electric Traction Weekly.*

The painting of sills and floors of the wooden flat cars used with unloading plows, at Panama, which has been done for some time past, has so materially lengthened the life of the wood used in these cars that all the flat cars brought into Gorgona shops during December were given a coat of black tar paint on the high side and floor. This experiment is made to determine the effect of painting in preserving the wood on the surface subjected to the wear of the unloading plows.

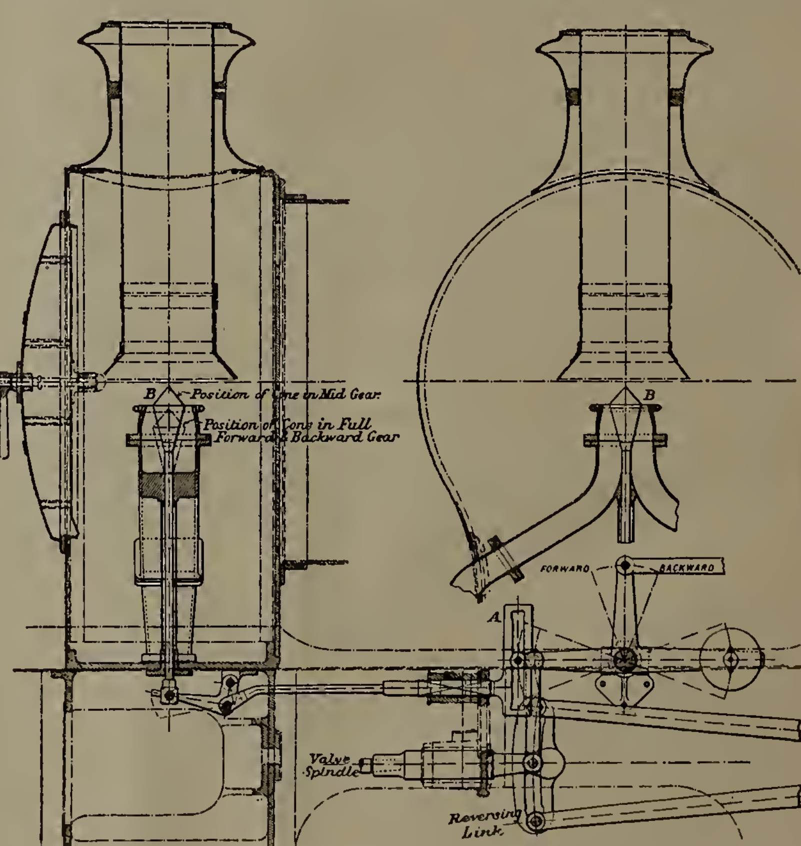
What is said to be the longest railroad train ever drawn by a single engine left Roanoke, Va., on December 17, for Norfolk over the Virginian railway, the H. H. Rogers road. The train consisted of 120 steel coal hoppers, each 44 feet long and each loaded with 50 tons of coal.. A Mallet compound engine, a tender and caboose made up the rest of the train. The train from cowcatcher to caboose was 6 feet more than a mile long and the coal was valued at $18,000.

Considerable work is done by the brake pumps when the locomotive is at a standstill or when the train is running down grade, the steam then used often saying the safety valves from blowing off, while any increase of draft under those conditions is, of course, wasteful of fuel. On one hundred and fifty locomotives of the Lehigh Valley R. R., the brake pump exhaust has recently been changed to deliver outside instead of inside the smokestack. Tests show that the company is saving about 1,000 pounds of coal per locomotive on the descent of the grade from Glen Summit to Penn Haven Junction, twenty-six miles.—Compressed Air Magazine.

Automatic Variable Exhaust Nozzle

The accompanying drawing, taken from Engineering (London), illustrates an interesting device for automatically adjusting the exhaust nozzle of a locomotive with relation to the position of the cut-off. The locomotive was built in Darlington, England, from the designs of Thomas Whitelegg, locomotive superintendent of the London, Tilbury & Southend Ry.

From the illustration the action of the apparatus will readily be understood. It will be seen that there is on the reversing shaft a central arm, having a jawed end, which takes the



Automatic Variable Exhaust Nozzle.

block sliding in a rectangular link A; this link is formed on the end of a rod which passes horizontally into the space below the smoke-box. When the engine is reversed the end of the lever which takes the sliding block in the link A travels in the arc of a circle, and gives to the link a horizontal motion between the points of mid gear and forward or backward gear, as the case may be. This motion is transmitted through a bell-crank and a rod to the cone B at the top of the blast-pipe, the cone thereby altering the size of the annular orifice in this pipe. The action is entirely automatic, the size of the blast orifice being regulated solely by the position of the reversing-lever or gear. When in full gear, either forward or backward, the cone B is lowered and the blast orifice enlarged; whilst when the engine is notched up and less steam is being used, the cone is raised, and the area of the orifice decreased, thereby keeping the strength of the blast up the chimney as regular as possible. The device is a simple one, and it is said to give good results in practice, both as regards fuel economy and the prevention of spark-throwing.

Saving in Use of Oil

A saving of over $500 was made in the use of valve, engine, kerosene, and signal oils on locomotives during the month of December on the Panama R. R., due to the instruction given by the representative of the oil contractor and the work of the commission's two traveling engineers. At Las Cascadas 50 per cent less oil was issued than in November, the saving amounting to over $200. At Pedro Miguel and Balboa the saving over the previous month in the amount of oil and waste issued was over $300. A saving of one load was made in the amount of coal issued at Las Cascadas and Pedro Miguel. These economies were absolute, and in addition to those effected by the instruction given the crews of trains in handling the engines and air equipment.

The Bental & Margedant Co., of Hamilton, Ohio, has recently published a small neatly bound book of wood-working machinery which is something more of a convenience than the ordinary catalog. It lists a complete line of woodworking machine tools in such form as to render the information, so often required, very easy of access.

Recent Development of the Producer Gas Power Plant

By Robert Heywood Fernald, Dept. of the Interior
U. S. Geological Survey.

The rapid advance of the large gas engine during the past few years has been made possible by improvements in the production of cheap gas directly from fuel by means of the gas producer. An early form of producer introduced in Europe, and now in general use both abroad and in the United States, is known as the suction producer, a name suggested by the fact that the engine develops its charge of gas in the producer by means of its own suction stroke. Although many producers of this type are now used, most of them are small, seldom exceeding 200 horsepower. A serious limitation to the utility of the suction producer has been the fact that, owing to the manner of generating the gas, no tarry fuels could be used, a restriction that prevented the use of bituminous coals, lignites, peats and other like fuels. The fuels in most common use for producers of this type are charcoal, coke, and anthracite coal, although attempts are being made so to construct suction plants that they can be operated with bituminous or tarry coals.

To meet the demand for the concentration of power in large units, instead of operating a large number of separate installations of small power capacity, the pressure producer was devised. This producer develops its gas under a slight pressure due to the introduction of an air and steam blast, and the gas is stored in a holder until it is required by the engine. As the gas may thus be stored before passing to the engine, and as its generation does not depend on the suction stroke of the engine, tar and other impurities may be removed from it by suitable devices, and the use of bituminous coal, lignite, and peat is thus permitted.

The pressure producer was closely followed in the course of development by the down-draft producer, which fixes the tar as a permanent gas and therefore completely uses the volatile hydrocarbons in bituminous coal, lignite and peat.

A few scattered producer-gas plants were installed for power purposes in the United States before 1900, but the application of this type of power in any general sense has been developed since that date. During the first few years of this period of development anthracite coal, coke and charcoal were used almost exclusively, although occasionally pressure and down-draft plants ventured to use a well-tried bituminous coal known to be especially free from sulphur and caking difficulties and low in both ash and tar-making compounds. The rapid development of the anthracite plant was to be expected, but it remained for the United States Geological Survey in its testing plants at St. Louis and Norfolk to demonstrate the possibility of using in such plants practically all grades of fuel of any commercial value, without reference to the amount of sulphur or tarry matter which they contain.

The series of tests conducted by the United States Geological Survey from October, 1904, to December, 1907, furnished valuable data as to the relative consumption of coal per horsepower per hour by steam and gas plants. The steam plant with which these tests were made consisted of two 210-horsepower Heine boilers, furnishing steam to a 250-horsepower simple noncondensing Corliss engine, which was belted to a Bullock electric generator. The producer-gas plant was a Taylor pressure gas producer No. 7, of 250-horsepower capacity. Connected with the producer was the usual apparatus for cleaning and storing the gas before it is delivered to the engine—the economizer, scrubber, tar extractor, purifier and holder.

The gas engine was of the three-cylinder vertical Westinghouse type, with cylinders of 19-inch diameter and 22-inch stroke, rated at 235 brake horsepower on producer gas. The engine was belted to a 6-pole 175-kilowatt Westinghouse direct-current generator. The load on the generator was controlled by a water rheostat specially constructed for the purpose, through which also the energy developed was dissipated.

In considering the relation between the economic results of steam and producer-gas plants, the fact should be remembered that today, in the ordinary manufacturing plant operated by steam power, less than 5 per cent of the total energy in the fuel consumed is available for useful work at the machine.

In that connection it is of interest and value to glance at the possibilities of the best designed and most skillfully operated commercial plant now in use. The data concerning the steam plant selected for this determination are derived from a table prepared by Mr. Stott, superintendent of motive power, Interborough Rapid Transit Company, New York City, which, as Mr. Stott says, shows "the losses found in a year's operation of what is probably one of the most efficient plants in existence today, and, therefore, typical of the present state of the art."

Average losses in steam plant of the Interborough Company in converting 1 pound of coal, containing 12,500 British thermal units, into electricity.

	British thermal units.	Per cent.
Loss by friction	138	1.1
Loss in exhaust	7,513	60.1
Loss in pipes and auxiliaries	275	2.2
Loss in boiler	1,000	8.0
Loss in stack	1,987	15.9
Loss in ashes	300	2.4
Total losses	11,213	89.7
Energy utilized	1,287	10.3
	12,500	100.0

Mr. Stott further presents a table showing the thermal efficiency of producer-gas plants, concerning which he says: "The following heat balance is believed to represent the best results obtained in Europe and the United States up to date in the formation and utilization of producer gas:

Average losses in a producer-gas plant in the conversion of 1 pound of coal, containing 12,500 British thermal units, into electricity.

	British thermal units.	Per cent.
Loss in gas producer and auxiliaries	2,500	20.0
Loss in cooling water in jackets	2,375	19.0
Loss in exhaust gases	3,750	30.0
Loss in engine friction	813	6.5
Loss in electric generator	62	.5
Total losses	9,500	76.0
Converted into electric energy	3,000	24.0
	12,500	100.0

The thermal efficiency of such plants, as given by different writers, runs as high as 33, 36 and 38.5 per cent, and for some plants figures as extravagant as "above 40" are boldly published. Although the present aim has been to give figures for a producer-gas plant that may compare favorably with those of the steam plant of the Interborough Company, an effort has been made to keep well within obtainable efficiencies. Attention is also directed to the fact that the producer-gas plant considered should be large enough to compare favorably with the steam plant. This precludes comparisons with suction plants, which are relatively small but give higher proportional efficiencies than the larger pressure and down-draft plants, for these require more or less auxiliary apparatus.

Mr. Stott seems ready to accept a thermal efficiency of 24 per cent for the best producer-gas plants for comparison with 10.3 per cent efficiency for his steam plant, but the results obtained in the government plant at St. Louis are probably more nearly representative of the ordinary type of apparatus. These results are as follows:

Relative economies of steam and gas power plants at St. Louis in the conversion of 1 pound of coal containing 12,500 British thermal units into electricity.

	Steam power		Gas power	
	British thermal units.	Per cent.	British thermal units.	Per cent.
Loss in exhaust, friction, etc.	11,892	95.14	10,812	86.5
Converted into electric energy	608	4.86	1,688	13.5
	12,500	100.00	12,500	100.0

The ratios of the total fuel per brake-horsepower hour required by the steam plant and producer gas plant, under full load, not counting stand-by losses, are represented below as derived from 75 coals, 6 lignites, and 1 peat (Florida).

Ratiors of fuel used in steam and gas plants.

Average ratio, coal as fired per brake-horsepower hour under boiler to coal as fired per brake-horsepower hour in producer	2.7
Maximum ratio, coal as fired per brake-horsepower hour under boiler to coal as fired per brake-horsepower hour in producer	3.7
Minimum ratio, coal as fired per brake-horsepower hour under boiler to coal as fired per brake-horsepower hour in producer	1.8
Average ratio, lignite and subbituminous coal as fired per brake-horsepower hour under boiler to lignite as fired per brake-horsepower in producer	2.7
Maximum ratio, lignite and subbituminous coal as fired per brake-horsepower hour under boiler to lignite as fired per brake-horsepower hour in producer	2.9
Minimum ratio, lignite and subbituminous coal as fired per brake-horsepower hour under boiler to lignite as fired per brake-horsepower hour in producer	2.2
Average ratio, peat as fired per brake-horsepower hour under boiler to peat as fired per brake-horsepower hour in producer	2.3

The figures for the producer-gas tests include not only the coal consumed in the gas producer, but also the coal used in the auxiliary boiler for generating the steam necessary for the pressure blast—that is, the figures given include the total coal required by the gas-producer plant. The great economy secured from the 75 bituminous coals and 6 lignites when used in the gas producer instead of under the steam boiler is evident.

In the above comparisons between the steam and producer-gas plants no consideration has been made of stand-by lossses. The result for each plant has been derived from experiments made during continuous operation for a given period. Data on stand-by losses for plants operated during a portion of each 24-hour day are not at present obtainable at the fuel-testing plant. Very few results of experiments relating to this point have been published, and opinions regarding the amount of fuel required for holding fires over night or during idle periods in both boiler and producer plants seem to differ widely.

In considering the possible increase in efficiency of the steam tests with a compound engine, as compared with the simple engine used, the fact should not be overlooked that a corresponding increase in the efficiency of the producer-gas tests may be brought about under corresponding favorable conditions. Not only is the producer passing through a transitional period, but the gas engine must still be regarded in the same light. In the larger sizes the vertical single-acting engine is being replaced by the horizontal double-acting engine. Other changes and improvements are constantly being made which tend to increase the efficiency of the gas engine, as compounding and tripling the expansions have already increased the efficiency of the steam engine.

As has been stated, the gas engine used in the tests here reported is of a type that is rapidly becoming obsolete for this size, namely, the vertical, three-cylinder, single-acting.

A brief consideration of these points will lead at once to the conclusions that a comparison of the producer-gas plant and steam plant used in these tests is very favorable to the former, and that any increase in efficiency in the steam tests that might result from using a compound engine can be offset by the introduction of a gas engine of more modern type and a producer plant designed to handle the special kinds of fuel used.

It should be noted that many fuels which give poor results under steam boilers have been used with great ease and efficiency in the gas producer, which thus makes it possible to utilize low-grade coals and lignites that have heretofore been regarded as practically useless. Several of the poorest grades of bituminous coals have shown remarkable efficiency in the gas producer, and lignites and peat have been used in it with great facility, thus opening the way to the introduction of cheap power into large districts that have thus far been commercially unimportant owing to lack of industrial opportunities. Experiments with "bone," a refuse product in bituminous-coal mining, have given excellent results, showing an efficiency in the producer equal to that reached by good steam coal under boilers. Recent investigations with other low-grade fuels, such as mine roof slabs, culm, and washery refuse, have also demonstrated the possibility of using such materials to advantage in the producer under proper commercial conditions.

It has not been the aim of the testing plant to determine the lowest possible amounts of coal that could produce a given amount of power or to determine the highest possible efficiency of the particular producer plant installed. By an act of Congress, the work of the plant was restricted to the determination of the possibilities of utilizing bituminous coals, lignites and other fuels for the production of power. In spite of the fact that no series of runs has been made on any one coal for determining the best possible results obtainable, it is nevertheless gratifying to report that official records show that as small an amount of dry coal as 0.95 pound per hour has been burned in the producer per electrical horsepower developed at the switchboard; or 0.80 pound of dry coal per hour has been burned in the producer per brake horsepower per hour, on the basis of an efficiency of 85 per cent for generator and belt.

Although the attitude of the manufacturers of producer-gas power plants has been encouraging in the past, their position to-day is extremely gratifying. Their fair-mindedness, their appreciation of the difficulties involved, and their realization of the shortcomings of the present producer-gas power plant all point directly toward the development of highly efficient gas power units which can operate on many types of fuel and can be installed at a total cost that compares favorably with that of the corresponding steam plant and at the same time insures the manufacturer a fair profit. Although the development of this type of power has been in a way remarkable, it must be acknowledged that difficulties have hindered the development that might be expected of a prime mover showing such marked economy in fuel consumption.

The attitude of the manufacturers as a whole with regard to assistance at new installations has materially changed. The distrust and jealousies which have characterized the dealings of some in the not distant past are gradually disappearing, and on the whole to-day the manufacturers seem ready to render all the assistance possible in connection with the proper manipulation of their installations. There is, however, still room for improvement, and the indications are certainly in the right direction when the manufacturers themselves recognize these faults, as is shown by their own statements.

Many of the difficulties due to lack of knowledge of their own plants, improper design, faulty construction, impossible contracts, and failure to render reasonable assistance in putting up and starting new installations have been due in part to undesirable competition and jealousy on the part of certain manufacturers. Within the past two years the varied interests working for the development of gas power have been brought more closely into touch through friendly organizations, with the result that a better understanding and a heartier co-operation is beginning to prevail. Notable among the organizations which are tending to unite these many interests on a common basis is the gas-power section of the American Society of Mechanical Engineers.

It is worthy of note, too, that a few years ago would-be purchasers had to deal with ignorant and often unscrupulous salesmen. Except possibly in a very few insignificant companies, the unscrupulous agent seems to be rapidly dropping into the background. Incompetent and uninformed salesmen will always be with us, but the situation to-day in this respect is greatly improved.

The investigations by the Geological Survey have demonstrated without question that both the up-draft or pressure producer and the down-draft type will generate an excellent gas from bituminous coals, entirely suitable for the commercial operation of gas engines. There are, of course, inherent difficulties in each type, such as the mechanical extraction of the tar in the up-draft producer, both reducing the efficiency of the plant and forcing upon the owner an undesirable by-product, and the excessive labor in cleaning the down-draft system, the requirements of cleaning also prohibiting the continuous operation of a single generator unit. Undoubtedly modifications will be made that will reduce these objections to a minimum, and other developments will gradually simplify such plants; but even as the plants exist today the fact is that approximately 57 per cent of the total producer-gas horsepower in this country is developed from bituminous coal and lignite.

Owing to commercial considerations these installations for the most part use fuels of good quality—that is, the regular marketable grades. That it is not necessary to restrict the operation to these better grades, so far as making gas of the proper quality is concerned, has been demonstrated beyond question by the United States Geological Survey.

The testing plant ran satisfactorily on many coals containing over 20 per cent ash. One West Virginia bone coal contained as much as 44 per cent ash, and with this fuel the consumption was only 1.65 pounds of coal as fired per brake horsepower per hour. Among the other fuels which may be classed as low grade and which have been successfully used in this plant are the large slaty roof slabs, or roof coal, Illinois bone, washery refuse, and Rhode Island graphitic anthracite. Peat forms an excellent fuel, and at present two producer-gas installations for operation in this country on peat are in process of construction.

With such a wide range of available fuels, and with the supply of anthracite and the better grades of bituminous coal decidedly limited, the producer types now in use will doubtless in due time be improved and modified so as to adapt them to the lower-grade or high-ash fuels.

The general situation in Europe is not very different from our own, as owners are for the most part using the better-grade fuels and leaving the poorer grades in the mines. They recognize this as a serious situation and are deeply interested in the possible utilization of low-grade fuels in the gas producer. During a recent inspection trip in ten European countries I found anthracite coal, brown-coal briquets, and peat in very general use in producer-gas power plants. Bituminous coal is also extensively used, but in the majority of plants only non-caking coals, moderate in tar production and low in ash, are handled. For one installation of many thousand horsepower the coal is taken directly from mines bought by the owners expressly for the use of their plant, but I learned that the high-grade, marketable is used in these producers and the grades relatively high in ash are not taken from the mine. In two instances only was I able to learn of the use of high-ash fuels. In one installation a mixture of culm, roof coal, and washery refuse, reported as averaging 53 per cent ash, was being used in a by-product recovery plant. This plant, which was experimental, had been in commission about one year. Considerable time was reqiured for adapting the plant for the successful handling of the fuel, but the reports indicated that for three months before my visit little or no difficulty had been experienced. The other plant I found under full operation, using roof slabs that gave little indication, on casual inspecion, of containing any combustible material. It was claimed that this fuel averaged over 60 per cent ash—a claim which seemed entirely reasonable. At the time of this visit (1908) the producers were not only supplying a number of furnaces with gas, but were also operating a 1,000-horsepower and a 250-horsepower gas engine. A 500-horsepower engine was being added to the equipment. The engines in use were direct connected to electric generators. The 10,000-volt current is used for operating the local mine machinery and also for furnishing lights for neighboring towns and power for a street railroad. The plant was reported to be using over 100 tons of this low-grade fuel per day.

As one manufacturer has said, "A satisfactory suction soft-coal producer would be a great boon to the gas engine and producer business." There are at present a few plants operating successfully on lignite, and in special cases bituminous coal has been used, but this practice can not be regarded as sufficiently satisfactory in all particulars to warrant the indiscriminate installation of such plants. It is understood that the two producer plants now being erected in this country for operation with peat are of the suction type. The suction plant is used in Europe for practically the same varieties of fuel as in this country, namely, anthracite coal, coke, brown-coal briquets, and peat. The number of such peat producer-gas plants is great. My attention was drawn to but one suction plant in Europe actually operating under commercial conditions upon bituminous coal. This plant appeared to give entire satisfaction, but close inquiry brought out the fact that it was necessary to secure certain grades of coal and further that it was necessary to mix three varieties in definite proportions to insure successful operation. There is certainly opportunity for further development along this line.

After examination of many tables of costs, the conclusion is that complete producer-gas installations for the larger plants, say from 4,000 to 5,000 horsepower, cost about the same as those of first-class steam plants of the same rating. With smaller installations the balance is probably in favor of the steam plant. However, even if the steam plant costs 15 per cent less than the producer-gas plant, it should not be forgotten that the increased efficiency in operating the latter will make up the difference in the first cost within a short time—probably in two or three years in the average plant.

It must be acknowledged that the cost of producer-gas power installations is excessive, and that there must necessarily be a reduction in price when the amount of business will warrant it.

Recently a transaction came to my attention in which a gas producer was offered at a figure which was reported to be "actual shop cost." Within ten days another company offered a plant of the same rated capacity for one-third of the price. and this manufacturer casually remarked, "and I shall not lose on it at this price."

The demand for figures of the approximate cost of these installations has become so persistent that the following tables are presented, although somewhat incomplete.

Cost per horsepower of producer-gas installations.

Horsepower.	Gas producer and engine erected. exclusive of foundations.	Gas producer and engine erected including foundations.	Complete plant exclusive of buildings.*	Complete plant including buildings.*
20	$105.00	$108.50	......	......
25	62.50	......	......	......
25	115.00	......	......	......
50	86.50	......	......	......
60	69.50	74.50	......	......
75	75.00	......	......	......
75	86.50	......	......	......
80	62.00	......	......	......
100	67.00	......	......	......
110	60.50	68.00	......	......
110	62.50	......	......	......
125	65.00	......	......	......
125	90.00	......	$100.00	......
150	70.00	......	......	......
200	67.00	......	......	......
250	65.00	68.00	79.00	$93.00
300	58.00	......	......	......
500	......	......	84.40	......
1,000	55.50	......	69.60	79.50
2,000	46.00	47.50	56.50	63.50
2,800	......	......	......	76.00
4,000	......	......	......	69.00
4,000	......	......	......	72.00
4,000	......	......	......	77.50
4,800	......	......	......	72.00
4,800	......	......	......	79.50
5,500	......	......	......	70.00

*Includes producer, engine, electric generator, piping, and auxiliaries, all erected, with suitable foundations.

Considerable variation will be noticed in the prices quoted by different manufacturers for plants of the same rated capacity. In some cases this difference is warranted by a difference in the "quality." In others it is due to a difference in the number of units installed to make up the total required horsepower or to different requirements for auxiliary equipment.

Among the difficulties in the way of the proper development of producer-gas power, special attention is called to the overrating of producers. It is exceedingly gratifying to note that this point is at last recognized by at least one of the companies building these plants. This tendency to overrate producers has been especially prevalent among the builders of the suction plants. In inspecting a large number of installations throughout the country this weakness has repeatedly attracted attention. It has been observed frequently that a given plant using anthracite fuel of good quality will present no operating difficulties when working up to 50 or 75 per cent of the rated capacity of the producer, but if the producer is forced to its full rating for any length of time, clinkering and other operating difficulties are encountered. These are often sufficiently serious to necessitate a reduction in load at a time most unfortunate for the factory.

This overrating has come about very naturally through early attempts to adopt European figures for rate of fuel consumption. Experience with American fuels has shown that decided modifications in this fuel-consumption rate are absolutely necessary, and although some manufacturers have given this matter careful consideration it is undoubtedly true that others are still using grate areas too small for the demands which their producers are expected to meet.

In spite of the difficulties indicated, the producer-gas power plant is in the main an assured success. In fact, it is in the appreciation of these difficulties by conservative manufacturers that the possibilities of a steady and strong development lie. The true status of this type of power is well defined by a representative of one of the strongest companies in this country when he states that "the gas engine and producer have come to stay. They are of great economic value. They have their peculiar application, however, and are not a universal panacea for all previous ills."

There are at present over 500 producer-gas power plants in operation in the United States, ranging in size from 15 to 6,000 horsepower. Data secured are summarized in the following table according to the type of fuel used, and separately for all plants above 500 horsepower and for those not exceeding 500 horsepower.

Summarized data of producer-gas power plants in United State.

	No. of plants.	Horsepower. Total.	Average.	Minimum.	Maximum.	Per cent of total number.	Per cent of total horsepower.
Anthracite coal:							
Over 500 horsepower...	8	7,550	950	600	1,500	....	....
500 horsepower or less..	407	40,550	100	15	500	....	....
	415	48,100	116	15	1,500	88	43
Bituminous coal:							
Over 500 horsepower...	20	49,000	2,450	750	6,000	....	....
500 horsepower or less..	17	5,150	300	35	500	....	....
	37	54,150	1,460	35	6,000	8	49
Lignite:							
Over 500 horsepower...	3	7,275	2,430	525	3,750	....	....
500 horsepower or less..	19	1,725	90	25	250	....	....
	22	9,000	410	25	3,750	4	8
All plants	474	111,250	235	15	6,000	100	100

It will be observed from this table that about 88 per cent of the total number of installations in this country are operating on anthracite coal (a few using charcoal or coke), and that bituminous coal and lignite are used in the remaining 12 per cent. Of the total horsepower approximately 57 per cent is derived from bituminous coal and lignite and 43 per cent from anthracite coal, charcoal and coke. In point of size it will be noted that the bituminous plants average 12½ times the size of the anthracite plants.

In the United States cheaper power is constantly sought. The water-power possibilities of the country are being realized and the hydro-electric power plant is a wholesome cause of competition. The supply of fuel of marketable grades is not unlimited. Prices for such fuel must of necessity increase. The cost of transporting coal from the mines is high, and the possibility of obtaining a sufficient supply of cars to handle low-grade fuels is questionable. The power demands of the country are increasing, and this power must be developed at a reasonable cost. The time is approaching when the cheapest fuel obtainable must be used to the best economic advantage in order to develop power at a unit cost consistent with commercial progress.

Consideration of the conditions indicates that in order to keep the price of power developed from fuel down to a consistent figure—

(*a*) Grades of fuel which warrant transportation, or which may be defined as 'marketable," should be used with the greatest practicable economy.

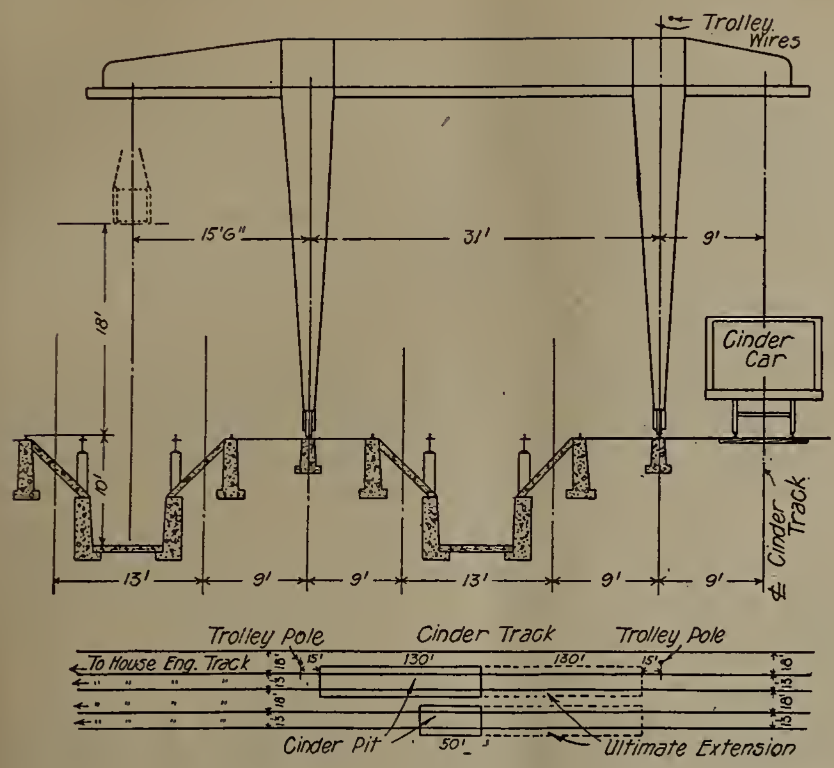
(*b*) The very large percentage of coal of so-called low grade which today is left at or in the mine must be utilized.

(*c*) Advantage must be taken of the large deposits of lignite and peat which are found in many sections of the country.

It is undoubtedly true that in general, under conditions which do not require the use of steam for other than power purposes, the producer-gas power plant meets the requirements of (*a*).

At present the only method of advantageously handling the fuels mentioned in (*b*) and (*c*) is in the gas producer, and the utilization of these lower grades of fuel on an extensive scale demands concentration of the power plants within close proximity to the fuel supply.

The logical conclusion from a careful study of the producer-gas power situation is that the time is not distant when financial interests in power production will be directed toward the



Ash Handling Plant, Vandalia R. R.

centralization of the producer-gas power plant at the mines and the distribution of the energy developed either by high-voltage long-distance electrical transmission or by pipe systems for conveying the gas.

Terre Haute Shops, Vandalia R. R.

The Vandalia shops at Terre Haute, Ind., have long been of insufficient capacity to take care of the locomotive and car repairs for the system. Rather than attempt the reconstruction of the present plant on a site of limited space, the officials have been for some time past, contemplating an entirely new plant, the site for which is located about a mile northeast of the present shops, opposite the station at Terre Haute.

One of the accompanying drawings illustrates a very comprehensive layout upon which work has been started and has progressed, as far as the round-house only is concerned, nearly to completion.

It will be noted by reference to the layout that the present engine house consists of twenty-five stalls with provision for an ultimate extension to forty-seven stalls. The erecting shop is to have a capacity of twenty-four engines with an ultimate capacity of considerably more than twice this number. The scheme of allowing liberally for future extensions is carried throughout the plans.

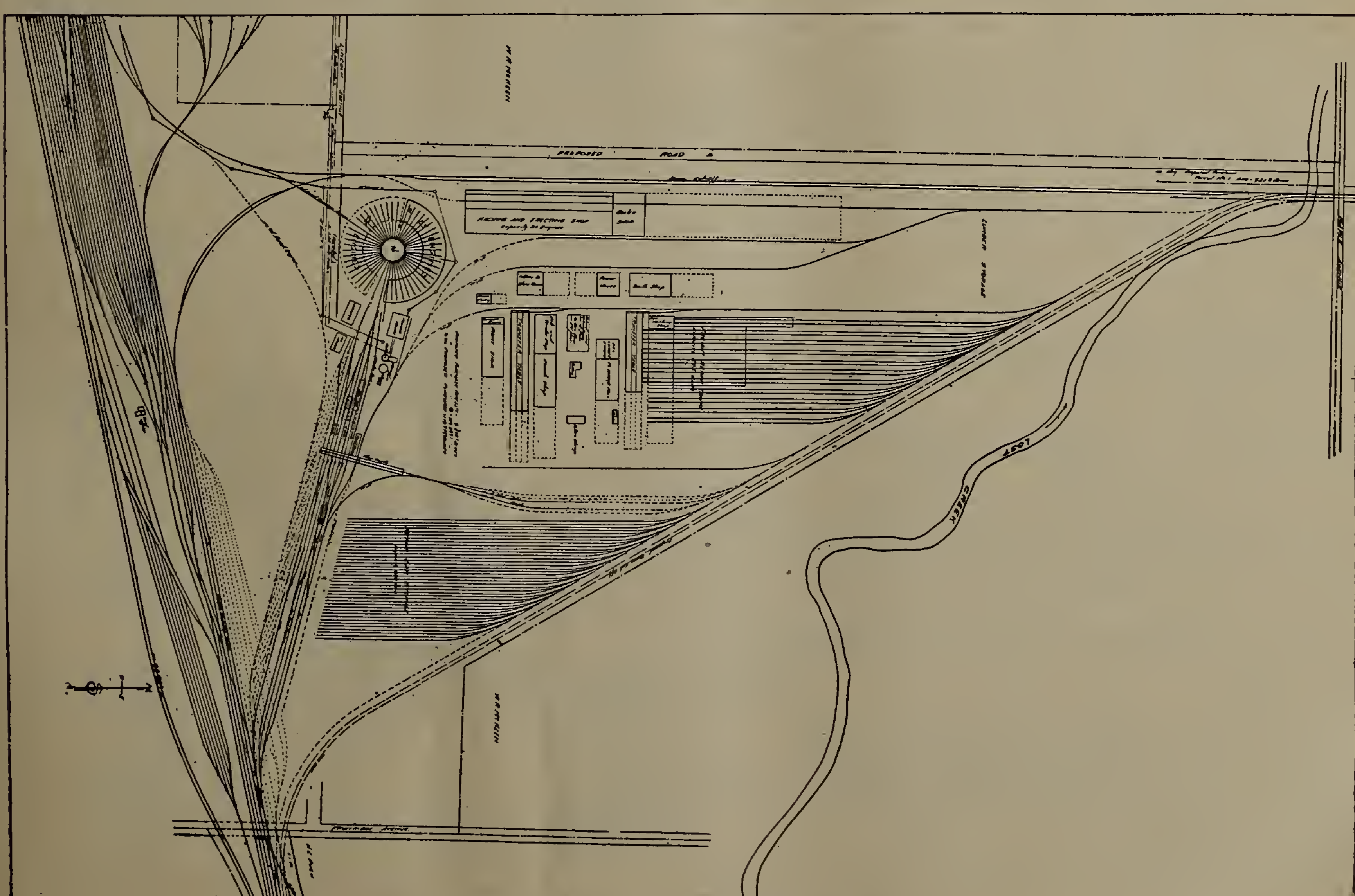
Cinder and inspection pits have been given special attention with the result that, as at present arranged for, delays due to incapacity, so manifest in a large number of terminal installations, will be entirely avoided.

An ash-handling plant, herewith illustrated, has been designed with the same care given the other features and it is expected that the plant will be a model one in all respects.

The equipment of the yards includes a Booth water softener of large capacity.

We are indebted to Mr. W. C. Arp, superintendent of motive power, and Mr. R. C. Rochester, engineer maintenance of way, for the drawings reproduced in this article.

Eleven of the twenty-four 100-class locomotives, used in the freight and passenger service of the Panama railroad prior to the arrival of the new 600-class engines, have been converted at Cristobal shops, and the remainder are being converted at the rate of two or three a month. These locomotives were made by the Schenectady locomotive works and were of the suburban type, that is, the tender and locomotive were on one



Vandalia R. R. Shop Layout at Terre Haute, Ind.

base. In the conversion the tender is placed on a double truck of its own, and the fuel storage has been made interchangeable for oil or coal. The remodeled engines will be put in service on the Canal and railroad construction work, and for that reason will use coal for the present, since there are no oil storage tanks accessible on the relocation work. One engine has been fitted for oil burning, however, as an experiment, and will be tested on the main line.

Piece Work

By A. R. Kipp, Mech. Supt., M. St. P. & S. S. M. Ry.

There are various systems employed by manufacturing institutions and railroads for the payment of mechanics. Those with which I am most familiar comprise the payment of stipulated rates per hour regardless of the amount of work done by a man; piecework, by which the man is paid for what he does; and the bonus system, under which a man is given an allotted time to perform certain operations and is given a bonus for any amount of time saved beyond that limit.

The latter systems are, in my opinion, the only methods of wage payment correct in principle. My preference is for the piece-work system. In this the words "For value received" apply as they do in so many financial transactions, and under this system if the workman spoils his work his pays for it, unless, of course, he does other damage to co-related parts beyond his control. Nevertheless, the premium is time-saving and good workmanship.

In paying a flat rate per hour, the only recourse an employer has is dismissal, which is at times when skilled labor is scarce very unsatisfactory, so that in my opinion the only solution of the problem of placing spoiled work where it belongs lies in a system of using the piecework principle.

Another question suggests itself as going hand in hand with this one, which is, "What system will present the bill for spoiled work to the proper party?" I believe the answer to this is worthy of consideration when the first one is solved.—*Factory.*

Shop Kinks at Beach Grove Shops, C., C., C. & St. L. Ry.

On page 13 of the RAILWAY MASTER MECHANIC issue for January, a number of home made shop appliances in use at the Beech Grove shops of the "Big Four" Ry., were illustrated. Owing to the limitations of space, a number of drawings had to be omitted and they are shown herewith:

(Continued from page 15 of the January issue.)

Figure 12 is a self-centering mandrel which is a great time saver in centering up work to be turned.

Figure 13 shows a very powerful bending machine. The air cylinder need not be specially made but in this case it is of large capacity. The machine was designed by H. D. Wright, foreman of the forge shop.

Figure 14 represents a portable pneumatic pipe bender. This machine may be hauled to any part of the shop to perform numerous jobs of pipe bending. It is evident that the necessity for carrying long lengths of pipe about the shop would be very inconvenient and this machine obviates that necessity. It was worked out by W. J. Moffatt, tin and pipe shop foreman.

Figure 15 shows a jig for drilling eccentric blocks. This is a job which requires considerable adjusting unless a device of this kind is in use. This jig was designed by W. O. Milles, machinist.

Figure 16 is the drawing of a set of lifting hooks which makes easy the lifting into position of locomotive air reservoirs. It was designed by John Dean, third year apprentice.

Figure 17 shows a set of moulds for casting the gaskets used in engineer's valves. It was designed by W. R. Beck, air brake foreman.

Figure 18 shows a boiler sheet clamp. Flat plates are handled without inconvenience by means of this device which grips the sheet without danger of dropping it. The clamp was designed by A. Green, assistant boiler shop foreman.

Figure 19 illustrates a set of shoe and wedge trams with a gauge for adjustment. It was designed by W. J. Greleich, tool room foreman.

Figure 20 shows a jig for sawing air pump packing. It was designed by Clarence Domhoff, second year apprentice.

Figure 21 shows a ball joint flue sheet reamer. The method of using it is shown on the same drawing. It was designed by Ray Hettenbaugh, second year apprentice.

Figure 22 illustrates a very handy recessing tool. The tool may be built for either heavy or light work, the spring having been given the proper tension. This tool was designed by Ray Hettenbaugh, second year apprentice.

Figure 23 shows a special flue sheet cutter. Its application is at once evident. It was designed by Fred Bauer, general foreman.

Figure 24 is the drawing of a set of adjusting blocks for lifting yokes. This device obviates the danger of dropping locomotive parts when lifting by means of the crane. The blocks were designed by A. W. Martin, apprentice instructor.

Figure 25 illustrates the apparatus used at Beech Grove in tapping staybolt holes in locomotive fireboxes. As shown in the drawing, motors are swung from a framework into the proper position on the boiler and the holes tapped out with great facility.

Figure 26 shows a staybolt drilling rack. Its application is somewhat similar to that of the tapping device described above except that it is supported from the floor and rail rather than from the boiler.

Figure 27 illustrates a device for reaming holes in bell yokes and frames.

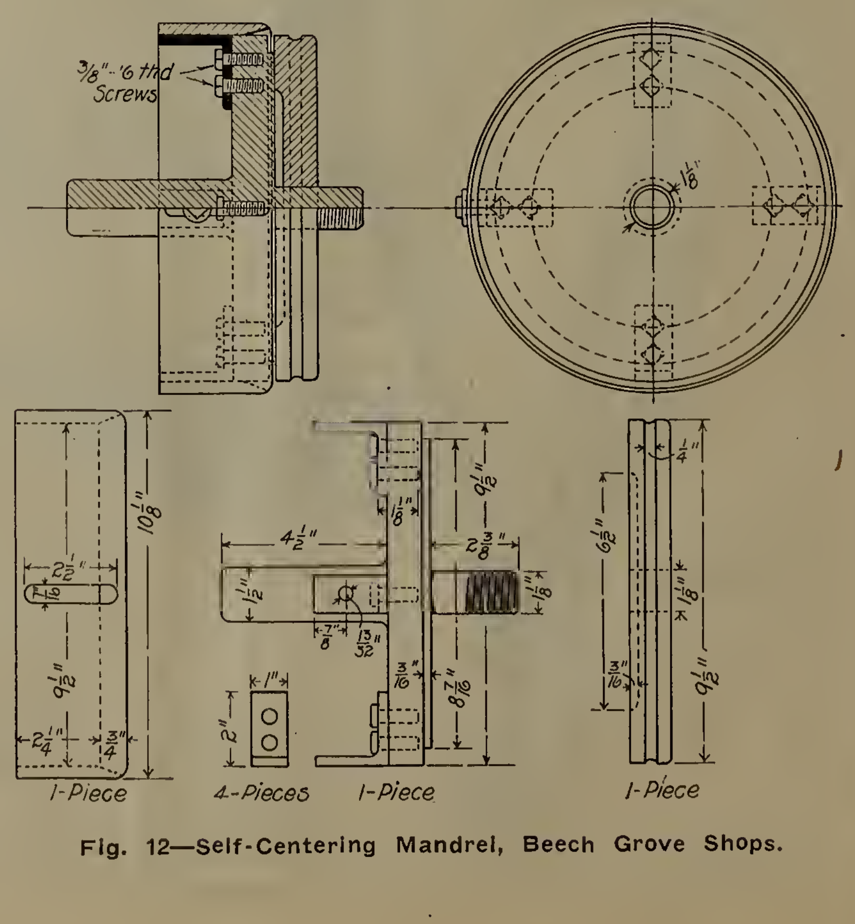


Fig. 12—Self-Centering Mandrel, Beech Grove Shops.

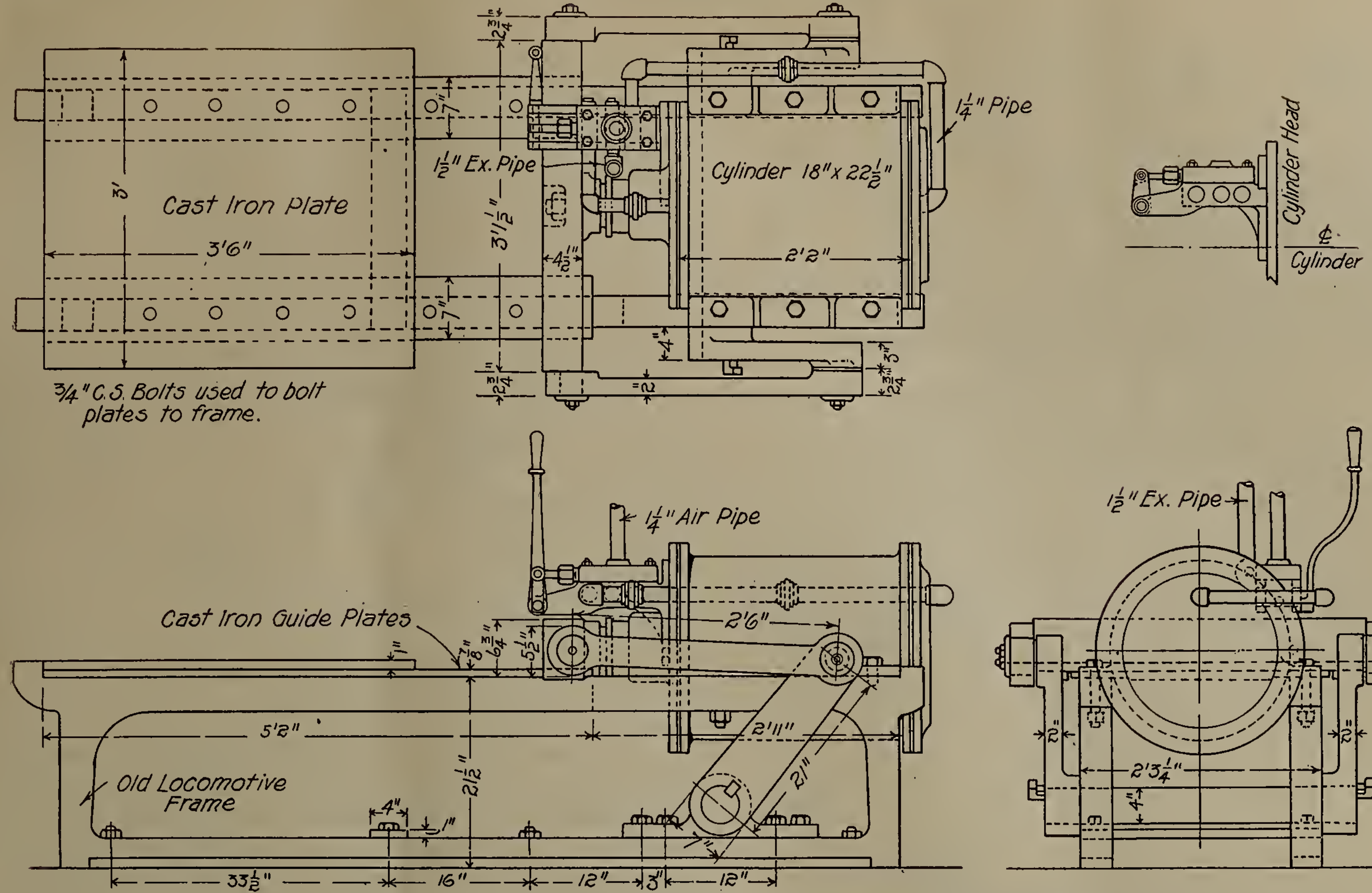


Fig. 13—Powerful Pneumatic Bending Machine, Beech Grove Shops.

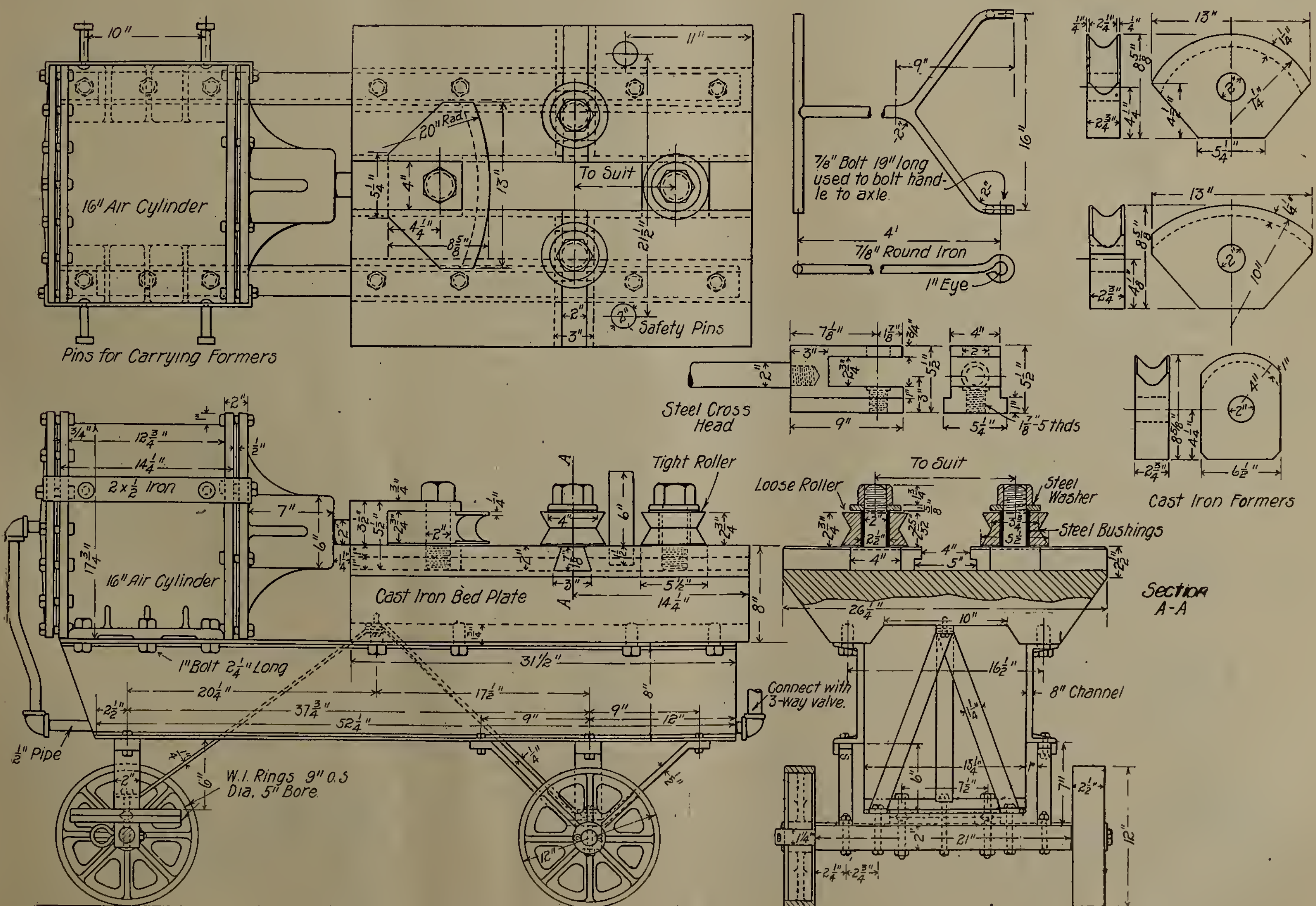


Fig. 14—Portable Pneumatic Pipe Bender, Beech Grove Shops.

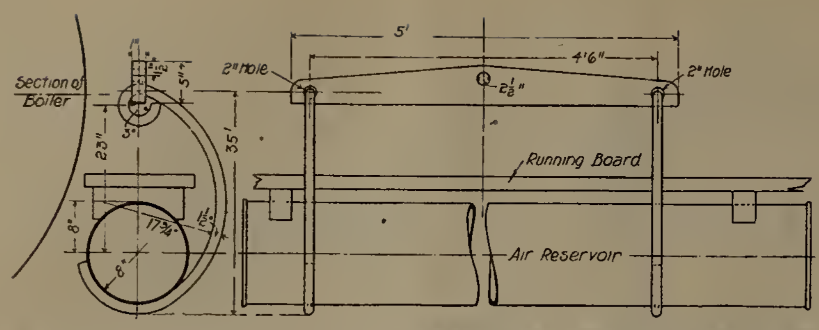


Fig. 16—Lifting Hooks for Air Reservoirs, Beech Grove Shops.

The Unit System of Organization*

By Major Charles Hine.

The most difficult task in any organization of human endeavor is to correlate the activities of the workers on the outside with the necessary requirements of correspondence, records and accounting on the inside. The artisan in the shop, the traveling salesman on the road, the soldier in the field, the sailor at sea, the railroad man on the line, all have their troubles with the man in the office. When the inside man knows the outside game at first hand such differences in points of view are minimized, friction avoided, and therefore money

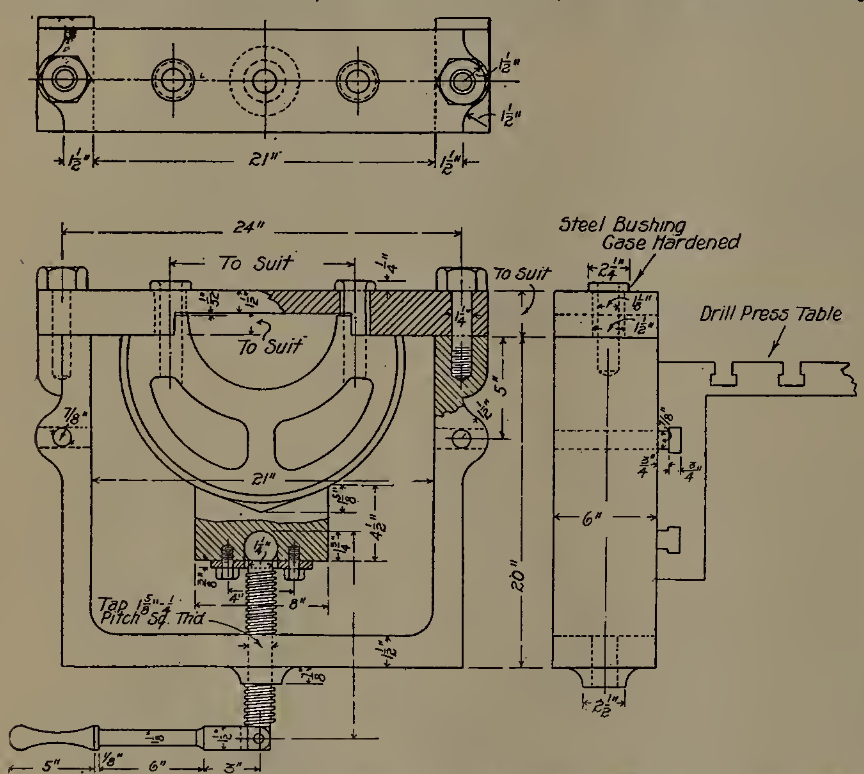


Fig. 15—Jig for Drilling Eccentric Blocks, Beech Grove Shops.

saved. Railway operation is the most exacting of human tasks. Like the conduct of a household, a farm, a hotel or ship, it is a continuous performance. Unlike those exacting occupations it must maintain its own communications over hundreds or thousands of miles of territory. So complex is its administration that chances should not be taken of losing money through half baked decisions of partially trained office

* From a paper read before the Western Railway Club.

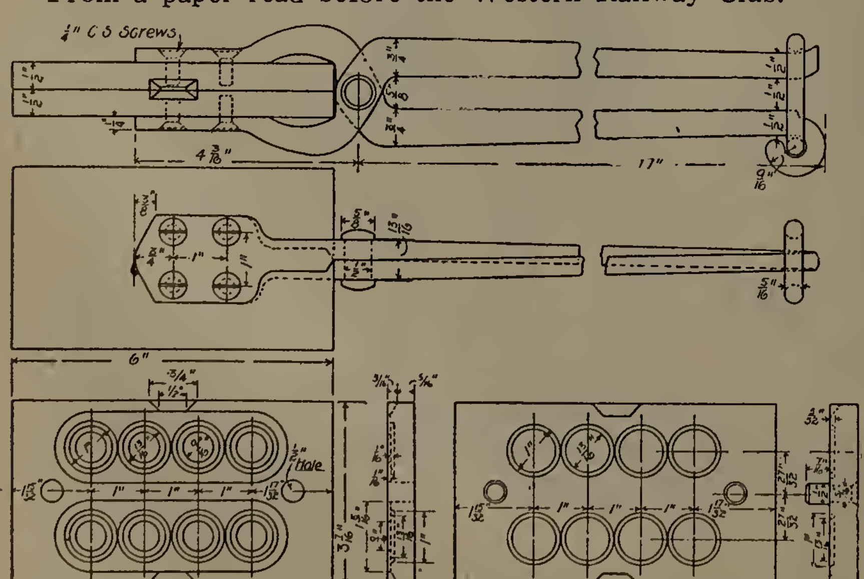


Fig. 17—Gasket Molds for Engineers' Valves.

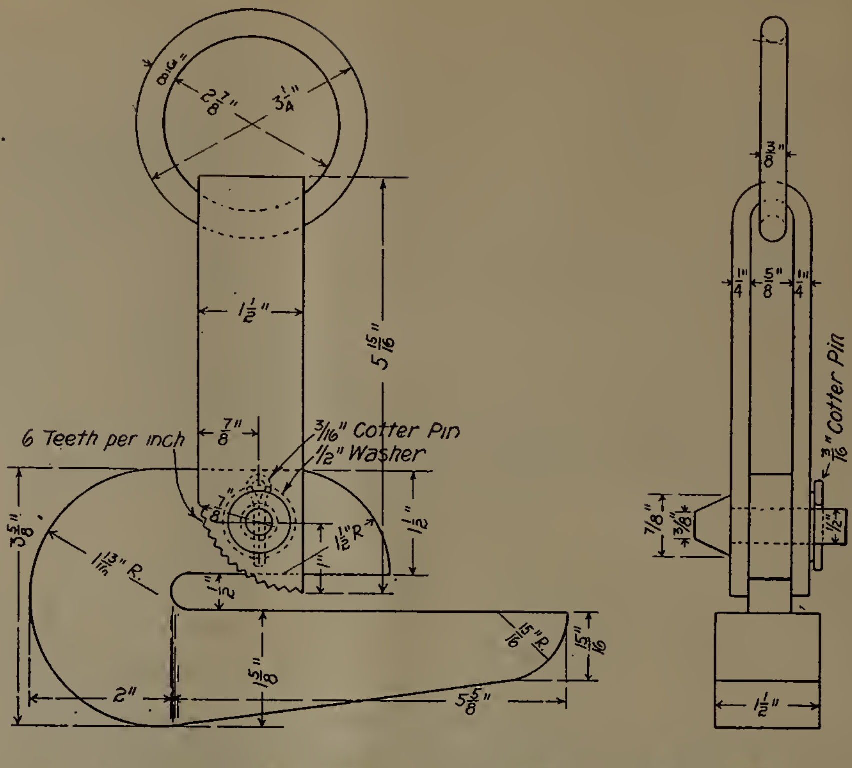


Fig. 18—Boiler Sheet Clamp, Beech Grove Shops.

occupants. Most railway officials flatter themselves that when on the line they maintain a grasp on the office. Yet every hour in their absence action must be taken on matters which, apparently trivial in themselves, have far reaching results. This statement is not a reflection upon the splendid ability and earnestness of railway officials. It is merely a recognition of the fact that a man can be in only one place at a time; that there are only 24 hours in the day and only 365 days in the year. The salary of one official is negligible as a percentage of the operating cost of the average unit. Accordingly the system insists that the second best man of the unit, with practical outside training, shall stay at headquarters and sit on the lid. In some cases it has been found necessary to appoint another official to perform the previous outside duties of the senior assistant. In other cases it has been found that the outside work could be divided among other members of the staff.

In any system of organization the most important unit is the individual. It is claimed that when one man signs the name of another the first by so much loses initiative and individuality. A man's name is his birthright, his signature his patent of enlightened manhood. Long habit on railways has perhaps minimized the pernicious effect of unconsciously building up one individual at the expense of many. Such industrial feudalism, however, can no more permanently endure than did the feudal serfdom of the middle ages. The unit system, therefore, insists that every man shall transact the company's business in his own name. There is nothing new in this. The whole system is really an extended application of the simple principles of train dispatching. A train order is addressed impersonally "Conductor and Engineman." Where proper discipline obtains, the signatures to the orders are genuine. When the oldest conductor lays off the youngest extra man does not sign the former's name to orders and reports. Addresses in

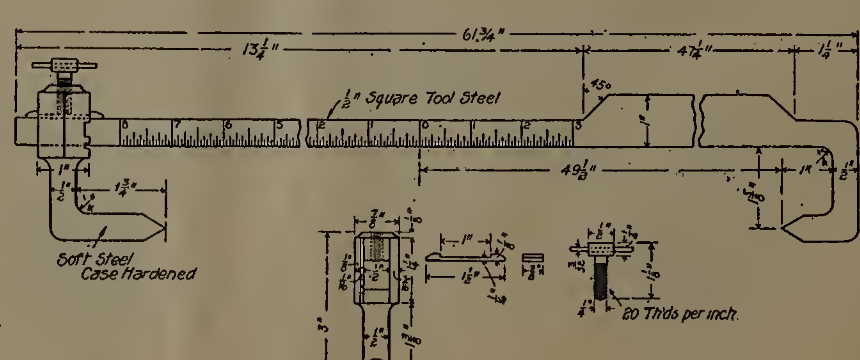


Fig. 19—Shoe and Wedge Trams, Beech Grove Shops.

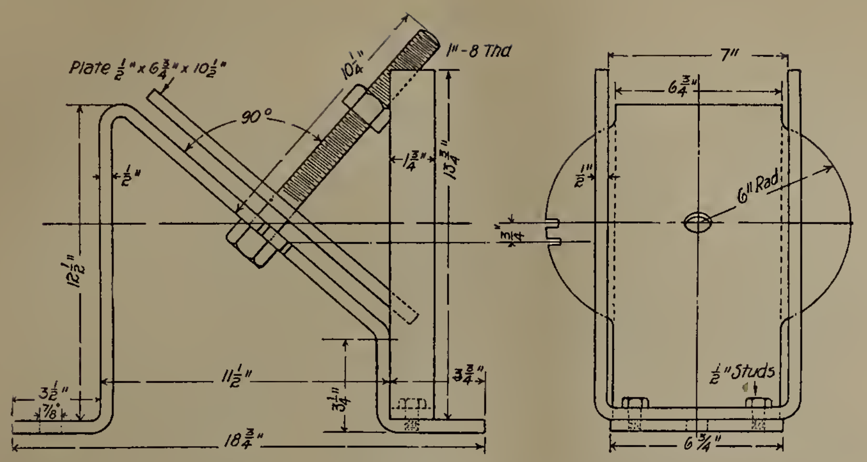


Fig. 20—Jig for Sawing Air Pump Packing, Beech Grove Shops.

official matters should be impersonal because of the possible difficulty of identification; because of the resulting elasticity in interior administration. One does not ordinarily address a letter to an individual attache of a firm, a bank, a hotel or a newspaper. He does not normally attempt to dictate who shall handle his communication. He leaves that to the intelligence and discretion of the organization that he is addressing. Under the unit system communications are addressed to the office—except when personal. The action taken however, is by a real live man, whose identity is not concealed. The position is assumed that the recipient of a communication has the right to know what person is responsible therefor. The principle is established that except for a strictly personal staff, as for example a private secretary, all persons report ordinarily to a headquarters or an office and not to an individual. The authority of such headquarters or office is always exercised by an individual. Authority, in an enlightened organization of society or industry, should be impersonal. Its exercise is highly personal.

The application of the above established principle to the reorganization of an operating division requires that the assistant superintendent shall become the senior assistant. If previously there is no assistant superintendent the trainmaster or most probable successor of the superintendent becomes the senior assistant.

The next step in making the division a complete unit with its head, the superintendent, in effect general manager, is to move the division master mechanic and the traveling engineer (road foreman of engines) to the same building with the superintendent. The division shop as a sub-unit is left in charge of a general foreman. The old theory has been that a master mechanic if located at the shops can better supervise the shop forces. It is believed that the volume of business and complexity of modern conditions have outgrown this theory. It is found in practice that the master mechanic spends much of his time in an office near the shop writing letters to the superintendent, the superintendent of motive power and other officials. Again, human nature is such that the master mechanic so located may unconsciously dwell on the plane of the division shop foreman at the expense of the former's mechanical responsibilities along the road and at outlying terminals. When this results his value as a division official is diminished. The governing reason for locating the master mechanic and the traveling engineer with the superintendent is not only to gain a closer personal touch. Such contact is largely a matter of personal equation and of training regardless of location. The main object is to eliminate red tape by making possible a consolidation of files in one office of record. It has been demonstrated that relieved of a bureau of unnecessary correspondence the master mechanic can and does spend more hours among his men whether in shops, on the road, or at terminals.

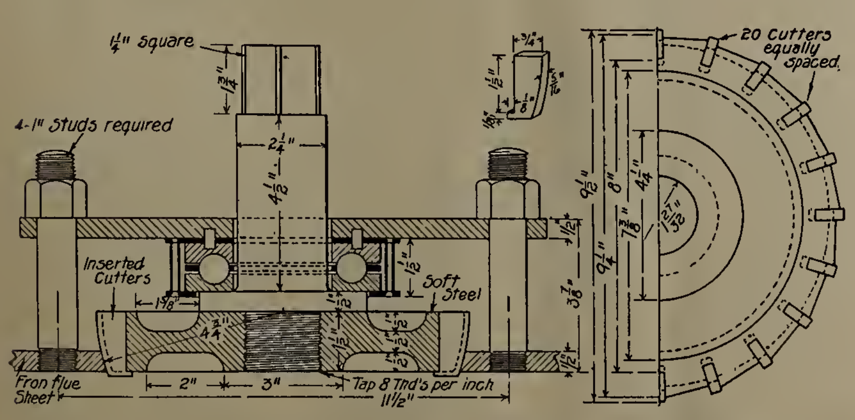


Fig. 21—Flue Sheet Reamer, Beech Grove Shops.

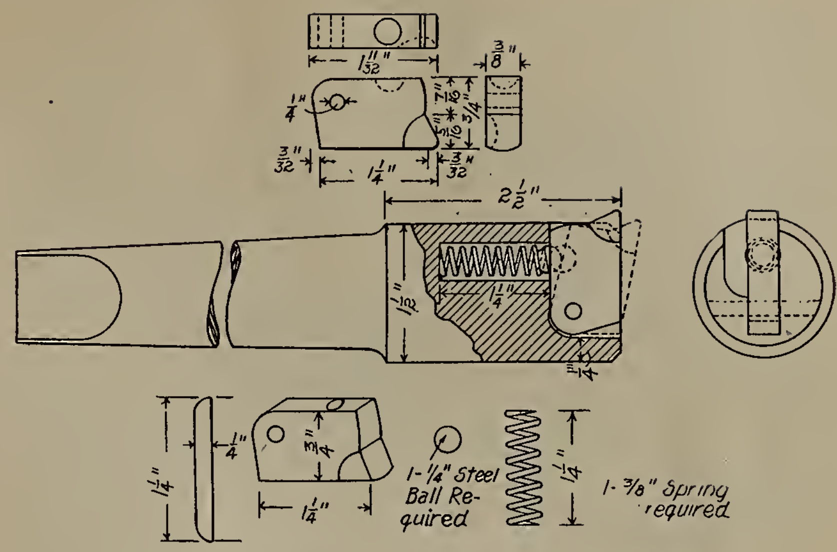


Fig. 22—Recessing Tool, Beech Grove Shops.

Assuming that the division engineer, the trainmaster, and the chief dispatcher are already located in the same building with the superintendent, the division is ready for reorganization. The general superintendent and the instructor visit division headquarters where are assembled the division officials and their old chief clerks. In an informal lecture of two or three hours duration the principles of the system and its unwritten laws are outlined. Explanations are given of the revised standard circular of organization, which reads as follows:

............RAIL.... COMPANY.

.... DIVISION.

CIRCULAR NO. ....

.......................191....

Effective .... 191...., this Division discontinues among its officials the use of titles—Master Mechanic, Division Engineer, Trainmaster, Traveling Engineer, and Chief Dispatcher.

The following named officials are designated:

1. Mr. E. F..............................Assistant Superintendent.
2. Mr. G. H..............................Assistant Superintendent.
3. Mr. I. K..............................Assistant Superintendent.
4. Mr. L. M..............................Assistant Superintendent.

They will be obeyed and respected accordingly.

Each of the above named officials continues charged with the responsibilities heretofore devolving upon him, and in ad-

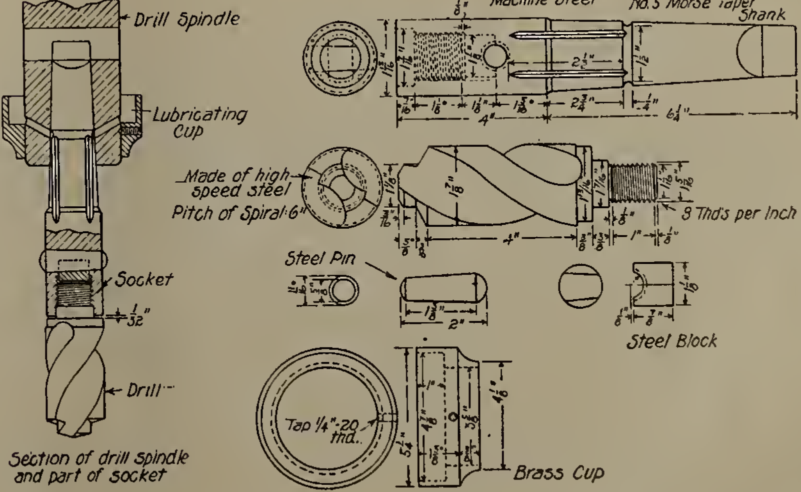


Fig. 23—Special Flue Sheet Reamer, Beech Grove Shops.

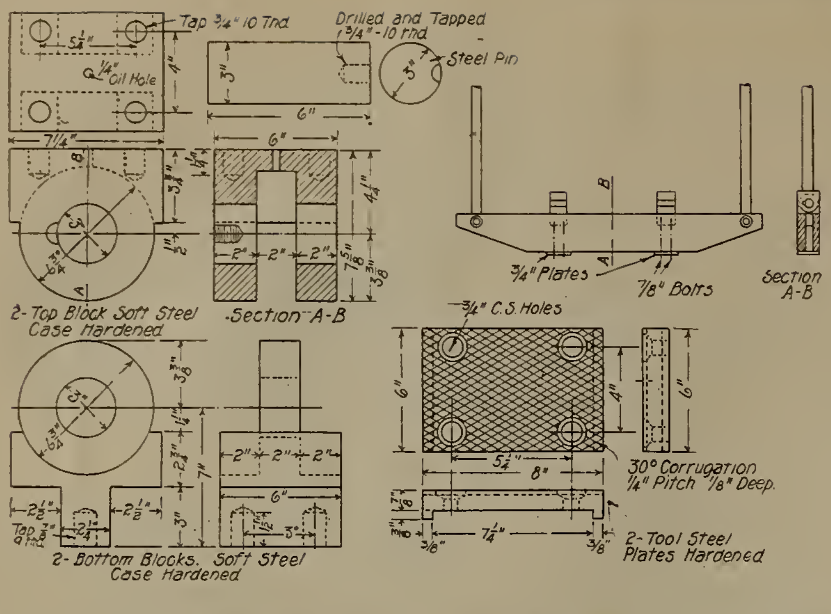


Fig. 24—Adjusting Blocks for Lifting Yokes, Beech Grove Shops.

dition assumes such other duties as may from time to time be assigned.

Such of the above as are located in the same building have one consolidated office file in common with the superintendent.

All reports and communications on the company's business, originating on this division, intended for the superintendent, or for any assistant superintendent, should be addressed simply "Assistant Superintendent" (telegrams "A. S."), no name being used unless the communication is intended to be personal rather than official, in which case it will be held unopened for the person addressed. It is intended that an assistant superintendent shall always be on duty in charge of the division headquarters offices during office hours. The designation of a particular assistant superintendent to handle specified classes of correspondence and telegrams is a matter concerning only this office. Each official transacts business in his own name, and no person should sign the name or initials of another. The principle to guide subordinate officials and employes is to be governed by the latest instructions issued and received.

Train orders will be given over the initials of the train dispatcher on duty.

The domifications of pre-existing organization and methods herein ordered have been carefully worked out to expedite the company's business by the reduction and simplification of correspondence and records. It is expected and believed that officials and employes will insure a successful outcome by lending their usual intelligent co-operation and hearty support.

Officials and other persons outside the jurisdiction of this division are requested to address official communications, intended for the superintendent or any assistant superintendent, "Superintendent, ... Division, ..." (telegrams "Supt.") without using the name of the superintendent except for personal matter.

C. D.
Superintendent.

Approved:
A. B.
General Superintendent.

It will be observed that no distinct grade of senior assistant is created. The unwritten law is that whatever assistant is assigned to the charge of the headquarters' office becomes the senior for the time being. It was originally intended that different assistants should be detailed as the senior for certain definite periods. In some cases such a rigid rule may be necessary. The experience of a year indicates that the incidents and casualties of the service may usually be depended upon to let the situation work itself out. This is gratifying since in such matters self-suggesting procedure is preferable to rigid rules. For example, if an assistant sprains his ankle or mashes his foot the superintendent can assign him to the office and send the then office man out on the road. Vacations and enforced absences afford the superintendent an opportunity to cover the situation by a common sense assignment. On one division the senior assistant was necessarily absent for some weeks. The maintenance assistant who happened to be next in rank was busy outside relaying the division with new steel. The third man, the mechanical assistant, had few troubles of his own in summer and to him fell the opportunity to be broadened by a tour in the office.. The superintendent and the other assistants, including the old traveling engineer, did the engine chasing. No circular was necessary, and there was less confusion than if two dispatchers had exchanged tricks.

The assistant superintendent when at headquarters, except the senior assistant, have equal rank. On the road they have the relative rank indicated by the circular or the current working time table. In case two or more find themselves together and an interruption to traffic or other emergency requires, the highest on the list takes charge and becomes responsible. The system forces more officials to assume responsibility and by much increases the protection to the company's interests. More and more is heard about "this division," and "the company" and less and less about "my department."

Most division officials have welcomed the title of assistant superintendent as a real promotion and as an increase in opportunity. Some still feel the loss of a distinctive title. Time alone will prove that railroading has become great enough as a profession to carry its own marks of distinction and to permit of a properly balanced specilization along the lines of greatest aptitude. Men like Julius Kruttschnitt, James McCrea, L. F. Loree, Epes Randolph, J. W. Kendrick, F. A. Delano and W. W. Atterbury, have not lost any reputation as civil and mechanical engineers because of their greater prominence as railway executives. For the same reason that a chief engineer blushingly accepts the title of vice president, a division engineer should modestly aspire to the position of assistant superintendent. This is one of the features of the unit system that it will take a generation to work out. Eventually an official cannot hope to perform the duties of chief engineer, or superintendent of motive power, until he has had experience in the grade of division superintendent. When superintendents are selected from diversified sources this will be possible. An advantage of the uniform title of assistant superintendent is that as in the case of vice presidents, it necessitates speaking of a particular official by name. When any official is away from his headquarters, he is addressed by name.

The unit system makes a distinction between superior or co-ordinate units and subordinate units. Employes address "Assistant Superintendent." If they addressed "Superintendent" there would be an implied obligation on the part of the superintendent to answer. If his personal action is desired he must

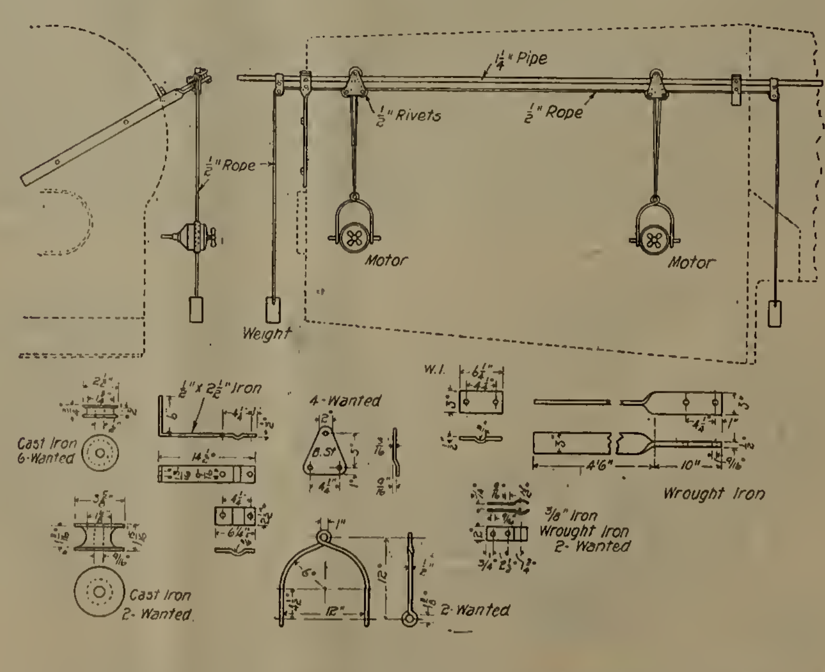


Fig. 25—Device for Tapping Stay Bolt Holes, Beech Grove Shops.

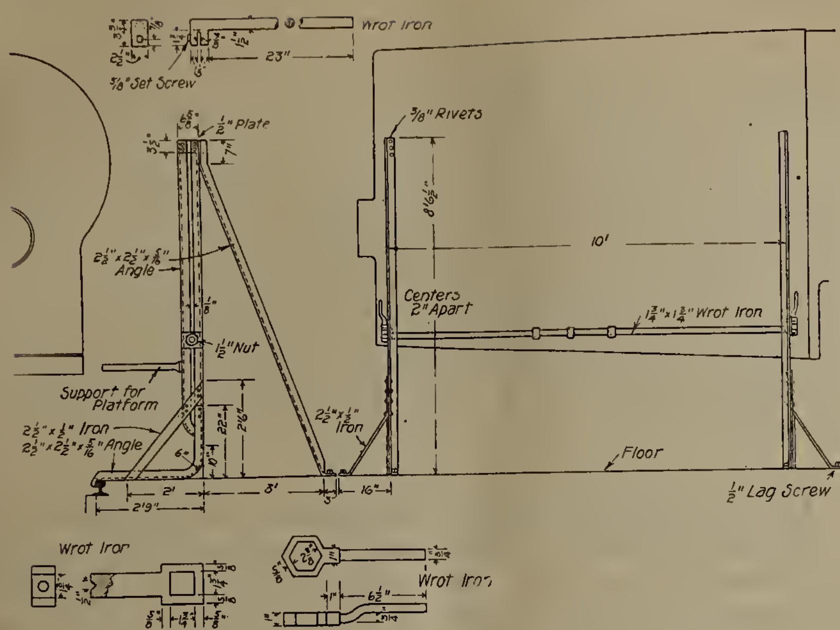


Fig. 26—Stay Bolt Drilling Rack, Beech Grove Shops.

be addressed by name. Even though "Assistant Superintendent" is addressed the reply may be signed by the superintendent himself. Subject always to his superior's wishes, the superintendent makes his own office rules as to what he shall personally handle. It is up to him to see all, a part, or nothing for a given period, just as he sees fit. Should the superintendent's letter call for further information from the employee, the latter's reply would still be addressed "Assistant Superintendent." For all that the sender knows the particular official may be necessarily absent when the letter is received. Numerous old conductors have expressed their appreciation of the fact that a man knows what official has addressed him, and that it is no longer possible to be jacked up by a clerk using the name of an official.

Communications from superior or co-ordinate authority are addressed to the head of the unit, the superintendent. In his absence routine matters for higher or co-ordinate authority are signed by the senior assistant who appends to his own title the explanatory phrase, "For and in the absence of the Superintendent." Going down on the division no such explanation is necessary, as the authority of any assistant superintendent carries over the division itself.

The superintendent being in effect general manager of his division is given charge of division stores as well as division shops. He must, therefore, obey the instructions of the general storekeeper as well as superintendent of motive power. The general storekeeper has thus placed at his disposal all the administrative machinery of the division. Instead of a lack of practical sympathy between the stores and the users of material, it is made the duty of the superintendent and the assistant superintendents to watch material costs as well as labor costs, to help keep down interest charge on stocks as well as overtime. A railway company harnesses the forces of nature, including its divinely human elements for one purpose, the manufacture and sale of an intangible commodity, transportation. The more closely interwoven the constituent parts of production the more efficient and economical should be the output. When weaknesses develop, when education is needed as to the increased importance of a given element, the remedy is not ncessarily the creation of a separate department. A general storekeeper there should be, whatever his title, technically expert in his important specialty, responsible to the general manager and in a position to insist upon efficiency to the extent even of ordering material moved in special trains when it is true economy for the company to do so.

It will be noted that the superintendent, as the representative of all so-called departments on his division, has about as many superiors as he has assistants. The work of these superiors is balanced by the general manager. The scheme will not be fully effective until the unit system is applied to the general offices, making the general superintendent, the chief engineer, the superintendent of motive power, the general storekeeper, the car service agent, the superintendent of telegraph, the signal engineer, and the superintendent of dining cars all assistant general managers with one consolidated office file, and their activities co-ordinated by a senior assistant general manager at headquarters. Thus far only one general office, that of the new Oregon and Washington Railroad at Seattle, has been reorganized in accordance with this conception.

The number of divisions now re-organized is twenty-one with eleven still to follow. The number of assistant superintendents on a division varies from three to twelve. Every superintendent has shown his ability to handle as many assistants as the management may give him. The most gratifying feature of the re-organization is the fact that in all cases the talent at hand has been sufficient. No importations have been necessary. The incumbents of official positions have responded splendidly to the confidence reposed in their ability. Some divisions have gone farther than others. This always has been and always will be the case. Every one, however, has made real progress, some of it unconscious. The human element has been recognized. Division officials who from lack of early breadth of opportunity have not the qualifications for senior assistant are not required to fill the position. Their services to the company have been too faithful to warrant humiliation or elimination. Their grasp of present conditions is greater than could be that of student successors. When in the course of nature, a new crop of officials matures it will be ripened younger but attain a fuller growth.

Consideration has been shown for the clerical forces affected by the changes. No individual has had his salary cut. As vacancies occur through natural causes salaries are readjusted; some increased, some diminished to meet the new conditions. All of these matters are left to the local officials. Principles are enunciated, suggestions made, but responsibility for details is left to the officials on the ground. The system means more officials and eventually fewer clerks. Probably by a cheese paring effort enough clerks could be eliminated to offset such increases in official salary lists as have been found necessary. The management has felt that increased supervision will warrant the outlay. This liberal policy is justified by good business sense rather than by the prosperity of the Harriman Lines. The poorer a road the more money it should spend for supervision and the development of esprit de corps.

As a general proposition officials at headquarters should not

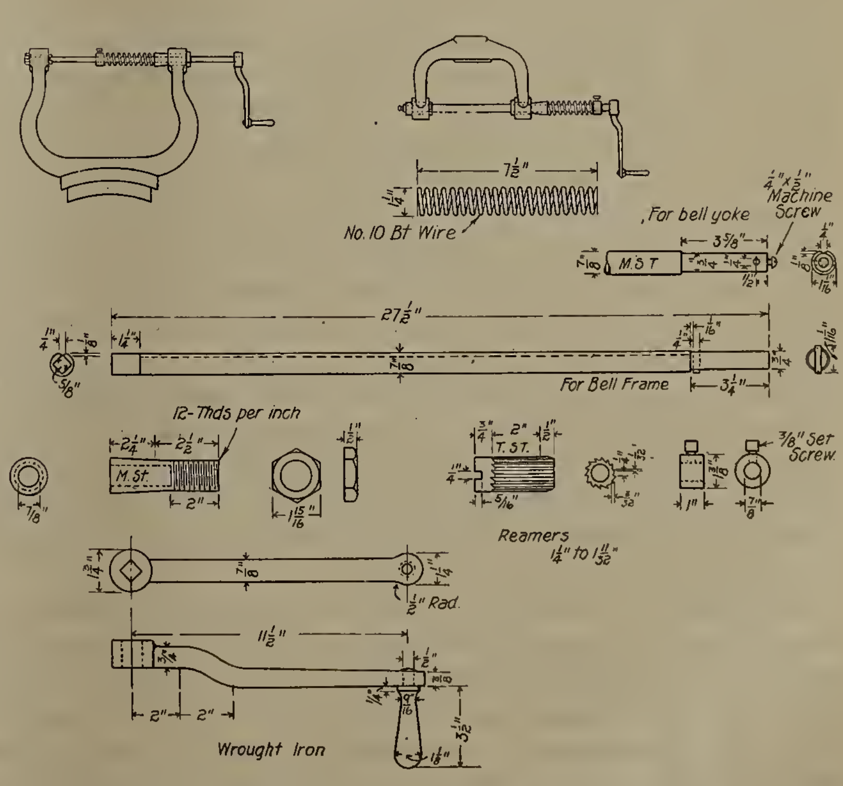


Fig. 27—Method of Reaming Holes in Bell Yokes, Beech Grove Shops.

exchange written communications among themselves. Superintendents must apply this principle without hard and fast rules. For example the superintendent of a heavy division being on the line some 200 miles from headquarters, very properly addressed a joint letter to each of his ten assistants, calling their attention to a wreck he had just picked up and as the lesson to be learned enjoining upon them a vigilant enforcement of certain rules. It has been found possible to reduce the correspondence of divisions reorganized from thirty to fifty per cent. Even with reduced clerical forces night and Sunday office work has been eliminated. The great reduction is made possible by the constant presence of the senior assistant who is alert to discourage the letter writing propensities of headquarters. It is expected that when all of the units under the Chicago office are reorganized there will be a net saving of at least 500,000 letters per year. Every letter costs a few cents to produce. Its retarding effect upon administration cannot be measured in money. Its dwarfing influence upon the individual initiative of the man below is likewise indeterminate. It is expected also that when the reorganization is completed numerous routine reports can be dispensed with.

It is not expected that a mere change of title or an assignment by a superintendent will make a man a skilled mechanic or an experienced engineer. For technical questions arising on a division the most expert knowledge available will continue to be utilized. It is claimed, however, that as the average division official has been in the service at least ten or fifteen years, he cannot fail to have acquired some familiarity with the requirements of the various branches of the work. The old trainmaster may as third trick dispatcher have ordered an engine taken down and towed in without awakening the master mechanic. By so much more should he with wider experience be able to say whether or not the company's interests are being best observed in the handling of a locomotive that may happen to come under his notice. The mechanical assistant cannot be everywhere and any help that his fellow officials can render the company should receive. Conflict of authority is avoided by the common sense and courtesy of the assistants and by the attention of the superintendent. Nothing makes men so conservative as responsibility. It is claimed that the superintendent on the ground is better able to decide these questions intelligently than is a hard and fast code formulated by a man behind a distant desk. What is construction today will be maintenance tomorrow. What is motive power at the turn table becomes transportation at the switch.

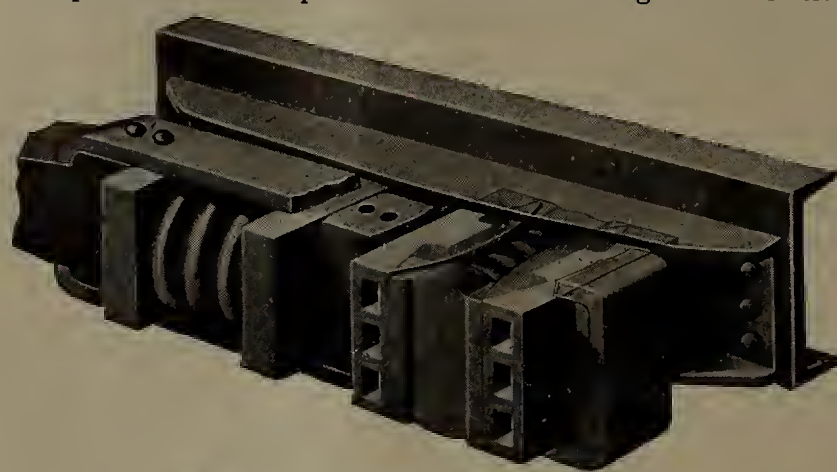
Each official continues responsible for his branch of the work until otherwise indicated by the superintendent. The maintenance assistant is not allowed to plead transportation duties as an excuse for defective track. With him track must come first. When the train stops he cannot inspect track until it resumes. Meantime he may be able to minimize the delay by seeing that employes perform their duties promptly. He is not allowed, except for insubordination, to discharge employes on another assistant's payroll. He is expected however, tactfully and politely but forcefully, to insist that the rules be obeyed. The faithful old employes need only encouragement to perform their duties well. The young and inexperienced require constant supervision and instruction. Due to its great extent of territory a railway exercises less control over its employes than any other line of organized effort. The safety of lives and property demands the greatest possible intelligent supervision.

Adaptability to changed conditions is largely a matter of temperament. Among his intimates one can usually predict in advance what position a particular person will take on a question of politics, religion or organization. Some men believe in an early convergence of authority, in wide latitude of discretion. Others believe that the best results are obtained by postponing decisions until the highest possible authority is reached. On important questions there are usually two schools of opinion. Nearly every civilized country has two great political parties. On the railways of America there will always be diversity of opinions and practices as to the organization of forces. The executive officers of the Harriman Lines have felt that the individual will be broadened and the service correspondingly improved by the introduction of the elastic methods herein outlined. While many are enthusiastic, not all of the persons affected are convinced. It is to the credit of the latter that in spite of honest doubts all have contributed more or less to the success of the scheme. The work is being kept on a high plane, guided by those exalted ideals of duty: freedom from personalities: and the good of the service.

Butler-Miner Combination Draft Gear

The Butler Drawbar Attachment Co. under the Piper patents has adapted its friction elements to the Miner tandem class "G" spring gear for cars with 12⅞-in. sill spacing, in such a manner that the spring gear can be raised from a 60,000-lb. to a 200,000-lb. capacity friction gear. The interesting tests made during the past year of friction draft gears in actual service have shown the enormous value of absorbing more of the shocks of buffs and jerks than is possible with the best of the spring gears.

Col. W. B. Dunn, chief inspector of the "Bureau for the Safe Transportation of Explosives and other Dangerous Articles,"



Butler-Miner Combination Draft Gear.

in speaking of recent tests of the shocks of loaded cars, says that "the results show in a striking manner the value of the friction draft gear in reducing impact pressures."

In applying the Butler friction elements to the Miner spring gear, no material need be thrown away, as that which is removed is still good for repairs. The friction element introduced is now in use in a large number of cars and the slight change in the "Miner" makes an improvement to the gears now in service, or to new equipment, that will be both inexpensive and valuable.

A static test of this combined gear gives a splendid card, the action of the single "G" spring giving a fine preliminary movement, which gradually glides into the friction elements without a sudden jump or shock, a thing which tests have shown in quick impact often prevents the friction parts going into operation at all. This fact makes the early spring movement a valuable feature in the gear, as well as taking up the very large amount of slight shocks incident to shifting and starting movements.

According to press reports, bids were recently opened for the construction of about 100 miles of line from Lometa, Tex., via San Saba and Brady to a point near Eden as an extension of the Gulf, Colorado & Santa Fe. Surveys have been finished and it is thought that the construction work will be pushed to early completion.

It is reported that the Chicago, Memphis & Gulf, which was formerly known as the Dyersburg Northern, is quoted as saying that an extension is to be built from the southern terminus at Dyersburg, Tenn., south via Memphis to a point in Mississippi. Work is said to be under way from the northern terminus at Tiptonville, Tenn., northeast to Hickman, Ky., 21 miles.

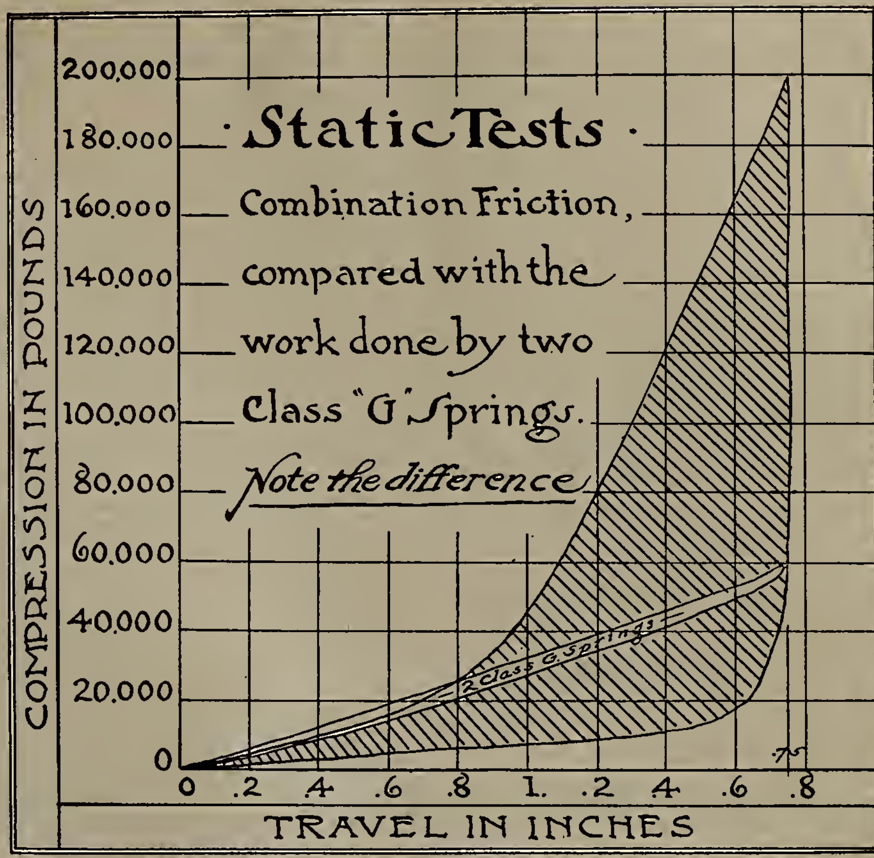
Lubrication of Locomotives

The two factors of locomotive hauling power are tractive force and speed. The tractive force which can be exerted by a locomotive engine is dependent on the size of the cylinders in relation to that of the driving wheels and the mean effective steam pressure which can be developed in the cylinders. Speed is dependent upon the rate at which the boiler can supply steam to the cylinders and this is dependent on the combination of grate area and heating surface. The potential hauling power of a locomotive is, therefore, determined solely by its dimensions and if two locomotives are built to the same dimensions, their potential hauling power must be identical, if the actual hauling power of one proves to be less than that of the other when they are both worked in the same manner and under precisely similar conditions the only possible explanation of the difference is that the engine giving the lesser hauling power has more energy absorbed in overcoming internal or running friction, which points to any of three things, i. e., either it is not so well built, or the materials of which the surfaces in friction are composed are unsuitable, or the lubrication is deficient or defective. With the first two we are not concerned. Let us suppose that they are non-existent and examine the latter.

In the machinery of a locomotive, rubbing of metal on metal occurs in bearings, slide blocks, expansion links, quadrant blocks and pins, eccentric sheaves and straps, big end brasses, axlebox brasses, journals, slide-valves, etc., etc., and it is to facilitate the slipping of these parts, to lessen and overcome the friction resultant on their rubbing, that lubrication is requisite. The friction between an unlubricated journal and bearing varies with pressure, the greater the pressure, the greater the friction: the smaller the pressure, the smaller the friction. This is the friction of solids. The friction between the parts of a liquid is not increased by pressure at all, water and oil are both equally liquid under any pressure and friction in them is not at any time increased. The friction between a lubricated journal and bearing is, so far as these surfaces come in contact with one another, affected by pressure; so far as these surfaces are kept apart by a fluid lubricant, let us take oil, the friction is not affected by pressure. Consistent and successful lubrication is the removing of friction from the metal, where pressure effects it, to the oil, where pressure does not effect it. Lubrication, therefore, is designed to overcome the friction consequent on the contact of two hard metal surfaces by placing it in the oil, where its pressure exercises no adverse effect on the working of the engine.

It should, however, be remembered that a want of proper hardness in the surface of the wearing parts is seriously detrimental to the economical operation of a locomotive, the excessive friction even when lubricated, produced by too easily eroded surfaces, results in rapid wear, lessened hauling power and increased fuel consumption, all caused by the heavier working necessary to overcome the greater friction. The rate of wear of a rubbing part is, approximately, proportioned to the power absorbed by friction and is also dependent on the degree of hardness of the material. To illustrate, take two engines in one of which 20 per cent greater power is absorbed by internal friction than in the other. The rate of wear in this engine may, therefore, be reasonably expected to be at least 20 per cent greater, also, as its boiler would have to be worked more heavily in producing the extra steam required to make up for the loss of efficiency, the wastage and deterioration of the tubes and firebox will be more rapid and necessitate earlier renewal.

As has been said, the result of friction is to lessen hauling power, increase the rate of wear and coal consumption and to generally lower the efficiency of the locomotive. To overcome this friction, lubrication is necessary, and lubrication of the right kind in the proper place. The friction of any bearing is, of course, the sum of two elements—rubbing between the surfaces of two metals and rubbing between the lubricant or films of oil. At all pressures and at all speeds we get the



Butler-Miner Draft Chart.

least possible friction with oil that is applied sufficiently thick to keep the journal and bearnig apart, but is yet thin enough to avoid any excess of friction inside of the oil itself. Where the perfect compromise is obtained, and it is to be doubted if it ever is, we have true lubrication, doing away with all friction affected by pressure and extracting the utmost power possible from the machinery with a minimum of wear and tear.

The relation of speed in lubrication is noticeable. The slower the speed, the thicker the application of oil requisite to keep the surfaces of journal and bearing apart; the higher the speed, the thinner the application which will do the same work and yet give an identical effect. The law governing this principle is the elementary one which shows that speed takes oil in with a certain force, the friction of oil upon oil is governed by speed and practically by it only.

If, therefore, the indicated hauling power of a locomotive is to be maintained and all increased and excessive wear avoided, it is obvious that careful and thorough lubrication is a primary consideration, a consideration which should be regarded as vital to economics and worthy of exhaustive study. The nature of the lubricant employed, its suitability to the particular part to which it is applied and the extent to which its application overcomes internal of running friction, are all points bearing very directly on the subject and ones which cannot be overlooked.

An essential principle of good oil is the endurance it exhibits; *i. e.,* the amount of work that one gallon will do as compared with an equal quantity of another and possibly inferior oil. If the effort is, as it of course should be, towards true lubrication, the inferior article has in the endeavor to attain it, to be used profusely, run from a free feed, and once used it is perished beyond recovery. The higher class oil, the oil of greater endurance, can be used with an equally satisfactory result in a more sparing manner and can, if recovered, be filtered and used again. The difference in value between the two is the cost of what one saves and the other does not. A reliable oil, a good oil, one which in the end pays its extra initial cost many times over, saves coal, repairs, lengthens the life of the machinery, ensures greater working efficiency and obviates a very large portion of the risk of breakdowns and engine failures from hot boxes, broken eccentric straps, melted motions and other like causes. To the obtaining of such an oil, the consideration of motive power officials should be seriously directed.

*From Indian Engineering.

Tests of Run-of-Mine and Briquetted Coal in a Locomotive Boiler*

By Walter T. Ray and Henry Kreisinger.

In its investigation of more efficient methods for utilizing the coals and lignites in the United States, to the end that waste may be avoided, the value of low-grade coals increased, and the life of the nation's fuel resources prolonged, the United States Geological Survey has carried on a study of the factors involved in the manufacture and use of briquets, including the suitability of various coals for briquettting, the cheapest and most satisfactory binders, and the furnace behavior and evaporative efficiency of briquetted fuel. The investigations began with the work done at the coal-testing plant at the Louisiana Purchase Exposition, St. Louis, Mo., in 1904, and were continued at St. Louis and later at Norfolk, Va., as an essential part of the scheme of technologic research by the government fuel-testing plant. Accounts of various tests and statements of the conclusions to be drawn from them have appeared in a number of bulletins.

In connection with the work at Norfolk, comparative steaming tests were made in stationary, marine, and locomotive boilers with run-of-mine coal and the same coal formed into briquets of two sizes. The tests in a locomotive boiler that are described in detail in this bulletin were undertaken to add cumulative evidence to work done at other places. They were made possible through the courtesy of the Sea-board Air Line in supplying both the locomotive and the coal used. During the trials the locomotive stood on a side track in the shop yards of the railway company at Portsmouth, Va. No running tests were made.

All the coal was run-of-mine from the Turkey Gap mine, working the Pocahontas No. 3 bed at Ennis, McDowell County, W. Va. Part of it went to the briquetting section of the fuel-testing plant at Norfolk, where it was made into two sizes of briquets.

The smaller of these two sizes was circular in horizontal cross section, 3¼ inches in diameter. Its vertical cross section was nearly oval, 2¾ inches at the center by 1¼ inches near the circumference. The larger size was rectangular in either cross section, its dimensions being 3 by 4¼ by 6¾ inches. The small briquets were compressed at about 1,000 pounds and the large ones at about 2,500 pounds per square inch. The pitch used was approximately the same in kind and percentage.

All tests were made while the locomotive, which was of the ten-wheeled freight type, was standing out of doors in the yard of the Portsmouth shops of the Seaboard Air Line. "Draft" was produced by removing both valves from the steam chests and blowing steam through the main throttle and the cylinders into the nozzle (fig. 4) and out through the stack. Steam not thus used was discharged through special pipe connections into the main steam header of one of the stationary boiler plants. This plant carried a pressure of less than 100 pounds per square inch, while the pressure in the locomotive was 200 pounds; a globe valve, in the pipe between the locomotive and the header, was used to regulate the pressure in the locomotive.

Steam pressure was read off the regular locomotive gage, which was reliable within 2 or 3 pounds. The pressure was also automatically recorded by a Crosby recording gage, which was accurate within 2 or 3 pounds.

A modification of the "alternate method" was used in starting and closing tests. Fire was kindled with wood on a clean grate and built up very rapidly with coal. As soon as the steam pressure had risen to 200 pounds the fire was leveled and the test started. This preparatory firing took one to two hours and required the burning of 300 to 500 pounds of coal.

*Bulletin 412 U. S. Geological Survey.

On starting the test the thickness of the fuel bed was measured as accurately as possible with a prong, and readings were taken of steam pressure, height of water in the boiler, height of water in the tender, and "draft" in the furnace. Closing conditions of the tests were made as nearly as possible the same as those of starting. The tests were usually started with a layer of burning coal 3 or 4 inches thick.

Just at closing, the thickness of the bed of fuel above the layer of clinker was estimated as nearly as possible. After closing the test the fire was burned down entirely, the clinkers pulled out through the fire door, weighed, and charged to the test. It was impracticable to clean the fire before the close of the test, because the lower edge of the fire door was 14 inches above the grate. Immediately before starting each test the ash pan was cleaned. After closing and removing the clinker from the grate all the ash was taken from the ash pan, weighed, and charged to the test. At first thought it might appear that the weight of ash thus obtained must be too great, but the chemical analysis of the coal shows that it was too low in all cases excepting one. Items figured from the weight of ash actually obtained are inaccurate and are given to show the futility of calculations and deductions so based.

Coal was weighed with small platform scales on which was placed a box of 300 pounds capacity. The scales with the box thereon were located in the front part of the tender directly in front of the furnace, and one side of the box was let down so that coal could be easily fired from it. The time of each firing was recorded, the coal being weighed only each time the box was filled, the times of filling being recorded. Each time while the box was being filled a sample of coal was taken for analysis, a little at a time, amounting to a total of about a shovelful per box.

Water was weighed on a small platform scale in a tank having a capacity of 636 pounds. The scale and tank were placed on top of the tender near the rear end. Specially erected piping carried water from the city main to the weighing tank. The water drained from the weighing tank into the tender tank, and on each occasion the time of emptying and the weight of water were recorded. A long glass water-level gage was connected to the tender tank so that the height of water in it could be read from a scale at regular or special observations. Tests were opened with the tender tank nearly full of water and closed at the same level. A thermometer was immersed in the water in the tender and temperatures taken at regular intervals.

During tests all leakage from the boiler and tender was caught in buckets and weighed, and its total weight was subtracted from the total weight of the water put into the tender tank. The overflows from the injectors were likewise caught and allowed for.

Flue gas was sampled with the specially constructed gas sampler and piped into a box car set just behind the tender. In the car was an improvised laboratory in which the gas was analyzed for CO_2, O_2, and CO, in an Orsat apparatus. The gas was drawn into the car with a steam ejector. Samples thus collected were occasionally checked by samples taken immediately at the smoke box.

On most of the tests the smoke-box temperature was measured with a mercury thermometer; on two or three of the high-capacity tests it was measured with a platinum and platinum-rhodium thermocouple.

Gas pressures ("drafts") were measured on all tests, over the fuel bed, at the exit of the boiler tubes, and nera the nozzle. On the first six tests the pressures were also taken over the arch in the fire box. Ordinary U-tube manometers were used for all these readings.

A set of Ringlemann smoke charts were prepared as an aid in the estimation of the comparative darkness of smoke; but inasmuch as the darkness was usually between No. 0 and No. 1 the charts were of little advantage and were seldom used.

The densities of smoke given in the tables herewith are averages of the estimates of two or three observers.

The weight of sparks ejected from the stack was determined by means of a collecting device. As is there stated, this apparatus collected sparks from one-tenth of the total cross-sectional area of the stack, so that the total weight of sparks ejected from the stack could be fairly well obtained by multiplying by 10 the amount caught in the receptacle. In most cases the sparks were collected during the entire time of the test. On the high-capacity tests the receptacle was removed when about full and the time noted. It was then emptied and replaced. After weighing the sparks from the whole test they were carefully mixed and a sample of about 2 pounds taken and sent in an air-tight can for chemical analysis. The chemical analyses of the sparks and of the coal and refuse were made under the immediate supervision of Fred M. Stanton in the chemical laboratories of the technologic branch of the United States Geological Survey at Pittsburg, Pa.

A throttling calorimeter was attached to the steam pipe leading from the steam dome to the stationary-boiler plant and the moisture in the steam was determined at regular intervals. Of course the steam used in producing "draft" was not sampled by the calorimeter, but the location of the latter was the best under the given conditions.

Test No.	Per cent smoke.	Sparks (pounds). Total collected.	Sparks (pounds). Ejected. During test.	Sparks (pounds). Ejected. Per hour.	Heat balance.[a] Heat value of 1 pound of "combustible." B.t.u.	Heat value of 1 pound of "combustible." Per cent.	Heat absorbed by boiler (1). B.t.u.	Heat absorbed by boiler (1). Pr.ct.	Loss in sparks. B.t.u.	Loss in sparks. Pr.ct.
1	68 (77)	69	70	71	72	73	74	75	76	77
1	0	1	10	1.65	15,705	100	12,790	81.44	....	....
2	15.4	7	70	13.77	15,720	100	12,181	77.48	137.1	0.88
3	19.4	21	210	34	15,782	100	11,544	73.14	216	1.36
4	24	No sparks collected.			15,818	100	12,558	79.39	....	....
6	10	2	20	3.79	15,846	100	11,891	75.00	41	.26
6	10	9	90	20	15,955	100	11,727	73.50	161	1.00
7	10	14	140	31.5	15,810	100	11,582	73.26	216	1.36
8	8	31	310	81.6	15,865	100	10,656	67.16	441	2.78
9	8	[b]27	629	135	15,688	100	9,206	58.69	861	5.49
10	12	6	50	12.3	15,838	100	11,940	75.39	112	.71
11	0	35	350	114	15,743	100	11,177	70.99	603	3.83
12	0	22	220	63.2	15,915	100	11,186	70.29	431	2.71
13	0	23	230	55	15,680	100	10,539	67.21	361	2.30
14	0	37.5	376	185	15,865	100	9,766	61.66	683	4.32

Test No.	Heat balance.[a] Loss due to moisture— In fuel (2). B.t.u.	In fuel (2). Pr.ct.	Of hydrogen (3). B.t.u.	Of hydrogen (3). Pr.ct.	Heat lost in dry flue gases (4). B.t.u.	Heat lost in dry flue gases (4). Pr.ct.	Loss due to incomplete combustion of carbon in CO (5). B.t.u.	Loss due to incomplete combustion of carbon in CO (5). Pr.ct.	Loss in escaping hydrocarbons, radiation, and unaccounted for (6). B.t.u.	Loss in escaping hydrocarbons, radiation, and unaccounted for (6). Pr.ct.
1	78	79	80	81	82	83	84	85	86	87
1	53.1	0.34	539	3.43	2,302	14.65	....	....	21	0.13
2	64.8	.41	542.7	3.45	2,451	15.60	173.6	1.10	170	1.08
3	71.7	.45	529.9	3.36	2,603	16.50	79	.50	741	4.69
4	55.5	.35	525	3.32	2,158	13.64	186	1.18	335.5	2.12
5	50	.32	542	3.42	2,307	14.56	107	.69	908	5.74
6	63	.39	530	3.31	2,384	14.91	176	1.17	914	5.72
7	73	.46	573	3.63	2,795	17.68	139	.88	432	2.73
8	71	.45	591	3.73	2,951	18.61	113	.78	1,043	6.56
9	111	.71	588	3.75	3,340	21.28	117	.74	1,465	9.34
10	34	.21	506	3.19	2,089	13.18	162	1.02	995	6.28
11	49	.31	574	3.65	3,058	19.43	20	.13	262	1.66
12	33	.21	577	3.62	2,894	18.18	227	1.43	567	3.56
13	96	.61	553	3.53	2,821	17.99	38	.24	1,272	8.12
14	78	.50	758	4.75	4,214	26.56	163	1.03	203	1.28

[a] Heat-balance items (designated by numbers in parentheses under this heading) are explained in Bull. U. S. Geol. Survey No. 325, p. 153.
[b] Sparks collected for two hours only.

Observations and Computations.

In all, 14 tests were made; 6 on run-of-mine coal, 4 on large briquets, and 4 on small briquets. The tests were made at various rates of combustion, the lowest being 18 pounds of dry fuel per hour per square foot of grate surface when burning coal, and the highest being about 110 pounds of dry fuel when burning small briquets. The recorded observations made during the tests and the results calculated therefrom are given in the tables herewith.

The computations embodied in the table were made according to the method in practical accord with the recommendations of the American Society of Mechanical Engineers. The figures in parentheses at the heads of columns in the table are the item numbers of the society's code for boiler tests.

General Deductions.

At the usual rate of combustion in locomotives the equivalent evaporation with either kind of briquet is 10 to 15 per cent higher than with run-of-mine coal.

So far as blackness of smoke is concerned there seems to be little advantage in briquets over the run-of-mine coal. However, the loss in sparks is less, and especially with the larger size of briquets.

It is a great deal easier to raise and to keep up steam with briquets than with run-of-mine coal. Higher rates of combustion are feasible, and consequently higher power, which is of especially great advantage on long grades.

As to efficiency, there is practically no difference between the two kinds of briquet, but the smaller ones are easier to handle.

Suggested Changes in Design and Construction of Locomotive.

Although the combustion of this particular coal and of briquets made therefrom was very complete, combustion is not usually at all good with most of the coals of the country, even when briquetted. The fire-brick arches of this type of boiler are undoubtedly of great benefit in mixing the gases and in igniting freshly fired coal, but some roads object to them because they interfere with stay-bolt inspection. The great trouble is that the time elapsing between the instant the gases leave the fuel bed and the instant they enter the tubes is much too short with ordinary coals. On way of materially remedying this trouble, which is being more and more employed, is to add a "combustion chamber" inside the cylindrical portion of the boiler, opening out of the front side of the fire box. To accomplish much improvement this additional length of gas travel must amount to several feet. It is usual to keep the fire tubes the same length and to make the whole boiler much longer—a subterfuge to which there are practical objections.

In Bulletin 325 there is an extended discussion, touching, among other things, on the ratios between the length and diameter of boiler tubes as affecting their efficiency and capacity as heat absorbers. Specifically stated for the present case, if the tubes were made half as long and of half the internal diam-

Test No	Ash and refuse in dry fuel (per cent).	Proximate analysis (per cent). Fixed carbon. In moist coal.	Fixed carbon. In "combustible."	Volatile matter. In moist coal.	Volatile matter. In "combustible."	Moisture. In fuel as fired.	Moisture. ([b])	Ash. Moist basis.	Ash. Dry basis.	Sulphur.[a] Moist basis.	Sulphur.[a] Dry basis.
1	24 (31)	25 (32)	26	27 (33)	28	29 (34)	30	31	32 (42)	33	34 (41)
1	8.57	73.35	83.13	14.97	16.87	3.66	4.13	7.62	7.91	0.45	0.47
2	7.82	73.67	83.49	14.56	16.51	4.36	4.93	7.42	7.76	.49	.51
3	....	74.24	84.46	13.66	15.54	4.76	5.42	7.34	7.71	.36	.38
4	....	73.25	84.48	13.46	15.52	3.78	4.36	9.61	9.88	.38	.39
5	....	73.13	81.67	16.41	18.33	3.43	3.83	7.03	7.28	.52	.54
6	....	73.12	82.35	15.67	17.65	4.25	4.79	6.96	7.27	.50	.50
7	5.62	73.47	82.85	15.21	17.15	4.63	5.22	6.69	7.01	.51	.53
8	6.00	72.12	81.04	16.86	18.96	4.31	4.85	6.71	7.01	.42	.44
9	6.03	71.24	82.58	15.01	17.42	6.64	7.70	7.11	7.62	.54	.58
10	9.83	74.41	81.07	17.37	18.93	2.42	2.53	5.80	5.94	.39	.40
11	6.14	72.66	80.87	17.18	19.13	3.01	3.45	7.15	7.37	.47	.48
12	....	73.82	80.43	17.96	19.57	2.24	2.44	5.98	6.12	.61	.52
13	....	73.17	83.91	14.03	16.09	6.18	7.09	6.62	7.06	.52	.55
14	6.32	69.04	80.30	16.93	19.70	4.56	5.31	9.47	9.92	.58	.61

Test No	Ultimate analysis, dry basis (per cent). Carbon	Hydrogen.	Oxygen.	Nitrogen.	Carbon in refuse.	Earthy matter in refuse, including moisture.	Heat value per pound (B.t.u.). Dry fuel.	Heat value per pound (B.t.u.). "Combustible."	Steam (per cent) Moisture in.	Steam (per cent) Quality of.
1	35 (37)	36 (38)	37 (39)	38 (40)	39 (44)	40	41 (50)	42 (51)	43 (54)	44 (56)
1	83.15	4.29	3.14	1.04	46.28	53.72	14,463	15,705	0.6	0.996
2	84.30	4.23	2.21	99	20.40	79.60	14,494	15,720	.7	.995
3	82.73	4.11	4.02	1.05	25.14	74.86	14,553	15,782	.3	.998
4	81.38	4.13	3.19	1.03	17.42	83.58	14,245	15,816	.6	.996
6	84.84	4.31	2.05	98	22.31	77.69	14,693	15,844	1.4	.990
6	83.66	4.16	3.41	1.00	34.51	65.49	14,789	15,945	.9	.992
7	83.98	4.22	3.32	.94	27.68	72.32	14,702	15,815	1.0	.993
8	84.19	4.18	3.07	1.11	29.42	70.58	14,753	15,868	1.0	.993
9	84.12	4.18	2.54	96	26.91	73.09	14,503	16,688	.8	.994
10	84.48	4.05	4.03	1.10	34.69	65.31	14,897	15,838	1.0	.993
11	83.19	4.16	3.99	.81	26.57	73.43	14,742	16,743	1.0	.993
12	84.62	4.42	3.31	1.01	26.08	73.92	14,936	15,915	.7	.995
13	84.73	4.23	2.45	.98	28.31	71.69	14,571	15,680	9	.993
14	82.21	4.25	2.03	98	34.92	65.08	14,292	15,871	1.4	.988

[a] Separately determined.
[b] Accompanying 100 per cent of "combustible."

eter, the gases would leave them a little cooler than now; if they were made two-thirds as long, and of two-thirds the internal diameter, the gases would also leave them a little cooler than now. That is, the efficiency of a tube, aside from slight modifying factors, depends solely on the ratio of its length to its internal diameter, other conditions of cleanliness, etc., being the same. The sameness of efficiency is nearly independent of the amount of gas passing through. It is certainly the case that if the tubes were made half as long, of half the internal diameter, and if four times as many were used (to give the same area of flow for the gases), then the total weight of gas passing through per minute would be fully as great, and the total amount of heat absorbed somewhat greater. It is indeed probable that the number of tubes would not have to be quadrupled for the same "draft" in the smoke bo, but perhaps only doubled.

One objection to making the tubes smaller is that they would choke up more quickly; nevertheless the authors have sometimes observed that about one-third of the tubes of locomotives are choked up anyhow within a short time after cleaning, although such is probably not the general condition of such boilers. The higher velocity of gas through the smaller tubes should tend to keep them clean, unless they fill up at the entrance.

It is well here to introduce a short calculation of the effect of reduced dimensions on the strength of tubes against shearing ("cutting off") at the tube sheets. Suppose the tube to be halved in all its dimensions, including thickness, then it will weigh one-eighth as much and have one-half the bearing surface in tube sheets of the same thickness as before; it is therefore about one-fourth as likely to cut off, although the reasoning is mathematically only approximate.

As to bending, the tube may be considered to be a beam uniformly subjected along its entire length to a live load of its own weight, though here again the reasoning is only approximate. A calculation with formulas for hollow cylinders used as beams shows that the smaller tube will be one-half as apt to bend from jarring.

The function of a locomotive called "draft" production is so intimately connected with the speed, steam pressure, per cent of cut-off, etc., that it would probably be hard to greatly improve nozzles; the very fact that the present shapes are the result of a long evolution is fair evidence that they are reasonably satisfactory, especially when we recall that the Master Car Builders' Association has experimented considerably on nozzles.

Nevertheless, it is hard for a layman to believe that it is necessary to absorb so large a part of the possible power in moving air through the fuel bed and boiler tubes; if nothing can be done to make nozzles more efficient, there is likely hope in the direction of utilizing some of the unavoidable impact of the locomotive front against the air; the fact that certain experiments of this kind have failed is not conclusive negation.

Test No.	Water fed to boiler (pounds).							Evaporation.		Equivalent evaporation per pound of—		
	Total.	Equivalent evaporated from and at 212°.				Actually evaporated.[a]		([b])	Factor of.	Fuel as fired.	Dry fuel.	"Combustible*."[d]
		Total.	Per hour.	([c])	Into dry steam.	Total.	Per hour.					
1	45 (57)	46 (58)	47 (63)	48	49 (61)	50 (59)	51 (62)	52 (68)	53 (60)	54 (69)	55 (70)	56 (71)
1....	43,655	52,998	8,681	3.36	52,786	43,480	7,151	9.49	1.214	11.47	11.91	13.24
2....	50,064	60,452	11,840	4.58	60,125	49,814	9,806	9.10	1.207	10.94	11.43	12.61
3....	61,028	74,332	12,023	4.65	74,183	60,906	9,871	8.48	1.218	10.30	10.82	11.95
4....	36,333	44,363	6,312	2.442	44,186	36,188	5,170	9.11	1.221	11.08	11.52	13.00
5....	40,070	48,885	8,977	3.474	47,397	39,669	7,513	9.18	1.220	10.85	11.24	12.31
6....	52,713	64,204	14,153	5.48	63,690	52,291	11,620	8.79	1.218	10.62	11.08	12.14
7....	63,688	77,890	17,381	6.726	77,345	63,242	14,211	8.58	1.223	10.42	10.93	11.99
8....	72,558	88,593	23,151	8.966	87,973	72,050	18,960	8.03	1.221	9.74	10.18	11.03
9....	60,283	73,704	18,689	7.233	73,262	59,921	15,285	6.64	1.223	8.08	8.65	9.53
10....	43,305	52,832	12,889	4.99	52,462	43,002	10,565	9.02	1.221	10.93	11.20	12.36
11....	62,998	77,109	24,941	9.64	76,569	62,557	20,377	8.40	1.224	10.21	10.52	11.57
12....	53,956	66,096	18,898	7.313	65,766	53,686	15,429	8.56	1.225	10.44	10.68	11.58
13....	59,484	72,689	17,268	6.682	72,180	59,068	14,131	7.63	1.222	9.25	9.86	10.91
14....	47,730	58,326	28,528	11.040	57,627	47,157	23,345	7.02	1.222	8.48	8.88	10.11

Test No.	Horsepower developed.		Efficiency of the boiler, etc.		Average thickness of fuel bed (inches).[g]	Average time intervals (minutes) between—		Analysis of dry flue gasses (per cent).			
	In boiler.	Per cent of rated.[e]	(*)[f]	Including grate.		Firings.	Leveling and breaking up.	CO_2.	O_2.	CO.	N_2.
1	57 (65)	58 (67)	59 (72)	60 (73)	61 (81)	62 (82)	63 (83)	64 (84)	65 (85)	66 (86)	67 (88)
1......	251.7	97.4	81.44	79.48	8	3–4	16	11.45	6.92	....	81.63
2......	343.2	132.8	77.48	76.18	10–12	8	10	11.96	7.00	0.23	80.81
3......	348.5	134.4	73.14	71.79	12	3	12	11.46	7.49	.10	80.95
4......	183.0	70.8	79.39	78.12	6	4–5	40	11.10	7.84	.23	80.83
5......	260.0	100.6	75.00	73.90	14–16	3	40	11.96	7.07	.14	80.83
6......	410.2	159.0	73.50	72.37	14–16	3	([h])	12.45	5.87	.22	81.46
7......	503.8	195.0	73.26	71.81	18	3	80	11.50	7.08	.17	81.25
8......	671.0	259.5	67.16	66.67	16	3	([h])	12.05	6.93	.15	80.87
9......	541.1	209.3	58.69	57.61	16	3	20	10.16	8.49	.13	81.22
10......	373.6	144.5	75.39	72.62	6–8	....	([h])	13.87	4.75	.25	81.13
11......	722.9	279.7	70.99	68.94	12	3	([h])	13.57	4.49	.03	81.91
12......	547.7	211.9	70.29	69.08	8	3	([h])	11.78	6.74	.30	81.18
13......	500.5	193.7	67.21	65.36	14–16	8	16	12.20	6.94	.05	80.81
14......	827.0	320.0	61.56	60.02	16–18	([i])	([h])	11.15	7.52	.20	81.13

[a] Corrected for quality of steam.
[b] Apparent per pound of coal as fired.
[c] Per hour per square foot of water-heating surface.
[d] Figured from chemical analyses of ash and coal.
[e] Arbitrarily rated by authors, counting 10 square feet of heating surface to a boiler horsepower.
[f] Figured from chemical analyses of ash and coal.
[g] Method of firing, spreading.
[h] Fire not disturbed.
[i] Firing continuous.

Test No.	Form and condition of fuel.	Date of trial.	Duration (hours).	Average pressures.		"Draft"[b] below atmosphere (inches of water).				Clinker in ash and refuse (per cent).
				Barometer (inches of mercury).	Steam[c] (pounds per sq. in.).	Near nozzle.	Over fuel bed.	Over furnace arch.	Leaving boiler tubes.	
1	2	3 (1)	4 (2)	5 (11)	6 (11.1)	7	8	9	10	11 (29)
1...	Run of mine.....	Feb. 7	6.08	30.34	171	0.77	0.39	0.48	0.61	52.7
2...	.....do.[d]........	Feb. 8	5.08	30.51	172	2.30	1.05	1.01	1.86	52.7
3...	.....do..........	Feb. 10	6.17	30.68	149	2.27	.87	1.12	1.86	45.0
4...	.....do............	Feb. 11	7.00	30.50	159	.59	.33	.41	.53	52.7
5...	Large briquets...	Feb. 12	5.28	30.52	171	1.25	.57	.70	1.00	46.0
6...	.....do............	Feb. 13	4.50	30.31	162	2.63	1.03	1.37	1.96	56.0
7...	.....do............	Feb. 14	4.45	29.97	186	5.48	1.95	2.54	3.69	28.3
8...	.....do............	Feb. 17	3.80	30.06	182	7.70	....	3.01	4.10	45.8
9...	Run of mine[e]....	Feb. 18	3.92	30.36	168	7.36	....	2.65	4.54	19.7
10...	Small briquets[f]..	Feb. 19	4.07	29.80	167	2.11	....	.56	1.59	21.5
11...	.....do............	Feb. 20	3.07	30.03	182	8.10	....	2.73	5.48	22.2
12...	.....do............	Feb. 21	3.48	30.16	171	5.07	....	1.95	3.69	24.5
13...	Run of mine.....	Feb. 26	4.18	29.67	168	5.50	....	2.41	3.89	21.6
14...	Small briquets[g]..	Feb. 27	2.02	29.78	150	11.80	....	3.10	8.74	21.8

Test No.	Average temperatures (° F.) of—				Fuel (total weights in pounds).			"Combustible*"[h] consumed (lbs.).	Fired per hour (pounds).			
									Dry fuel.		"Combustible*."[h]	
	Atmosphere.	Steam.	Feed water in tank.	Gases leaving boiler tubes.	As fired.	Dry.	Ash and refuse.		For grate.	Per sq. ft. of grate.	For grate.	([i])
1	12 (15)	13 (17)	14 (18)	15 (21)	16 (25)	17 (27)	18 (28)	19 (30)	20 (46)	21 (48)	22 (47)	23 (49)
1....	45	375	55	530	4,600	4,432	210	3,985	729	24.60	655	0.253
2....	40	376	63	580	5,500	5,260	425	4,770	1,035	34.83	955	.368
3....	39	365	49	596	7,200	6,856	472	6,208	1,112	37.53	1,026	.395
4....	37	370	48	487	3,986	3,834	324	3,400	548	18.47	494	.187
5....	44	375	51	550	4,367	4,217	272	3,849	799	26.95	729	.282
6....	56	371	51	612	6,000	5,748	231	5,247	1,277	43.10	1,166	.451
7....	63	375	50	663	7,420	7,073	465	6,451	1,590	53.62	1,450	.561
8....	36	380	51	697	9,030	8,638	522	7,882	2,274	76.70	2,074	.803
9....	36	374	49	666	9,070	8,469	517	7,685	2,160	72.85	1,960	.759
10....	55	374	49	595	4,800	4,683	474	4,242	1,151	38.80	1,024	.403
11....	41	380	48	804	7,500	7,271	450	6,618	2,369	79.90	2,155	.834
12....	41	375	46	684	6,300	6,156	391	5,680	1,770	59.69	1,632	.631
13....	51	374	48	679	7,800	7,318	651	6,617	1,750	59.02	1,583	.613
14....	40	365	46	910	6,800	6,489	417	5,701	3,213	108.30	2,822	1.092

[a] Code numbers (in parentheses at the top of certain columns) refer to corresponding items described in Bull. U. S. Geol. Survey No. 325, pp. 151–153. See also Prof. Paper U. S. Geol. Survey No. 48, pt. 2.
[b] The word "draft" is placed in quotation marks because it is misused when applied to the moving of gases or to the pressure difference which causes them to move.
[c] Above atmosphere.
[d] Wet, much slack.
[e] Wet, mostly slack.
[f] 10 per cent crumbled.
[g] 30 per cent crumbled.
[h] The "combustible" factor in all columns of this table marked thus (*) is obtained by subtracting from the total weight of dry fuel fired the weight of ash therein, as figured from the chemical analysis, and further substracting weight of the combustible in the refuse, the latter combustible being calculated from the total weight of refuse and its analysis; the composition of the refuse combustible is loosely considered to be the same as that of the "combustible" of the dry fuel.
[i] Per square foot of water-heating surface.

The tests herein described show that this one boiler is capable of producing enough steam for two or three locomotives; part of the increase could be utilized in this one locomotive, providing the "draft" was economically obtainable and more weight was put on the drivers; or, in western portions of the United States, the gain could be utilized in making better time or by pulling longer trains when using poorer coals than are commonly used at present.

Conclusions.

The more important results and conclusions for the locomotives used are briefly summarized here:

At low rates of working, run-of-mine coal gives a higher equivalent evaporation than briquets; at medium rates there is little difference; at high rates briquets do considerably better.

There is little difference between the large and the small briquets; the larger ones crumble less.

The smaller briquets are easier to fire and to level on the fire than are the larger ones; either form gives the fireman far less work and trouble than run-of-mine coal.

In sparks briquet fires lose less than coal fires.

On roads having heavy grades it will probably pay well to burn briquets, at least part of the time.

The high-capacity test run with briquets (test 14) was by no means the upper limit of fairly efficient combustion and evaporation, but it was higher than is likely ever to be attained by such draft as is feasibly available from a nozzle.

These particular briquets produced about as much smoke as the coal under similar conditions; some of the blame for this tendency to smoke may rest on the pitch binder.

Perhaps it would pay to add combustion chambers several feet long to the front ends of some locomotive fire boxes, and use a larger number of boiler tubes of shorter and smaller diameters.

New Literature

THE LOCOMOTIVE UP TO DATE. By Chas. McShane; 711 pages, cloth, 5½x8½; published by Griffin & Winters, New York Life Bldg., Chicago. Price $2.50.

This book is a very thorough treatise on the railway locomotive. Commencing with the history of the subject the work takes up design of the parts, rules of maintenance and operation, instruction for emergency use, general machine shop work, an interesting chapter on "Fast Runs," and, of course, a study of the air brake. The book is in its ninety-sixth thousand and while this is the 1909 edition, the book belies its title to the extent that it is complete to 1899 only. Aside from the development of the articulated compound, however, there is little in the interval which should be covered in a book with the title of this one. The subject matter is well interspersed with illustrations in both line drawings and half-tones. A chapter on valve gears impresses the reviewer as being a very strong treatise in itself.

* * *

The proceedings of the seventeenth annual convention of the Traveling Engineers' Association in leather-bound book form is a recent receipt. The importance of the 1909 convention of this association is realized by all concerned and the value of the papers and discussions when bound in a permanent binding for reference can hardly be overestimated.

* * *

The proceedings of the eleventh annual convention of the International Railroad Master Blacksmiths' Association is a book in board covers arranged in a manner which does credit to the association. All of the papers with their illustrations are now in a form convenient for the use of all those interested. The secretary and treasurer, A. L. Woodworth of the Cincinnati, Hamilton & Dayton R. R., Lima, Ohio, is the man principally responsible for the neat publication of this book.

* * *

HENLEY'S TWENTIETH CENTURY BOOK OF RECIPES, FORMULAS AND PROCESSES. By Gardner D. Hiscox; 787 pages, cloth, 6x9; published by the Norman W. Henley Publishing Co., 132 Nassau St., New York. Price $3.00.

In this work, the author has endeavored to meet the practical requirements of the mechanic, manufacturer, artisan and housewife. The result is unique, to say the least. It is the first time the reviewer has seen cook books with a department given to the study of metal alloys or a mechanics' hand book with a department which gives advice on the preservation of the human hair. It is evident, however, from the fact that there are about ten thousand selected scientific, chemical, technical and household, recipes, all alphabetically arranged by subjects, that the book should have a certain value to every member of the human race who can read print. As a reference book of concrete information it is a wonder. As a general educator it is excellent.

* * *

MECHANICAL APPLIANCES AND NOVELTIES OF CONSTRUCTION. By Gardner D. Hiscox; 396 pages, cloth, 6x9; published by the Norman W. Henley Publishing Co., 132 Nassau St., New York. Price $2.50.

Although a complete work in itself, this book is a continuation as a second volume of the author's "Mechanical Movements, Powers and Devices. The book deals with the peculiar requirements of the various arts and manufactures. An interesting feature is an explanatory chapter on the leading conceptions of perpetual motion "invented" during the last three centuries.. The book deals with all manner of mechanical movements, simple and complicated. It is divided into twenty three sections, each treating with a branch of the subject. The book is now in its second edition.

* * *

PURCHASING AGENTS BUYING LIST. 540 pages, cloth, 9-12; published by the Buyers' Index Co., 47 Plymouth Place, Chicago.

A complete index of railway supplies with the addresses of the manufacturers. The book is divided into four sections. Section 1 lists alphabetically the supplies used by railroads giving the names of the firms manufacturing them; Section II lists alphabetically supplies sold under trade names. Section III is an index to the personnel of the various railway supply firms, and section IV is an index to the catalog department. The book impresses the reviewer as being a work of very large scope with a very wide application. It is assumed that the information given is authoritative and correct and such being the case its convenience is evident.

* * *

GAS, GASOLINE AND OIL ENGINES. By Gardner D. Hiscox. 475 pages; cloth, 6½x9 inches; published by the Norman W. Henley Publishing Co., 132 Nassau St., New York. Price $2.50.

This book has been revised and brought down to date by the addition of chapters on the use of crude oil, blast furnace and coke-oven gases. New matter has been added in the chapter on marine engines and many new illustrations have been inserted throughout the book. The theoretical discussion of the "explosive motor," as the author seems to prefer calling it, is rather brief but the chapter on explosive motor ignition and the pages devoted to fire underwriters regulation are especially good. As a whole, however, the subject matter of this book covers practically the same ground as a number of similar works on the subject.

* * *

The Charles H. Besley Co., of Chicago, Ill., has issued a booklet giving descriptive matter and illustrations of the adaption of the Besly spiral disc grinder to various classes of work. Much useful information on the subject of disc grinding is also given.

* * *

The H. W. Johns-Manville Co., of New York City has issued two small phamphlets on the insulation of pipes and boilers. The various forms of insulating materials used for this purpose are shown together with prices and sizes.

* * *

The custom of remembering employes at the Christmas season is one which is being practiced more and more each year. The American Blower Co., of New York, following its usual custom, recently presented each of their employes with a sum in dollars equal to their continued service with the company, accompanied by a neat booklet dealing with the company and its men.

* * *

"Hauck Oil Fuel Burners" is the title of a booklet issued by the Hauck Mfg. Co., of Brooklyn, N. Y., showing many of the uses to which their burners can be applied.

* * *

The L. M. Booth Co., of New York City, has issued a leaflet calling attention to a few of the important features of its water softener.

* * *

The Hart Steel Co., of Elyria, Ohio, has issued a very attractive catalogue dealing with tie plates. A considerable number of pages are devoted to diagrams showing the punching data for a number of different rail bases used on some two dozen leading roads.

The Industrial Instrument Co., of Foxboro, Mass., has issued a bulletin on the Hutchison marine tachometer. This instrument is designed to indicate at vairous points about a ship the direction and rate of rotation of the screws.

* * *

The Joseph Dixon Crucible Co., of Jersey City, N. J., has issued a leaflet concerning Dixon's graphite engine front finish.

* * *

A very attractive and comprehensive catalogue on the subject of dry kilns for timber products has been issued by the American Blower Co., of Detroit, Mich. A large number of specialties for dry kiln work are described. This company has also recently issued bulletins on the subjects of "Detroit" steam traps, "A. B. C." steel plate fans and "A. B. C." cone fans.

Among the Manufacturers

ECONOMIES POSSIBLE BY SCIENTIFIC METHODS OF CAR PAINTING.

That a saving of twenty to thirty dollars on the cost of painting each car, and an increase of from five to ten years in wearing capacity are attainable by scientific methods of finishing is the important argument presented to the recent convention of the American Chemical Society by Carl F. Woods, of the Arthur D. Little, Inc., laboratory of engineering chemistry, in Boston. "It is probable," Mr. Woods says, "that no one of the methods in use embodies the maximum efficiency possible of attainment, and in view of the very large amount of money involved, it is desirable that the entire subject be given careful study by technical chemists."

The heavy cost of such painting as railway companies have felt to be necessary to appearance, and "appearances" have long been an excessive burden to the income of the companies. The decorative effect of bright colors and glossy varnish has seemed to be demanded on grounds of policy. A cheap solution has been reached by the Interborough Rapid Transit Co. operating the subways in New York City, where the cars are merely covered with a dark red house paint, guiltless of either decoration or varnish. But for surface cars, which are always in the public eye, and whose appearance is taken as an indication of the company's attitude toward the public, varnish and decoration seem to be a necessity. The cost of painting the same type of car varies on different roads from $30 to $60, or even more. Some roads are forced to repaint their cars every two years, while other roads, by means of an annual coat of varnish, make one painting wear from ten to fifteen years. These variations make it clear that much money has been ill-spent through failure to employ the best methods of painting and finishing, especially as the most costly finish has by no means always turned out to be the most durable.

The "Color and Varnish" process, Mr. Woods explains, is of very recent origin and is a radical departure from the older "Lead and Oil" and "Surfacer" systems. The fundamental idea of the new process is that the fewer the number of coats and the more similar these coats are in composition, the more durable will be the final results obtained. With this in view, a combination of coats is applied which are so composed as to prime the wood, prepare a surface, and obtain the desired color at the same time. This is accomplished by employing heavy silicate paints, containing the proper color ground in the same kind of varnish, each coat possessing suitable drying qualities for its respective demands. The best results are obtained by the use of dark colors, such as green or brown, because the principal ingredient may be ochre, umber or some other natural earth pigment which not only produces the desired shade, but is well adapted for preparing a foundation. The surface so obtained is covered with a coat of the body color ground in varnish followed by one thick coat of finishing varnish.

Each of the processes referred to has its specified faults and virtues. The "Lead and Oil" process, if properly applied, requires from three to four weeks and the application of ten or more coats. The "Surfacer" process requires about the same number of coats, but, owing to the quicker drying of the surfacers, requires but two to three weeks for application. The "Color and Varnish" process is the simplest of all, and has been applied with apparently successful results in from six to eight days, with an application of four to six coats.

The faults of the "Color and Varnish" process are not as yet thoroughly understood, as the method is of very recent development and has not been subjected to the test of long continued service. It should be understood that the aim of this shorter process is durability at the lowest cost; and that appearance is in a measure sacrificed; but it is claimed that the finish obtained is fully as durable as by the older methods, that it is free from many of their faults, and that it produces a finished appearance sufficiently good for the purpose. On the other hand, the process is dependent upon specially made paints in which adulteration is difficult of detection, and which if carelessly made are not only short lieved, but render more difficult the refinishing of the car.

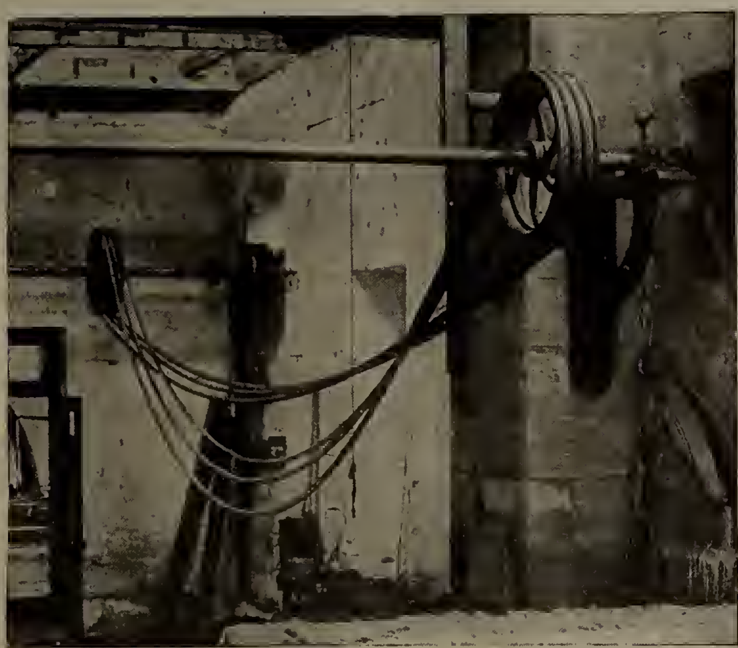
The system is only applicable to dark colors as the lighter and more brilliant pigments do not possess sufficient covering power, but this is not in itself a failing, as the use of dark green and brown colors is rapidly increasing, owing to the greater stability and length of life obtained. In this connection it is of interest to note that the Pullman Company has adopted a brown body color as the most satisfactory shade available, while a large proportion of the railroads, both steam and electric, employ a color of similar nature.

It has been shown by actual results that a saving of $20 to $30 can be made on the painting of each car and an increase in life obtained of from 5 to 10 years by the adoption of scientific methods of finishing. It is probable that no one of the methods in use embody the maximum efficiency possible of attainment, and in view of the very large amount of money involved it is desirable that the entire subject be given careful study by technical chemists.

AUSTRALIAN ROPE DRIVE.

The rope drive installed in the Paramatta Woolen Mills, Sydney, N. S. W., as shown in the picture is rather odd in several ways. The three ropes are independent of each other (English system) and have stretched to such lengths that their slack parts sag far below and run in between the driving halves. The ropes run well in spite of contact with each other, and although such an arrangement may not be considered good practice, the extreme sag is beneficial to the extent that it materially increases the arcs of pulley contact.

It will be noted, too, that in spite of the stretch of ropes to unequal lengths, each assumes about an equal portion of the load, as shown by the similarity of the curves of driving halves. The equal distribution of the load was made possible in this instance by treating the ropes with Cling-Surface, made by the Cling-Surface Company, of Buffalo, N. Y., to prevent surface slip and to preserve the interior of all kinds of driving ropes and belting. This drive demonstrates that ropes working on the English system, if properly treated, can be made to deliver maximum power without regard to their looseness, and that the constantly increasing length due to stretch need not effect the distribution of the load among the individual ropes. Under these conditions, re-splicing is seldom necessary.



Extreme Looseness in Rope Drive.

It might be added that a reliable anti-slip and preservative treatment, aside from the benefit to the ropes, is also desirable when the ropes are arranged to drive by the American system. In this instance the tighter grip of each strand on the pulley sheaves permits of a reduced initial tension on the drive, and consequently less weight is necessary on the tighteners.

ADVANTAGES OF LAMINATED CONSTRUCTION IN LEATHER BELTING.

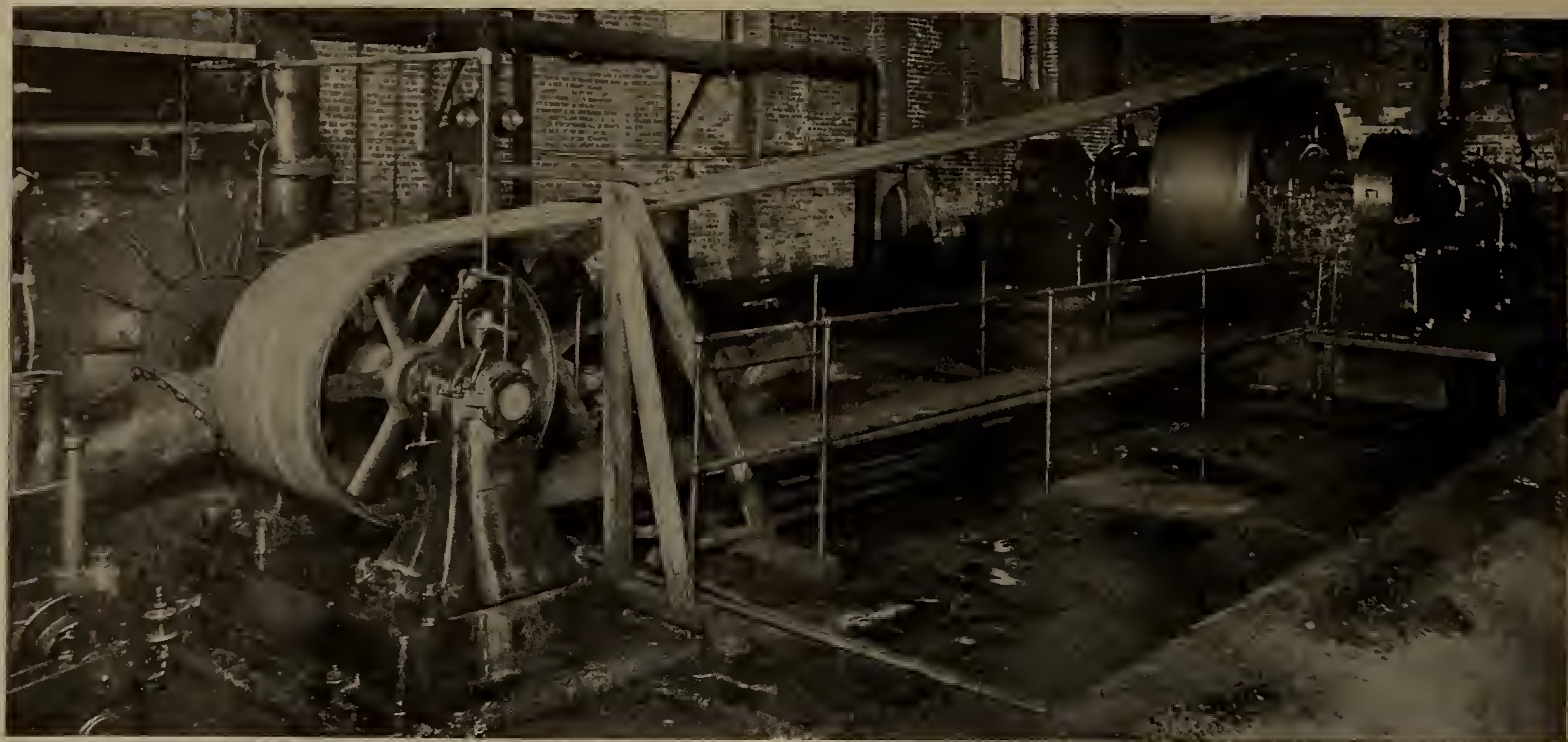
Economy in transmitting power by belted drives depends first all upon flexibility of the belting and smoothness of its surface. If the belt is stiff and hard either internally or on the contact surface it cannot be expected to wrap around the pulleys as closely as it must to prevent slip. Surface smoothness in a multi-lap belt is dependent upon placing the grain or hair side of the leather to the outside and in an ordinary single belt by placing this next to the pulley. Yet the grain surface is the weakest part of the leather, being the first to be injured by improper tannage, the first that will burn from slippage of a belt on its pulleys, and the part that is likely to be ripped off in patches by sticky belt dressing. The steady pounding which this surface naturally receives with every pulley contact tends to make it hard and brittle until as the amount of slip increases, the outside leather burns and leaves the interior of the belt open to gradual deterioration.

The fibres of leather are mostly parallel to the surface, and when brought into sidewise contact with the pulley as they must be in ordinary belting, the effect might well be compared to that of daily traffic on wood paving blocks laid with grain parallel to the street. In the latter instance, the wood would splinter to destruction in no time, but when placed to receive the blows against the ends of the fibres, the continual pounding does no damage. Similarly a butcher's block with the grain parallel to the top would be ruined in a hurry. The fibres in belting are affected or rather unaffected in much the same way when the pressure comes end-on. This is precisely the condition which is brought about in laminated belting. The leather strips or laminations, all of equal cross section, are bound side by side without cement and so placed that the cut edge of the leather forms the belt surface. The leather is not only longer lived and more flexible when so placed but by reason of the fibres being better able to retain their natural dense interwoven position, they seat themselves more firmly against the pulley surface, cling better and permit the belt to transmit a far greater percentage of the power.

The advantages of bringing the cut edge of the leather into contact with the pulley as compared to using it in the ordinary way are strikingly shown by an experience of the Standard Oil Company with one of the belts in its Eagle Plant at Jersey City. In this plant, which is its largest refinery of lubricating oils, the condenser water is circulated by a 16,000,000 gallon centrifugal pump which in turn is belt driven from a 500 H. P. Fleming-Harrisburg engine. The driving pulley is 90 inches in diameter, the driven 42 inches and the distance between centers is 28 feet, 2 inches. As first installed, a 32-inch, 3-ply ordinary leather belt strengthened by a 24-inch, 3-ply rider were employed to drive the pump. In justice to this outfit, it must be stated that the varying temperatures and moisture in the plant are very severe on flat-lapped belting. Trouble was experienced with the belting almost from the beginning and as the stretching of the leather continued, the belt slip increased until by actual test the power loss was over 20 per cent. The driven pulley face overheated to such an extent that shut downs were necessary at various times during the day. Belt dressings were tried but offered nothing more than a temporary relief. So much dressing was used that on hot days it would ooze out of the belt and cause an all-day shut down, during which the auxiliary pumps had to be used. To make matters worse, the plies of both belts parted, due probably to the surrounding moisture, and the belts had to be sent back to their manufacturer for reglueing. There had been no stinting of price in buying these belts. On the contrary, every effort had been made to get the best, and when the trouble had reached the stages mentioned, the Standard Oil Company was about decided that the only remedy was to remove the entire installation and replace it with a direct-connected outfit.

As a last resort before doing this, it was proposed to try laminated belting, and the drive was equipped with an Albeco laminated belt made by the American Laminated Belting Company, of New York. This drive is shown in the illustration. The belt is 28 inches wide, and equivalent in thickness to a three-ply lapped belt. The results are of more than passing interest. The power loss now from belt slip is hardly perceptible. The pump when driven by the old belts would lose its suction if the steam pressure fell below 85 pounds, while with the Albeco laminated belt the pump can be operated with as low as 65 pounds of steam. The laminated belt has never been taken up, nor has it required other attention. It is doing with 21 square inches cross-section of leather what could not be done by six plies of the best leather of about 39 square inches cross-section. The laminated belt has never deviated more than one-fourth inch from its true position on the pulleys and its even motion has been the source of much comment.

The stout guard of 2-inch by 4-inch timbers shown near the pump in the illustration had to be used with the lapped belts



Laminated Belt Installation.

to keep them from going over the side of the driven pulley when full load was thrown on, and at other times as well. The guard on the far side was faced with leather three inches deep, but in the natural course of running the edge of the lapped belt cut through this clear down to the wood in several months' time. The guard was left in place when the laminated belt was installed, thinking it might be needed, but so far it has nothing to do.

HUTCHISON ELECTRICAL TACHOMETER.

The tachometers with which American engineers are most familiar use either the principle of centrifugal force or electricity in their operation. In the present forms the indicator of speed bears a limited place relation to the rotating shaft, the rate of which is to be shown. That is, the rotor is mounted in the indication portion, and is direct connected, belted or driven through some flexible coupling from the shaft, and must necessarily be located adjacent to the shaft, or at a short distance, limited by the mechanical difficulties of positively transmitting motion therefrom. An illustration of successful short transmission of rotation is the automobile speed meter.

For greater distances and for precise work, recourse must, however, be had to other than mechanical means. To cover this broad field, beyond the reach of ordinary speed indicators is the purpose of the Hutchison Electrical Long Distance Tachometer, which is the subject of this description.

Essentially the Hutchison tachometer may be considered as two parts:

(1) An alternating current generator, or magneto, of the revolving field inductor type, driven by the shaft, the speed of which is to be measured.

(2) A voltmeter, wired up to the generator, and located at any remote point where indications of speed are desired.

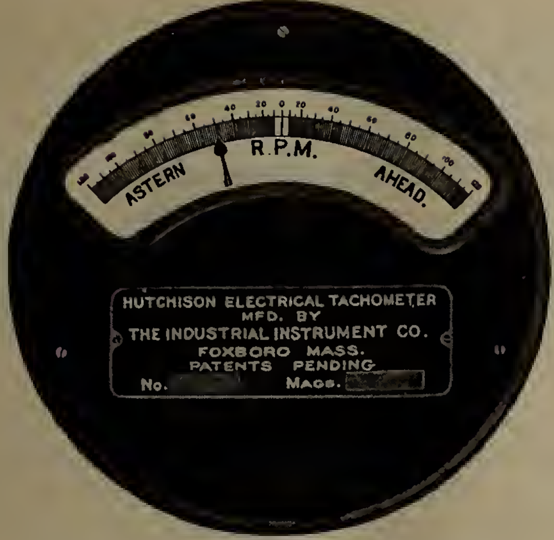
The voltage of the generator is proportional to its speed, so that the voltmeter can be calibrated to read direct in R. P. M.

In practice a plurality of voltmeters or indicators, placed at widely separated points, may be operated from the same generator, so that the tachometer will indicate speeds at as many points as desired, as far away as desired, within reasonable limits. A number of operators, therefore, at widely separated points can have precise indications of speed always before them, so that intelligent, concerted action may result. The closer bond between navigator and engine room on steamships is an illustration of the service rendered by this instrument. It makes remote control of speeds precise, sure and easy.

One of the illustrations shows the generator of the Hutchison tachometer, as developed particularly for marine service. The shaft of the ship is represented by P and rotation is imparted to the driving sprocket B by chain C. Sprocket B is rotatively mounted on the generator shaft D and drives the flywheel F through two oppositely coiled spiral springs, E-E[1], one end of spring being attached to B and the other end to F. Any inequalities in the angular rate of P are absorbed by the springs and flywheel, so that uniform resultant velocity is imparted to the magnetos so that their voltage does not jump and cause the indicator needle to vibrate.

In this marine type it is desirable to show the direction of rotation as well as rate, so that two magnetos are used

Generator of Hutchison Tachometer.



Indicator of Hutchison Tachometer.

and so geared from the flywheel F that their E. M. F. is in phase when P is running "Ahead" and 180° out of phase when P is reversed.

The indicator, shown in the other illustration, has two coils. One stationary, connected to one of the magnetos L and the other movable and connected to the other magneto M. If, therefore, the current from magnetos L and M is in phase the needle will deflect to the right and indicate speed "Ahead." When M and L are 180° out of phase the needle will deflect in the reverse direction and indicate speed "Astern."

The use of the alternating current system makes the Hutchison tachometer extremely simple and free from errors, due to changing resistance. There are, of course, no brushes, slip rings, or commutators, and in fact every joint from the armatures of M and L to the indicator is soldered. The current required for the operation of the indicators, even if a number of them are employed, is minute, making the transmission safe and easy. It is said that many other novel electrical and mechanical improvements have been employed in this instrument, which has been under development for many months.

The instrument is manufactured by the Industrial Instrument Co., 50 Church St., New York.

THE "L. N. CRECO" BRAKE BEAM.

Owing to an error on the part of the proofreader, the advertisement of the Chicago Railway Equipment Co. in the January "Master Mechanic" soberly states that the "L. N. Creco" brake beam will withstand a load of 400,000 lbs. with 1/16 in. deflection. It is hardly necessary to state that the 400,000-lb. load should have been 40,000 lbs.

On account of considerable increases in the weight of passenger equipment within the past few years and particularly on account of the adoption of all-steel passenger cars, together with increases in speed, it has been necessary to strengthen the brake equipment to keep pace with the greater demands upon it. Good practice demands that there should not be a greater deflection than 1/16 inch in the brake beam under its full share of the car braking load or about 40,000 lbs. in the new passenger cars.

An important feature of the "L. N. Creco" design is that, while it represents a considerable advance in strength over the "Diamond Special" brakebeam, which has been the standard on many roads with the Westinghouse reinforced brake, it does not require any more room for application. The space allowed on the center wheels of triple trucks has always been somewhat confined, and the "Diamond Special" was thought by the manufacturers to represent the greatest strength that could very well be designed for the limited space given for the application. The greater capacity of the "L. N. Creco" beam was, as will be seen from the illustration, accomplished without deepening the truss of the structure, by making use of a larger truss rod by means of the extension which is connected with the main portion of the enlarged truss rod by means of the turnbuckle shown.

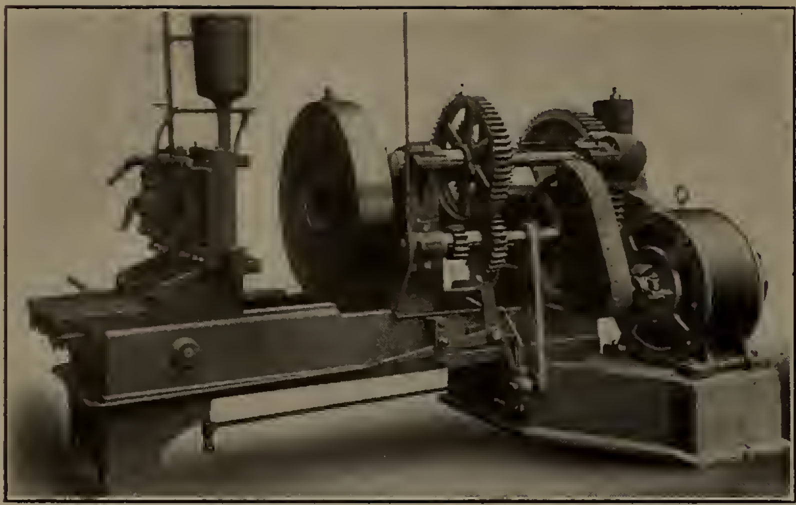
The requirements which this beam had to meet were that the depth of the "Diamond Special" truss should not be materially increased and that the brake conditions demanded the application of the same, or at least the same sized, adjustable heads as have been in service on the "Diamond Special" beams. As the diameter of these adjustable heads could not be enlarged, the compression and tension members of the beam could not be increased further than to such an extent as would allow the socketing of their ends in the sleeve casting on which the head proper adjusts itself. The U-shaped compression member was found to give the best results for a given weight of material. Many difficulties incidental to securing a brake beam of sufficient strength aside from those mentioned have been surmounted in the "L. N. Creco" design which appears to have given entire satisfaction.

LARGE PIPE THREADER WITH VARIABLE SPEED MOTOR.

In securing economy and rapidity of production in many machine tool operations, the individual adjustable speed motor has many decided advantages over other methods of drive. The older methods of speed variation,—cone pulleys or gear reductions,—provide only comparatively large, rough changes in speed. On the other hand, the adjustable speed motor makes possible fine gradations in the working rate of the tool driven, enabling it to be worked at all times at the proper speed to insure operation of its productive capacity. In many cases the avoidance of expensive and cumbersome speed changing apparatus, following the use of the adjustable speed motor, has resulted in reducing the cost of the tool taken complete with its adjustable speed motor, aside from the items of increased convenience and improved operation.

The accompanying illustration shows a Westinghouse type "SA" adjustable speed direct-current motor driving a machine for cutting and threading pipe from 2½ inches to 8 inches in diameter, built by the Cox & Sons Company, Philadelphia. These machines are designed in sizes to handle pipes up to 18 inches internal diameter, and the special motor drive supplied has proven especially satisfactory. Where quick changes in speed may be required, as in small shops handling a number of different sizes of pipe, such changes can be most easily made with the adjustable speed drive; saving the time lost in shifting gears or belts, and bringing the machine promptly to its most efficient cutting rate. As seen from the illustration, the pipe threader is provided with one set of gear changes, and has an oil system which keeps

"L. N. Creco" Brake Beam.



Large Pipe Threader, Variable Speed Motor.

the cutting tool well flooded with oil. The types of tool holders mounted on the movable carriage are of the most improved design for this class of work. The Westinghouse type "SA" adjustable speed direct-current motor gives a speed ratio of one to four.

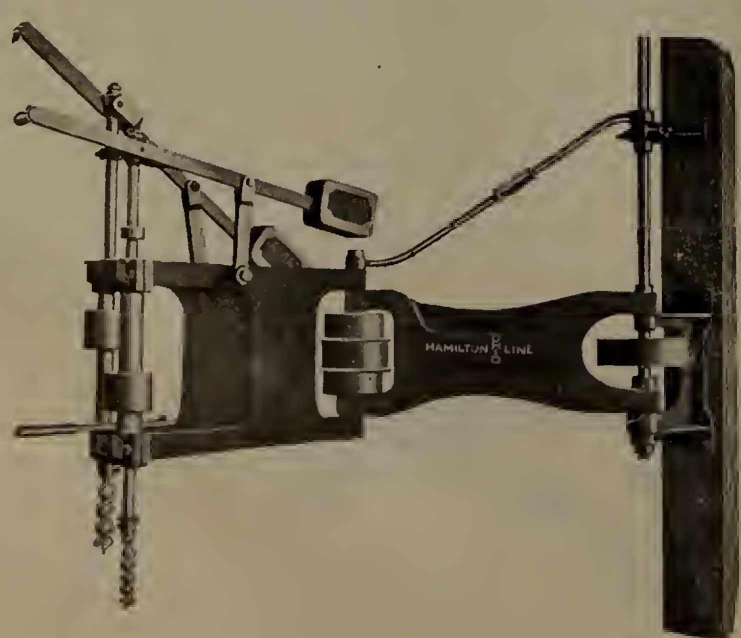
HAMILTON FLEXIBLE ARM BORER.

The accompanying illustration shows a machine for use in car shops and other factories where a large number of holes must be bored over a large area and where the material is too heavy or cumbersome to handle. It consists of a double swing, which will cover a radius of 5 ft. The forward swing is provided with a double housing in which are mounted two boring spindles driven by separate belts from the countershaft attached to a post, and having a movement of 16 ins. up and down operated by two separate hand pulls. It has been found much faster in operation (using one operator only) than the usual four-spindle vertical boring machines requiring from two to three operators. The material is placed on a roller table and brought within range of the machine, all holes within that range being bored before the material is moved forward.

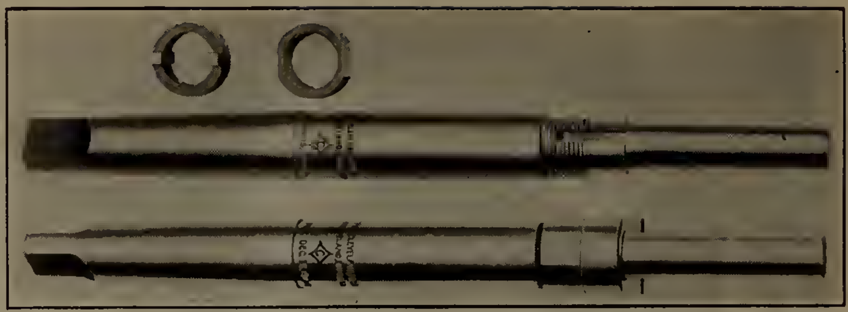
The machine weighs 800 lbs., requires a horse power of between two and four, a floor space of 10x5 ft. and is speeded to 375 r. p. m. It is manufactured by the Bentel & Margedant Co., of Hamilton, Ohio.

NEW ARBOR FOR SHELL TOOLS.

The Cleveland Twist Drill Co. has secured the patents and is about to place on the market a new arbor for shell tools. As is indicated in the accompanying illustration the essential difference between this patent arbor and the regular type is



Hamilton Flexible Arm Borer.



New Arbor for Shell Tools.

that it is equipped with an adjustable collar provided with integral keys which slide in longitudinal keyways in the arbor. The arbor is also threaded for a short distance to receive an adjusting nut which bears on the collar. The collar engages the shell reamers in the usual way.

Perhaps the chief advantage of the new arbor is the quickness and ease with which it releases the shell tool no matter how tightly it may have become jammed on the arbor; a turn or two of the adjusting nut does the trick, with no necessity for removing the arbor from the spindle, and no excuse for the vise and hammer methods which often cause considerable damage. Another decided advantage is the fact that the collar can always be set so as to allow the shell tool to fit snugly on the arbor, and yet fully engage with its slots the collar keys.

The Selling Side

A man of good address with several years experience as master mechanic, well acquainted in Mexico, also speaks Spanish, desires a position on road to represent some good railway supply house at reasonable salary and road expenses. Can furnish A-1 references. Location or district is immaterial. Will go to any part of the county, United States or elsewhere. Address S. E. Kildoyle, 1308 Magoffin Ave., El Paso, Texas.

The Isthmian Canal Commission is asking for bids on the following: Until February 14 for piles, split-sheave pulleys, cold-rolled shafting, car wheels, gear cutters, valves, pipe fittings, etc. (Circular No. 555.) Until February 21 for oil for locomotives, cars, stationary engines, marine engines, air compressors, etc. (Circular No. 557.) Until February 28 for boilers, pumps, universal grinder, steam trap, cable, vanadian steel chain, spiral riveted pipe and fittings, valves, etc. (Circular No. 558.)

The Atlantic Equipment Co. of New York has opened an office in Pittsburg, Pa. The office will be located at 2101 Beaver avenue and will be in charge of Mr. H. Kleinhans, as manager.

The Buckeye Jack Manufacturing Co., Louisville, Ohio, moved into its new factory at Alliance, Ohio, on February 1st. This move into larger quarters was occasioned by the increase of business beyond the capacity of the present factory. The new plant is equipped with modern machinery and is so located that additions can be made to accommodate a further increase of business.

The Standard Steel Car Co. of Pittsburg has purchased the plant and property of the General Castings Co. The property included in the deal comprises 9½ acres of ground on the line of the Allegheny Valley Railroad, together with a large steel-frame, iron-clad, slate-roof building, a powerhouse, pattern house, tenement house of 10 apartments, a brick office building, stable and other buildings together with all the equipment, machinery, trackage, three open-hearth furnaces, five electric traveling cranes, melting stock, foundry stores, metal flasks, patterns, knuckles, brakeshoes and miscellaneous castings for railway equipment, property upon the premises. The plant has been idle since the failure of the Castings company, and it is announced that the Standard Steel Car Company proposes beginning the work of rehabilitating its acquisition at once and will make many improvements with the idea of converting it into a car-building plant.

The Chanute Medal, which is each year awarded by the Western Society of Engineers for the best paper presented to the society in the field of civil engineering during the preceding year, has been given to Professor Arthur M. Talbot of the University of Illinois. Professor Talbot's paper, which has been the basis of the award, is entitled "Tests of Cast Iron and Reinforced Concrete Culvert Pipe," and describes an elaborate research which in its various stages has been in progress for a number of years at the University of Illinois. The foundation for the medal given by the Western Society of Engineers was established by Dr. Octave Chanute. The arrangement provides for three medals, one for work in the line of mechanical engineering, one in civil engineering and one in electrical engineering.

The Whipple Supply Co., 50 Church St., New York, has been incorporated. The officers are: A. L. Whipple, president and general manager; R. L. MacDuffie, vice president; H. E. Oesterrick, secretary and treasurer.

Mr. F. A. Hall, who for the past twelve years has been manager of the Chain Block & Hoist Dept. of the Yale & Towne Mfg. Co., 9-13 Murray St., New York, has resigned his position in order to accept election as vice-president and treasurer of the Cameron Engineering Co., of Brooklyn, N. Y. Mr. Hall's successor will be Mr. R. T. Hodgkins, who for several years has been his chief assistant, and who is thoroughly qualified by experience and ability successfully to perform the duties of the position. In his new connection Mr. Hall expects to make a specialty of trolleys and appliances for overhead handling of materials, and in connection therewith, to make use of the Yale & Towne blocks and hoists, with the sale of which he has so long and prominently been identified.

J. E. Buker, superintendent car department of the Illinois Central R. R., has been elected first vice president of the Chicago Car Heating Co. with headquarters at the Railway Exchange Building, Chicago, effective February 1.

The Pittsburg Seamless Tube Co, has secured a square in Elmwood City, Pa., adjoining the present works of the company, on which it plans to erect an open hearth furnace that will give employment to about 200 additional men. It is the intention of the company to construct a switch to the plant and when completed will ship its own ore and make the iron necessary for the manufacture of tubing at this plant. About $250,000 will be expended in buildings.

Mr. L. M. Viles, formerly treasurer of the Buda Co., Railway Exchange building, Chicago, has been elected vice-president and treasurer of the company in charge of manufacturing and Mr. Wm. P. Hunt, Jr., formerly secretary, has been elected vice-president and secretary of the company in charge of sales.

At a recent meeting of the directors of the Northwestern Metal Mfg. Co., Minneapolis, Minn., the following officers were elected: Geo. A. Cook, president; W. C. Schroeder, vice president and general manager; A. Munch, secretary and manager railway department; R. E. Cook, treasurer. The Brydges Engineering & Supply Co. has been appointed sales agent for Manitoba.

The American Automatic Railway Brake Co., Baker City, Ore., has been incorporated with a capital stock of $500,000 to manufacture an automatic brake which applies the air to the whole train when any car leaves the track. The incorporators are F. W. Eppinger, H. A. Mitchell and E. B. McDaniels.

The Automatic Steel Grain Door Co., Wichita, Kan., advises that communications will be welcomed from firms equipped for the manufacture of all-steel non-destructible grain doors. Delivery is desired on 2,000 of these doors at the earliest possible date, and a permanent contract for future orders will made.

The American Car & Foundry Co. plans to build an addition to its present steel coach plant at St. Charles, Mo., which will be 120 ft. wide and 1,800 ft. long. A new power house has been built and electric power is to be installed.

Fayette Brown, president of the Brown Hoisting Machine Co., Cleveland, Ohio, died at his home in Cleveland January 20. Mr. Brown has been connected with the iron and machinery trade since the close of the civil war, in which he served as paymaster for the Union army. In addition to the machinery company of which he was president, he was connected with the Stewart Iron Co., Ltd., the Union Steel Screw Co., the National Chemical Co., the G. H. Kuhlman Car Co. and several Cleveland banks.

Leroy M. Harvey, sales manager of the Milwaukee district office of the Allis-Chalmers Co., Detroit, Mich., died January 19, at Augusta, Ga., where he had gone for his health. Mr. Harvey was about 37 years old. He was born in Oak Park, Ill., graduated from the University of Michigan in 1898, and was connected with the Westinghouse Electric Co., Siemens & Halske, and the Northern Electric Manufacturing Co. before entering the sales department of th Allis-Chalmers Co.

A. D. McAdam, formerly vice-president of the Damascus Brake-Beam Co., Cleveland, Ohio, has resigned and has been elected vice-president of the St. Louis Surfacer & Paint Co., St. Louis, Mo., with headquarters at 1101 Fisher building, Chicago. Mr. McAdam was for several years connected with the American Car & Foundry Co. and the Michigan Malleable Iron Co., Detroit, Mich.

The semi-annual statement of the Lackawanna Steel Co. and its subsidiary companies, shows total gross earnings of $3,271,879 for the six months ending Dec. 31, 1909, an increase of $1,943,168 over the gross earnings for the corresponding period a year ago. The surplus for the six months was $1,268,739, as against a deficit of $280,766 for the corresponding six months of 1908. Unfilled orders at the beginning of the new year were 467,533 tons, as against 205,236 at the beginning of 1909.

The Blue Island Rolling Mill & Car Co., Chicago, which recently changed its name from the Blue Island Car & Equipment Co., is building a shop 87 ft. x 250 ft., and will install a 20-in. mill and four double busheling furnaces.

The Modoc Co., Philadelphia, Pa., has opened an office at 109 Chestnut street. Several additional pieces of machinery have been installed at its factory in Fernwood, Pa., which machinery is for the manufacture of car cleaner and soap powder.

The Rail Laying Machine Co., Chicago, Ill., has been incorporated to manufacture and sell rail-laying machines. The incorporators are Otto R. Barnett, P. H. Truman and H. L. Peck. Capital $2,500.

The Lynch Railway Automatic Brake Co., Kansas City, Mo., has been incorporated in Missouri with a capital of $100,000. The incorporators are James Iynch, G. A. Dehaven and W. H. England.

The Duplex uncoupler and automatic release, manufactured by the National Railway Devices Co., of Chicago, has been specified on 250 of the cars recently ordered by the Duluth, Missabe & Northern and on 150 cars ordered by the Duluth & Iron Range.

The Geo. E. Molleson Co. has been incorporated under the laws of the state of New York for the purpose of buying and selling iron and steel products and railway supplies. The officers of the company are: Geo. E. Molleson, president and treasurer; L. M. Shook, secretary. The New York office will be continued at 50 Church street and the Chicago office will be in the Railway Exchange building. Mr. Molleson has been railroad representative for the Tyler Tube & Pipe Co., Pittsburgh, Pa., for the past 17 years, and the Geo. E. Molleson Co. will continue to represent this company, Mr. Molleson giving the business his personal attention.

The Watson-Stillman Co. has made several additions to its sales department to handle the increasing business in hydraulic tools and turbine pumps. Edwin Stillman has entered the sales department, and is assisting in taking care of customers in New York state, while all Southern R. R. business is now in charge of Frank C. Clark. The more direct representation that has become necessary in the Orient will be in the hands of F. W. Horn, the well-known machinery importer of Yokahama, Japan.

J. W. Coyle, who was connected with the Best American Calorific Co., until it retired from business, is now with the Rockwell Furnace Co., making a specialty of oil and gas furnaces for railway work. Mr. Coyle is an experienced railway man, having formerly been master blacksmith for the "Lehigh" at Wilkes-barre, and later in charge of the drop hammer and machine department at the forge shops of the Philadelphia & Reading at Reading, Pa.

The McKeen Motor Car Co. advises that it has received an order for a 70-ft. car of standard steel design for the Oregon R. R. & Navigation Co. An order for one of the same style and capacity has also been received from the Oregon & California R. R. This makes six McKeen cars in operation on or being built for these roads.

Mr. J. E. Osmer has been appointed assistant superintendent of the Hicks Locomotive & Car Works, Chicago Heights, Ill., in charge of the locomotive works. Mr. Osmer has been master mechanic of the Northwestern Elevated R. R. of Chicago about six years, and previously was connected with the mechanical departments of the Iowa Central, C. & A., and C. & N. W.

John D. Conway, secretary of the Railway Supply Manufacturers' Association, 313 Sixth avenue, Pittsburg, Pa., has issued a circular announcing the principal features of the arrangements for the Master Car Builders' and Master Mechanics' conventions at Atlantic City, N. J., June 15-22 next. The exhibits and the offices of the association will be located on Young's Pier as before, with the exception of the track exhibits, which will be placed as they were in 1909, on the tracks of the Philadelphia & Reading Ry., about 200 yards from the convention pier. Contract has been let for the erection of exhibit structures. It provides for 69,000 sq. ft. of exhibit space, exclusive of aisles, and 40 cents per sq. ft. will cover the cost of erecting structures and providing the usual facilities. The color scheme will again be green and white. A telephone will be provided between every two exhibitors with free local service from Monday, June 13, to Thursday, June 23. Aquarium Court will have the column construction of previous years. The upper floor of Exhibition Hall will not be used, and the lower floor will have ceiling and walls calcimined white. Eight candle-power electric lamps will be placed 2 ft. apart along each of ten cornice lines and will be lighted throughout the day, so that each aisle will have two rows of these lights and each booth a row at the front and a row at the back. Annex court contains large spaces which may be built largely to suit occupants. The annex will have the column and panel construction substantially as in 1909, but very heavy exhibits cannot be placed on this end of the pier. Exhibits of medium heavy weight can be put in the addition to the hotel men's annex in the side spaces, as these are over concrete piles, but only light exhibits can go in the center spaces. Power for operating exhibits will be furnished as heretofore. An additional boiler and a larger motor-driven compressor will be installed, and it is expected that with these additions all reasonable demands can be met. On February 16, in Pittsburg, space will be assigned to all exhibitors who have made application prior to that date, and the procedure will be substantially the same as in 1909. The exhibitors, if any, whose requirements, in the judgment of the exhibit committee, make it imperative that they be specially taken care of, will be asigned space first. Lots will then be drawn to determine the order in which exhibitors may choose space. If a representative of the exhibitor is present, he may choose in his turn; if there is no representative present, the application will be used as a guide in assigning the best space possible. The number of advance applications already received indicates a very great demand for space. Mr. Conway gives the prices at which Joseph L. Shoemaker & Co., 926 Arch street, Philadelphia, will rent furniture for the eight days of the conventions, also rates for rugs. A complete list of hotels will be given in a later circular. Mr. Conway calls attention to the resolution of the executive committee, prohibiting the distribution of souvenirs at the conventions; and also to the rule prohibiting the distribution of advertising matter from booth to booth.

The International Steel Tie Co. held its first annual meeting of stockholders in the offices of the company in the Central Trust building, Altoona, Pa., recently. There was a large attendance of those carrying the stock and much enthusiasm was manifested over the outlook for the future of the corporation. The annual election was held and the following board of directors selected: V. A. Oswald, J. R. Boeckel, William P. Day of Altoona, and John P. O'Donnell, a retired iron manufacturer of Cleveland, and P. H. Lavin, secretary-treasurer of the Inter-State Steel Co. of the same city, and Harry Emmons of Delaware. The directors organized by the election of V. A. Oswald, president; George Marpham, secretary; S. M. Hoyer, treasurer, and W. P. Day, manager. The tie made by the company is winning the commendation of railroad managers everywhere and the outlook is very bright.

On Jan. 4th, 1910, Mr. F. F. Prentiss, on account of ill health, resigned from the presidency of the Cleveland Twist Drill Co., and Mr. J. D. Cox was elected to that office. Mr. Cox was the founder of this business and has always been the practical man of the concern. He has probably had as much experience and has been in as close touch with the manufacturing of twist drills as any other man living.

Geo. L. Kippenberger, for seven years purchasing agent of the St. Louis Car Co., St. Louis, Mo., has resigned that position and since January 1 has been connected with the Forsyth Bros. Co., Chicago. Mr. Kippenberger served as purchasing agent for the American Car Co., St. Louis, Mo., for eleven years before going to the St. Louis Car Co.

Mr. Fred A. Preston has been appointed general sales agent of the Railway Specialty & Supply Co. He will have charge of the sales department of this company, which manufacture the P. & M. rail anchor and other railway devices.

The Standard Railway & Timber Co. has been incorporated in Delaware, with a capital of $100,000. The incorporators are J. H. Scott, Tacoma, Wash.; E. H. Brehm, Seattle, Wash., and Joseph Irving, Everett, Wash.

The National Engineering & Construction Co. has been incorporated in Delaware, with a capital of $500,000. The incorporators are William S. McGuire, New York city; J. D. Fackenthal, Brooklyn, N. Y.; James W. Williams, Waston, Pa.

The Chesapeake & Western Ry. has one second hand 56-ton consolidation engine for sale.

The North Coast has ordered, from the Hicks Locomotive & Car Works, two 70-ton passenger locomotives. Delivery is specified for February.

Frank B. Smith, president of the Crucible Steel Co. of America, Pittsburgh, Pa., died suddenly, on December 30, at his home in Sewickley, Pa.

Charles A. Fisher, formerly assistant auditor and assistant treasurer of the Jones & Laughlin Steel Co., Pittsburgh, Pa., becomes treasurer of that company, effective January 1, vice J. B. Laughlin, resigned.

Aaron Dean, Jr., formerly western manager of the Federal Signal Co., Albany, N. Y., with headquarters at Chicago, Ill., has been appointed general manager, with headquarters at Albany. H. H. Cade, formerly superintendent of construction, with headquarters at Chicago, has been appointed resident manager, with headquarters at Chicago. C. Henze has been appointed superintendent of construction, with headquarters at Albany.

The Bucyrus Company, South Milwaukee, Wis., has received an order from the Chicago & Northwestern Ry. for two locomotive pile drivers, one from the Grand Trunk Pacific for a rotary snow plow and one from the Chicago, Milwaukee & St. Paul for a 100-ton wrecking crane. In addition to these orders, the capacity of the company is completely filled up well into the future with large steam shovel and dredge orders, and the company has found it necessary to make extensive additions to its machine shop in order to care for its increasing business.

The Maryland Steel Co. has, under construction, a number of open hearth burners for a rail mill at Sparrows Point. The company will be prepared to deliver open hearth rails in May, 1910.

The American Car & Foundry Co., Railway Exchange, Chicago, has for sale 1000 forty-ton capacity wooden gondola cars, equipped with cast steel body and truck bolsters, airbrakes, etc. The cars are in first class condition and are ready for immediate delivery. The same company also has for sale twenty-five 87-ton consolidation locomotives about three years old in fist-class condition and ready for immediate delivery.

The Northern Engineering Works, Detroit, Mich., builders of Northern cranes, have purchased additional land adjoining their plant, on which they expect to build additions to their crane plant.

According to press reports the Gould interests have under consideration the question of building an extension of the International & Great Northern from Laredo, Tex., into Mexico, southeast. It is thought that the line may be continued to the port of Tampico on the Gulf, or further south to the City of Mexico. It is said that about 120 miles of grading was furnished some years ago from Nuevo Laredo, Mexico, to a point on the Soto la Marina river, by the Gould interests. The government concession for the proposed line has lapsed. The line is to be built to control traffic which may otherwise be diverted over the St. Louis, Brownsville & Mexico, through a direct connection with the National Railways of Mexico via the international bridge now being built over the Rio Grande river from Brownsville, Tex., to Matamoras, Mex. Reports indicate that the bridge will be completed and ready for service about June 1.

The Omaha & Council Bluffs Street Ry. Co. has prepared plans for an addition to its car shops in Omaha. The present shops are to be used for repair work and the addition, which will be practically a duplicate of the present plant, will be used entirely for new work.

The Baltimore & Ohio is said to be making plans for improvements, to include freight and passenger stations at Bedford and Baumer streets, and an extension of the freight shipping facilities at Washington and Franklin streets, in Johnstown, Pa. The work, it is understood, will be started soon and pushed to completion. The new freight and passenger stations will cost about $1,000,000.

Personals

Edward Wees has been appointed general foreman of the Ann Arbor R. R. at Frankfort, Mich. He succeeds W. J. Davis who has been assigned to other duties.

W. H. Walker succeeds W. Northgraves as roundhouse foreman of the Central Vermont Ry., at Brattlboro, Vt.

A. S. Wright has been appointed foreman of car repairs of the Central Vermont R., at White River Jct., Vt. He succeeds G. H. Shaw.

W. T. Hinchey succeeds L. Chartier as foreman of car repairs of the Central Vermont Ry., at New London, Conn.

F. B. Heitman has been appointed the master mechanic of the Chicago Union Transfer Ry., with office at Clearing, Ill.

O. S. Jackson has been appointed the master mechanic of the Chicago, Indianapolis and Louisville Ry., with office at Lafayette, Ind.

N. M. Maine, general master mechanic of the Chicago, Milwaukee & Puget Sound Ry., has moved his office from Seattle to Tacoma, Wash.

G. H. Matthews has been appointed the master mechanic of the Colorado Southern, New Orleans & Pacific R. R., vice M. S. Curley. His office is at De Quincy, La.

J. F. Enright succeeds T. B. Purvis as superintendent of motive power of the Denver & Rio Grande R. R., with office at Denver, Col.

W. J. Bennett succeeds A. H. Powell as master mechanic of the Utah lines of the Denver & Rio Grande R. R. His office is at Salt Lake City, Utah.

C. H. Montague succeeds J. H. Stubbs as the master mechanic of the Des Moines Western Ry., with office at Des Moines, Ia.

The following have been appointed general foremen of the Detroit, Toledo & Ironton Ry.: W. J. Davis, Ironton, Ohio; J. A. Hannigan, Jackson, Ohio; G. R. West, Springfield, Ohio; M. A. Craig, Lima, Ohio.

M. J. Stoll succeeds K. A. Froberg as superintendent of shops of the great Northern Ry. at Superior, Wis.

H. Fark succeeds M. J. Stoll as superintendent of shops of the Great Northern Ry., at Devils Lake, N. D.

C. J. Anderson succeeds J. W. Guill as a master mechanic of the National Rys. of Mexico with office at Monterey, Mex.

G. F. Goble succeeds C. K. Woods as general machine foreman of the Pere Marquette R. R. at Chicago.

Samuel G. Thomson has been appointed assistant engineer of motive power of the Philadelphia & Reading Ry., with office at Reading, Pa.

D. J. Redding, master mechanic of the Pittsburg & Lake Erie R. R. has been promoted to assistant superintendent of motive power with office at McKees Rocks, Pa.

J. A. Mitchell has been appointed the master mechanic of the Spokane and Inland Empire R. R. with office at Spokane.

G. M. Crownover has been appointed master mechanic in charge of the general shops of the Chicago Great Western R. R. with office at Oelwein, Ia. Mr. Crownover has been for many years in the mechanical department of the Illinois Central R. R., commencing as machinist apprentice in April, 1881. He was appointed roundhouse foreman at Clinton, Ill., in April 1887 and in April 1892, was transferred to Waterloo, Ia., as machine shop foreman and later as general foreman. In November, 1902, he was appointed master mechanic of the Freeport division and in November 1904, was transferred to the Burnside shops as assistant master mechanic in charge of both locomotive and car departments. He was made shop superintendent of the Burnside shops in October, 1908. He left the service of the Illinois Central on December 20, 1909, to take his present position. Mr. Crownover's work while in charge of the Burnside shops is familiar history to almost every reader of this paper. The new boiler shop which was built during his incumbency, is a monument to his efficiency.

Railway Mechanical Patents Issued During January

Drive wheel, 944,495 and 944,496—John E. Osmer, Chicago, Ill.

Brake head, 944,526—Albert Waycott, Cleveland, Ohio.

Brake shoe, 944,573—Henry H. McAlister, Fitzgerald, Ga.

Car truck, 944,587—Charles D. Young, Columbus, Ohio.

Slack adjuster for railway brakes, 944,609—Harvey G. Hamer, Hooversville, Pa.

Car stake, 944,739—Taylor H. MacLafferty, Tenino, Wash.

Car mover, 944,763—Fred C. Bailey, Rib Lake, Wis.

Truck bolster for railway cars, 944,818—Herman Pries, Michigan City, Ind.

Car truck, 944,820—Theodore W. Remmers, St. Louis, Mo.

Stake for logging cars, 944,838—Austin Benedict, Merrill, Wis.

Draft appliance for railway cars, 944,844—Harry C. Buhoup, Chicago, Ill.

Train pipe coupling, 944,941—Thomas C. Brett, Red Oak, Ia.

Car coupling, 944,953—Harry J. Daubert, Tamaqua, Pa.

Automatic air brake, 945,063—Walter V. Turner, Edgewood, Pa.

Draw bar, 945,079—Samuel W. Beeson, Buffalo, N. Y.

Carline for box cars, 945,084—Theodore De Vinney, Albany, N. Y.

Fluid pressure railway brake, 945,087—Charles G. Frey, Youngwood, Pa.

Car drop door mechanism, 945,108—John Pearson, Chicago, Ill.

Lock washer, 945,127—Frederick G. Kollenberg, Owensboro, Ky.

Truck side frame, 945,133—John H. McCormick, Columbus, Ohio.

Car body underframe, 945,142—Max M. Schneider, Chicago, Ill.

Automatic train pipe coupling, 945,158—Robert A. Fontaine, Martinsville, Va.

Car door, 945,253—James Warnock, Walpole, and George C. Lewis, Kissinia, Saskatchewan, Can.

Pipe coupling, 945,298—John E. Ward, New York, N. Y.

Automatic headlight adjuster, 945,369—Amos B. Brackbill, Salunga, Pa.

Grain car door, 945,381—Winfield S. Driskell, Gretna, Neb.

Automatic throttle closing and brake controlling device, 945,406—Sven T. Nelson, Harbert B. Halvorsen, and Frank A. Halleck, Chicago, Ill.

Brake shoe, 945,409—John E. Osmer, Chicago, Ill.

Car step, 945,531—Charles E. Hedgepeth, Nashville, N. C.

Car construction, 945,666—Harry H. Adams, New York, N. Y.

Car truck, 945,672—John C. Barber, Chicago, Ill.

Friction draft gear, 945,700—John F. Courson, Pitcairn, Pa.

Smoke stack, 945,709—Claire F. Dickinson, Winnetka, Ill.

Turn table center, 945,723—Richard Kuehn, Pittsburg, Pa.

Lining for freight cars, 945,747—William J. Brennan, Dannemora, N. Y.

Car replacer, 945,755—Lewis A. Coleman and Harvey Abrames, Norfolk, Va.

Air brake apparatus, 945,758—Nathan H. Davis, Philadelphia, Pa.

Car door seal, 945,804—Walter Reichert, Des Moines, Ia.

Car underframe, 945,830—Charles T. Westlake, St. Louis, Mo.

Car wheel and axle, 945,894—Burt L. Worthen, Tucson, Ariz.

Differential car axle, 945,915—Peter C. Cookingham, Longbeach, Colo.

Metallic roofing for cars, 945,918—Joseph T. Crawford, Philadelphia, Pa.

Tire heating device, 945,966 and 945,968—Julius A. Mahr, Minneapolis, Minn.

Liner for locomotive driving boxes and the like, 946,035—Grant Hall, Winnipeg, Manitoba, Canada.

Locomotive engine, 946,084—Harry S. Vincent, Ridgewood, N. J.

Car bolster, 946,099—Edwin H. Benners, Elizabeth, N. J.

Car seat, 946,125—Frederick Hachmann, St. Paul, Minn.

Washer for screw bolts, 946,127—George L. Hall, New York, N. Y.

Car coupling, 946,176—Edwin C. Washburn, Minneapolis, Minn.

Journal box lid fastener, 946,227—Thomas H. Joye, Charleston, S. C.

Journal box, 946,237—George W. Lewis, Portsmouth, Va.

Roller side bearing, 946,261—John F. O'Connor, Chicago, Ill.

Dynamometer, 946,264—Samuel T. Park and John E. Phillips, Danville, Ill.

Car truck, 946,293—Andrew C. Vauclain, Philadelphia, Pa.

Automatic stopping mechanism for railway trains, 946,298—William J. Wilgus, New York, N. Y.

Track sanding apparatus, 946,346—Isaac A. Gibbs, Roanoke, Va.

Automatic adjustment device for railway brake mechanism, 946,356—Robert Harrington and Edwin W. S. Young, Pietermaritzburg, Natal.

Pipe or hose coupling, 946,396—John H. Phillips, Jr., Jackson, Mich.

Automatic stopping mechanism for railway trains, 946,415—William J. Wilgus, New York, N. Y.

Curtain attachment for sleeping car berths, 946,417—James W. Winn, Chicago, Ill.

Locomotive ash pan, 946,440—Harry A. Hoke, Altoona, Pa.

Journal box lubricating device, 946.495—Charles B. Coon, Evanston, Ill.

Differential axle for railway cars and locomotives, 946,527—Charles F. Phillips, Los Angeles, Cal.

Locomotive ash pan, 946,553—Robert J. Mitchell, Marion, O.

Car-coupling uncoupling device, 946,592—Gustave F. Brandon, Muskegon, Mich.

Automatic recording car scale, 946,600—Geo. Goetz, Chicago, Ill.

Automatic weighing and recording car scale, 946,601—Geo. Goetz, Chicago, Ill.

Coupling Yoke, 946,603—Jno. A. Jackson, Chicago, Ill.

Tank car, 946,647—Herman C. Priebe, Chicago, Ill.

Metallic car roof, 946,729—Jno. J. Hoffman, St. Louis, Mo.

Spark arrester, 946,804—Lauritz Miller, Laramie, Wyo.

Car roof, 946,823—Walter P. Murphy, St. Louis, Mo.

Metallic running board saddle for railway cars, 946,847—Chas. J. Nash, Chicago, Ill.

Motor car, 946,855—Chas. A. Harp, Sacramento, Cal.

Car underframe, 946,865—Herman C. Priebe, Chicago, Ill.

Passenger car, 946,871—Chas. H. Anderson, Seattle, Wash.

Radial draft gear and vestibule, 946,875—Harry T. Krakau, Cleveland, O.

Carburetted vapor lighting system, 946,901—Geo. E. Hulse, Newark, N. J.

Truck brake, 946,931—Walter S. Adams, Philadelphia, Pa.

Draft gear, 946,994—Mathew Carr, Chicago, Ill.

Car wheel, 946,995—Wm. McConway, Pittsburg, Pa.

Grain door, 947,063—Hezekiah M. Hickman, Wellington, Kan.

Car stop, 947,068—Herman H. Weiske, Wheeling, W. Va.

Car brake, 947,074—Thos. E. Cruess, Salinas, Cal.

Journal box and dust guard, 947,105—Jno. D. Jones, Walla Walla, Wash.

Snow plow, 947,121—Eugene M. McLain, Clare, Iowa.

Safety attachment for car brakes, 947,142—Jno. B. Wright, Greensboro, N. C.

Car coupling, 947,161—Chas. Rosenzweig, Allengheny, Pa.

Railway car ventilator, 947,171—Edward A. Barber, York, Pa.

Dump car, 947,197—Jno. K. Furst, New Castle. Pa.

Air brake indicator, 947,213—Odie R. Snyder, Knoxville, Tenn.

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AUTOMATIC STOKERS.

An item which originally appeared in one of the electrical trade papers and which has been copied by the nontechnical papers and by a number of trade papers outside of the railway mechanical field, is quoted below:

> "Automatic stokers for firing locomotives are not common practice, but the Chicago & Alton Railroad is said to have started the policy of equipping its locomotives with such devices. The first installation ordered was 10 automatic stokers, which are reported to have proven so satisfactory that 26 locomotives, including fast passenger service between Chicago, St. Louis and Kansas City, have also been equipped. The road has found that the device used will fire successfully all sizes and kinds of coal, and by the use of the inferior grades has produced a substantial saving, as well as cutting down the amount of smoke made. The stokers make it possible to fire at frequent intervals, to keep a light, bright fire, to maintain full steam pressure at all times and to give a chance for inspection of the fire whenever necessary. The stokers leave the firemen free to watch signals and to take charge of the throttle should emergency arise."

The only statement in this item which is borne out by fact is contained in the first sentence. It is true, of course, that automatic stokers for firing locomotives are not common practice. It is not true that twenty-six locomotives of the Chicago & Alton, including those in fast passenger service, are equipped with stokers. It is not true that the road has found that the device used will fire successfully all sizes and kinds of coal. or that it can produce a substantial saving. It is not true that fire, to maintain steam pressure at all times and to "give a the stoker in question makes it possible to keep a light, bright

Perhaps these unqualified denials call for an expression of opinion as to what these stokers will do, and in order to make clear this paper's opinion, a description of the machine is necessary. The stoker which, as far as the Chicago & Alton R. R. is concerned, was originally applied to a yard engine, was later placed on several freight and passenger locomotives. It worked with comparative success as long as it was given the attention which novelties always get. There were no benefits accruing from its use, however, even with conditions ideal to its proper working. The statement that it saves manual labor on the part of the fireman is totally in error. On the contrary, the fireman's manual labors are not only as great as is the case without the use of the stoker, but his mental capacity is taxed to operate properly a machine which is destined to do only part of his work for him. In other words, the fireman handles the same amount of coal in the same old scoop. Instead of placing it in the fire box, he puts it in a hopper and then operates a lever on the machine which is expected to place the coal on the fire. After the most thorough trials, during which the stoker was given every chance to make good, engines were towed in on account of lack of steam several times. The stokers were remodeled and refitted, but with the same unsatisfactory results, until they are unpopular with both the men and the officials of the Chicago & Alton R. R. As an advertising medium, the automatic stoker may have produced results, but its adoption as a means of firing a railway locomotive should rest upon more solid ground. So much has been said in favor of this particular stoker that it must be concluded that the greater part of the testimony has been somewhat biased. Few have been misled, however. A successful mechanical stoker will probably be invented in the near future, but as its need rests primarily upon the necessity for greater capacity, it will entail the use of a means for conveying as well as for firing the fuel.

ELECTRIFICATION PROBLEMS.

Elsewhere in this issue we are publishing two articles dealing with the electrification problem: "Electrification of the Bavarian State Railways," from the report of the Bavarian Minister of Transportation, and "Electrification of Trunk Lines," by L. R. Pomeroy. Both of these are of especial interest in view of the small amount of information at hand on this timely subject. Bavaria is one of the largest kingdoms or states of the German Empire, with an area of 29,290 square miles, and a population of 6,524,000; an area about one-half that of the state of Wisconsin with a population three times as great. Bordered on two sides by mountain ranges, the country contains an abundance of undeveloped water power which will be used in connection with the electrification of the steam lines in the southern part, and which is an advantage not usually found in these problems. It is interesting to note that the report recommends single-phase alternating current as best suited to the requirements of main line railways and states that electric working becomes the more advantageous, the greater the increase in the price of coal. The Bavarian railways, however, have few trunk lines and large terminals to electrify; Munich, the capital, having a population of some 539,000.

In "Electrification of Trunk Lines" Mr. Pomeroy hits the right note when he says: "Whether electricity will replace steam traction or not is entirely a commercial proposition." It is quite apparent, however, that the electrification of trunk lines is a proposition for the indefinite future, and that electrification in certain localities presents very different problems in each case.

Mallet Locomotive for Narrow Gauge

The American Locomotive Co. has recently completed a Mallet articulated compound locomotive for the Central South African Railways. This engine is designed for a 3 ft. 6 in. gauge of track and is the heaviest and most powerful articulated locomotive so far constructed by this company for a narrow gauge road, weighing 29,000 lbs. more than the engine of this type built last year by these same builders for the Natal Government Railways of South Africa. This last mentioned engine, which was of the 2660 type of wheel arrangement had a total weight in working order of 196,000 pounds, 179,500 pounds on driving wheels and a tractive power of 46,600 pounds. It has been in service for several months and has fully met the expectations of the Natal Government Railway officials and has proved a most efficient and successful locomotive for conditions existing on that road. On a 3.3 per cent grade it easily handles 325 long tons which is 50 per cent more than their heaviest engines of other types can haul. It has also proved a remarkably good curving engine, passing through the sharp curves, many of which are of 19.5 degrees, much more easily and with less flange friction than their eight coupled engines, with rigid wheel bases.

The engine here illustrated is of the 2662 type of wheel arrangement, having a two-wheel truck front and rear. Both trucks are of the radial center bearing, swing bolster type with journals outside of the wheels. The construction of the trucks which is shown in the accompanying illustrations is of interest. The boiler is suspended by 3-point or stable equilibrium hangers. The frame, which is of cast steel of light but strong construction is in three parts.

The main frame has two arms on each side which extend outside of and partially surround the wheel and between the ends of these arms the section forming the pedestal for the journal box is securely bolted. Coil springs seated on top of the boxes transmit the load to the journals. As the engine is designed to pass through curves of 350 feet radius it was necessary in order to provide the required truck swing and bring the point of support as low as possible to suspend the bolster underneath the axle and employ a long center pin which is built up in two parts, the lower one straddling the axle.

In working order, the engine has a total weight of 225,000 pounds of which 192,500 pounds is carried on the driving wheels. As far as the features peculiar to the articulated type of construction are concerned, the design in general follows the builders' standard practice. The high pressure cylinders are 18 inches in diameter by 26 inches in stroke and the low pressure cylinders are 28½ inches in diameter by the same stroke. The exhaust passages of the low pressure cylinders are carried forward to the front of the cylinder where they connect to the branches of a "Y" pipe. This has a ball joint connection with an elbow which is connected by a pipe fitted with a slip joint with an elbow having a ball joint connection with the exhaust pipe in the smoke box. This arrangement was necessary in order to secure a proper length of flexible exhaust pipe so as to reduce the angle of its deflections when the locomotive passes through sharp curves. In order to provide room between the top of the cylinder casting and the smoke box for the flexible exhaust pipe it was necessary in this case to provide an offset of 5⅜ inches in the bottom of the smoke box from a point 15½ inches back of the center line of the exhaust pipe.

Following the usual practice, the high pressure cylinders are equipped with piston valves and the low pressure with Allen-Richardson balanced slide valves both being operated by a simple design of the Walschaert valve gear. The reversing mechanism is so arranged that the weights of the parts of the two sets of valve motions counter-balance each other. Reversing is effected by means of the builders usual design of power reversing gear except that in this case the reversing cylinder is operated by steam as this engine is not equipped with

Narrow Gauge Mallet, Cent. So. Africa Rys.

compressed air. The frames which are four inches wide are of wrought iron, the rear frames having a single front rail integral with the main frame, while the forward frames are fitted with double front rails. There is a single articulation connection between the front and rear engines. That part of the weight of the boiler which is carried on the front system is supported by a single self-adjusting sliding bearing which is provided with the builders usual design of spring centering device.

The three pairs of driving wheels of the front system are all equalized together and with the leading truck by a single central equalizing beam while the rear set of driving wheels are equalized in a similar manner except that the cross equalization is omitted and each side is equalized with the trailing truck by means of an equalizing beam which fits into a pocket in the truck center pin. This arrangement gives a three-point suspended engine.

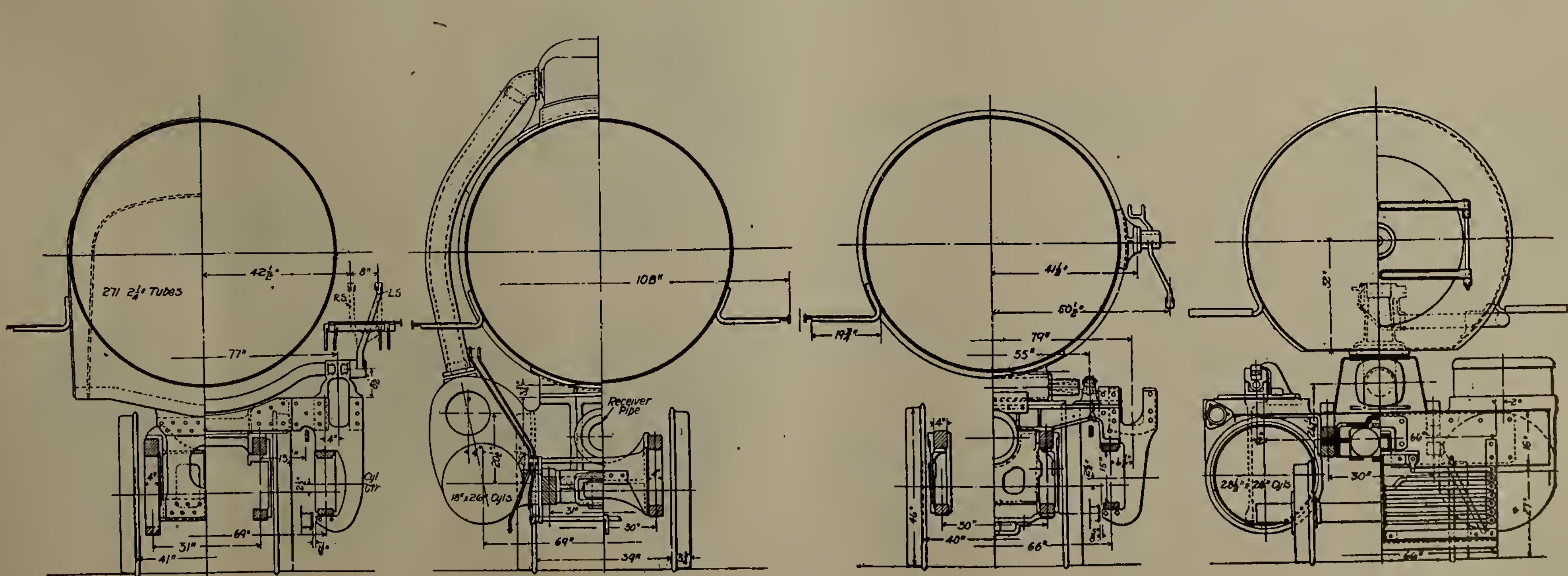
The boiler is of the radial stayed straight top type and the barrel measures 72⅛ inches in diameter inside at the first ring. The design incorporates an 18-inch combination chamber the bottom of which is laid with fire brick.

There are 271 tubes 2¼ inches in diameter and 20 feet long, which provide a heating surface of 3,167.7 square feet. The total heating surface of the boiler is 3,324.2 square feet. This gives a ratio of total heating surface to the volume of equivalent simple cylinders of 281. The firebox is 107 15-16 inches long and 66 inches wide and provides a grate area of 49.5 square feet. Following English practice the inside firebox is made of copper, the crown and side sheets being in one piece, and copper staybolts are used for the water-space stays.

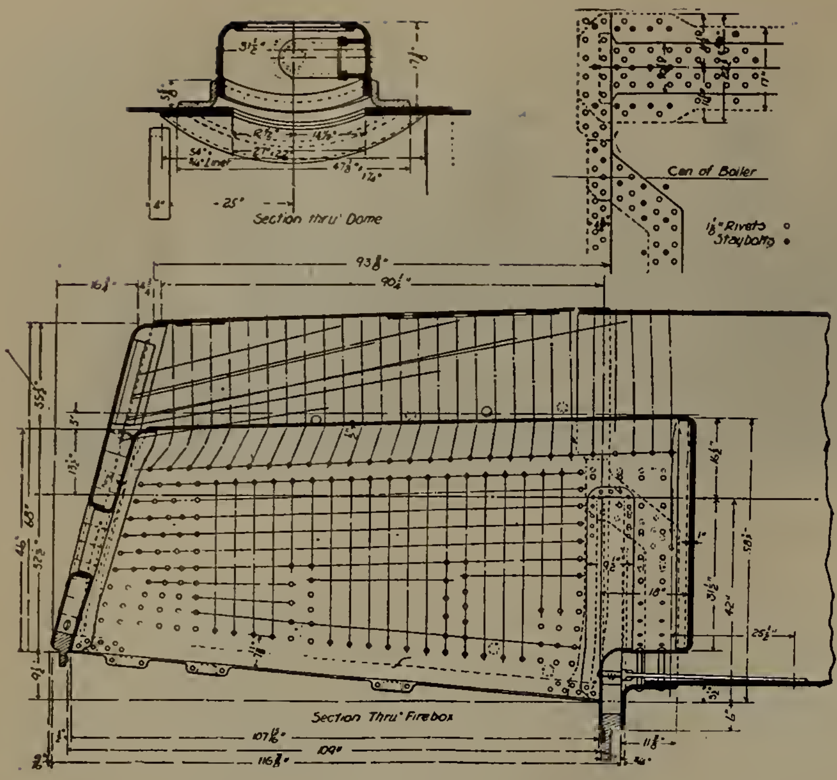
The tender is of the railroad company's design throughout. It is fitted with a tank having a water capacity of 5,000 gallons and space for 10 long tons of coal. The tender frame is of steel, the center and side sills being constructed of 10-inch channels. It is mounted on two four-wheel traucks of the equalized pedestal type, the frames being constructed of steel plate. The tender is equipped with automatic vacuum brakes, while steam brakes are used on the engine.

Some of the principal dimensions and ratios of the design are given in the following table:

Cylinder—	
Type	Mallet Art. Comp.
Diameter	18 and 28½ ins.
Stroke	26 ins.
Track gauge	3 ft. 6 ins.
Tractive power	48,100 tons
Wheel Base—	
Driving	8 ft. 4 ins.
Rigid	8 ft. 4 ins.
Total	40 ft. 3 ins.
Total, engine and tender	65 ft. 6 1-16 ins.
Weight—	
In working order	225,000 lbs.
On drivers	192,500 lbs.
In working order, engine and tender	352,000 lbs.
Heating Surface—	
Tubes	3,167.7 sq. ft.
Firebox	156.5
Total	3,324.2 sq. ft.
Grate area	49.5 sq. ft.



Cross Sections, Narrow Gauge Mallet.



Firebox and Boiler Details.

Axles—
Driving journals....Main, 8x10 ins.
Driving journals....Others, 8x10 ins.
Engine truck journals....Diameter, 5½ ins.; length, 10 ins.
Trailing truck journals....Diameter, 5½ ins.; length, 10 ins.
Tender truck journals....Diameter, 5½ ins.; length, 10⅛ ins.

Boiler—
Type....Straight top
O. D. first ring....73¾ ins.
Working pressure....200 lbs.
Fuel....Bituminous coal

Firebox—
Type....Wide
Length....107 15-16 ins.
Width....66 ins.
Thickness of crown....½ in.
Thickness of tube....1 and ½ in.
Thickness of sides....½ in.
Thickness of back....½ in.
Water space, front....4 ins.
Sides....3½ ins.
Back....3½ ins.

Crown staying....Radial

Tubes—
Material....Cold drawn seamless steel
No....271
Diameter....2¼ ins.
Length....20 ft.
Gauge....No. 11 B. W. C.

Boxes—
Driving, main....Cast steel
Others....Cast steel

Brake—
Driver....Steam brake
Truck..Engine also to have vacuum brake equipment acting on tender only.

Engine truck....Two-wheeled swing cent. bearing

Trailing truck....Two-wheeled swing cent. bearing

Exhaust pipe....Single nozzles, 5 and 5½ ins.

Grate, style....Rocking
Piston....Rod diameter, 3¼ ins.
Piston packing....C. iron rings

Smoke Stack—
Diameter....17 ins.
Top above rail....12 ft. 10⅜ ins.

Tender frame....10-in. steel channels

Tank—
Style....R. R. Co.'s Print
Capacity....5,000 gals.
Capacity, fuel....10 tons (2,240 lbs. per ton)

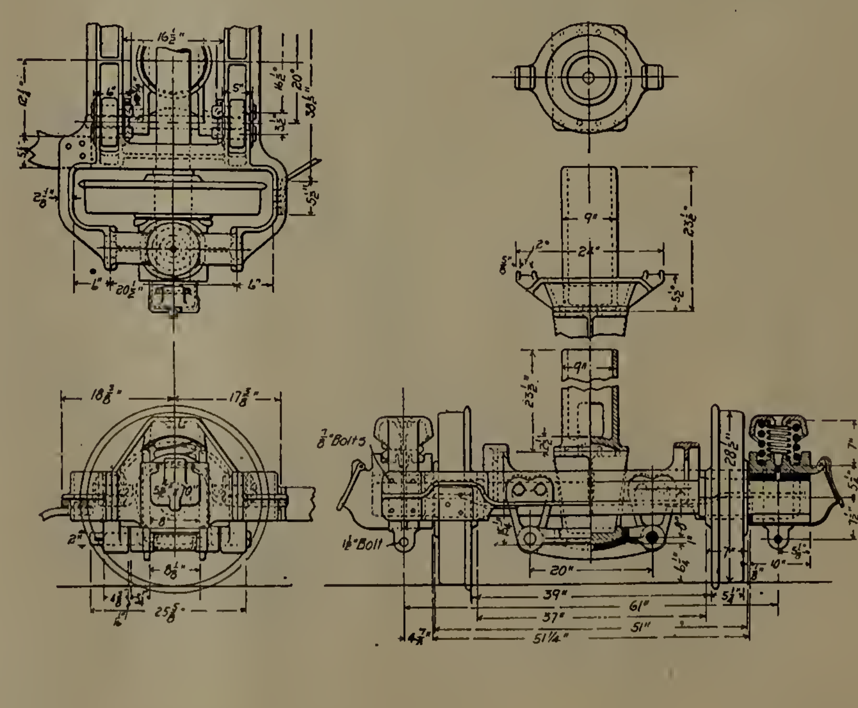
Valves—
Type....H. P., piston; L. P., Allen-Rich. slide
Travel....H. P., 5 ins.; L. P., 5½ ins.
Steam lap....H. P., 1 in.; L. P., ⅞ in.
Ex. lap....Clear, H. and L. P.

Setting....Lead, 3-16 in., H. and L. P.

Wheels—
Driver....Diameter outside tire, 46 ins.
Centers....Diameter, 40 ins.
Driver, material....Main, cast steel
Others....Cast steel
Engine truck....Diameter, 28½ ins.
Kind....Spoke centers
Trailing truck....Diameter, 28½ ins.
Kind....Spoke centers
Tender truck....Diameter, 33½ ins.
Kind....Spoke centers

Ratios.

Weight on drivers ÷ tractive effort	4.00
Total weight ÷ tractive effort	4.68
Tractive effort × diameter drivers ÷ heating surface (B. D. factor)	666
Total heating surface ÷ grate area	67
Firebox heating ÷ total heating surface (per cent)	4.7
Weight on drivers ÷ total heating surface	57.8
Total weight ÷ total heating surface	67.6
Volume of equivalent simple cylinders (cu. ft.)	11.8
Total heating surface ÷ volume equivalent simple cylinder	281
Grate area ÷ volume equivalent simple cylinders	4.2



Engine Trucks, Narrow Gauge Mallet.

Electrification of the Bavarian States Railways*

By J. Jacqmin, Engineer to the Belgian State Railways.

The Bavarian Minister of Transportation has recently submitted to the Parliament of that country a very detailed report on the electrification of the Bavarian State Railways and the purpose of this paper is to review some of the important points of that report.

Bavaria possesses a large number of water-power sources, which, until now, have not been utilized. Before being able to compute whether these sources of power are ample to furnish the energy requisite for traction on the Bavarian railways. the required power must be known. The schedules established for steam lines must undergo considerable modifications when electric traction is substituted. After determining the average load on the central generating stations it is usual to replace the relatively infrequent heavy trains by a more frequent service of light trains, thus allowing, as in the case of tramways, nearer approximation to the traffic requirements as varied by the time of day.

This rearrangement of trains cannot, however, be invariably applied, notably in the case of international through trains, which must be handled from frontier to frontier in their entirety; likewise in the case of freight trains, the speed of which is generally low, and which if split up into smaller units would congest the line. The running schedules will be reduced proportionately to the increased acceleration attainable by electric traction. To establish the energy consumption, the trains are divided into four classes having the characteristics enumerated in the following table:

CLASSES.	Regulation speed in miles per hour(¹).	Weight of the hauled load in tons Q_2.	Weight of the locomotive in tons Q_1.	Maximum authorized speed in miles per hour.	Ratio $\frac{Q_1+Q_2}{Q_2}$
Freight trains	38	300-600	60	31	1-2
Suburban trains	46-6	200 300	50 90	56	1-25
Through and express trains	56 to 62	165	50	62 to 74-5	1-3
Local trains	18-6	100	24	18-6	1-25

Using the above as basis, we are in a position to determine both the load on, and the capacity of the generating stations; in other words, the output in kilowatt-hours and the capacity in kilowatts. To determine the capacity, calculate separately the total daily consumption for each of the lines in the system and add the results. In order to do this, it is necessary to determine the consumption of each class of train on the different lines in both running directions and multiply the results thus obtained by the daily number of trains of each of the above classes. The average power is computed by dividing the consumption of each of the classes of trains by the running time, and then adding, for any moment of the day, the power of all the trains in operation at that time.

In the case of a suburban and through train, the curves of current input are very irregular and differ essentially, being principally dependent on the number of stops. On the line between Munich, Garmisch and Partenkirchen, the mean daily load is 2,860 kilowatts, although the maxim load is 9,800 kilowatts.

However, the generating stations must be capable of supplying a maximum demand of 21,500 horse-power, that is to say 21,500 horse-power for 24 hours, equaling 516,000 horse-power hours, whereas the total consumption is only 5,700×24 =136,800 horse-power hours, being a loss of 73.5 per cent of the total capacity. This loss is an actual one, more especially in the case of those water power stations which have no storage capacity.

If we now add the losses from the generating station to the traction motors we shall obtain the power necessary at the generating station. For the line under consideration we would have the outputs 5,700 and 21,500 horse-power respectively, giving a ratio of $\frac{21,500}{5,700} = 3.78$. Similar calculations for other lines give: load coefficients 1.68 on the congested Munich-Gauting line; 5.37 on the summer line Salzbourg-Bad—Reichenhall-Berchtesgaden. As is known, these load factors are of tremendous importance, both from the viewpoint of the generating station as well as of the use of the power available.

The constant aim is to make the load coefficients approximate unity as nearly as possible, and in order to accomplish this end, it is necessary to revise the factors which make them up; that is to say, the number and weight of trains; the speed; the gradient; the distance between stops; the interval between trains as well as their conformity to timetable; the proficiency of the drivers and lastly the system of supply adopted.

The coefficient having been improved as much as possible, it is advisable to feed several lines from the same generating station, as unfavorable load conditions do not as a rule coincide on several lines; also by supplying different industries with the power available. In the case of water-power central stations it is well to install reservoirs (if the actual physical conditions permit) so that water may be stored during the period of light loads, and thus be available in most cases when the supply of water is insufficient for peak loads.

For the Bavarian system 43 feeding points were chosen and the total daily consumption amounts to 1,447,095 kilowatt-hours, being an average hourly consumption of 60,410 kilowatt hours. This includes not only the power for traction but also the consumption for lighting, heating, braking, shunting, etc. Table 2 gives the distribution of total consumption, and the number of ton-miles carried, from which can be reduced the consumption per ton-mile for the various services under consideration.

AVERAGE DAILY TRAFFIC IN JULY, 1906.	Total load in ton-miles.	Percentage of total.	Consumption in Kilowatt hours.	Percentage of traction consumption.	Percentage of total consumption.	Consumption in watt-hours per ton-mile.
Main Lines:						
Passenger and Freight..	1,433,976	5.9	78,525	6.1	5.5	54.61
Freight	14,542,236	59.6	646,010	49.7	45	44.48
Branch Lines:						
Passenger and Freight..	1,433,976	5-9	78,525	6-1	5-5	54-61
Total for Traction..	24,393,025	100	1,299,425	100	...	53.31
Shunting		...	135,400	...	9.5	.....
Consumption for traction purposes on the State Railways		...	1,434,825	...	100	58.87
Consumption for traction purposes on locally authorized lines.........	197,359	...	12,270	...	...	62.46
Total	24,590,384	...	1,447,095	...	...	58.87

TABLE 2.

As will be seen, there is considerable variation between the average consumption per ton-mile for passenger and

*From January Bulletin of the International Railway Congress.

freight traffic. It is higher for passenger traffic because of the greater speed. On the branch lines, despite the lower speed, the consumption is greater because of the less favorable configuration of the line.

As seen by table 2, the total daily consumption in July, 1906, for the state systems reached a total of 1,434,825, or in round figures 1,435,000 kilowatt-hours. This figure should be increased as follows:

(a) 10 per cent allowance for irregularities in running, delays and unforeseen stoppages;

(b) 15 per cent allowance for transformation losses at the central station and the feeding points;

(c) 25 per cent allowance for transmission line losses.

Hence the water turbines must give $\frac{1,435,000}{0.9 \times 0.85 \times 0.75 \times 0.736}$ = 3,400,000 horse-power hours, on an average hourly load of $\frac{3,400,000}{24}$ = 142,000 horse-power, to supply electric traction for the Bavarian State trains during a day in July, 1906.

What must be the maximum capacity of the central stations to supply this average demand? The capacity will depend on the load factor. This varies for each line and depends on a number of factors. On the main lines this factor is nearer unity because of infrequent stops, and the night traffic not differing materially from the day; on branch lines, however, the load factor is much less favorable.

But as shown in table 2 the branch lines account for only 6.1 per cent of the total consumption, while the main lines take 93.9 per cent. The influence of the former on the load factor is therefore very small.

These coefficients have already been given as 3.78, 4.68, 5.37. For the Munich-Rosenheim line, 40.2 miles in length, with a daily traffic of 24 express, 15 suburban, 12 freight and 16 local trains, the coefficient is 2.37. It is 2.58 on the Munich-Augsbourg line of 38.5 miles and a daily traffic of 13 express, 12 suburban, 29 freight and 16 local trains. These figures permit us to assume 3 as the probable coefficient for the entire system. Consequently the capacity of the generators must be 142,000 × 3 = 426,000 horse-power.

The preceding calculations are based on the daily traffic in July, 1906. The curve of increase of traffic in axle kilometres from 1875 to 1907, shows that it will attain in 1920 approximately 1,833 millions axle-miles as compared with 1,291 millions axle-miles in 1906. The increase will, therefore, be 42 per cent. Under these conditions the average load on the hydraulic power-houses in 1920 will be 142,000 × 1.42 = 202,000 horse-power and the maximum capacity will be 202,000 × 3 = 606,000 horse-power. As transportation conditions will be subjected to large changes between now and 1920, it is not necessary to consider a longer period.

An analogous calculation has been established for the different months of 1906. Account has also been taken of the current necessary for lighting the stations, and for driving and lighting the shops. The average daily load at the feeding points indicates slight difference between summer and winter output; although the winter traffic is less, the requirements of lighting and healing are then much more. The greatest output is in November, when it reaches 1,569,310 kilowatt-hours and the least in April, being 1,365,340 kilowatt-hours. The total annual output is 533,400,000 kilowatt-hours, and the average daily consumption is 1,461,400 kilowatt-hours; this amount is 7.38 per cent less than the maximum and 6.57 per cent more than the minimum. For a day in July table 2 gives a consumption of 1,447,095 kilowatt-hours which figure is within 1 per cent of the average for the year. In other words the figures for a day in July are practically representative of the average daily traffic for the whole year.

We know now what is required for the systems, and it only remains to be seen if the water powers of Bavaria will suffice. The report at this stage refers to a work entitled "Les forces hydrauliques de la Baviere," from which it appears that the waterfalls still not utilized are amply large to furnish the necessary power for the electrification of the entire Bavarian system.

The nature of the current and the determination of the principal electrical factors such as the voltage and subsequently the frequency, are of great importance when electric motive power is used on railways.

The choice made, and the installations completed, changes can only be made at great cost, whereas during erection they will not greatly increase the outlay. Hence it is necessary to settle at the outstet which system will ensure the greatest safety to the service combined with greatest technical and pecuniary advantages. It will therefore be necessary to consider the loads to be carried, the density of traffic, the distances hauled, on the one hand, and on the other the performances of the locomotives depending on the system adopted.

The power to be transmitted is considerable, being for the 62 miles of the Munich-Garmisch-Partenkirchen line, at certain times, 9,800 kilowatts. Now it is known that the line loss increases as the square of the current and the length of the line; the weight of copper increases inversely as the square of the voltage; and that, moreover, the section of the line limits its carrying capacity. Hence to keep the line loss, and copper outlay within economical limits, it is necessary to use small currents and relatively high pressures, when transmitting large powers over long distances. In regard to the traction motors, they must be of robust design, capable of large speed variation, a high starting torque, and a tractive effort little affected by voltage drop.

What system at this time best fulfills these conditions?

At this point the report refers briefly to the advantages and disadvantages of direct current, three-phase and single-phase current from the view-point of traction and transmission. The comparison is based on 44 points and is digested in a very interesting table. The report comes to the following conclusions therefrom:

"From the considerations relative to the kind of system, it appears, from the present state of the art, that the advantages of single-phase alternating current outweigh the disadvantages. Single-phase current best fulfills the conditions existing for the electrifications of long-distance railways, not only because of the possible transmission by a single overhead line, but also because of the case of obtaining wide variation of motor speeds."

Although this conclusion may apply to the Bavarian railways, it cannot be generally accepted, and in certain cases, direct current with a third rail is preferable, despite numerous and costly sub-stations, owing to the greater certainty,

Average Daily Work in July, 1906.	Energy consumption in kilo-watt-hours.	Energy recovered in kilo-watt-hours.	Ratio of energy recovered to total energy consumed. column 3 / column 2	
Main lines:				
Passenger traffic	574,890	6,559	0.0114 = 1.14 p. c.	
Freight traffic	646,010	16,043	0.0249 = 2.49 p. c.	1.85 p. c.
Branch lines:				
Pasenger and freight traffic	78,525	9,518	0.121 = 12.1 p. c.	
Total for traction...	1,299,425	32,120	2.47 p. c.	
Shunting operations.....	135,400	...	...	
Total consumption:				
a) On the State Railways	1,434,825	...	2.24 p. c.	
b) On privately-owned Railways	12,270	1,523	12.4 p. c.	
	1,447,095	33,643	2.325 p. c.	

TABLE 3.

and providing the existing or contemplated traffic be such as to ensure sufficient revenue.

The adoption of the three-phase system, has, however, an advantage over other systems, in that it allows of some regeneration. As is known, a three-phase motor acts as a generator when the gravity component exceeds the train resistance and returns recoverable energy to the line without change of the circuit connections.

This regeneration may be considerable in the case of heavy freight traffic on a line with long, severe gradients. Calculations of the energy recoverable have been made for each of the lines in the Bavarian system, and the results of the inquiry for a day in the month of July, 1906, are given in table 3.

As may be seen the energy recovered is greater with freight trains (2.49 per cent) than for passenger trains (1.14 per cent) running over the same lines, on account of the lower speeds. Another reason to be considered on the secondary lines is, that on this class of line the influence of an irregular profile still further increases the energy recovered (12.1 per cent).

The recovery possible on branch lines is, however, of little importance to the final result, because of the small share of consumption (6.1 per cent of the energy required by the entire system, see table 2.) Consequently it only increases the total percentage by from 1.85 to 2.47 per cent.

If we do not exceed this figure, the gain is too small, and in any event insufficient to be taken into consideration when making a choice of the kind of current for traction as required for the Bavarian railways.

In the first appendix the report reviews what will be the voltage of the transmission line and feeding power line, if single phase current be adopted. A voltage of 50,000 for transmission from the central generating stations to the substations and of 10,000 on the power line are recommended for adoption.

The feeders will be strung on the post supports carrying the running trolley line, that is to say, along the line of rails, even if detours are thus introduced; inspection and maintenance of the line in first-class state being much more certain.

The post supports will be spaced from 82 to 109 yards, the trolley wires will be catenary suspended, and not less than 197,350 circular mils in section; their minimum height above ground will be 18 feet.

In the third chapter the report reviews the conditions under which the substitution of electric for steam traction presents financial advantages. A principal consideration in the cost of steam working is the price of coal; in the case of electric traction the preponderating factor is the cost price of a kilowatt hour. We know how much this latter varies with the load factor of the central generating stations. If then the management wish to reduce the cost price to the lowest possible figure, they will often endeavor to sell to third parties the surplus power.

There are two methods of determining whether electric traction will be more economical for railways than steam traction.

The first method is to determine, on one hand, the cost of electric traction neglecting the cost of the energy consumed, and on the other hand the cost of steam traction including the cost of fuel, and then to calculate the difference between these costs and the maximum possible cost of a kilowatt hour.

The second method consists in determining the minimum daily electric consumption per mile of line, that is to say, the density of traffic which must exist, to give economic results with an assumed cost per kilowatt hour. This minimum consumption is referred to in the report as "The critical consumption output."

Whereas by the first method the density of traffic is taken as a basis, upon which is determined, with the electrical output required, the limiting cost per unit of power, by the second method the cost per unit of power is assumed, and the minimum consumption which will justify electrification determined therefrom.

It is assumed that the comparative calculations of the costs of steam working and electric working are limited by factors the values of which are changed by the very fact of the change. We cite the question of large staff reduction, the elimination of cost of fuel and water when electric traction is employed, but replaced by the costs of production and distribution of electric energy, etc.

Coal is imported into Bavaria via Aschaffenburg in the northwest and the price per ton is seldom less than $4.95 per ton; on the other hand, the water powers are in the south and southeast, at the foot of the Alps. Under these circumstances it is obvious that the conditions for introducing electric working are more favorable in the south and southeastern portions of Bavaria than in the northwestern, because the economic possibility of electric working as compared with steam working increases as the cost price per kilowatt hour is reduced, while the price per ton of coal is greater.

It is therefore easily possible to determine for which lines the substitution will be advantageous, by ascertaining in which districts in the north and south of Bavaria the price of coal reaches certain fixed values.

The report thus fixes upon two zones: one in the north (Nuremberg-Bamberg) the price per ton of coal delivered on the locomotives being $5.19 per ton; the other in the south (Kempten-Munich-Rosenheim) the price per ton being $5.93 per ton.

If now we assume that the cost price per kilowatt hour is from $0.0024 to $0.0048 in the southern zone, and varies from $0.0048 to $0.0066 in the northern zone, the comparison of costs for electric and steam working give the following values for the "critical consumption" (table 4). This table shows that in the southern zone of the country the introduction of electric traction is economically advantageous on lines with much less traffic density that for the northern lines.

The minimum compression in kilowatt-hours per mile of line necessary that electric traction may be employed under economical conditions is for:	On the Kempten-Munich-Rosenheim: price per ton of coal, $5.93; price per kilowatt-hour $.0024 to $.0048. Kilowatt-hours.	On the Nuremberg-Bamberg zone, price per ton of coal, $5.19; price per kilowatt-hour $.0048 to $.0066. Kilowatt-hours.
Double line main lines.	233 to 322	394 to 764
Single line main lines.	129 to 169	209 to 370
Local trains	64 to 74	86 to 105

TABLE 4.

In a second part comprising the two last chapters, the report shows in chapter IV the costs of electric and steam traction on those lines likely to be electrified in the near future.

Let us consider the following lines: Salsbourg-Bad-Reichenhall-Berchtergaden (25.2 miles), Garmisch-Partenkirchen-Scharnitz (15.2 miles), Garmisch-Partenkirchen-Griesen (9.3 miles), Munich-Garmisch-Partenkirchen and branch lines (90 miles), Munich-Gauting (11.7 miles), Munich-Bad Tölz-Schliersee-Holzkirchen-Rosenheim (74.4 miles).

As an example we reproduce in the table following the detail of expenditures for the lines of 90 miles: Munich-Garmisch-Partenkirchen and including the branch lines toward Kochel, Penzberg and Peissenberg.

Traffic on which the expenditures are based: 691,504 train miles.
113,311,732 ton miles.

I.—*Initial outlay for the first installation for electrification (without generating stations).*

Locomotives	$ 536,500
Overhead running line 10,000 volts, comprising 20.5 miles of double line, 58.4 miles of single line and 36.7 miles of line in stations..........................	645,000
Transmission line from central generating stations to substations (50,000 volts), comprising 49.7 miles of wire 236,820 circular mils cross section and 10.6 miles of wire 69,070 circular mils cross section..........	130,400
Displacement of telephones, telegraphs and other lines	79,100
Transformer stations (Pasing, Murnau and Kochel)..	51,100
Total	$1,442,100

II.—*Consumption of electrical energy in kilowatt hours.*

	Kilowatt Hours.
Traction	7,166,400
Shunting	139,200
Air for the brakes	61,100
Train lighting	42,900
Train heating	477,000
Loss in the transmission and running lines	591,500
Total (in round figures)	8,500,000

III.—*Total expenses for electric traction (without cost of power)*

Train staff	$ 24,600
Materials	1,560
Maintenance of locomotives	27,400
Sinking fund for locomotives	4,430
Renewal of locomotives	12,920
Interest on capital of locomotives	21,500
Interest, sinking fund and renewal of the electric line equipment	51,650
Total	$144,060

IV.—*Total expenses for steam traction.*

Train staff	$ 44,200
Materials	99,650
Maintenance of locomotives	23,450
Sinking fund for locomotives	6,970
Renewal of locomotives	8,990
Interest on capital of locomotives	14,960
Total	$198,220

V.—*Conclusions.*

Total expenses for steam traction	$198,220
Total expenses for electric traction	144,060
Difference applicable to cost of power	54,160
Annual consumption of kilowatts	8,500,000

Maximum cost price of energy at generating station at which it will pay to electrify:

$$\frac{\$54{,}160}{8{,}500{,}000} = \$.0063$$

In conclusion the report which relates to the electrification of the Bavarian State Railways says:

1. From the technical point of view, electric traction is possible either by using motor cars or heavy locomotives.

2. In the present state of the art, single phase alternating current is best suited to the requirements of working main line railways.

3. The advantages of electric traction are possible increase of speed, and the abolition of smoke.

4. The water power resources of Bavaria are ample to furnish the necessary electrical energy, but military and economic reasons may retard the substitution.

5. The question has not yet been settled from the military standpoint. But the military authorities have given their consent to the electrification of certain lines of secondary military importance.

6. From the financial standpoint, electric traction can compete successfully with steam traction.

a) When the cost price per kilowatt hour does not exceed a certain limit.

b) When a given traffic density exists.

These desiderata are obtained more especially on the lines of southern Bavaria, because coal is more expensive than in the north, and electrical energy is cheaper because of the proximity of water power.

7. With the existing traffic, electrification will give satisfactory financial results on the lines Salzbourg-Bad-Reichenhall-Bertesgarden, Garmisch-Partenkirchen-Scharnitz and Garmisch-Partenkirchen-Griesen.

8. Electric working becomes the more advantageous the greater the increase in the price of coal; and the coal mines of the world are not inexhaustible.

9. Two conditions are therefore to be considered in the electrification of the whole system suggested by the first experimental lines:

a) Electrification of those lines where the financial results will be of advantage.

b) Electrification of those other lines on which electric traction can only be a question of *the distant future.*

Locomotives for the Chicago Great Western R. R.

The Baldwin Locmotive Works have recently completed 24 locomotives for the Chicago Great Western Ry. Four of these engines are of the ten-wheel type for express passenger service, while the remaining twenty are of the consolidation type for heavy freight service. Both designs follow the Associated Lines standards in many respects, although important changes have been made in various details.

The passenger locomotives are of special interest, in that they are equipped with the Emerson type of fire-tube superheater. This device was first used on the Great Northern Ry., and the results so far on that road, have been satisfactory. In the Emerson type, the smoke-box headers approximate the usual steam pipes in form. Each header is divided into two compartments, one for saturated, and the other for superheated steam. The large boiler tubes which accommodate the superheater elements, are placed immediately back of their corresponding headers, instead of being grouped in the upper part of the boiler barrel, as is usually the case with fire-tube superheaters. In the engines now under notice, the headers are straight, and stand vertically. The superheater elements on each side are placed in 12 tubes, arranged in two vertical rows of six tubes each. The superheated steam section of the header is centrally located between the two arms of the saturated steam section, the latter being divided at the top. At the lower end, the superheated steam sections are connected by a transverse equalizing pipe. The superheater elements are composed of steel tubes having an internal diameter of 1 inch. These tubes are expanded into the headers and are arranged with a double loop in each large boiler tube. The loops are connected by cast steel return bends. A plug is screwed into the front of the header opposite each tube opening. Application has been made for a patent covering this design of superheater.

The smokebox contains a single high nozzle, and the stack is tapered, with a minimum internal diameter of 20 inches. An adjustable petticoat pipe extends downward from the stack base, and an adjustable diaphragm plate is located in front of the nozzle.

The boiler of this locomotive is straight topped with a wide fire-box. The mud ring is 5 inches in width all around, so that liberal water spaces are provided. The crown is flat, and is stayed by T-bars hung on expansion links. The longitudinal barrel seams are butt-jointed, with "diamond" welt strips.

The safety valves are set at 150 pounds, and with cylinders 26x28 inches and driving wheels 73 inches in diameter,

New Pacific Equipped with Superheater, C. G. W. R. R.

the resulting tractive force developed is 33,000 pounds. The cylinders are equipped with 13-inch piston valves, having cast iron bodies and three snap rings in each end. The cylinder castings are built with heavy walls, and are secured to the smoke-box and to each other by a double row of bolts. The by-pass valves are similar to the well-known Pennsylvania R. R. design, which has been extensively used by the builders. In the present instance the relief ports are covered by a flat plate of cast steel, made in one piece with a central spindle which acts as a guide.

The valve motion is of the Walschaerts type, and presents a simple arrangement of this form of gear. The link is mounted in a specially designed steel casting, which also serves as a support for the reverse shaft bearings. This casting is bolted at the front, to the guide yoke, and at the back to a crosstie located between the first and second pairs of driving wheels. The combining lever is pinned directly to the valve rod, and the latter is supported by a suitable bracket mounted on the upper guide bar. The frame construction and arrangement of the spring rigging call for no special comment.

The consolidation type locomotives use saturated steam at a pressure of 200 pounds. With 24x30-inch cylinders, and driving wheels 63 inches in diameter, the resulting tractive force is 46,600 pounds. The weight available for adhesion is thus utilized to the best possible advantage.

The steam distribution in these locomotives is controlled by balanced slide valves. The cylinders are arranged with their center lines coincident with the steam chest centers. Each combining lever is pinned to a long crosshead sliding in two brackets which are bolted to the top guide bar. This crosshead carries a lug to which the valve rod is secured. In this way the motion is transferred from the plane of the link to that of the steam chest center, without the use of a rocker.

The boilers of these engines are straight topped, with crown-bar staying, and as far as construction is concerned, they follow Associated Lines practice closely. The design of the frames and running gear presents no unusual features. The tenders of both classes are similar, and are mounted on arch-bar trucks having steel bolsters and "Standard" rolled steel wheels. The longitudinal sills are composed of 12-inch steel channels.

The tables contain the principal dimensions of both classes of locomotives.

Ten-Wheel Type.

Gauge	4 ft. 8½ in.
Cylinder	26 in. x 28 in.
Valve	Balanced Piston

Boiler.

Type	Straight
Material	Steel
Diameter	70 in.
Thickness of sheets	11/16 in.
Working Pressure	150 lbs.
Fuel	Soft coal
Staying	Crown bar

Fire Box.

Material	Steel
Length	107 15/16 in.
Width	66⅛ in.

New Consolidation, C. G. W. R. R.

Depth, front	67½ in.
Depth, back	49 in.
Thickness of sheets, sides	5/16 in.
Thickness of sheets, back	5/16 in.
Thickness of sheets, crown	⅜ in.
Thickness of sheets, tube	⅝ in.

Water Space.

Front	5 in.
Sides	5 in.
Back	5 in.

Tubes.

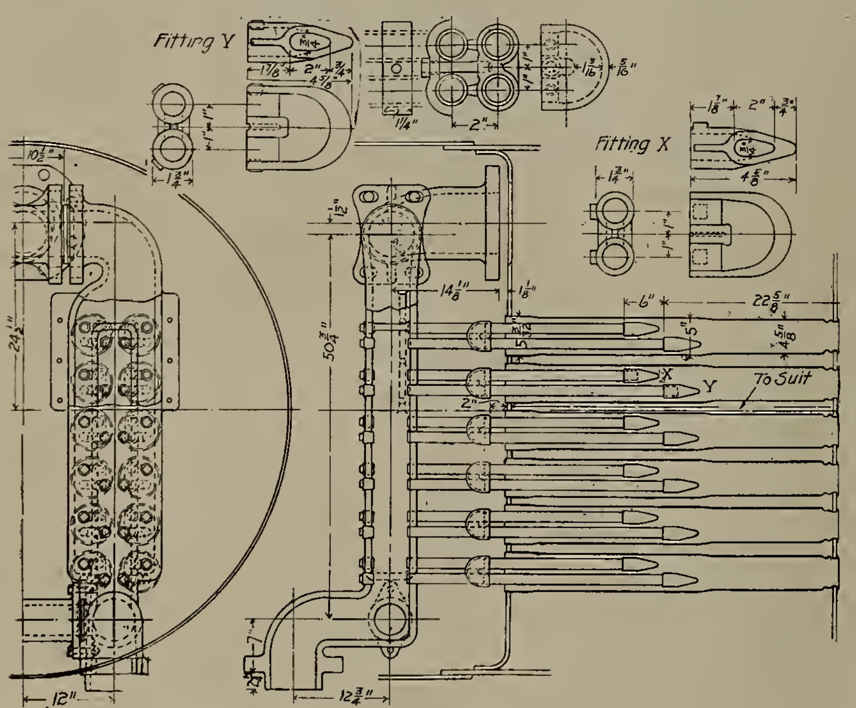
Material	Steel
Wire gauge	5 in., No. 9; 2 in., No. 11
Number	5 in., 24; 2 in., 203
Diameter	5 in. and 2 in.
Length	16 ft. 0 in.

Heating Surface.

Fire box	149 sq. ft.
Tubes	2206 sq. ft.
Total	2355 sq. ft.
Grate Area	49.5 sq. ft.

Driving Wheels.

Diameter, outside	73 ft.
Diameter, center	66 in.
Journals, main	10½ in. x 12 in.
Journals, others	9 in. x. 12 in.



Emerson Superheater Applied to Chicago Great Western Locomotive.

Engine Truck Wheels.

Diameter, Front	33½ in.
Journals	6 in. x 10 in.

Wheel Base.

Driving	15 ft. 3 in.
Rigid	15 ft. 3 in.
Total Engine	27 ft. 1 in.
Total Engine and Tender	57 ft. 9½ in.

Weight.

On Driv. Wheels	144,950 lbs.
On Truck, front	53,100 lbs.
Total Engine	198,050 lbs.
Total engine and tender, about	343,000 lbs.

Tender.

Wheels, Number	8
Wheels, Diameter	36 in.
Journals	5½ in. x 10 in.
Tank capacity	8,000 gals.
Fuel capacity	11 tons.
Service	Passenger

Engine equipped with Emerson Superheater. Superheating Surface, 460 sq. ft.

Consolidation Type.

Gauge	4 in. 8½ in.
Cylinder	24 in. x. 30 in.
Valve	Balanced

Boiler.

Type	Straight
Material	Steel
Diameter	80 in.
Thickness of sheets	¾ in.
Working Pressure	200 lbs.
Fuel	Soft coal
Staying	Crown bar

Fire Box.

Material	Steel
Length	108 1/16 in.
Width	66⅛ in.
Depth, front	74 in.
Depth, back	63¾ in.
Thickness of sheets, sides	5/16 in.
Thickness of sheets, back	5/16 in.
Thickness of sheets, crown	⅜ in.
Thickness of sheets, tube	½ in.

Water Space.

Front	5 in.
Sides	5 in.
Back	5 in.

Tubes.

Material	Steel
Wire gauge	No. 11
Number	413
Diameter	2 in.
Length	16 ft. 4 in.

Heating Surface.

Fire box	171 sq. ft.
Tubes	3514 sq. ft.
Total	3685 sq. ft.
Grate Area	49.6 sq. ft.

Driving Wheels.

Diameter, outside	63 in.
Diameter, center	56 in.
Journals, main	10½ in. x 12 in.
Journals, others	9 in. x 12 in.

Engine Truck Wheels.

Diameter, Front	33 in.
Journals	6 in. x. 10 in.

Wheel Base.

Driving	17 ft. 0 in.
Rigid	17 ft. 0 in.
Total Engine	25 ft. 8 in.
Total engine and tender	58 ft. 6 in.

Weight (estimated.)

On Driv. Wheels	187,000 lbs.
On Truck, front	29,000 lbs.
Total Engine	216,000 lbs.
Total engine and tender, about	360,000 lbs.

Tender.

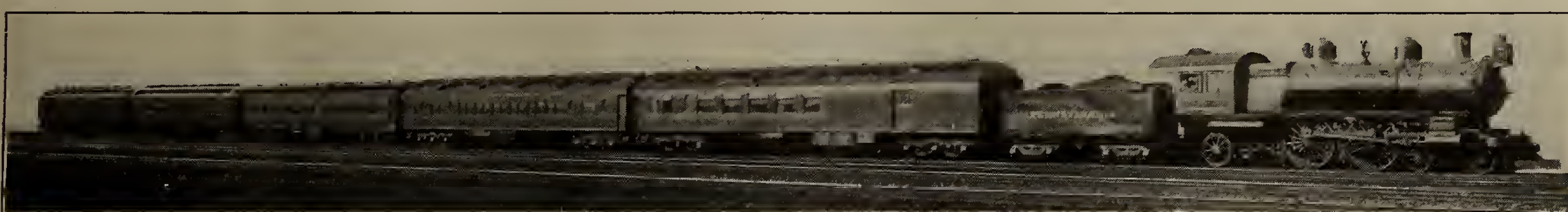
Wheels, Number	8
Wheels, Diameter	33 ins.
Journals	5½ in. x 10 in.
Fuel	11 tons
Service	Freight

Solid Steel Passenger Train, Penn. R. R.

What is probably the largest steel passenger car equipment owned by any railroad in the world is that of the Pennsylvania Railroad, which, with the cars just completed and those in course of construction, has 630 all-steel passenger cars. With this large number of steel cars, the Pennsylvania Railroad is now to start the operation of all-steel passenger trains on some of its lines of densest traffic. On August 12, 1906, the Pennsylvania Railroad announced that all future passenger equipment would be built of steel. In planning the cars and establishing the standards, which are now copied in all Pennsylvania passenger cars, no expense has been spared by the company to build a coach which should provide the greatest possible strength, a steel framing which could not be affected by fire, an inside lining which should be absolutely unburnable, and, at the same time, one that would not conduct heat or sound.

The Pennsylvania Railroad in November, 1906, ordered 100 all-steel passenger cars. Since that time additional orders have been placed and there are now in service on the company's lines 245 coaches, 10 dining cars, 21 combination passenger and baggage cars, 29 baggage cars, 18 postal cars, and one company car; a total of 324 cars. In course of construction there are 140 coaches, 34 dining cars, 48 combination passenger and baggage cars, 4 baggage cars, 42 postal cars, 27 mail storage cars, and 11 baggage and mail cars.

The Pullman Co., at the instance of the Pennsylvania Railroad, has for the past four years been at work designing all-steel parlor and sleeping cars. Some 500 such cars are shortly to be completed and placed in service. With the all-steel passenger equipment now in service or on order, and some all-steel cars to be ordered on the 1910 passenger equipment program, the Pennsylvania Railroad will in a short time have in service about 900 of its own steel passenger cars and steel Pullman cars.



First Solid Steel Passenger Train, P. R. R.

Executive Committee Meeting, C. J. C. I. & C. F. Assn.

The executive committee of the Chief Joint Car Inspectors' and Car Foremen's Association met at the Congress Hotel, Chicago, February 18, for the purpose of recommending a revision of the M. C. B. rules. Those present were the following: H. Boutet, Cincinnati, Ohio; F. C. Schultz, Chicago, Ill.; A. Berg, Erie, Pa.; W. J. Stoll, Toledo, O.; C. S. Shearman, Chicago, Ill.; J. Constant, Chicago, Ill.; M. F. Covert, Chicago, Ill.; L. F. Wilson, editor Railway Master Mechanic, Chicago, Ill.; F. W. Trapnell, Kansas City, Mo.; Edw. Pendleton, Alton, Ill.; P. A. Martin, Chicago, Ill.; F. M. Lucore, Chicago, Ill.; T. J. O'Donnell, Buffalo, N. Y.; W. R. McMunn, Albany, N. Y.; H. LaRue, Chicago, Ill.

The meeting was called to order by President Boutet, in absence of chairman, and in the absence of the secretary, S. Skidmore, Wm. R. McMunn acted as secretary.

The recommendations resultant are as follows:

Preface.

These rules make car owners responsible for, and therefore chargeable with, the repairs to their cars necessitated by ordinary wear and tear in fair service, so that defect cards will not be required for any defects thus arising. Railways handling cars are responsible for damage done to any car by unfair usage, derailment, or accident, and for improper repairs made by them, and they must make proper repairs at their own expense, or issue defect card covering all such damage or improper repairs. All inspection of freight cars for interchange will be made in accordance with the following rules:

Rule 1. Each railway company shall give to foreign cars while on its line, the same care as to oiling, packing, inspection, and adjusting brakes, that it gives to its own cars.

Rule 2. No car must be offered in interchange unless safety appliances are in good serviceable condition and car is safe to go to the receiving line's repair or transfer track.

Rule 3. Loaded cars must be accepted in interchange, if safe to go to the repair or transfer track of the receiving line. Receiving line to run, repair or transfer. If repairs are made and chargeable to owners, they will so charge; if the defects are such the delivering line is responsible, a defect card shall be given against the delivering line; if transfer is necessary the receiving line will transfer at its own expense.

(This rule was adopted with an amendment by Mr. Trapnell as follows: "Loaded cars must be accepted in interchange. Receiving line to run repair or transfer, and if repairs are made and are chargeable to owners, so charge. If defects occur, for which the delivering company is responsible, a defect card shall be given against the delivering line.")

Rule 4.. Empty cars must be accepted in interchange, if they do not require more than ten hours' labor of two men to put them in condition to load. Repairs to be charged to owners, if owners' defects; defect cards to be given if the defects are chargeable to the delivering line. In case empty cars are rejected by the receiving road and returned to the delivering company, all the defects objected to must be designated on a r-turn card 3½ by 8 ins. of the following form, filled in with ink or black indelible pencil, and placed on the car adjacent to the destination card.

Rule 6. Defect cards shall not be required for defects for which owners are responsible, neither shall they be required for improper repairs that are not made by the delivering line, except wooden brake beams in place of metal brake beams, and car is so stencilled "stem in place of pocket coupler."

Rule 7. If a car has defects for which the owners are not responsible, but do not render it unsafe to run, nor unsafe to trainmen, nor to any lading suitable to the car, the receiving road may require that a defect card be securely attached to the car with four tacks, preferably on the outside face of intermediate sill, between cross-tie timbers, on wooden cars; and on steel cars to cardboard located on cross-tie under car on inside of side sill at the end of car.

Rule 8. Duplicate defect cards shall be furnished for lost or illegible cards.

Defects for Which the Delivering Line is Responsible.

Rule 9. Flat siding; if the spot caused by sliding is 2½ ins. or over in length. (Care should be taken to distinguish this defect from worn through chill.)

Rule 10. Cars stenciled steel wheels and found with cast wheels.

Rule 11. Cut journals, axle bent or axles rendered unsafe by unfair usage, derailment or accident.

Rule 12. Damage of any kind to either body or trucks, due to unfair usage, derailment or accident.

Rule 13. For missing brake beams, levers, connections and brake levers when missing with brake beams on same end of car.

Rule 14. Missing steam and air signal pipe and hose, provided the car is stenciled that it is so equipped.

Rule 15. Cars equipped with new air brake hose other than 1⅜ ins. M. C. B. standard. Except cars offered in interchange where delivering line is responsible.

NOTE: Cars equipped with 1¼ in. M. C. B. standard hose, and so branded, applied prior to September 1, 1909, will be accepted in interchange.

NOTE: A fac-simile of the badge plate to be incorporated in the rules for the guidance of the inspectors, and the figures designating the size of the hose on the badge plate be increased to ¼ or 5-16 ins.

Rule 16. Missing brake hose, angle cock, cut-out cock, retaining valve, release valve, triple valve, cylinder, reservoir, air pipe or any parts of these items.

Rule 17. All freight cars offered in interchange must be equipped with air brakes.

Rule. 18. Temporary advertisements, tacked, glued, pasted or varnished on cars.

Combination of Defects for Which the Delivering Line is Responsible. If Occuring at the Safe End of Car.

Rule 19. Damage to end sill and three longitudinal sills.

Rule 20. Damage to four or more longitudinal sills.

(It was moved and seconded that rules 19 and 20 be reconsidered. Mr. Schutz moved that rule 19 be changed to read: "Damage to and replacing or splicing of three or more longitudinal sills." The motion was carried.)

Shop Kinks, C. & N. W. Ry.

In the accompanying sketches are shown a few devices in use at the Chicago shops of the Chicago & North-Western Railway. Figure 1 shows an appliance consisting of a cylindrical piece of old boiler plate around the upper edge of which are secured a number of swinging arms, each bearing a carrier. The apparatus is used on the stripping pits, being picked up by the crane and dropped over the steam dome. Air motors balanced by counterweights are suspended from the carriers and the task of the men working below is made lighter and time is saved. The sketch shows but one arm and carrier, whereas a number are commonly used.

Figure 2 is a plate for drilling packing rings. Three rings are laid on each of the four arms or extensions shown and the points to be drilled are laid under the angle or Z iron shown at the corner; in the top of which it will be noted there are two holes for guiding the drills. The cylinder shown at the center is connected to the shop air line and upon turning on the air pressure a tapering piston causes four arms to move outward and hold the rings securely in place. It will be noted that this also causes a tapering piece at the end of each arm to engage under the angle iron and thus the rings are pressed downward as well as outward.

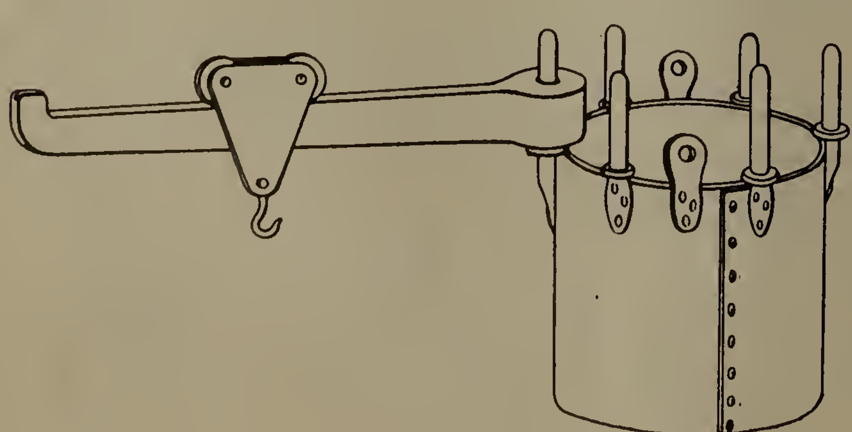


Fig. 1.

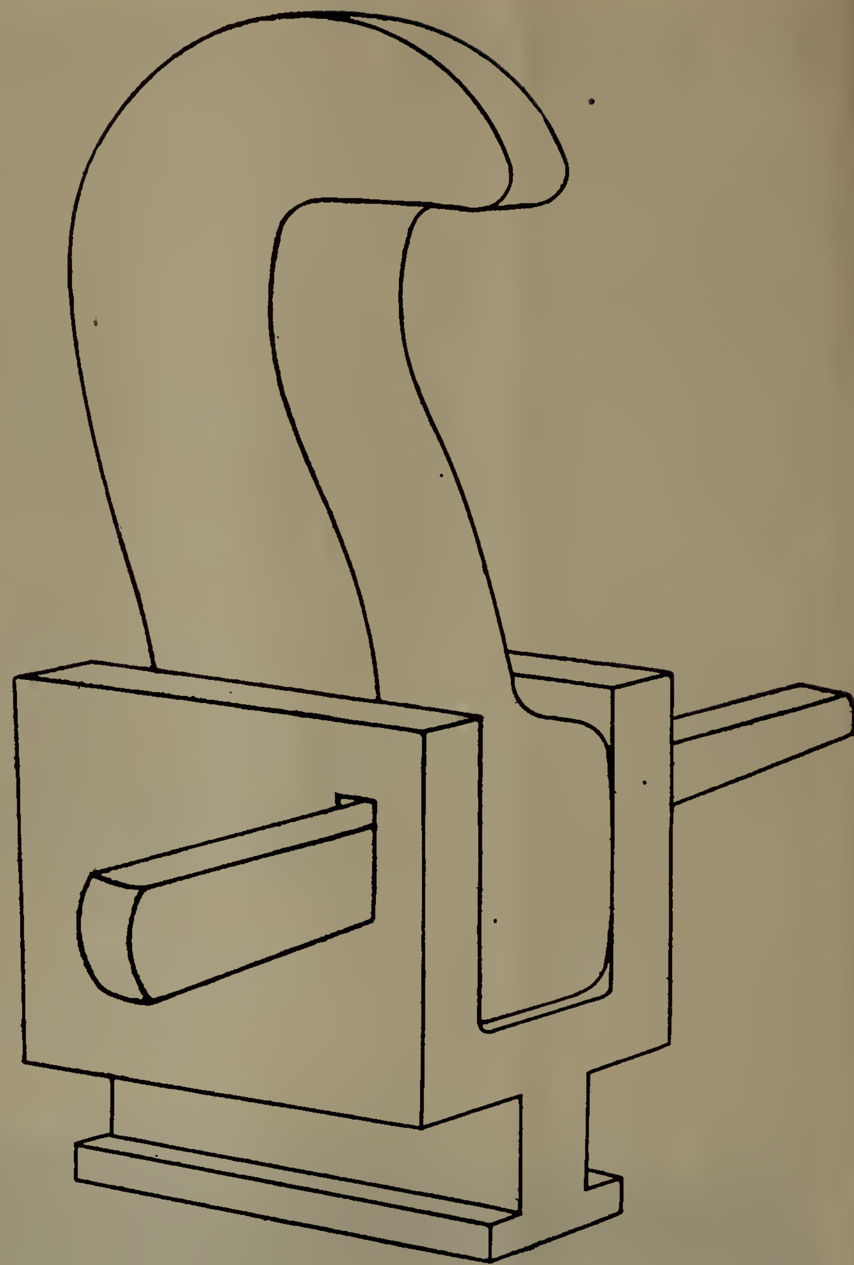


Fig. 3.

Figure 3 is a clamp for tires which is made to fit the T slots of a boring mill. A tapering pin serves to draw the tire firmly down into place.

Figure 4 is a clamp for holding pins while they are being drilled. The pin is laid in the V block shown and by admitting air to the small cylinder at the right the lever is pressed down on the pin, and as the pressure on the shop air line is 90 pounds it will be seen that the pin is firmly held in place. A spring at the top of the air piston and a three-way cock quickly relieve the pressure.

Hack-Saw Hints

Keep separate frames for brasswork and iron-work; a blade that has been used on iron and steel is quickly spoiled for brass, just as in the case of files, and by keeping a blade only for brass the latter can be sawn much more quickly.

Do not start a cut on the sharp corner of a piece of work, or the teeth will be broken off; always make a nick with a file so that the blade can commence smoothly.

Do not saw narrow work with the blade moving across at right angles, because the teeth catch in the edges and break. The frame should be tilted to increase the length of cut.

Never cut thin tubing with a coarse-toothed blade; the teeth hitch and snap off when breaking through. A finely toothed blade is the proper one to use, with 22 to 24 teeth to the inch.

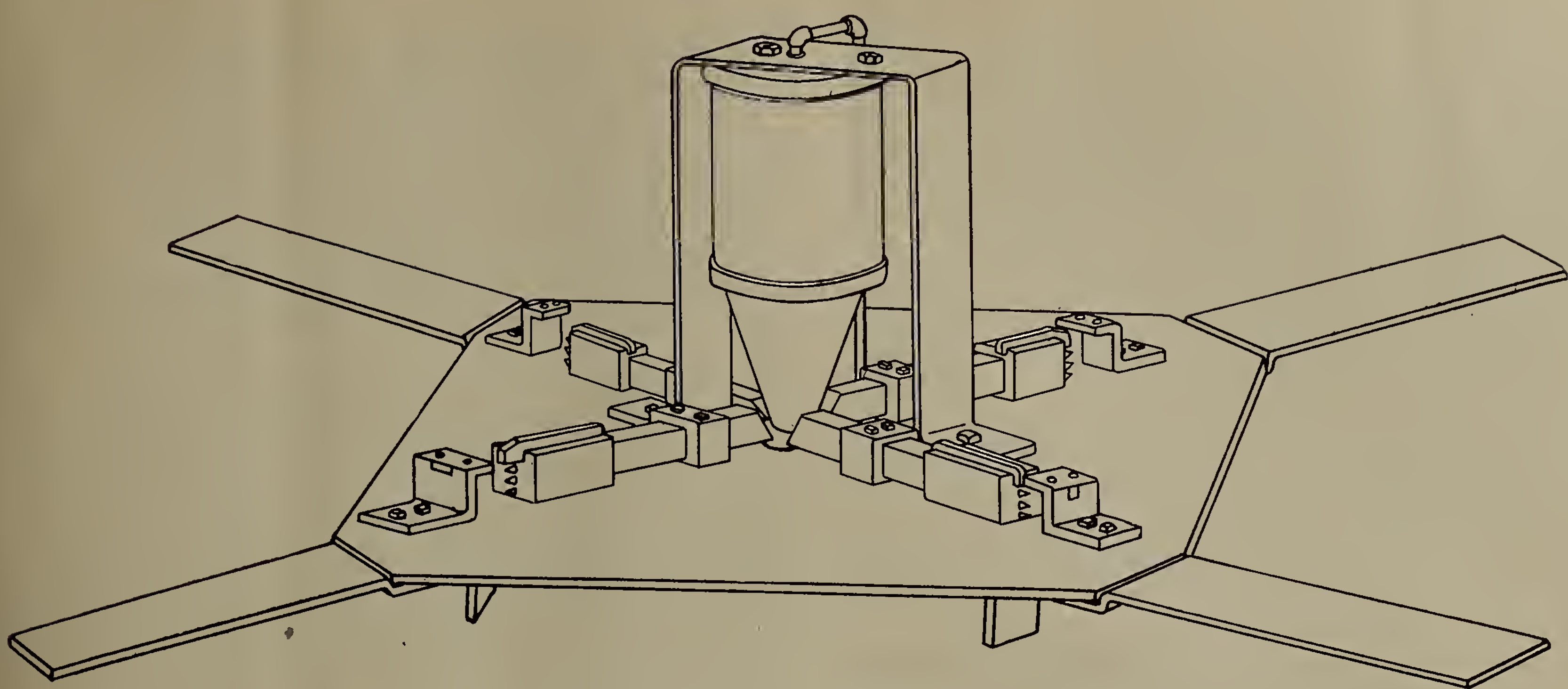


Fig. 2.

Blades for ordinary sawing have 14 to 16 teeth to the inch.

Relieve the pressure on the back stroke, just as with a file, to save the teeth.

Be more careful with a new blade, as the teeth are more liable to rip out than when slightly worn.

Do not hold the frame stiffly, but allow flexibility to the wrist, so that the blade will not be strained, or catch in the work, which often results in a crack.

If two or three teeth should break out of a new blade, it is a good plan to grind them right out, on the periphery of an emery wheel. The risk of the other teeth breaking will thereby be lessened.

A worn blade is excellent for very thin tubing, as the teeth do not tend to hitch so badly as sharp new ones.

A broken blade can be united with a thin strip on one or on both sides, rivets being inserted and lightly hammered over. The ends of the blade must be softened in the gas flame to allow of the necessary holes being drilled. Another way is to tie the broken ends with wire passed through the holes and twisted together. This may also be done in an emergency when a blade too short for the frame has to be used; the wire reaches from the end of the blade to the attaching pin.

Keep the blade strained up well in the frame; if slack it buckles easily, and may crack.

If a slot of extra width is required, it is often possible to use two blades laid side by side to make up the width.

When a cut has to be very accurate, the start should always be made with a file, and in addition the blade should be guided by the finger or thumb laid against it.

In buying a saw frame, it is preferable to choose an adjustable one, not only because various lengths of saws can be used, but because broken blades can be used up by making a fresh holes in the end.—Mechanical World.

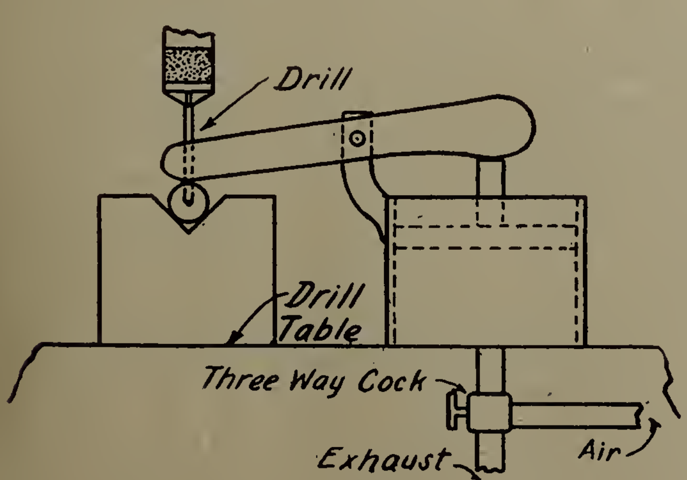


Fig. 4.

The Assembly of Draft Gear

East St. Louis, Ills., Feb. 2, 1910.

Editor Railway Master Mechanic: I desire to compliment you on the January issue of the Master Mechanic, as the information contained therein relative to the Farlow, McCord, Gould and Westinghouse draft rigging is of great benefit to all car men reading your journal. It is instructive in applying or repairing parts of the above named draft gears, and also in ordering them, and if the names of the different parts had been inserted it would have been still better. Hoping other owners of friction draft gears will follow suit and show their draft gear parts in a like manner in the near future, and assuring you that the January issue of the Railway Master Mechanic will always have a prominent place on my desk, I beg to remain,

J. J. Devaney, Foreman Car Dept.,
Term. R. R. Ass'n of St. Louis.

The Electrolysis of Metals

By Chas. E. Koons.

The new electrolysis theory is an added destructive force to the already overloaded destroying power that are supposed to be mostly responsible for the destruction of iron and steel. Sunlight, rain, moisture and air have been doing their share of the deterioration of protectives of iron and steel; now we have discovered this new enemy which works through the air and in currents through the earth, in moisture and the many substances that the earth is composed of and the metals that are placed there through piping, etc., and have become vital to all metallic structures, especially to water and sewer mains, gas piping, and in this same sense all iron and steel encased and buried in concrete. In many cases the theories and the practical evidence coincide with one another, but for the whys and wherefore there is great confusion, and utter chaos as to the reasons.

The student of the electrical forces theorize from the standpoint of evident wear from the action of the currents to and fro through certain metals, while the practical man sees the actual thing and cannot account for it, but considers it a mystery far beyond his heretofore knowledge of protecting iron with paints. This matter has kept him busy with outer coatings to keep up with the demands of the times, and now when an unhidden inner force has to be guarded against as well, he is practically speaking, "up against it." This might apply to the paint maker as well. The protection of iron and steel is a subject that is ever interesting to all manufacturers of iron and steel paints, and it is well that we give it serious thought in view of the late new ideas that have been brought out.

Quoting Dr. Allenton S. Cushman, "The vast importance of the matter is obvious now that the world has taken to constructing its buildings not of stone, or brick, but of iron, and so far as we know this material is constantly at war with nature, who is endeavoring ceaselessly to reduce it again to its original condition as found in the earth, and if nature should succeed, all our fine buildings of steel and concrete will crumble to dust, perhaps suddenly and with awful catastrophe."

Dr. Cushman has invented or rather promulgated the electric theory of rust, called electrolysis. The corrosion of all metal he says is due more or less to electro-chemical action. Electrolytic action takes place in and on the surface of the iron and causes rapid corrosion at the positive nodes, and the chemical character of the film of preservatives and its electrical effect upon iron were of the greatest importance. Yet few, if any, of the vast array of practical men in steel construction doubtless have ever given it a passing thought. Architects, engineers and builders in general have been too careless in their specifications regarding proper paint to meet such a destroying force. Also in allowing iron and steel to be cased in with cement without even any kind of paint to protect it.

The very thing that should have the very best of protection on account of being covered up, never to be seen again, is considered good enough, on the theory that what is hidden from the wear of the outside elements is free from corrosion; according to the electrolysis theory. There never was a greater mistake, as has been proven time and time again through the repairs of recently built buildings.

Paint manufacturers are then forced to the fact of the peculiar needs of iron protectives as against wood protectives. This new idea has developed, principally through the government chemists, and has evidently put a new phase on the iron and steel protective paint problem. The question heretofore has always been, how could we protect iron and steel surfaces from corrosion by outside coatings? This fact has not been eliminated, however, by the electrolysis idea. It takes good oil and the proper pigment to do the work as yet, but is it not possible that electricity through the electric current has ever been a destroying force from the inside out, which has evidently never been seriously considered by paint makers before? The facts are electricity is a destructive power; that all iron and steel are natural magnets that are continually drawing electricity from the elements, and more especially during electric storms than at any other time, and the numerous tests that have been made by experts and also by the government chemists have proven along with the above facts that there are also inhibitive paint pigments that are non-conductors of electricity, and also more absorbent of moisture than the non-conductors, which would make them naturally encouragers of rust.

With these facts well known, there is this indication about the corrosion of iron and steel that has always been a mystery, and it shows itself most always in spots, going to prove that there are weak places here and there all over an iron surface that are more susceptible of decay than the general run of the iron. It may be that electricity attacks these soft places and destroys the iron quicker than the harder and more firmer iron, which is less porous, and there is no doubt but what moisture from the outside would show quicker deterioration of the paint on these soft places than it would on hard iron.

Then it is reasonable to suppose that the quality of iron has a great deal to do with its resistance to corrosion. Soft fibred and open poroused quality iron has not the durability or strength that hard iron will show, and it is quite natural to think that it would not have the same resistance to the elements, and especially to electricity and the best paint that can be procured will not protect it if it has not the quality in it in the first place. It would well compare with unseasoned and rotten lumber in this respect.

The office of paint is to preserve and protect against decay in both iron and wood, but if the destruction is once started, paint will not check it unless the rottenness is thoroughly eliminated; rust is nothing more than rotten iron, brought to that state by moisture and possibly encouraged by electricity. The moisture absorbing and electric conducting pigments acting as the opposite pole to the electric current, one being the positive and the other the negative force that draws toward one another, causing a destructive agency, that would only be eliminated by a property that was inhibitive. In other words if the coating next to the steel was of such a nature as to check the force of the electric current, the moisture also being overcome by non-absorbing mediums mixed with non-conducting pigments the question of the rust problem would be solved and the steel would remain protected as long as it was kept properly painted with non-absorbing and non-conducting paints.

If the theory of this destructive force is true the matter is quite a serious one, and is doubly greater today than it was yesterday, not only on account of improper care in painting, but in the increase in impure air, which is more detrimental to paint coating on the outside than any other property of building material. It is greater at this time than it was a decade ago, and is getting worse all the time.

Sulphur smoke in cities and along railroads are forever increasing, and being constantly infused with moisture makes an air that is destructive, almost as bad as sulphuric acid, in fact, it is sometimes worse than the acid, because it has properties that settle upon the earth here, there and everywhere, that are saturated with sulphur ingredients that makes it like a spongy coat, that causes a disintegrating, coloring mass that shows for itself in discoloring and tarnishing the color, and destroys the life of the paint as well as the color.

Electricity as the heretofore unknown enemy destroys almost every known substance, even the impure air around and about us. There is nothing exempt when it strikes with full force on the outside. If this same force in a milder form is constantly being drawn through the iron and steel there must be some energy and action on the first outside paint covering, although slow perhaps, but sufficient to start decomposition, especially when encouraged by a moisture absorbing, conducting property. The only check would be a non-conducting medium and pigment that would act as an inhibitive to this force, so as to seal it from working through; the question then would be to apply enough of the proper coatings on the outside to make it non-conducting moisture proofing coat, and this should be replenished from time to time before the outer coating becomes lifeless.

If the above theory is true the question would naturally be asked what becomes of the electric force that is constantly playing through the steel, and the force of which is checked and baffed? The same answer would apply; what becomes of the electric power that permeates the air around and all about us, that is taken up and utilized for good in some instances and flashes and destroys in others. The answer is, it would be passed along harmlessly, losing its force here and there, when checked. In proof of the possible correctness of this theory I wish to submit the following facts that have come under my own observation through watching and experimenting with paint formulas on iron and steel.

I have always noticed that rust first shows itself through little pin points pressing out through the paint covering, and not always because there was not enough paint to cover it, but many times because there was some action underneath eating and boring its way through, these little specks at first are not broken, but when punctured would invariably show all around underneath, the signs of decomposition. The corrosive force seemingly came from the inside, and many times would show a little raise on the paint surface before it would break through. It has also been known for a great many years that vessels that have been liberally coated with paint on the outside, where the numerous coats of paint have increased to an ⅛ of an inch in thickness have shown rust under all this mass of paint. Where did it come from? It may have been covered over at the start by some careless workman in applying the first coat, and kept on feeding upon the steel ever afterwards, but even that, it must have had some energizing force to help it to do its work. It is well known that rust when started will keep on, why could not electricity be the hidden agent that encouraged it? This illustration does not prove that there is no help or cure for even this evil; but that through the careless way of painting iron or steel the rust seeds are covered over, and numerous paint coats will never remedy the deviltry, only prolong it.

The old theory of allowing some metals to be exposed for weeks before apply a proper covering in the form of paint, to eliminate acids, etc., is a wrong one entirely; acids are easier to overcome than rust when it has once started. Acids can be absolved by paint mediums, but when peroxide of iron, which is decomposed iron is covered over, it is only hiding it for the time being, and it will surely eat through the paint surface in time; energized by the electric force through the iron and encouraged by the moisture on the outside. If this theory is true, and I don't doubt it, it is plainly seen that the question of a protection for iron and steel has a double destroying force to combat; the first or inside coat, and the outside finishing coat; having two different disintegrating powers wearing upon them.

This is entirely different from a wood surface; although paint is made and sold to be used on both alike. Without any question regarding the possibility of other forces playing upon metals, that have no power on wood. The two surfaces are entirely different. While we expect the oils and mediums to penetrate the wood pores in order to make a durable and lasting paint, we cannot expect the same thing on an iron surface to any extent; but rather the oil and pigment together being worked into the iron surface forming a filling property that gradually through several coatings gives the protection. The wood surface that has been properly primed holds the pigment to it, while the iron surface does not allow very much penetration of the oil, but is dependent upon the surface being well cemented by both oil and pigment for a lasting protection.

This question becomes more serious and certainly more interesting the farther along we get with it. Whether the electrolysis theory is true or not, it stands to reason that it will bear investigation, and will be finally settled through a great deal of experiments and research by painters and chemists; and even now there are many practical minds agitated over the fact that they have been working along in the dark without any knowledge of the heretofore rust promoter. If, in the past, manufacturers have been using pigments that are detrimental and which have been encouraging corrosion, you may depend upon it that there will be a general turning over of paint formulas, to see whether they carry inhibitive properties or stimulating pigment.

Pigments that have always been considered the best for high class paints in the past are scaled very low in the list for proper steel and iron protectives: This does not set them aside as not being alright for metal protectives as yet; but for metal there must be an electrical scrutiny and division. What has made good paints for all other purposes have practically fallen down for iron and steel.

It is said that the Eiffel tower in France has been painted with the best paints that could be produced, yet the atmospheric electricity received every hour by such an unprecedented mass of iron is incalculable, and the effect on the paint is mysterious. It does not crack and peel off, but it is naturally burnt away by the electric power. It simply disappears in this high altitude, going to prove that the higher up in the air, the greater the power of the electric currents to destroy. On the other hand the electric currents that are constantly passing in close proximity to iron piping laid under the ground is subject to the same destroyer even worse on account of the moisture to that extent that the iron is destroyed as well as the protective paints. There is one place in this city (St. Louis) where the electric force is so strong that pipes are destroyed in three to four months. These are facts that have kept the city pipe men guessing. They can't account for it.

Radical Development in Methods of Obtaining Fuel Combustion in Locomotives

During the last few weeks a locomotive has been operating within the city limits of Chicago, which embodies in its combustion apparatus a principle entirely new in the field of locomotive practice. The locomotive which is being used for purposes of demonstration is a small one of the American type. The fire box is fitted with a magazine which serves practically as a coking furnace. The gases are combined with air and burned together with the coked coal in an incandescent flame.

The inventor is F. J. Doyle of the Globe Heat-Power Co., Chicago. A more detailed description of the system which has been applied with success in stationary steam, hot-water and hot air plants and which is known as the "Doylair" principle, is as follows:

In the application of the "Doylair" principle of combustion to the present type of locomotive, the magazine is built inside of the fire-box extending down to within about 18 inches of the grate, spaced apart from the inside of the outside water leg about seven inches, and at the front end, from the rear tube sheet, from eighteen to twenty-four inches. This magazine is kept filled with fuel. Attached under the body of the boiler proper is a fan operated by a small engine which forces air under pressure into the ash-pit which is practically air tight, and into the body of fuel above

F. J. Doyle

the grate at both ends and on each side, as well as into the gases of combustion above the fuel body. The front end of the flues of the boiler proper are plugged by an automatic device which can be set at any desired opening by the fireman or engineer in the cab, preferably they are closed to about one-eighth to one-quarter inch outlet. The exhaust nozzle is extended up into the base of the smokestack on the upper part of the boiler shell, which removes the fierce draft on the fire caused by the exhaust nozzle as applied in the ordinary locomotive. This condition when applied causes the fuel to be distilled into gases, and these gases are burned. In other words, that a proper supply of air at a proper temperature under proper conditions, is thoroughly mixed with the gases of combustion to effect their complete oxidization and utilization for the production of heat.

Locomotive Equipped with Doyle's Combustion Apparatus.

Recent Development in Car Ventilation

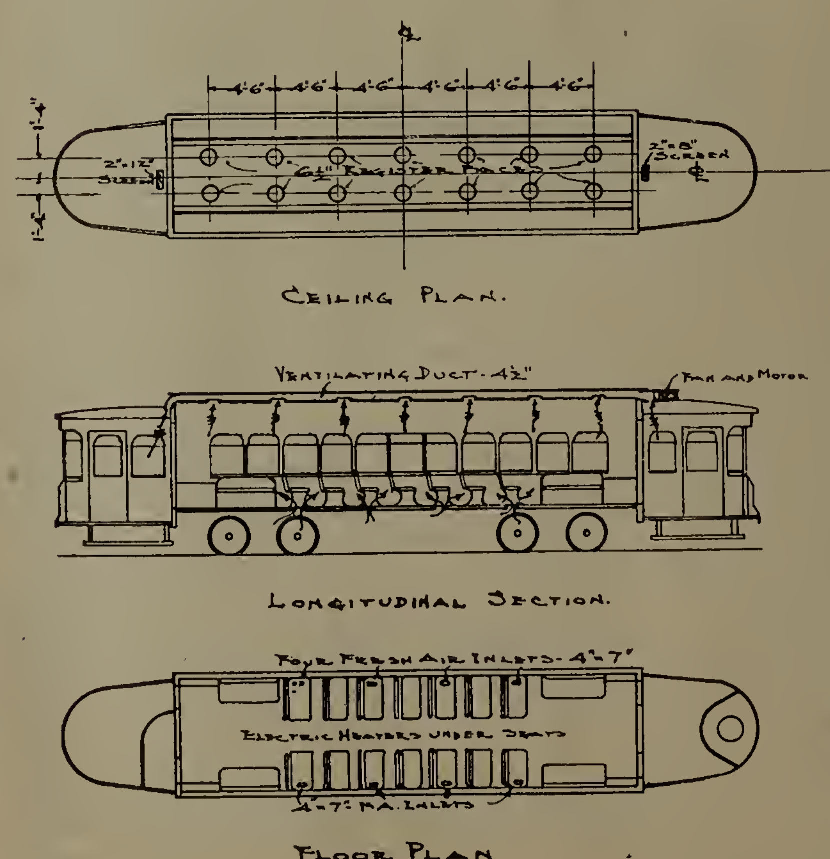
A ventilating system which has many distinctly new features is shown in the accompanying illustrations. It has been applied with success to many types of cars and has performed good service on a large number of pay-as-you-enter cars of the Chicago Railways Company.

The method of ventilation is on the vacuum or induced-draft system, the vitiated air being drawn off by a fan and causing the entrance of fresh air to take its place. The headlining of the monitor roof is placed about 4½ inches below the carlines, forming a chamber between the roof and the headlining. The sides of the chamber are sloped up at 45 degrees to the corners of the roof so as not to interfere with the operation of the hinged deck windows. There are 14 registers about 6 inches in diameter, with adjustable gratings, placed at intervals in the ceiling; they project upwards 2 inches into the air chamber. Each vestibule has a rectangular register in the ceiling, connected to the roof air chamber by a duct. In the front end of the monitor roof is a wide opening to a conical duct leading to a 10-inch exhaust fan driven by an electric motor at ½-HP. The fan and motor are mounted on the vestibule hood and are enclosed in a sheet copper housing, with lateral discharge openings. The fan is under the control of the motorman, but it operates at uniform speed. On this page is an interior view of a car equipped with this system, showing the registers in the ceiling.

The fresh air intakes are metal ducts fitted under the seats. Each has a screened bottom opening 4x7 inches in the floor of the car, and a larger upper opening directly beneath an electric heater, so that the entering air is passed over the heater coils before being diffused through the car. Each duct is of 1-16 inch pressed steel, made in two parts with an electrically welded seam; the top and bottom collars are riveted in place. After assemblage, the completed duct is treated with zinc by the Sherardizing process so as to give it a non-corrosive surface. There are eight of these ducts, weighing only 6 pounds each.

The areas of the intake and exhaust openings are proportioned to permit of the passage of air at a low velocity (approximately

Steel Car Equipped with Vacuum Ventilating System.



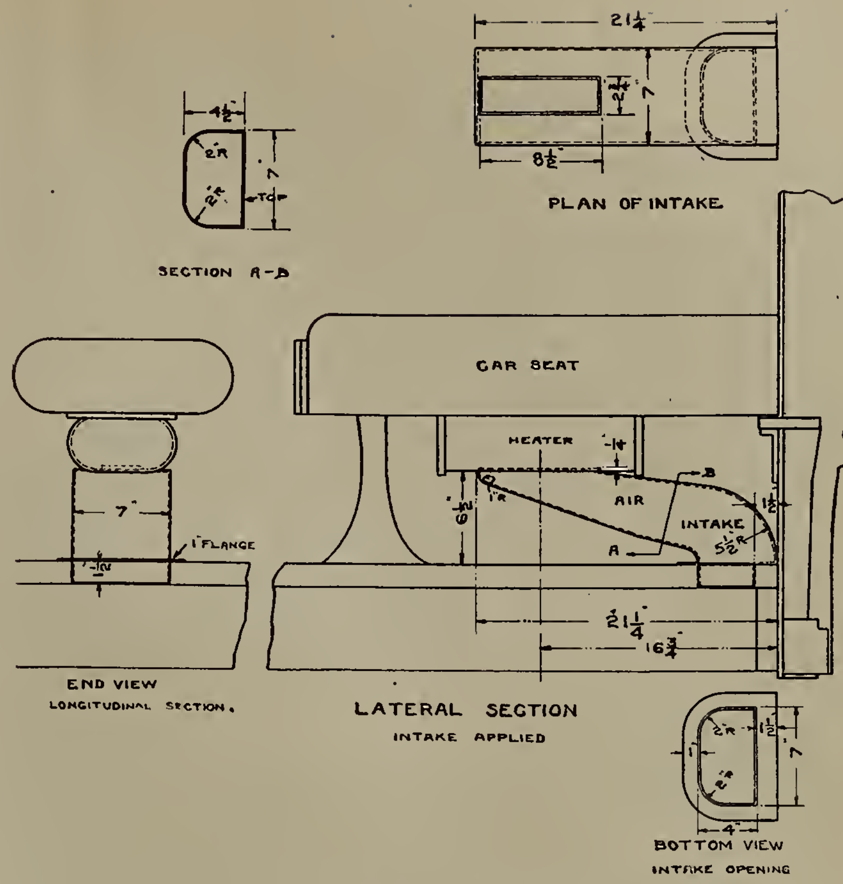
Plans and Elevation Showing Arrangement of Ventilating Apparatus.

325 feet per minute), so that there will be no perceptible draft. The rate of flow of the air is dependent upon the speed of the fan, and is not affected by the movement of the car. It is stated that expensive experiments have shown that the amount of air handled by this system remains practically constant, whether the car is at rest or in motion. The system is adaptable to other types of cars than that mentioned.

The application of this system to a car in no way detracts from the car interior, the register faces having same finish as metal trimmings. On the exterior there is no unsightly projection, there being only a compact sheet copper housing for the fan and motor at one end of the monitor deck, and at the opposite end an elbow of the same metal connecting duct on car interior with vestibule outlet. There are no hoods, arms or scoops required connecting with the intakes, as the free passage of air through same is assured by the vacuum produced on car interior.

The air circulating through car is under balance, as the air velocity through all exhaust ports is equivalent irrespective of their proximity to the fan. This is also true as regards flow of air through intake orifices.

This system requires no adjustment by the car operator to meet varying conditions of service, such as variation in speed, direction, or atmospheric conditions. It is the invention of D. I. Cooke, secretary and chief engineer of the Vacuum Car Ventilating Company, Fisher Building, Chicago.



Deails of Air Intake, Cook System of Ventilation.

Electrification of Trunk Lines*

By L. R. Pomeroy.

It is assumed from a physical and mechanical viewpoint, that electric traction can meet all the demands and requirements of railroad service. Therefore, whether electricity will replace steam traction or not is entirely a commercial problem. It may be stated at the outset that whatever system of electrification is adopted, a very large outlay has to be faced and no case for electrification can be made out unless an increase in net receipts can be secured sufficient to more than pay interest on the extra capital involved. This increase may be brought about either by decreasing the working expenses for the same service, by so modifying the service as to bring in a greater revenue, or by a combination of these.

However, there is hardly a steam road in existence today which does not have divisions or sections, where distinctly local traffic can be handled more profitably by light, comparatively frequent electric service, than as now, with heavy steam trains. Both steam and electric service can be operated over the same tracks without detriment or embarrassment to either. In so doing each kind of servivce would be approximately handled in a manner best suited to the conditions of each.

The fundamental principle, based on the present state of the art, seems to be that if you cannot accomplish something by means of electricity that is now impossible by steam traction, there is nothing to justify the change; the mere substitution of one kind of power for another, merely to obtain the same result, is not commercially warranted.

There are certain inherent advantages in electrical operation that has shown up very well, because the increase in business has absorbed the increased interest account, but these cases hardly apply to trunk line conditions as the law of induced travel has no bearing on freight train operation, the principal business of trunk line roads.

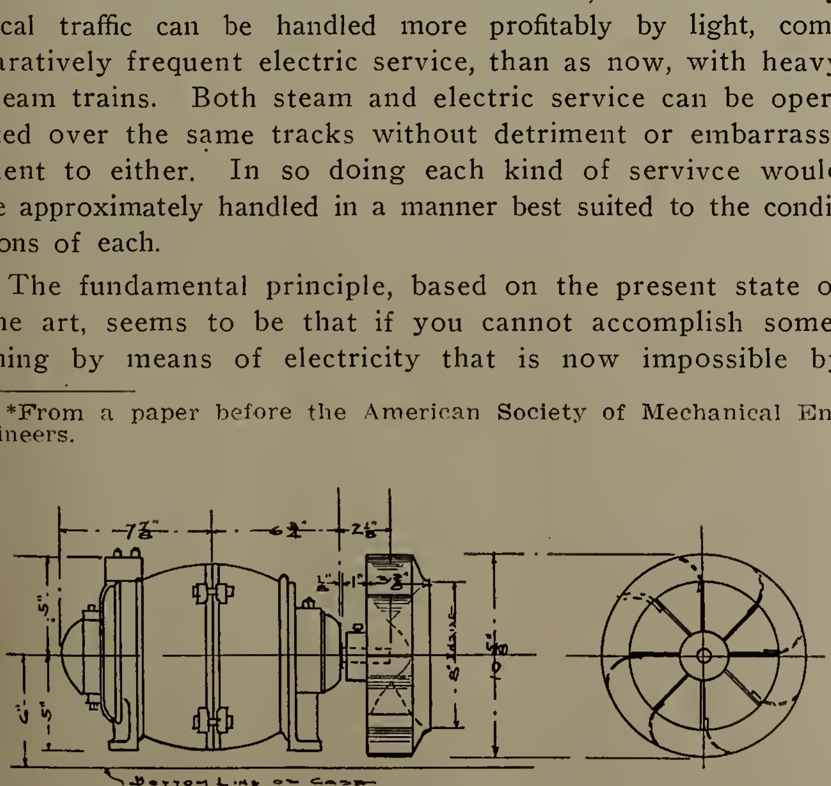
In heavy work the limiting feature of the steam locomotive is the boiler, and the maximum adhesion can be utilized only at low speeds. For example, a 2-8-0 locomotive with 180,000 lb. on the drivers, has a tractive force, at 10 miles per hour, of about 40,000 lb. or 4.5 to 1. At 30 miles per hour the tractive force becomes 13,250 lb. or 30.2 to 1. As tractive force governs the tonnage hauled, the ability of the electric locomotive to utilize almost indefinitely power proportional to the maximum adhesion and produce a drawbar pull entirely independent of the critical speed of a steam locomotive, as limited by the boiler, is a marked feature.

In heavy grade work the ability to increase the speed shows up favorably to the electric locomotive as enlarging the capacity of a given section, but here also the business has to be sufficient to absorb the increase in fixed charges.

With steam locomotives a coal consumption, when running, of 4 to 5 lb. per i. h. p. hr. really means 6 or 7 lb. at the rail, when the losses due to firing up, laying by in yards and sidings, blowing off at the pops, and consumption of the air pumps, are taken into account. Whereas, under electric operation, with an efficiency of 65 to 70 per cent between the power house and the rail, the coal consumption of 4 lb. per kilowatt hour at the rail can be counted on.

The writer is informed that the Metropolitan Street Railway station (1903) with a 40 per cent load factor, produced power, at the switchboard, at the rate of 4.7 mills per kilowatt hour (or 3.5 mills per horsepower hour), and with a load factor of 55 per cent which prevails in the winter time, the cost is at the rate of 4.43 and 3.3 mills respectively. These costs cover all expenses and repairs

*From a paper before the American Society of Mechanical Engineers.



Draft Fan and Its Motor.

except fixed charges. The coal consumption is 2.9 lb. per kilowatt and 2.16 per horse-power hour. L. B. Stillwell is authority for the statement that the Interborough is producing power at the rate of 2.6 lb. of coal per kilowatt hour or 3 lb. at the drawbar. Another authority gives the following figures for the elevated roads for cost of power, $0.005 per kilowatt hour at the switchboard, $0.0066 at the third rail shoes, or $0.0089 at the rims of the drivers. These figures are exceptional and hard to duplicate and as the fixed charges are not included, the writer would consider 1¼ cents per kilowatt hour at the rail a conservative figure, and will use this cost in the following computations.

Relative Cost of Coal for Steam and Electric Operation.

It may be fair to assume that where average coal is used, we can count on about $2.25 per ton for locomotive coal on the tender, while a much cheaper grade can be used in the power house, costing, with modern coal handling facilities, about $1.50 per ton. At this rate the relative difference in the cost of coal at the rail would be represented by the following figures:

Electric Power Station	$ 7.50
Steam Locomotive	$15.75

or 50 per cent in favor of electricity. The following results of the Mersey Tunnel operation are pertinent: Under electric operation one ton of coal at $2.10 yields 2.29 ton miles at 22½ miles per hour, while with steam, one ton of coal, at $3.84 yields 2.21 ton miles at 17¾ miles per hour. The difference amounting to 55 per cent is in favor of the electric operation.

On mountain grades or in heavy freight service, where the boiler of the freight locomotives is forced to the limit, and the boilers are designed for this particular purpose, the showing is still more favorable to the electric side. Especially is this true when the steam locomotive is detained on side tracks for as long a period as it takes to make the run, which is very frequently the case, since under these conditions the cost for fuel becomes a larger proportion of the total operating expense. A 2-8-0 locomotive with 50 sq. ft. of grate surface burns 300 lb. of coal per hour while lying on side tracks. Reports from Mallet locomotives indicate that from 600 to 800 lb. are burned per hour under the same conditions.

The cost of a unit of power with the steam locomotive becomes relatively higher under maximum than minimum boiler demands, while with electricity the cost per unit is at a uniform rate, whether working under extreme or light power demands.

For example: A consolidation (2-8-0) type locomotive with 180,000 lb. on 57 in. drivers, 50 sq. ft. of grate surface, working under maximum conditions on a 1½ per cent grade, would burn 150 lb. of coal per sq. ft., of grate surface per hour and evaporate from 12 to 15 lb. of water per sq. ft. of heating surface per hour. Under these conditions the cost per 1,000 ton miles would figure out to be $1.20. If the same service is handled by electric locomotives the cost on a similar basis becomes $0.90. If locomotive coal is taken at $1.70 per ton (the price in eastern Pennsylvania for low grade soft coal), the cost for coal for locomotives under the foregoing conditions would be $0.716. Electric current reduced to 1c per kw. hour at the rail, $0.72.

An express passenger locomotive of the Atlantic (4-4-2) type, with the following data: Cylinders 21 by 26 in., boiler pressure 200 lb. per sq. in., weight on drivers 102,000 lb., heating surface 2,821 sq. ft., grate surface 50 sq. ft., rate of combustion 150 lb. per sq. ft. of grate surface per hour, speed 70 miles per hour figures on the same basis, $0.71. Under electric conditions we have $0.50, or 28½ per cent less.

If coal is taken at $1.70 per ton, the cost is reduced from $0.71 tp $0.42, making the difference slightly in favor of steam. These figures apply only to the conditions named, and average conditions on an undulating profile, when coasting is occasionally possible. With the benefits of momentum grades, also, the figures would be relatively less, but the electric locomotive would respond and benefit accordingly, so that the percentages would be approximately the same.

When steam locomotives are loaded to their capacity, as is generally the case where tonnage rating is practiced, the rate of combustion of 150 lb. of coal per square foot of grate surface per hour, will still hold good and remain constant, the tons hauled being the variable, responding or being modified by the speed or physical conditions of the road.

In view of the foregoing the following extract from an article by Mr. C. L. De Muralt will be of interest. The figures are from the annual report of 1903 of the roads named.

Cost of Operating Trunk Lines.

	P. R. R.	N. Y. C.
Fuel for locomotives	$6,000,135	$4,635,877
Water for locomotives	335,286	295,583
Other supplies for locomotives	382,548	334,673
Wages:		
Engine men and roundhouse men	5,716,848	4,928,443
Other trainmen	4,442,127	2,991,335
Switchmen, flagmen and watchmen	3,900,427	2,511,552
Other expenses of conducting transportation	14,540,542	11,607,538
Repairs to locomotives	4,412,983	3,608,972
Repairs, other equipment	10,674,726	5,661,992
Repairs, roadbed	8,542,935	6,145,341
Repairs, structures	4,122,018	2,451,691
General expenses	1858,319	1,786,494
	$64,928,894	$46,962,491

Mr. De Muralt then applies the figures found during the course of his investigation, which would lead to the following reductions if electricity was adopted as a motive power.

	P. R.R.	N. Y. C.
Fuel 10 per cent	$600,013	$463,388
Water saved entirely	335,286	295,583
Other supplies, 50 per cent	191,274	167,336
Wages, enginemen, etc., 25 per cent	1,429,212	1,207,361
Repairs to locomotives	2,206,492	1,804,486
Total amount saved	$4,762,277	$3,942,154

The saving in water alone capitalized at 5 per cent equals $6,750,000 for the former and nearly $6,000,000 for the latter road. As large as these alleged savings are, yet they would not amount to more than 2½ to 3 per cent on the necessary increase in capital to electrify the roads on which the foregoing savings apply.

While the first cost for power stations and electric equipment represents a large outlay, yet such items as the cost for repairs of locomotives and shops, expensive hostlering at terminals, coaling and water stations, and the incidental labor charge and repairs thereto will, in the aggregate, be materially reduced. The comparative saving in repairs will be indicated by the following figures:

Repairs	Steam.	Electric
Boiler	20%	0%
Running gear	20%	20%
Machinery	30%	15%
Lagging and painting	12%	5%
Smoke box	5%	0
Tender	13%	0
	100%	40%

It is further claimed that, with electric operation, greater mileage is possible with the electric locomotive and that fewer units are necessary to perform the same service. Great stress is laid on the fact that the ordinary freight locomotive makes only 3,000 miles per month, or 100 miles per day, against which is put forward the ability of the electrive locomotive to perform practically continuous service, suggesting the propriety of comparing electric and steam operation on the basis of ton miles per annum each is able to make and also the relative weight on driving wheels and not their total weight.

The operating efficiency of a steam locomotive in freight service is so low, averaging about 3,000 miles per month, that it is generally thought due to limitations, per se, in the locomotive, whereas it is mainly due to operating and traffic conditions, which limitations would apply with equal force to the electric locomotives, so that, barring some increase in speed, the electric locomotive can make no greater mileage than its steam competitor in equivalent service, consequently its splendid ability to perform almost continuous service can not be realizzed in practice for reasons aforesaid.

The only cases where electric operation is commercially justified is in congested local passenger situations where the conditions closely approach those of a "moving sidewalk" and the records show that these cases have been profitable only when a large increase in business has been realized.

A modern Atlantic (4-4-2) type locomotive weighs, including tender, 321,620 lb. with a maximum tractive force of 23,500 lb. The ratio of total weight to tractive force is 133 to 1. The New York Central electric locomotive, with a total weight of 192,000 lb. and a tractive effort of 27,500 lb. has a ratio of 7 to 1. The comparison is still more favorable for electric freight locomotives where the entire weight is on the driving wheels.

Some Advantages of Electric Locomotives.

In the annual report of the P. R. R. (1903) the president states "That the congested condition of your system has brought about a large increase in the ton mile cost, which for 1903 was 25 per cent greater than for 1899. In order to prevent the increase in ton mile cost, it is necessary to move freight trains faster in places where traffic is dense, and for such purposes the electric locomotives is most efficient."

With steam locomotives the most economical average speed, for freight service, is 12 to 15 miles per hour, where there is ample track space for the free movement of trains. With a dense traffic this free movement can only be obtained by a higher speed and if the large train tonnage be maintained, more horsepower is required of the engine and boiler. It is difficult to increase the size of steam freight locomotives without resorting to the Mallet compound articulated type, and here we have the equivalent of two locomotives in one machine.

With the electric locomotive it is possible to develop a much greater horse-power and a large percentage of overload at the time when needed and do it more economically than with steam. The New York Central electric locomotive has a maximum peak horse-power of 3,000, which is 25 per cent above normal. This maximum is about double the power which can be obtained from the New York Central standard Atlantic (4-4-2) type locomotive. Similar proportions can be obtained for electric freight locomotives and their size and power are not limited by boiler capacity. If the steam locomotives is capable of developing 30,000 T. F. at the draw-bar at 12 m. p. h., or 960 h. p., and it is required to increase the speed of the train to 20 m. p. h. and maintain the same tonnage, then 1,600 horse-power will be required, which means the employment of a much larger locomotive or double heading. The advantage of the overload capacity on short mountain grades or for strategic peaks is one of the strong points in favor of the electric machine and would make electric operation applicable to special cases rather than a universal substitute, in the broad light of commercial considerations.

General Conclusions.

Our conclusion, from this survey of the situation, is that the rapid development of suburban passenger traction by electricity will require large power houses at large cities and these can gradually be made sufficient for working the line on further stretches in each direction, handling congested terminals, or used where commercially practicable, until it may be desirable to electrify the entire division.

Electric operation as compared with steam shows to greatest advantage in urban and suburban passenger service. Here, if multiple unit trains are employed, so that a considerable fraction of the total weight is carried on the driving wheels, thus permitting a high rate of acceleration to be used, a schedule speed quite impracticable in steam operation can be maintained. Moreover, a more frequent service can be given without a proportional increase in expense, whilst in times of light traffic small trains can be run, the energy consumption per train in such service being almost in proportion to the number of coaches. The law of induced travel, however, applies to urban and suburban passenger service, but does not hold for trunk lines and especially freight service.

Under trunk line conditions the only thing that interests railway managers is the traffic available at the present, relatively speaking; the future is too indefinite to be capitalized to any great degree in advance. It is more in the line of insurance companies to "capitalize expectations."

From a report of the Electrical Commission of the State of Massachusetts the following extracts are taken (letter of C. S. Mellen, president of the New Haven road):

"We believe we are warranted in saying that our electric installation is a success from the standpoint of handling the business in question efficiently and with reasonable satisfaction, and we believe we have arrived at the point where we can truthfully say that the interruptions to our service are no greater, nor more frequent, than was the case when steam was in use. But we are not prepared to state that there is any economy in the substitution of electrical traction for steam; on the contrary, we believe the expense is very much greater."

The Boston & Albany R. R. reports the result of their study and estimate the requirements as follows: A power station of 6,000 kilowatts will be necessary, with storage batteries to handle the peak load. The total cost of the installation is estimated at $4,000,000, and the interest, taxes and depreciation at 9 per cent, or about $400,000 per annum. A stock argument for electric operation is the saving to be made in operating expenses, but concerning this the following statement is made:

"Some slight economies would accrue in the transportation expenses under this operation, which would be substantially absorbed by the additional expenses to be incurred for the maintenance of the additional apparatus installed, and the net economies would be so small as to be inappreciable in the consideration."

Another stock argument of the advocates of electric locomotives is the growth of traffic which is supposed to result from electric operation. This argument is met as follows in the report:

"Considering now the possibilities of increasing the traffic, the statistics of the B. & A. R. R. show substantially the following number of passengers handled in the above territory per annum:

1891	4,552,918	1899	3,897,364
1894	4,799,578	1907	4,435,841

"The absence of any material increase in traffic is probably due to the fact that the circuit is occupied as a high class residential district not susceptible of rapid subdivision of property, and more particularly to the fact that suburban lines are being rapidly extended into all such outlying districts and afford a more advantageous means of collecting and distributing local travel through the commercial and residential districts than could possibly be afforded by a railroad constructed and operated upon private right of way and devoted largely to long haul operations."

The idea is all too prevalent with the public, and even with some of the bodies that have been given legal power of supervision over railway companies, that any expenditure which can be forced upon the railway companies is just so much gain for the public. Never was there a more absolute fallacy. In the long run, the cost of every bit of railway improvement must be paid by those who buy tickets and ship freight. Economy in the administration of our railways is just as important in the interest of the general public as if the railways were actually under government ownership.

Shop Kinks at Beech Grove Shops

The article on the shop kinks in use at the Beech Grove Shops of the Cleveland, Cincinnati, Chicago & St. Louis Railway, published in the February issue of the Railway Master Mechanic, stated that the credit for the design of the powerful pneumatic bending machine, illustrated as Figure 13, belonged to H. D. Wright.

F. F. Hoeffle, general master blasksmith of the Louisville & Nashville Railroad, South Louisville, Ky., informs us, under date of February 19, 1910, that this machine was originally designed in 1904 by John Jenkins, master blacksmith of the Louisville & Nashville, at its Decatur, Ala., shops. In substantiation of his assertion, Mr. Hoeffle sends us the original blue print, which appears to prove us in error in giving the credit to Mr. Wright.

We reproduce the illustration in question herewith.

A Modern Boiler Shop*

By E. F. Fish.

The design of a factory for building steam boilers and doing the kind of sheet metal work allied thereto is not as intricate a problem as that of most other lines of manufacture. There were some interesting features, however, connected with the building of a recent plant that may be of service to others. As an illustration of a modern factory of this kind, the description of the Heine Safety Boiler Co.'s new shop at St. Louis, Mo., is presented.

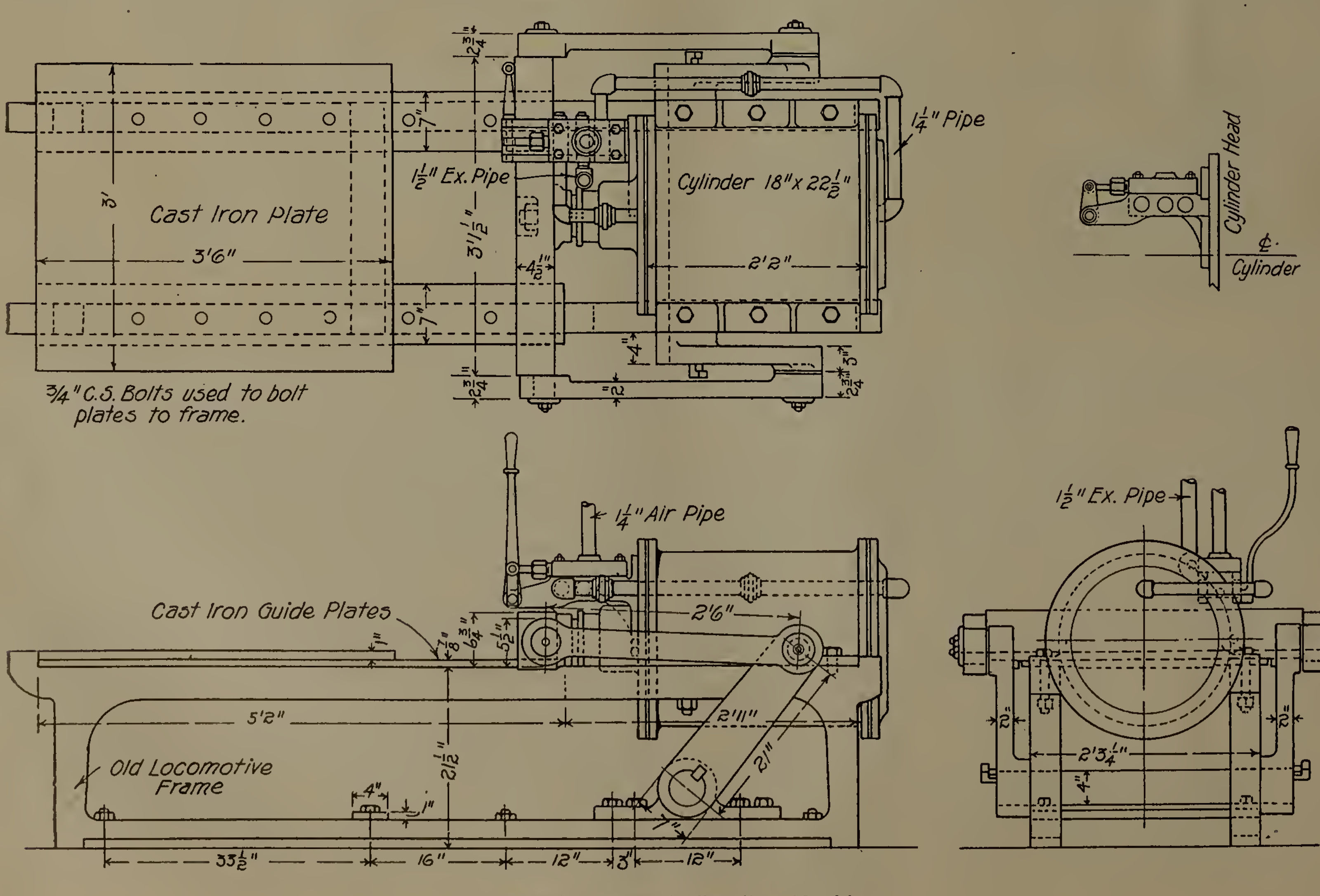
GENERAL PLAN.

To prepare the ground for building it was necessary to excavate the higher and fill in the lower portions o the site. There was just about enough material to fill in as much of the lot as was required or immediate use, leaving a considerable area for the future disposition of cinders, etc. The stream was straightened in two places. A large municipal trunk sewer will soon be built along its course, after which the entire area will be available for such use as may be desired.

A reinforced buttressed concrete retaining wall with a maximum height of 19.5 ft. above grade at the corner and stepped down on the end and side, following the slope of the hill, is built 4 ft. inside the property line so as to keep the wide footing within the site. This wall forms a part of the end and side of one of the buildings. The buildings consist of a main shop, flange shop (which is a wing of the main shop), power house, toilet and wash house, oil house and general office building, totaling about 2.5 acres of floor space.

The shape of the property made the location of the switch connections simple and convenient. They enter with long radii curves becoming tangents parallel to the buildings before reaching them. At present there are two switches, one of which enters the main shop and is the shipping track; the other passes alongside of the main shop between it and the flange shop and power house and is the receiving track. It is anticipated

*From a paper read before the Engineers' Club of St. Louis.



Powerful Pneumatic Bending Machine.

that another switch will be placed along the opposite side of the main building when conditions demand. A 100-ton 42-ft. extra heavy Howe track scale is located on the railway right-of-way near the connection to the main track. The office building is on the opposite side of the property facing Marcus avenue, far enough away to avoid serious interference from the noises of the shop.

In general, the raw material is received at the far end of the large building, that being the storage space. During the manufacturing processes it passes without reversal to the opposite end, where the completed boilers are stored and shipped. Tubes, not being needed until boilers are assembled, are received and stored at this end. The whole floor area of both main and flange shops is served by large or small traveling cranes, while a 24-in. gage Koppel industrial railway completely encircles the structures, with connections in the interior, so that the handling of material of all kinds may be carried on with the least expenditure of time and energy. A roadway leads from Marcus avenue into the receiving end of the main building. A portion of the interior of this building is partitioned off for a machine shop to do the little work of that nature required in the manufacturing processes and to care for the ordinary repairs and maintenance of the plant.

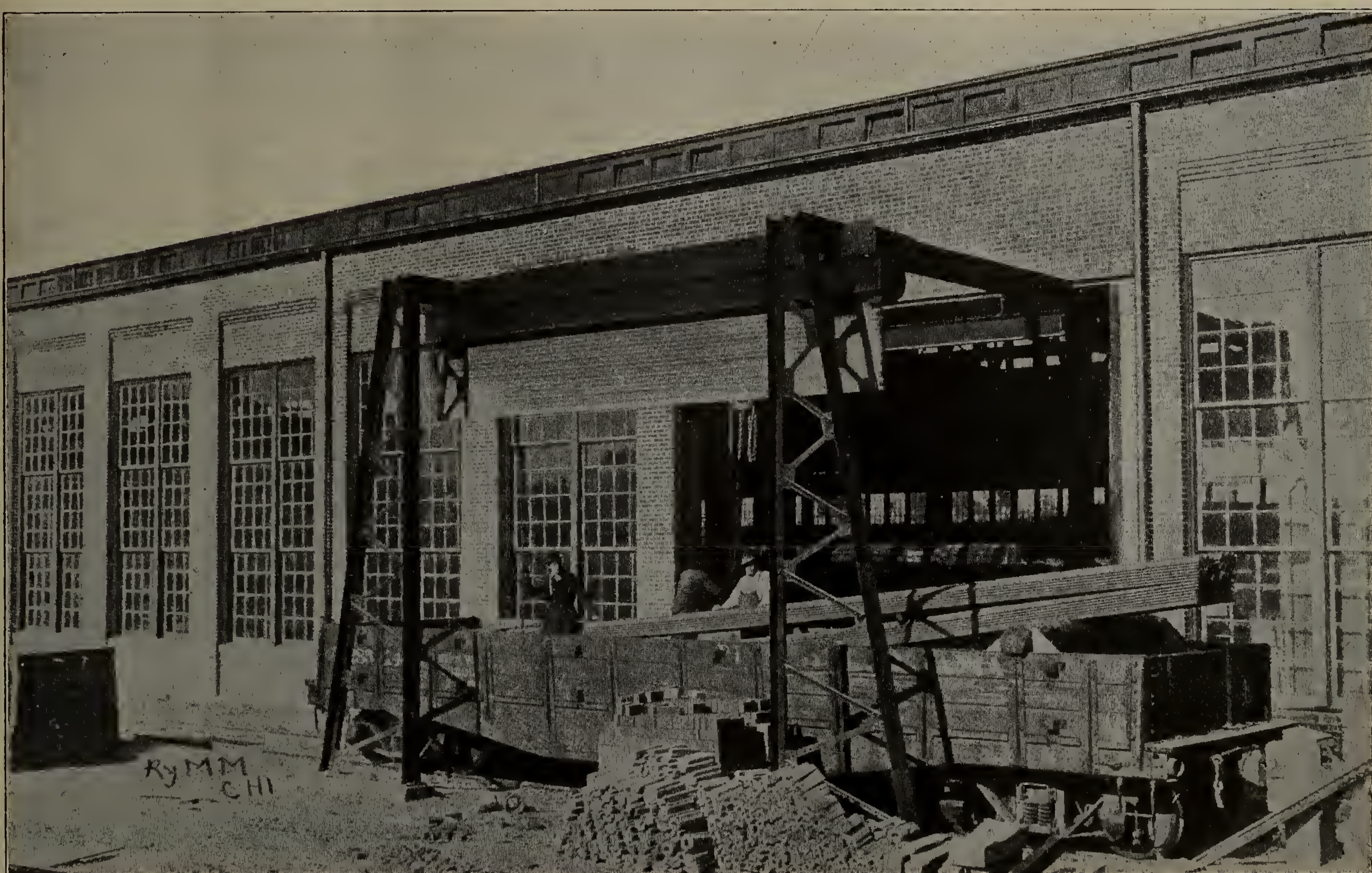
Three sources of power for the operation of the equipment are used—electric, hydraulic and pneumatic. All the generating machinery is located in the power house, which is placed in close proximity to the hydraulic and pneumatic tools, in order to reduce the length of the transmission lines, a saving both in first cost(frictional losses and maintenance. The great majority of the tools are electric, driven by individual Wagner motors, wherever practicable.

It is believed that the buildings as erected are amply large for some years of growth, so they are built with permanent ends; but, when conditions demand, the main shop may be extended toward the railway and the flange shop toward Marcus avenue. Also a wing or separate buildings can be built along the rear end of the lot as an extension of the main shop.

As far as practically all water is saved, to effect which a drainage system is provided into which all rain water from the roofs, as well as the clean waste from manufacturing processes, is discharged. This system discharges into a large cement-lined cistern 20 ft. diameter by 20 ft. deep near the power house. As the only source of water supply is from the city mains, this arrangement effects a very appreciable economy.

Types of Buildings.

The several buildings are all of the same general type, all structural details being standardized as far as practicable. At the outset it was determined to eliminate the fire hazard, and to build durably and yet have a maximum of natural light in the interior, which meant large window space. Steel frame structures with outside walls of brick and reinforced concrete slab roofs were accordingly adopted, with full-length monitors in the middle in order to obtain additional light and ventilation. About 75 per cent of the vertical areas exclusive of the retaining walls are glass. One size of window pane is used throughout, this being a commercial size, 12 in. by 16 in. The advantage of this will be appreciated when it is understood there are over 22,000 panes in the several buildings. Wood is used only for window and door frames and doors, the machine shop and sheet iron shop floors.



"A" Frame Craneway Over Receiving Track, Modern Boiler Shop.

Construction.

The main shop is 450 ft. long by 142 ft. wide for 250 ft. of its length, and 180 ft. for the remaining 200 ft. It is of this latter part that the retaining walls form one side and end. The narrow portion is divided into three longitudinal bays, the middle one being 60 ft. wide, and the two side ones 41.5 ft. The increase to 180 ft. is made by the addition of a fourth bay of 37 ft. The design of the steel frame follows standard practice, being calculated for the dead and live loads imposed by the roof and traveling cranes, the runways for which are 9-in. I-beams hung to the lower chords of the roof trusses, with the exception of the large crane way, which is carried directly on columns. The roof trusses are spaced 12.5 ft. centers, carried on the columns forming the bays. The columns of the central bay are spaced 25 ft. centers longitudianlly, 60 ft. transversely, and carry the 25-ton traveling crane way. The spacing of trusses thus provides stiffeners at the center points of the main crane runway and provides spaces of only 12.5 ft. for the support of the smaller crane runways in the side bays. The roof of the middle bay is 14 ft. higher than that of the side bays, thus forming the monitor in which the principal crane runs, as shown in one of the illustrations. About the middle of the side toward the power house is the riveting tower, 100 ft. long by 24 ft. wide, its roof being 55 ft. above the floor. The steel work of this tower is framed into that of the building proper.

The outside walls are of brick with concrete footings and completely enclose the outer steel columns. The outside columns carrying the trusses of the fourth bay rest on the retaining wall, which also serves as a foundation for the brick walls that close the end and side of the building at these points. Practically all the windows in the walls are 9 ft. 8 in. wide by 17 ft. 5 in. in height, this being the standard size for all buildings. The stone sills of the windows are 3 ft. 2 in. above the floor line, while the tops are practically at the height of the lower chords of the roof trusses. Each of these openings has two vertical rows of three sashes, each 3 ft. 5 in. by 5 ft. 10 in. high, and of the same construction. The middle sash is stationary, the upper and lower sashes are arranged so that they can be raised and lowered vertically. They counterbalance each other through steel chains over special pulleys at the top of the window frames, so that by raising the lower sash any degree of opening of the windows from nothing to two-thirds is very easily and conveniently accomplished by one man and from the floor level. The windows over the retaining walls at the rear end and side are arranged so as to utilize as much of the space between the top of the wall and the roof trusses as is practicable.

Both sides of the monitor are practically all window space, there being two rows of sashes which are also each 3 ft. 5 in. by 5 ft. 10 in. in size. Those in the lower row are stationary; those in the upper row are pivoted at the middle, so that they can be opened for ventilating purposes. One side of this monitor is unbroken, but the opposite side is divided into two sections by the riveting tower. Double rows of windows arranged similarly to those in the monitor are placed in both sides and ends of the tower. All the pivoted windows in the unbroken side of the monitor are operated in two sections of equal length, each by means of a single Lovell window operating device. The two sections on the opposite side are each separated by a single device of the same type.

The standard size of door opening is 9 ft. 8 in. by 12 ft. high, closed by two equal swinging doors, one of which contains a small door to permit employes to pass easily into and out of the building. Above these doors are two stationary window sashes of the standard size. In the receiving end is located a special door opening 22 ft. 2 in. wide by 20 ft. high. Through this is carried a transverse crane way 18 ft. 8¼ in. span projecting outside of the building over the receiving track, the outer end being carried by "A" frames. This connects with the longitudinal cranes in the inside, thus permitting the unloading of material from cars expeditiously and cheaply. This large opening is closed by means of a special variety rolling steel door carried on trolleys which run on the crane way. The carriage for this door is covered with a hood which entirely closes the opening above and between the beams when against the building, the door and its rolling mechanism being suspended below the crane way beams. When in this position the rolling door lowers into the guides provided at the side, and when it is entirely rolled up the whole carriage way may be moved to the outer end of the crane way, thus giving an unobstructed passage for the traveling crane and at the same time preserving the continuity of the crane way. This special door was made necessary because of the extreme size of the opening and by the governing conditions which rendered any other type of door impracticable. The door and carriage are operated by means of gears and hand chains. The hood so protects the mechanism of the carriage and the door when it is rolled up that it can be left exposed at the outer end of the crane way without harmful results. Although the door is of large dimensions, it can be opened and closed by one man, even in a high wind. A door 14 ft. by 16 ft. high is provided in the end of the fourth bay to permit the placing of cars inside the building when the proposed switch on that side is put in.

The roof is a 2½ in. concrete slab reinforced with wire mesh and carried by 6-in. I-beam purlins placed 5 ft. centers on the top chords of the roof trusses. This is covered with two-ply tar felt and gravel laid in hot asphalt. Two transverse expansion points, dividing the roof into three equal sections 250 ft. long, provide for changes in dimensions due to temperature. These joints are flashed with copper. The gutter troughs and down spouts are of 16-oz. copper, supported by ⅝-in. and 1½-in. galvanized iron brackets set in the brickwork. Ample expansion joints are provided in the troughs to prevent buckling or breakages. Each down spout connects with a cast-iron shoe to the underground drainage system so that rain water acts as an auxiliary water supply.

The exposed sides of the riveting tower are 4-in. reinforced concrete slabs to the height of the monitor roof, above which are the windows.

The machine shop is formed by partitioning off a space 46 ft. by 62 ft. with corrugated iron attached to angle iron frames fastened to the building columns. This partition, however, is largely window space.

Where the flange shop joins the main building the wall has been omitted, giving free communication between the two.

The floor will ultimately be of cinders, with a heavy residuum of binder and compacted by rolling. At present it is the natural clay. As before stated, the machine and sheet iron shops have a heavy plank floor. The shipping track at the front end enters through a sliding door 14 ft. by 16 ft., and holds two cars inside the building and bisects the testing floor, which is a brick pavement 62 ft. by 76 ft. laid in cement on a concrete base, draining into four sewer inlets which connect with the drainage system, thus returning the testing water to the cistern.

The flange shop is 62 ft. 4 in. wide by 144 ft. long, the construction being similar in every respect to that of the main building, to which it is connected, the end wall being omitted so that the two structures are practically one. The steel frame consists of a row of columns in each side wall, spaced 25 ft. centers, which carry the roof trusses. There are intermediate trusses spaced 12½ ft. centers. These trusses span the entire width of the building, leaving the floor area unobstructed, and carry two parallel traveling crane ways of 9-in. I-beams with 18 ft. 8 in. span, hung from the bottom chords, below which there is a clear height of 20 ft. This building has a monitor 13 ft. wide by 9 ft. high, made of light frames supported in the middle of and by the roof trusses. The window arrangement is exactly the same as is the main building except that the monitor has but one row of pivoted sashes on each side operated by a Lovell device. Door openings 16 ft. 10 in. wide by 20 ft. 9 in. high are placed in the side walls at the ends next the main building, through which the receiving switch passes. These openings are closed by Kinnear rolling steel doors, so that cars can be operated through the building on this track.

In one side of the building an opening is left in the wall for the large heating furnace, which is housed in a small steel frame structure placed against and outside the wall.

One of the outer corners of the flange shop is over a fill and a part of the original creek bed. This made it necessary to carry concrete footings down 24 ft. to bed rock. These footings are in the shape of concrete columns, carrying reinforced concrete beams just below the floor level, which, in turn, carry the steel frame columns and the brick walls. A standard door is in the middle of the outer end.

The power house is 75 ft. wide by 79 ft. long, being separated by a distance of 22 ft. from the flange shop and 16 ft. 10 in. from the main shop. In the main, its construction is the same as that of the other two buildings, the main difference being that it is divided into an engine room 34 ft. 7 in. wide, and boiler room 42 ft. 11 in. wide, by a brick wall in which is located a row of columns carrying the abutting ends of the roof trusses. The monitor, 13 ft. wide by 50 ft. long, with windows similar to those heretofore described, is half over one room and half over the other, the partition wall extending to its roof. The middle row of columns and the outer row carry the runway of an overhead traveling crane serving the engine room. The roof is continued over the space between this and the main building in order that coal cars may be unloaded without interference by the weather. The entire floor of this building is at the same level, made of concrete and provided with necessary pipe trenches, which are covered with iron plates. The outer wall of the boiler room is carried up solid to the coal holes, a height of 8 ft. The coal holes are oposite the boilers and are 3 ft. high and 10 ft. long, with heavy iron frames set in the brickwork and closed with iron doors. Above these coal holes is a row of windows.

The toilet and wash house is located 16 ft. 10 in. from the main shop and 20 ft. from the power house, where it is accessible with a minimum loss of time. It is a one-story brick building 20 ft. by 26 ft., with a concrete roof and floor and divided by a brick wall into two rooms about 9 ft. wide, one of which contains ten wash down closets and an iron enameled urinal, both with automatic flush; white enameled wash sinks with numerous hot and cold faucets are in the other room. A galvanized house boiler, heated by exhaust steam, furnishes a supply of hot water. Lighting is by small windows near the top of the walls. The sewerage is carried by a sanitary sewer to the creek at the far corner of the lot.

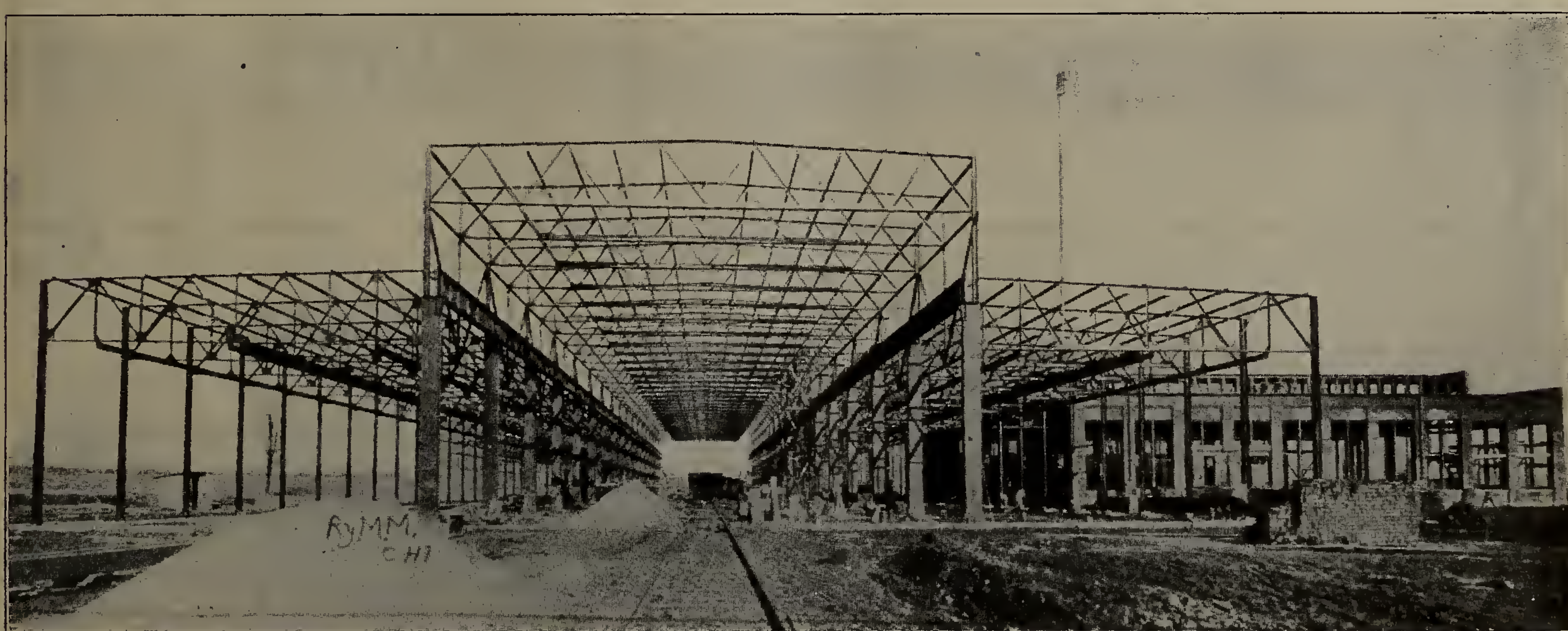
The oil house is a one-story brick building 12 ft. by 20 ft., with a concrete roof and floor, located 20 ft. from the toilet house and 20 ft. from the power house, from which it can be quickly reached. It is intended solely for the storage of inflammable liquids, etc.

Equipment.

In the main shop are stored all the raw material, supplies, etc. Most of this storing is done at the extreme near end and side, where there is the least light, yet it is accessible and easily removed to any point where it may be needed. A 3-ton Yale & Towne traveling crane on the transverse crane way, heretofore mentioned, serves the delivering track and places the boiler plate, which is the heaviest material received, directly into a series of racks that hold the plates in a vertical position so that any plate may be withdrawn without unnecessary handling. The side bays are each served by four 3-ton 14-ft. Curtis traveling cranes, with hand-operated triplex blocks running on two adjacent parallel crane ways in each bay hung to the bottom chords of the roof trusses.

This shop contains tools as follows. The motor sizes given indicate that the machine is driven by an individual motor.

1 Ryerson high-speed friction saw............30 h. p. motor
1 24-in Kraut punch........................ 7½ h. p. motor
1 36-in Cleveland punch...................... 7½ h. p. motor
1 8-ft. Lennox splitting shears................ 7½ h. p. motor
1 60-in. Cleveland punch and shear.............10 h. p. motor
1 Lennox rotary bevel shear.................. 7½ h. p. motor
1 14-ft. Hilles & Jones bending roll. .10 h. p. and 30 h. p. motors
2 100-ton Woods triple power hydraulic riveters..............
1 30-in. Long & Allstatter horizontal punch.... 7½ h. p. motor



Structural Work for Modern Boiler Shop

The three last machines are located under the riveting tower and are served by three 10-ton Wood hydraulic tower traveling cranes with 40-ft. lift and 20 ft. 7 in. span.

One unoccupied section in this tower provides for an additional riveter.

2 5-ft. radial drills belted from a shaft driven by a 10 h. p. motor supported overhead on a bracket bolted to the wall.

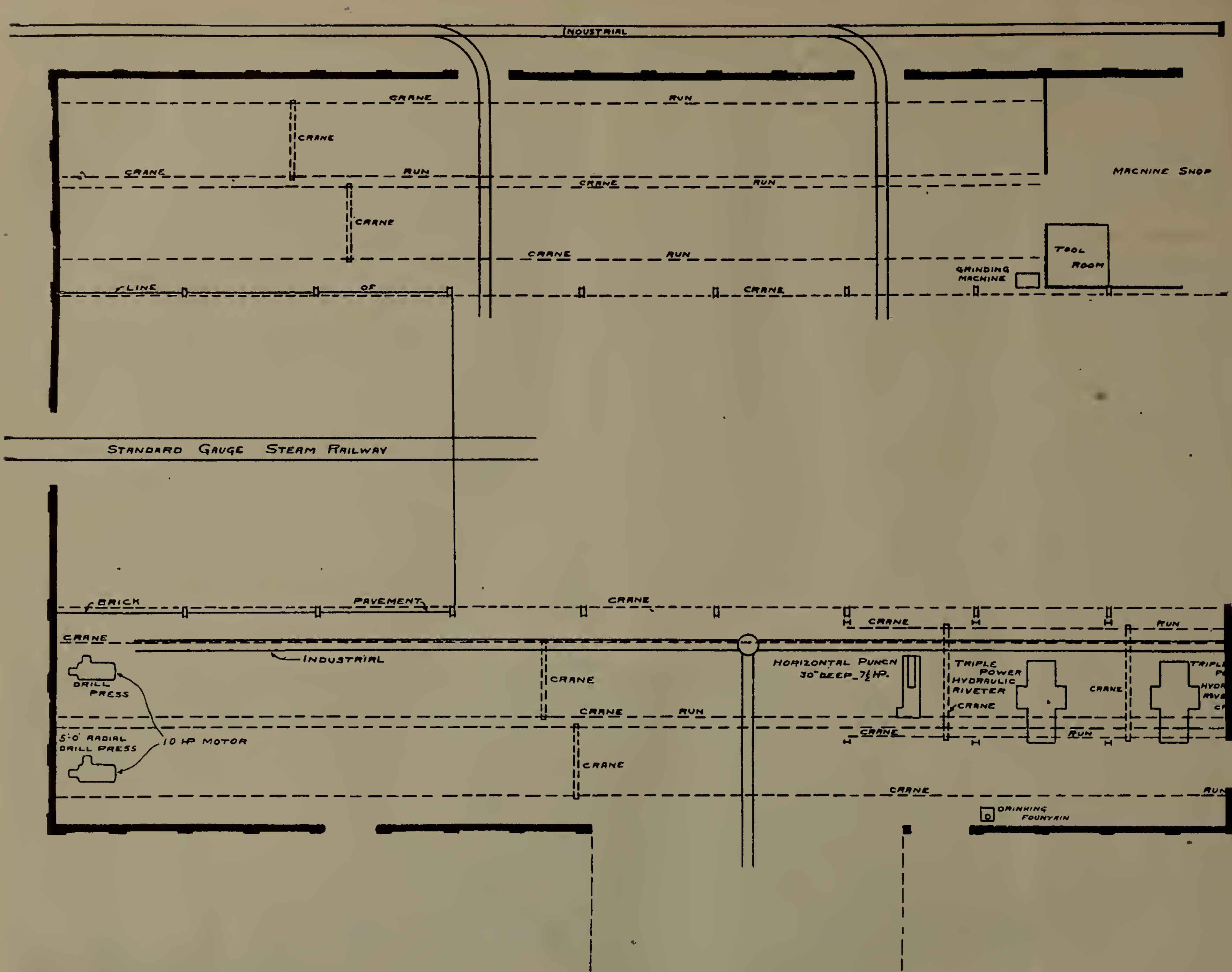
1 Wood portable hydraulic riveter, which is handled by the hydraulic hoist in the 30-in. horizontal punch tower.

1 25-ton Pawling & Harnishfeger electric traveling crane, 26½ ft. lift, 60 ft. span, with 5-ton auxiliary hoist, with General Electric motors for all movements.

An outfit of pneumatic calking, riveting and chipping hammers.

Also the following sheet iron working tools:

1 angle-bending roll............................10 h. p. motor
1 sheet iron break............................ 7½ h. p. motor



General Layout of Machinery.

1 42-in. Lennox rotary splitting shears......... 7½ h. p. motor
1 36-in. Kraut punch ....7½ h. p. motor
1 8-ft. Hilles & Jones bending roll............10 h. p. motor
3 6-in. Cleveland punches belted to a countershaft driven by a 7½ h. p. motor.
1 6-ft. Hilles & Jones bending roll...........................
1 24-in. Long & Allstatter punch..........................

These two latter are belted to a countershaft driven by a 7½ h. p. motor.

The machine shop equipment is mainly belt-driven by a 20 h. p. motor through a line shaft. There are four lathes of various sizes, one shaper, one universal milling machine, three different sizes of radial drills, one planer, one heavy duty motor-driven boring mill, one double-head bolt cutter, two pipe threading machines, a combination grinder, one wet grinder.

In the flange shop are:

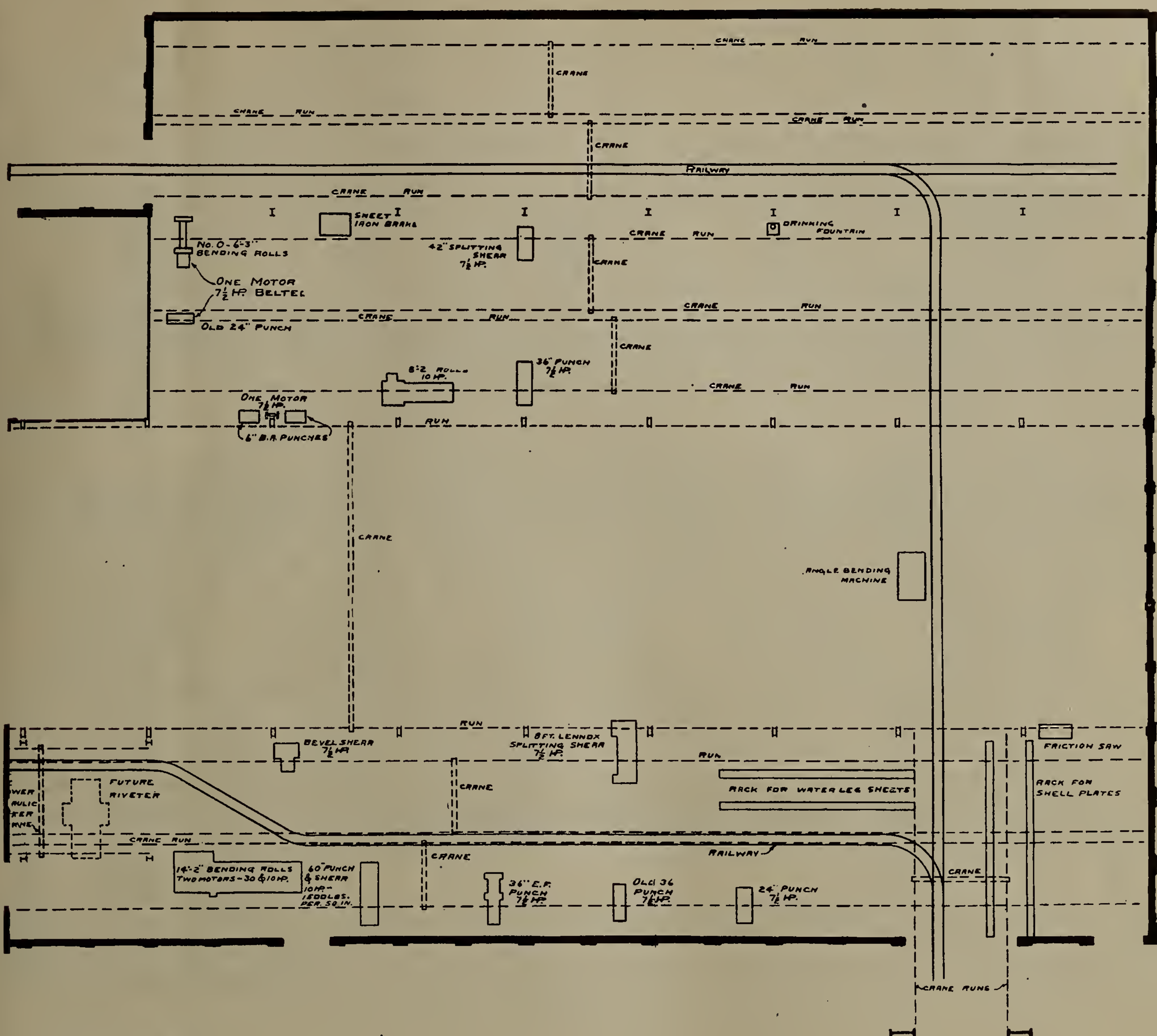
1 180-ton 60-in. Wood hydraulic punch and shear..............
1 130-ton 60-in. hydraulic sectional flanging machine..........
1 1,100-lb. Bement Niles steam hammer........................
1 10-in. Long & Allstatter horizontal punch.....7½ h. p. motor
1 250-lb. Bement Niles steam hammer.........................
2 2 ft. 10 in. by 14 ft. hearth open forge fires..................
1 2 ft. 10 in. by 6 ft. hearth open forge fire.................
1 4 ft. 3 in. by 6 ft. hearth reverberatory forge furnace......
1 10 ft. 6 in. by 15 ft. 6 in. hearth reverberatory plate heating furnace.
3 blacksmith forges..
1 24½-in. motor-driven blast fan and pipe connections to forges
1 cast iron plate straightened bed and roller....................
Complete set of cast iron forming blocks, dies, etc.............
4 3-ton Curtis traveling cranes...................................

All the small traveling cranes in both shops on adjacent parallel tracks overhang their runways far enough so they can be locked together and the trolley run from one to the other.

All the steam, hydraulic and air pipes and electric wires are brought over from the power house in covered trenches and are so arranged that they can be easily drained in cold weather to avoid the danger of freezing. The air pipes have numerous connections at convenient points throughout the main shop, flange shop and machine shop.

The boiler plant consists of three Heine boilers of 250 h. p. each, set separately. Two of them are provided with Heine superheaters of two different capacities. They are all fired by hand and have flat shaking grates. Back of the bridge walls of each furnace is a special fire brick wing wall construction for the prevention of smoke, which accomplishes the object very satisfactorily. The two boilers with the superheaters are set in brickwork in much the usual way. The third boiler has a reinforced cement setting with fire brick lining. This was tried as an experiment to determine the availability of concrete construction for this purpose, and with the expectation that it will be more durable than brick and less liable to the cracking that all brick settings are subject to. The three boilers differ each from the others in dimensions, and all are arranged so that measurements and observations of all kinds may be conveniently made.

The company has in view a great variety of experiments to determine questions now in doubt and to develop further im-



For Modern Boiler Shop.

provements in boiler practice. This will account for the boiler capacity being greatly out of proportion to the rest of the plant; one boiler will easily carry the load. A straight horizontal sheet iron breeching connects the boilers with the chimney located in the space between the boiler house and the flange shop. This is a reinforced cement chimney 66 in. inside diameter by 147 ft. high, the foundation for which is 11 ft. deep and 22 ft. square at the base, a concrete monolith.

As the power requirements are not great, the installation of automatic stokers and coal and ash handling machinery was not deemed expedient. Coal is, therefore, unloaded by hand into the space in front of the boilers, which has a capacity of about two cars.

A Hoppes exhaust steam feed water heater, with a capacity of 15,000 pounds of water per hour, is placed on an iron support against the division wall. The air supply for the compressor is brought from the roof through a 12-in. sheet iron duct to an air washer placed behind the boilers. A small duplex steam pump delivers water from the cistern to the heater, being regulated by a Fisher governor. A boiler tester of the injector type supplies hot water under the required pressure for the hydrostatic test applied to all boilers before shipment. This testing can also be done by pressure from the hydraulic system, and through proper connections by the boiler feed pumps. An injector for feeding the boilers is provided for the use of the night watchman in order to avoid running the pumps.

All hot piping and the smoke flue are heavily covered with 2-in., 85 per cent magnesium covering. Two openings 3 ft. wide and 7 ft. high are the only inside communication between the boiler and engine room and are closed by sliding wooden doors covered with sheet iron. One end of the boiler room serves as a workshop and has an enclosed dressing room and toilet.

The electrical energy is developed by a 262 h. p. 4-valve non-condensing Ball engine, 13 in. by 18 in., running 200 rev. per min. A 100-kilowatt, 220-volt, 3-phase, 60-cycle Western Electric Co.'s generator is directly connected to the engine. An 11-kilowatt exciter is belted to a pulley on the engine shaft. The voltage is maintained constant by a Tirrell regulator mounted on the switchboard. All wires in the engine room are placed in conduits under the floor. The switchboard is completely equipped with all the measuring, controlling and distributing devices, and is divided into four panels, one for the generator, all current delivered being measured by a wattmeter, two for the four power circuits, one for the six lighting circuits.

A Laidlow Dunn Gordon two-stage, compound, non-condensing air compressor is next to the engine. It has 12½-in. and 22-in. steam and 22½-in. and 14-in. air cylinders, with 18-in.

stroke. Its capacity is 1,200 cu. ft. of free air per min. at 100 lb. pressure when running at 145 rev. per min., 145 lb. steam pressure. It takes its supply from the air washer just the other side of the partition and discharges into a receiving tank 36 in. by 10 ft. standing nearby.

A Worthington duplex compound non-condensing pumping engine, with 14-in. and 22-in. diameter steam and 4-in. diameter water cylinders, 18-in. stroke, supplies the hydraulic system. Its capacity is 100 gal. per min. against 1,500 lb. pressure, with 145 lb. steam pressure. A Wood hydraulic accumulator, 12 in. diameter of ram and 15 ft. stroke, loaded to give 1,500 lb. pressure per sq. in., is located in one corner of the room. It is connected with an automatic controlling valve which shuts off the pump when the limit of lift is reached.

A 700 cu. ft. Norwalk air compressor, an old machine from the old shop, is located next the larger machine, and is connected to the same supply and discharge, but is intended only for emergency use. There is an additional space in the engine room for a duplicate generating set and also for another 1,500 lb. hydraulic pump.

Two 7½ in. by 4 in. by 6 in. Blake duplex outside packed plunger feed pumps are placed against the partition opposite the heater and are controlled by Fisher governors. The feed piping is in duplicate and so arranged that any boiler can be fed independently of the others and of the other pump. This is to permit the testing of any boiler without interfering in any way with the operation of the plant. The suctions of these pumps are connected to the heater, the city mains and the cistern. Means are provided for filling boilers directly with city water. The small pumps have a separate steam header so as to be independent of the main steam header.

A 10-ton Pawling & Harnischfeger hand-power traveling crane, with 33½ ft. span and 17½ ft. lift, serves the entire area of the engine room. Only the live steam pipes are exposed in this room, all others being laid in covered trenches.

Miscellaneous.

Artificial lighting is mainly by 10 flaming arc lights uniformly distributed through the shops. They are hung to clear the cranes in monitor and bays and in the latter are about 22 ft. from the ground. The engine and boiler room have each one lamp of the same kind. In addition, each machine tool has one or more incandescent lights near the workman. Special six-light incandescent fixtures are recessed in the walls 10 ft. from the floor around the sides of both engine and boiler room, with switches in closed hand-high pockets. The water and steam gage of the boilers each has a light on separate circuits for each boiler. No outside current is used for either lights or power, except for two arc lights for night use and for the office.

A boiler shop requires heating only in comparatively cold weather, say when the temperature falls below 45 degrees Fahr. It is, therefore, unnecessary to heat it above that temperature at any time. Open salamanders, usually without means for carrying off the gases of combustion, is the plan most often used, but a better plan from every point of view has been here adopted. The main shop is provided with a sort of hot blast system, consisting of five sets of enclosed coils of ¾-in. pipe, each containing about 3,000 sq. ft. of radiating surface. A motor-driven fan forces the air through the coils, discharging directly into the room in an opposite direction from the intake. These sets are distributed so as to give the greatest heating effect where needed. It is anticipated that the circulation thus created will be sufficient to make the temperature sufficiently high and as nearly uniform as is necessary. Exhaust steam is used, but whether there will be sufficient or not, and whether the system will be satisfactory, has yet to be determined. The machine shop, toilet house and office are heated by direct radiators. The flange shop needs no special heating, the fires there being ample. If there proves to be insufficient exhaust steam, live steam will be turned in through a reducing valve, provision for this having been made.

To provide cool drinking water in summer a special drinking fountain was designed, of which two are installed. This consists of a concrete-lined pit about 4 ft. by 6 ft. by 3 ft. deep, divided into two compartments, one 27 in. by 27 in., the other 18 in. by 37 in. The walls of the larger, which is the ice chamber are built with air spaces. Near the bottom is a horizontal coil of 1¼-in. galvanized pipe, with a wooden grating above the top of the coil, carries the warm water into the other compartment, in which are the valves for shutting off the supply, etc., and from which all waste is drained into the drainage system leading into the cistern. Over this latter compartment is the hydrant, with a suitable waste pipe and perforated cover. About 300 lbs. of ice can be put in the chamber, which is covered with both a thick wooden and an iron lid. In hot weather the supply of ice lasts two days. Water from the city mains is used exclusively for drinking.

Although the buildings are free from fire risk to such an extent that it is considered unnecessary to carry insurance, there is more or less inflammable material around in the shape of boxes, barrels and other packing material, as well as wooden railway cars. A simple fire system was, therefore, installed. Six 2-in. fire hydrants are uniformly distributed through the main shop, with 100 ft. of canvas hose and nozzle suspended on holders at each. There are also three hydrants outside, two on the opposite sides of the front end of the main building and one near the oil house. The water supply is from the city mains and under a pressure of 60 lb., so no other source of supply for this purpose is necessary. In addition, there are nine Minamax non-freezing and twenty-four Johns-Manville dry powder fire extinguishers hung at numerous convenient points. This is supplemented by a city fire-alarm box on the outside of the power house.

Cost

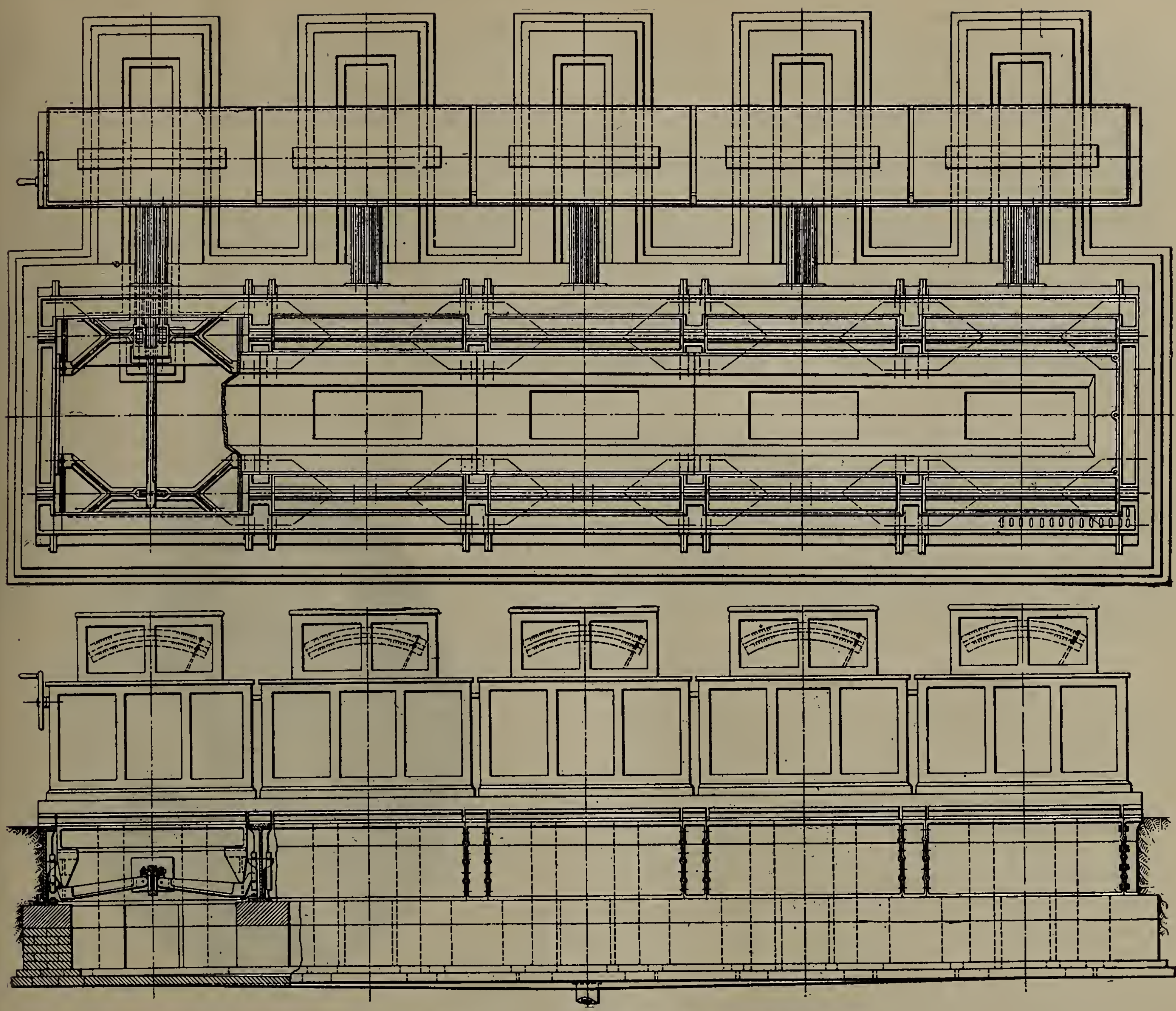
The land was purchased in the middle of 1907 and the general scheme worked out by the officers of the company in conjunction with Messrs. Lichter & Jens, consulting engineers, who drew the plans and superintended the work. Much of the preparatory drafting work was done prior to the time when the decision was reached to proceed with the building of the plant.

The actual construction was purposely undertaken at a time of business depression. So far as prospects for obtaining sufficient orders to anywhere nearly develop the capacity of the plant when completed, or soon thereafter, were concerned, there was little incentive to proceed. Owing, however, to the very limited building operations of this nature throughout the country at the time, it was certain that the first cost would be very low. Early in 1908, when materials were at their lowest prices, it was, therefore, determined to proceed, financial arragements having been satisfactorily concluded.

The grading was done in June and July, 1908. A little more than 18,000 cu. yds. of earth was excavated at a cost of 16 cents per yard. This and the retaining walls were executed by the Fruin-Colnon Contracting Company. The steel work, amounting to about 790 tons, was furnished by the Riter Conley Manufacturing Company at the rate of practically 2.6 cents per pound f. o. b. St. Louis. It was all inspected by the R. W. Hunt Bureau of Inspections and Tests before leaving the factory.

The erecting of the steel was done by the Midland Erection Company at the rate of $8.80 per ton. The general contract for the completion of the main shop, flange shop and power house was executed by the Fruin-Colnon Contracting Company.

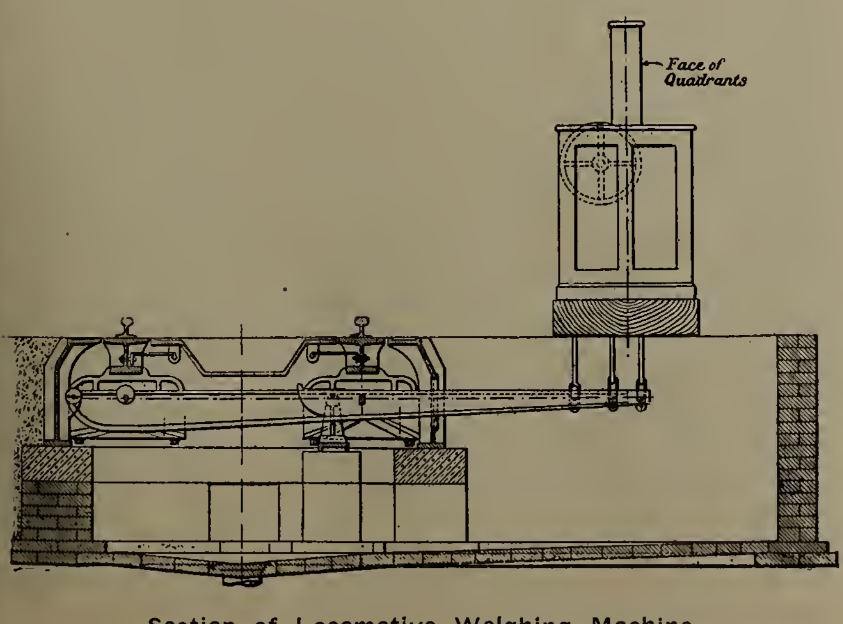
The total cost of these buildings was $1.15 per square foot of floor area, excluding the retaining walls and grading, and $1.29 including those two items. This, of course, does not include any of the equipment.



Plan and Elevation of Locomotive Weighing Machine.

Locomotive Weighing Machine

A novel design of locomotive scales is shown in the accompanying illustrations which we take from Engineering (London). It is a ten-table weighing machine with automatic quadrants and has recently been installed at the Eastleigh, England, works of the London and South-Western Railway. This machine, which was constructed by Messrs. W. and T. Avery, Limited, Soho Foundry, Birmingham. To the left hand in the drawings a portion of the casing and flooring is removed, in order to show more clearly the system of leverage.



Section of Locomotive Weighing Machine.

This machine has a total weighing capacity of 120 tons, each table taking a load of 12 tons. The tables are each 5 ft. long, and are fitted with flat-bottom steel rails set to proper gauge. The system of suspension adopted prevents all tipping when the locomotive is being run on to the machine. At the same time the three-lever type of gear adopted avoids all torsional stress, and allows the tables to oscillate in the direction in which the locomotive moves. The main triangular levers, of which there are two to each table, are of cast iron, and are fitted with hardened-steel knife-edges. The transfer levers are also similarly fitted. The connection between the main triangular levers and the transferring levers consists of iron shackles fitted with hardened-steel bearings. At the other end the main levers are suspended in cast-iron rockers or stirrups, fitted also with hardened steel bearing-blocks. The brackets from which these stirrups are hung are shown in the elevation and are cast on the machine-frame. The machine-frame is of cast iron, built up in sections and is 2 ft. 4 ins. deep.

Each table has a separate self-indicating quadrant, enclosed in a wooden case, with glass-window protection for the quadrant and pointer. The quadrants are graduated to 1-cwt. divisions, and the machine is stated to be sensitive to 7 lbs.

New Literature

RAILROAD ENGINEERING. By Walter L. Webb; 296 pages, cloth, 6½x9½; published by the American School of Correspondence, Chicago. Price, $3.00.

This book is one of a series which is intended to fill a need for practical working guides of convenient size and low cost embodying the results of experience and dealing with most approved modern practice. This volume is written by a man thoroughly familiar with his subject, who has ably treated it with a view to making available for home study the problems so often met. The work deals with modern practice in survey, location and contruction of railway lines and terminals, their operation and maintenance and the financing and economic management of railway corporations. It is well illustrated with diagrams, line drawings and halftones, and is beautifully bound in red covers.

* * *

THE STANDARD GUIDE FOR LOCOMOTIVE ENGINEERS AND FIREMEN. By Ed. Turner; 198 pages, leather, vest pocket size; published by Laird & Lee, Chicago. Price, 75 cents.

This little book is an elementary treatment of principles covering the operation of the locomotive. The subject matter is illustrated with seventy special drawings, which assist in making clear the explanation of certain operations. A department given to signals adds to the value of the book.

* * *

The Rockford Machine Tool Co. of Rockford, Ill., has recently issued a very attractive catalogue of the various styles of shapers and metal planers manufactured by this company. The descriptions, dimensions and illustrations for each machine are complete and concise.

* * *

Heating apparatus for railroad cars and locomotives together with many fittings for the same, are fully set forth in a 9x12 inch booklet of the Ward Equipment Co. of New York City. A great many illustrations of valves, pipe fittings, and other accessories are given.

* * *

The 1910 catalogue of the National Bolt & Nut Co. of Pittsburg, Pa., gives complete figures and prices on the various nuts, bolts and washers manufactured by the company. The telegraphic code of the Association of Bolt & Nut Manufacturers is also given.

* * *

"Vanadium Metals in Railroad Service" is the title of a booklet gotten out by the Vanadium Metals Co. of Pittsburg, Pa. Among other things, a number of tables are shown of the results of tests of Victor Vanadium metals and castings.

* * *

Publication No. 387 of the National Brake & Electric Co. of Milwaukee, Wis., deals with "National" motor-driven air compressors for both stationary and portable work and also their application to air lifts.

Personals

T. S. King has been appointed the master mechanic of the Brinson Ry., vice W. A. Behle. His office is at Springfield, Ga.

G. V. Wagner has been appointed a general foreman of the Central of Georgia, with office at Albany, Ga.

W. O. Derby has been appointed the acting engineer of tests of the Chicago, Burlington & Quincy, vice Max H. Wickhorst. His office is at Aurora, Ill.

W. H. Gardner has been appointed a road foreman of engines of the Chicago, Milwaukee & St. Paul, with office at Sioux City, Ia.

W. A. Kelly succeeds R. W. Colville as a master mechanic of the Chicago, Burlington & Quincy, with office at Galesburg, Ill.

L. M. Rice has been appointed a road foreman of engines of the Chicago, Milwaukee & St. Paul, with office at Western avenue, Chicago. He succeeds W. Ivens, who has resigned.

Arthur Sandy has been appointed a road foreman of engines of the Chicago, Milwaukee & St. Paul, with office at Mason City, Ia.

J. W. McCarthy has been appointed the road foreman of engines of the Chicago, Peoria & St. Louis Ry.,with office at Springfield, Ill. He succeeds W. T. Cousley.

E. C. Anderson has been appointed the mechanical engineer of the Colorado & Southern Ry., with office at Denver, Col.

W. Hamilton has been appointed master mechanic of the Western Division of the Grand Trunk Ry., with headquarters at Battle Creek, Mich. He succeeds E. D. Jameson, assigned to other duties.

E. O. Rollings has been appointed an assistant master mechanic of the Louisville & Nashville, with office at Howell, Ind.

A. W. Lewis has been appointed chief material inspector of the Norfolk & Western, with office at Roanoke, Va.

W. Alexander.

M. W. Lewis succeeds H. H. Johnson as the master mechanic of the Oklahoma Central Ry. His office is at Purcell, Okla.

J. E. O'Brien has been appointed superintendent of motive power of the Western Pacific Ry., with office at San Francisco.

T. M. Vickers and C. M. Stansbury have been appointed master mechanics on the Western Pacific Ry. Their offices are at Oakland, Cal., and Elko, Nev., respectively.

W. Alexander has been appointed a district master mechanic of the Chicago, Milwaukee & St. Paul, with office at Milwaukee. He succeeds J. C. Miller, who has resigned.

Mr. Alexander was born in Glasgow, Scotland, in 1872. He started railroad work as an apprentice in the drafting room of the Chicago, Milwaukee & St. Paul Ry. in 1887. After serving his apprenticeship he took a course in mechanical engineering at the University of Wisconsin, graduating in 1897. After this he was employed as an instructor and professor in the Universities of Wisconsin and Missouri, and in Armour institute. In 1902 he was appointed assistant district master mechanic of the Chicago, Milwaukee & St. Paul Ry. at Minneapolis, and two years later was moved to Milwaukee, where he held the same position until his recent promotion to master mechanic of the Middle District. Mr. Alexander has combined a technical training with practical experience in a manner calculated to make him one of the most solid men serving a railroad in like capacity, in the country, and those who have the pleasure of meeting him in connection with his work or in a social way are sure to be impressed with that fact.

Among the Manufacturers

WOOD LOCOMOTIVE FIREBOX.

Fred H. Snell, employed by the Wm. H. Wood Locomotive Firebox & Tube Plate Co., Media, Pa., reports under date of Nov. 30, 1909, on the Wood fireboxes in service on the New York Central, as follows:

This is to certify that I was engaged on or about February of this year by the Wm. H. Wood Locomotive Firebox & Tube Plate Co. of Media, Delaware Co., Pa., to examine, watch and report on engines equipped with their patent fireboxes and tube plates, the numbers of which are 2490, 2494 and 2481 respectively, which I found were running and being compared against engines of the 28 class instead of the 24 class, the numbers of which were 2844, 2924 and 2944. As the 28 class of engines and boilers were being compared by Mr. Crandall, road foreman, as being about even on coal consumption, for doing the same work as our engines and boilers, the comparison as against ours you will note had the following advantages: Extra firebox surface, extra height from grate to water bars, as well as being fitted with brick arches, and also being the latest type of new engines and boilers; whereas, our boilers are on old engines rebuilt. I found this out by getting into the firebox, and the boilermaker who was there at the time remarked, "If our boilers had 20 inches from grates to water bars instead of about 5½ inches, they would be wonders." After my complaining about the 28 class of boilers running against ours, and being compared on coal consumption, the order was changed to have identically the same size engines and boilers of the 24 class, the numbers of which are 2492, 2499 and 2487 respectively, and other engines have been substituted and referred to in my coal reports. You will note by the reports that our boilers are doing very superior work to those of the regular 24 class, inasmuch that they are better steamers and great coal savers, the data being secured by measuring the cubical contents of coal left in the tenders on the return trips. The firemen have been changed on these engines from time to time, in order to note the different results, but you will find, on referring to my reports in tabulated form, that it has made little or no difference in the quantity of fuel used. I have talked with the firemen, who have been changed from time to time on these engines, as well as the different engineers who have run them on their trips, and they all speak in the highest praise in regard to the workings of the boilers as against those which are not fitted with our patent fireboxes and tube plates. The engineers tell me that they have not seen any tubes leaking when they had the engines in their charge, and from the careful examination I have given these boilers every day, up to the present time, I am satisfied that the tubes could be run for 4 or 5 months without putting an expander in them, and if it was not for the fires being dumped so often and the engines run into the round houses under their own steam, taking cold air through firebox and tubes, they would go on working indefinitely without having any trouble from leakage.

There has not been a broken stay bolt since they were put into service. There was one defective throat sheet stay leaking, on account of it having the tell-tale hole drilled at an agle instead of straight in the center. After engine 2490 had been running nearly nine months, never missing a trip, I had a chance to examine her a number of times internally, when the tubes were taken out on account of the water being such that it honeycombed the tubes very badly. After they had taken out the tubes and fixed them over, I made, as previously stated, a thorough examination inside the boiler with torch and chisel, to find out the condition of the firebox and tube plates. I examined them very carefully indeed, and found the firebox and tube plates in first-class condition.

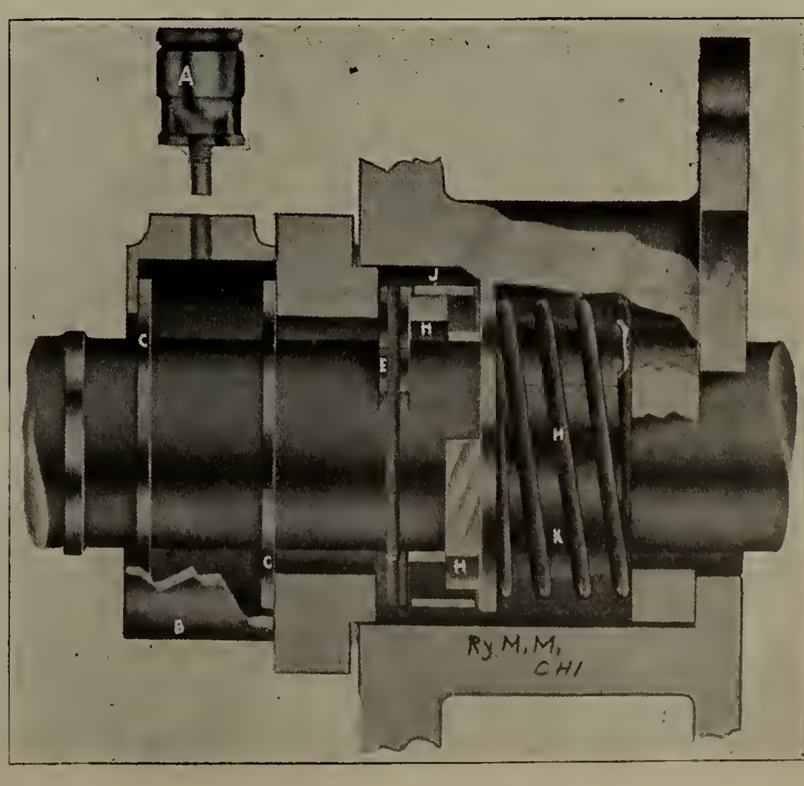
I also had occasion to examine engine 2494 after she had been running about nine months, as she was put in the shop to have her tubes replaced. It was such a remarkable coincidence that they had not broken any stay bolts in either boiler that after the tubes had been put in again, an order was issued for the building of twelve extra rows of radial stay bolts, with 3-16-inch holes 2½ inches deep, to see whether any of the stay bolts really were defective. I have to further report that after the non-conducting material had been taken off the back head of the boiler 2490, just over the left-hand firedoor, it was found that two stay bolts had been fractured. In engine 2494, just over the left-hand firedoor, it was found that one stay bolt had been fractured. The boilers and safety valves were tested in the usual way, and everything found O. K. I am examining these boilers daily, after each trip, and they are showing up good, and I have measured up the coal, as is usual. Engine 2481 is still working and doing good work. There have been no leaky or broken stay bolts, or leaky mud rings on any of the three boilers since I have been watching them. There have been several crown bolts leaking, from time to time, caused by dumping fires, but nothing of any consequence, and have easily been fixed. I am sure that the question of saving coal, as reported by me, will be found as nearly correct as it is practical to get it, and they will find it to be so if more scientific arrangement is adopted.

METALLIC PACKING FOR LOCOMOTIVE RODS.

The Paxton-Mitchell Co., Omaha, Neb., has placed on the market an interesting style of locomotive rod packing which is illustrated in the accompanying illustration, in which, for the sake of simplification in description the letters indicate the features as follows:

A—Oil Cup; B—Swab Cup; C—Swab Cup Disc; D—Piston Rod Gland; E—Split Joint Ring; F—Retaining Coil Spring; H—Babbitt Segments; I—Supplemental Spring; J—Retaining Ring; K—Split Follower; M—Coil Spring; N—Stuffing Box Bushing.

The packing can be used for either piston or valve rods, of course, and it is stated that it will successfully pack rods which are out of alignment, that it requires no replacing of parts other than babbitt segments, and that it reduces the



Paxton-Mitchell Packing.

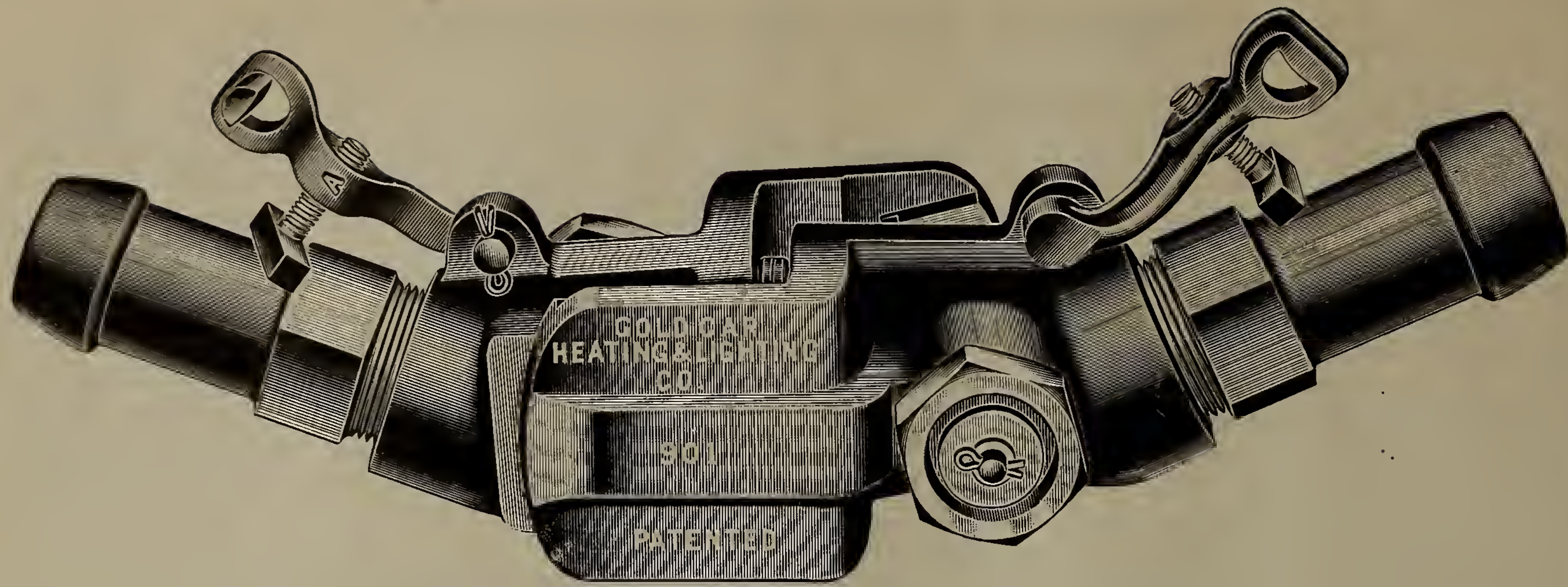


Fig. 1.

wear to minimum. The packing has seen considerable service in locomotive works and has given good satisfaction.

POSITIVE LOCK FOR STEAM HOSE COUPLINGS.

The Gold Car Heating & Lighting Co. has recently developed a positive lock for steam train line couplers which can be very quickly tightened and loosened without the use of tools. It is a generally accepted notion that the couplers for air, signal and steam connections between cars should be automatically separate in case the cars are uncoupled or a break in two occurs. Most roads, however, require their train men to separate the hose couplings by hand when trains are broken, as it is more or less injurious to the hose if they are "pulled" apart. The shape and weight of the coupler heads in connection with the angle at which the hose is attached ordinarily maintains the gaskets in close contact when coupled, but at the same time permits automatic uncoupling.

The high speed of modern trains, together with the increased steam pressure often carried in the trainline to operate electric generators in the baggage car makes a positive lock—one that cannot be loosened and caused to leak by vibration or excessive pressure—desirable between engine and tender, and also between engine and baggage car, and the new lock in question very simply performs this function. The illustrations herewith represent a pair of couplers with the new locks, the couplers connected, but not locked, being ilustrated by figure 1, a pair of locks detached from the couplers by figure 2, and the coupler with locks tightened by figure 3.

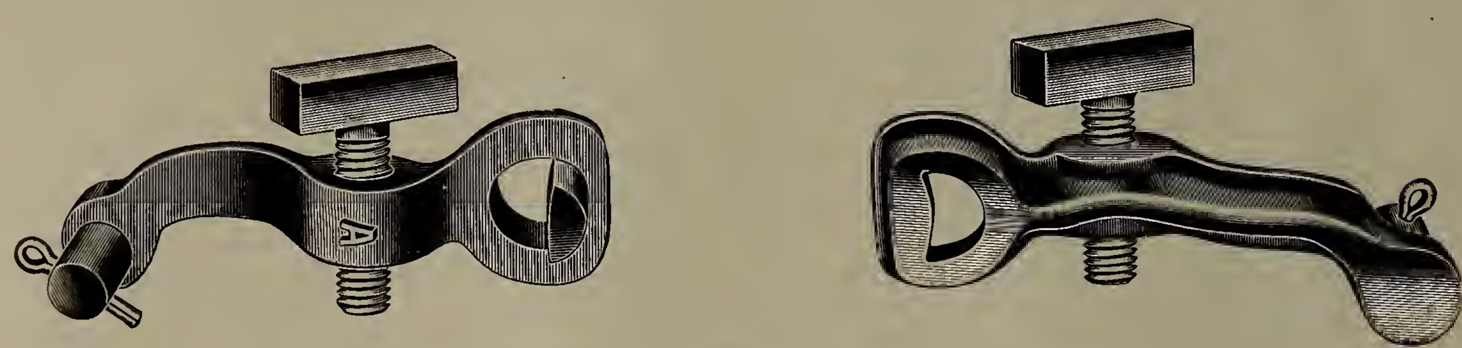


Fig. 2.

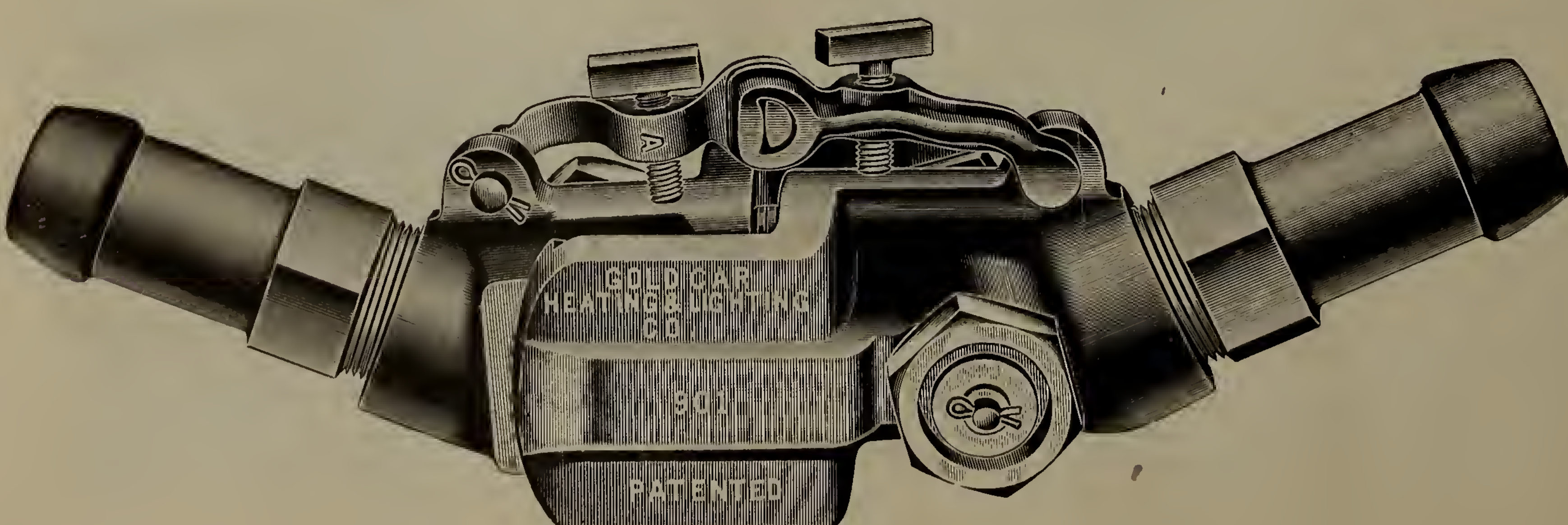


Fig. 3.

In the eye cast in the coupler, immediately over the gravity relief trap and where the chain was sometimes attached, is inserted one end of the lock, which is shaped like a pin and secured with a cotter, as seen in the cuts. (The chain may then be attached to the hose clamp, if desired.) The other end of the lock has a projection shaped like a cylinder split through its axis and an opening of similar shape to engage the semi-cylindrical part of the adjacent lock. A thumb screw near the middle serves to force the locks upwards when engaged and so pull the couplers tightly together like a toggle joint. The point of the screw bears against the body of the coupler and is riveted over to prevent working out of the lock. This lock is made of malleable iron and has sufficient play in the eye of the coupler to allow of readily inserting the half cylinder in the half circular opening of the mating lock. A few turns of the screws—which have large T heads—binds the couplers firmly together.

These locks are made for each size of coupler and are so designed that where couplers of different sizes will couple the locks will also operate properly. It is not necessary to confine these locks to the couplings at the head end of trains, however, and they may be used when desired between the various cars of a train. This has been done on some of the large lines in the Northwest, where it was felt that the additional security against leakage was more important than the automatic uncoupling if the train should break in two—a contingency which seldom happens. It incidentally prevents the "pulling" apart in switching and thus reduces the wear of the hose in the hands of careless trainmen.

The cuts show the gravity relief trap which has been so favorably known for a number of years. It has been recently improved by making the seat so wide that the gasket maintains a smooth surface against the seat, preventing leakage due to wear. As this trap is operated by gravity, it simply falls open when pressure ceases, allowing the water of condensation accumulated in the train line to flow to the ground and avoid freezing in very cold weather and reducing the time required to get steam at the rear of the train even in moderate spells, as there is no water in the pockets to be driven to the end of the train line. Trainmen can always tell if pressure is on the line by simply tapping the valves, thus avoiding being scalded by hot steam when uncoupling. With this trap it is unnecessary to separate the hose coupling every time the train is laid up, which operation is often forgotten. The life of the hose is also increased by reducing the amount of twisting and bending which is a necessary accompaniment of the process of coupling and uncoupling.

MOTOR-DRIVEN PUNCH PRESSES.

The old, dark punch shop, with its lines of overhead shafts and belts, has disappeared from the modern factory with the advent of individual motor drive. As its successor, there has been left a clean, well lighted apartment, free from ceiling obstructions, and having each machine separately driven by its own self-contained motor.

One of the most important operating results of this change has been the reduction in running costs. In order to operate a single machine it no longer becomes necessary to incur the transmission and friction losses of the whole shop. Each press is started and controlled from the switch and rheostat on its frame or in a nearby position. The mechanical connection from the motor to the crank shaft is made directly and efficiently by spur or chain gearing, giving a suitable speed reduction with a minimum number of parts.

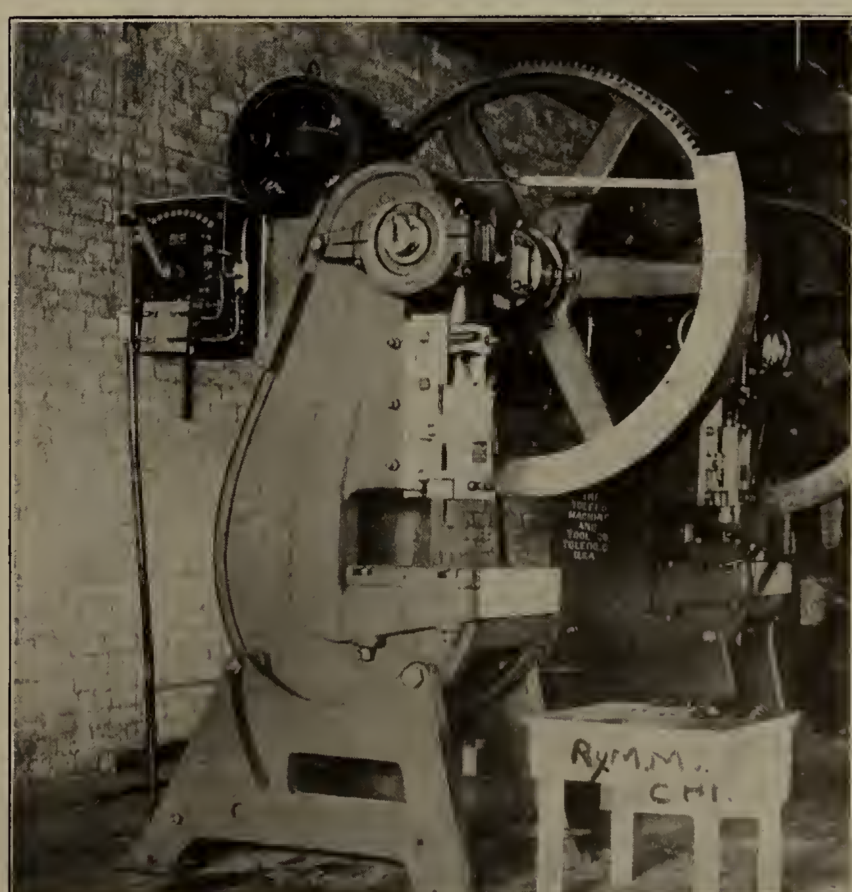
The accompanying photograph shows a motor-driven stamping press for making metal boxes, installed in the factory of the Eclipse Box Manufacturing Co., Grand Rapids, Michigan. The machine is a Toledo open-back, inclinable, plain press, used for making handles, lock parts, scutcheons, corner reinforcements and other similar parts of metal boxes. This machine is driven by a 2¾-H. P., 250-volt Westinghouse, type "S', direct current shunt motor' which runs at 1,025 revolutions per minute. Line switch and starting rheostat are shown mounted directly on the machine frame. The large spur-gear reduction, meshing with the motor pinion, transmits directly to the crank shaft, which varies the pitman connecting to the cross-head punch motion.

The demand for individually driven presses has been growing for several years, and at the present time the manufacturer is furnishing a greater number of machines fitted with this modern form of electrical operation than ever before. The growing scarcity of wood for packing cases has forced shippers into an increasing use of steel boxes. The industry thus started is destined to develop shortly into a very great business, which will include the manufacture of all kinds of containers for which wood is now used.

MECHANICAL FINDER OF MEN.

A device, which is used for the purpose of locating men in shops, factories, warehouses and institutions of like nature, has been placed on the market by the Autocall Co. of Shelby, Ohio.

The "Autocall" is an automatically operated signal system. A central or operating station is located in the main office and when any foreman desires to reach the superintendent or any other party that may be wanted a signal is automatically sent from the central station and repeated over a code of signals similar to the Morse code, but not so complicated. The party whose whereabouts are unknown hearing his signal, either returns to the office or merely steps to the nearest telephone and calls the office to learn what is wanted of him. It is estimated that in the average factory or shop 10 per cent of the working day is now wasted by being unable to quickly locate someone whose decision must be given in regard to certain work and there is no method except the Autocall which quickly reaches the party desired without disturbing anyone else in doing so. The Autocall Co. has sold nearly 300 systems in the past two years and from reports received from the users it would indicate that the Autocall will be adopted in 50 per cent of the factories, shops, mills, etc., in the country within the next two years.



Toledo Special Press with Motor Drive.

A PIPE FOR RAILWAY MEN.

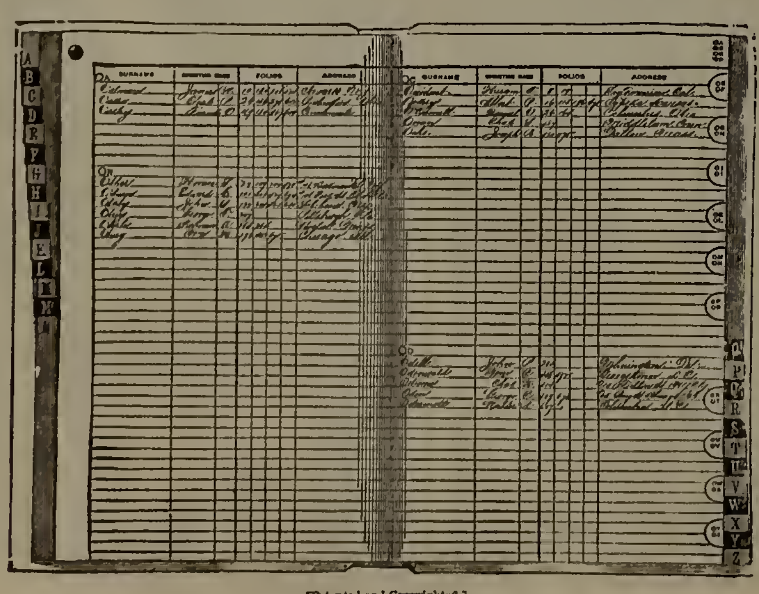
A pipe, new in construction, as will be noted by the accompanying illustration, has been placed on the market by the Acme Pipe Co., Station M, Cincinnati, Ohio. The shape of the bowl, it is stated, prevents the tobacco from packing so solidly as to preclude the possibility of good circulation of air. The bottom of the bowl has a series of holes angling through solid Vienna

New Design of Pipe.

meerschaum to a point at the apex of the bowl. This construction assists in the free circulation of the air through the tobacco. The result is a very pleasant, cool smoke, equal to that of a fine cigar. The bowl of this new pipe is said never to get wet or soggy, as other pipes do. This is owing to the air chambers in the briar part of the pipe between the stem and the meerschaum bowl. For purposes of introduction the pipes are being sold at $2 each.

BURR'S COMBINATION INDEX.

A system of indexing which appears to be highly efficient has been patented by the Burr Index Company of Hartford, Conn. An insight into the method used in this system may be gained from the accompanying illustration. The Burr index is arranged with a projecting alphabet printed in gold letters on morocco leather (red and black alternating) folded over sheet steel. The gold letters are printed on both sides, projecting one-half of an inch from the edges of the leaves, just even with the covers of the book. When the book is open, the whole alphabet can be seen at a glance, from either side, at any letter from A to Z, together with the combination of each letter, as shown by the above cut. It can be used with either hand for any length of time, without turning the covers of the book.



Patented and Copyrighted.
Burr's Combination Index.

Thumb-holes are cut in the edges of the leaves, in which appear combinations for all names in use, and are so arranged, when the index is opened at any letter of the alphabet, that the combinations of each letter appear in full, and do not conflict with the combinations of any other letter of the alphabet. The combinations are also printed in the body of the book to locate the entry of names. The location of any name can be found without any experimental turning of the leaves. For example: to find the name Owen, it is only necessary to turn to O, when the combination Ow is seen at once and only one turn of the hand is required to find the page. The same plan is used throughout the index.

The makers will arrange any of the record indexes to be divided on the first two, three or four letters, as desired.

The Selling Side

Mr. Harry W. Finnell, who has been connected with the Chicago Railway Equipment Co. for the past four years, has resigned to accept a position with the Carbon Steel Co., Pittsburg, Pa. Mr. Finnell will be located in the future at the steel company's New York office at 30 Church street.

The Minnequa plant of the Colorado Fuel & Iron Co. at Pueblo, Colo., was destroyed by fire February 22. The loss is estimated in press reports at $500,000.

The Northern Engineering Works, Detroit, Mich., has recently delivered three 15-ton and one five-ton Northern cranes to the Globe Arizona plant of the Miami Copper Co., New York.

The American Hoist & Derrick Co. are enlarging their power plant by the addition of an Allis-Chalmers 1000 K. W. 1800 R. P. M. 440 volt, 60 cycle, 3 phase, turbo unit receiving steam at 175 pound gauge and exhausting into a 28-inch vacuum.

The National Iron & Steel Co., 303 Chronicle building, Houston, Texas, has been organized with $10,000 capital stock. The officers are: J. M. West, president; I. H. Cohn, vice-president and general manager; J. R. Cohn, secretary-treasurer. The company will establish a sales agency for railway equipment, rails, railway supplies, angle bars, etc.

The Oliver Iron Mining Co., Duluth, Minn., users of about 150 steam shovels, has just placed an order for class 80-18-3 Atlantic steam shovel equipment for the coming season with the Atlantic Equipment Co., New York. The conditions under which these steam shovels are operated, in stripping the overburden from the Missabe range ore deposits, are very severe. The material is glacial drift, consisting mainly of stiff, hard clay full of boulders as large as 100 cu. yds. in volume. The shovels are in service summer and winter, and are worked double shift. The temperature is often as low as 50 deg. below zero. This year's order for steam shovels was placed with the Atlantic Equipment Co. after a season's test of one of the new design, class 80-18-3 Atlantic shovels in the Mountain Iron and Burt-Pool mines during 1908-1909.

George P. Heinz & Co., Denver, Colo., have been appointed western selling agents for David Lupton's Sons Co., Philadelphia, Pa. The new agents will handle the territory west of the Missouri river in the sale of Lupton factory specialties, including steel sash, rolled steel skylight, Pond operating device and Pond continuous sash.

The following, relating to particulars as to the assignment of space for the June conventions, is taken from a letter written by J. D. Conway, secretary of the Railway Supply Manufacturers' Association: "The drawing took place in Pittsburg in the Fort Pitt Hotel on February 16, the full exhibit committee being present, B. E. D. Stafford, chairman, S. P. Bush and C. P. Storrs. There was about 95 per cent of the entire exhibit space applied for and possibly 80 per cent of the applicants were given their preference as to location. Circular matter was mailed to all of the old exhibitors under date of January 10 and to those whose applications had not been received, we sent "puncher" on February 5. It may be that a few old exhibitors not heard from do not intend to exhibit this year. There are quite a few new exhibitors, however, and some few yet that we are expecting will want space, who necessarily will have to take what is left. It is the purpose to endeavor to locate all who may wish to exhibit this year in some manner. The badge committee has gotten up a very beautifully designed badge this year for the supply men, their ladies and railroad ladies, Mr. A. L. Whipple, chairman.

On May 1 the Dearborn Drug & Chemical Works will move its general offices and chemical laboratories from the Postal Telegraph Building, Chicago ,where they have been located since the organization of the company more than twenty years ago, to the new McCormick Building, on Michigan Avenue and Van Buren street. The extensive growth of the business of the company has made necessary this removal to its new location, where the general offices and laboratories will occupy the greater portion of the top floor of one of the finest office buildings in Chicago. The company will have the entire frontage on Michigan avenue for its offices and laboratories, with a total floor space of more than 5000 sq. ft.

The Gold Car Heating & Light Co., New York, has received orders for the heating equipment for the 30 passenger coaches now building at the Pullman works for the Pere Marquette.

W. D. Beck, formerly division superintendent on the Chicago & Northwestern at Chicago, has resigned to become general manager of the Aurora Automatic Machinery Company, Aurora, Ill.

The Williamsport Gas Engine Works, Williamsport, Pa., has reopened the plant of the Williamsport Gas Engine Co., which has been shut down during the past year, and will continue the entire line of gas and gasoline engines formerly manufactured by the old company. They are looking for active agents in all sections of the country.

W. C. DeArmond advises his many friends that he has taken over the business of the Protectus Company, having become owner, by purchase from the receivers. The manufacture of the same high-grade paints for the protection of metal and wood, marine compositions and insulating paints, will be continued, under the trade name of The Protectus Paint Co.

In the suit of the Simplex Railway Appliance Co. against the Pressed Steel Car Co. for infringement of "Simplex" bolster patents, Judge Hazel, of the United States Circuit Court for the Southern District of New York, has recently decided in favor of the Simplex people, and has ordered an injunction against the Pressed Steel Car Co. to restrain it from further use of the device, and has also ordered an accounting, with costs, in favor of the Simplex Co.

Burton W. Mudge & Co., Chicago, announces the appointment of Mr. Otto P. Hennig as sales manager. Mr. Hennig will have charge of sales, advertising and purchasing.

Hugh M. Wilson, for many years the head of the Railway Age of Chicago and recently vice-president of the Barney & Smith Car Co., has resigned the latter office to become first vice-president of the McGraw Publishing Co., New York.

Green, Hook & Co. has been organized to manufacture and sell chemicals for boiler treatment. Jacob W. Hook and Stanley K. Green are interested in the company. The main office will be in the Hudson Terminals building, New York; the main laboratory and works at Jersey City, N. J., and a branch laboratory at Baltimore, Md. Sales offices will be located in Boston, Mass.; Philadelphia, Pa.; Baltimore, Md.; Norfolk, Va., and Havana, Cuba.

At the annual stockholders' meeting of the King-Lawson Car Company, Middletown, Pa., on February 9, the following directors were elected for the ensuing year: Thomas Lawson, G. O. Draper, Edward Bailey, Harold C. Hansen, Paul A. Kunkel, Arthur King and Howard W. Bible. At the directors' meeting, called immediately after the adjournment of the stockholders' meeting, the following officers were chosen for 1910: Thomas Lawson, president and general manager; Howard W. Bible, vice-president; Harold C. Hansen, treasurer, and Paul A. Kunkel, secretary.

The annual report of the Chicago Pneumatic Tool Co. for the year ended December 31, 1909, shows total profits of $558,928. This compares with total profits of $289,625 for 1908. Last year there was written off for depreciation, including repairs and renewals to buildings and plants and developing and perfecting new tools, $140,168, comparing with $92,000 written off for depreciation, repairs and renewals in the previous year. After the payment of interest on bonds and sinking fund instalments there was a balance of $250,610 carried to surplus in 1909, as against $21,500 in 1908. Of the total profits in 1909 but $186,468 was earned in the first half year, leaving $372,460 profits earned in the second half year. The balance sheet of December 31 shows cash in hand amounting to $118,296, and accounts and bills receivable, less reserves, amounting to $1,909,032. Accounts and vouchers payable amounted to $106,981 and bills payable to $60,000. The president's report, dated February 11, says that at the present time virtually all of the plants are being operated to their full capacity.

The Gerlinger Steel Castings Co., West Allis, Wisconsin, is continually in the market for boiler punchings. A steel of 4 per cent phospher is desired.

A number of manufacturers of railway supplies whose shops are situated in the district in Chicago represented in Congress by James R. Mann, chairman of the House committee on interstate commerce, are circulating a petition asking Mr. Mann to use his influence to stop the agitation in Congress for drastic legislation affecting railways. Mr. Mann himself has introduced some of the most radical measures pending in the house. The petition says: * * * Without questioning the merits or demerits of the railway legislation proposed by you or others, we believe that no harm can be done by limiting much of the proposed railway legislation and giving the railways an opportunity to work out or demonstrate their intention of carrying out railway legislation already in effect. We have suffered greatly in our business during the last two years, largely on account of the poor financial condition of railways. The chief promoters of the petition are the following: "American Steel Foundries, American Brake-Shoe & Foundry Company, Blue Island Rolling Mill & Car Company, By-Products Coke Corporation, Dearborn Drug & Chemical Works, Federal Furnace Company, Featherstone Foundry & Machine Company, Griffin Wheel Company, Iroquois Iron Company, Pickards, Brown & Co., Rogers, Brown & Co., Railway Steel Spring Company, Sherwin, Williams & Co., Willard, Sons & Bell Company."

Mr. John B. Given, formerly assistant to the vice-president of the Duplex Metals Co., of New York, has been appointed representative of the C. H. Whall & Co., dealers in railroad specialties, whose main office is at 170 Summer street, Boston, Mass.

The Western Electric Company, New York, has adopted a new trade name for those types of telephones which have heretofore been known as Intercommunicating or Private Line Telephones. These are henceforth to be known as "Western Electric Inter-phones," and the word inter-phone is to be used to the exclusion of the old designations.

Railway Mechanical Patents Issued During February

Uncoupling device, 947,243—Harry T. Krakau, Cleveland, O.
Draft gear, 947,244—Harry T. Krakau, Cleveland, O.
Buffer for radial draft gear, 947,241—Harry T. Krakau, Cleveland, O.
Alloy for making car wheels, 947,248—Wm. W. Lobdell, Wilmington, Del.
Radial draft gear, 947,258—Henry F. Pope, Cleveland, O.
Car underframe, 947,259—Herman C. Priebe, Chicago, Ill.
Railway cattle guard, 947,268—Geo. F. Wood, McKinney, Tex.
Steam heat coupling, 947,280—Edward E. Gold, New York city.
Railway motor, 947,338—Samuel M. Kintner, Pittsburg, Pa.
Car underframe end construction, 947,339—Felix Koch, Bellevue, Pa.
Car Seat Frame, 947,342—Chas. A. Lindstrom, Pittsburg, Pa.
Draft gear, 947,348—Henry F. Pope, Cleveland, O.
Draft gear, 947,349—Henry F. Pope, Cleveland, O.
Bolster for steam shovels, 947,356—Wm. Sheppard, Paterson, N. J.
Railway car construction, 947,372—Jas. M. Coleman, St. Lambert, Quebec.
Screen for car openings, 947,413—Isaac Kommers, Jr., Chicago, Ill.
Car wheel, 947,435—Geo. H. Downs, North Powder, Ore.
Steam heat coupling, 947,487—Edward E. Gold, New York city.
Air brake cylinder attachment, 947,541—C. P. Cass, Maplewood, and H. A. Wahlert, St. Louis, Mo.
Gasket for hose coupling, 947,645—Robert S. MacEwan, Troy, N. Y.
Track sanding appliance, 947,652—Fred G. Schwartz, Colorado City, Col.
Draft appliance for front ends, 947,660—Jas. S. Downing, Atlanta, Ga.
Hopper car, 947,682—D. L. Knowles, John Marvel and Chas. Heselden, Danville, Ill.
Locomotive exhaust, 947,689—Mathias Speicher, Carbondale, Pa.
Car coupling, 947,745—Clinton A. Tower, Cleveland, O.
Uncoupling mechanism for cars, 947,747—Arthur J. Bageley, Cleveland, O.
Car coupling, 947,748—Arthur J. Bageley, Cleveland, O.
Radial draft gear, 947,756—Henry F. Pope, Cleveland, O.
Draft gear, 947,757—Henry F. Pope, Cleveland, O.
Swivel plate for motor truck, 947,792—Andrew Christianson, Butler, Pa.
Door opening device for hopper cars, 947,793—Andrew Christianson, Butler, Pa.
Draft rigging, 947,857—Chas. S. Shallenberger, St. Louis, Mo.
Car door fastening, 947,931—P. P. Peakes and Percy M. Hamlin, Milo, Me.
Car door, 947,947—Peter J. Schnoor, Holstein, Ia.
Train order catcher, 947,999—Louis C. Schweppe, Spokane, Wash.
Exhaust nozzle, 948,019—John Player, Schenectady, N. Y.
Exhaust pipe, 948,020—John Player, Schenectady, N. Y.
Locomotive exhaust pipe, 948,021—John Player, Schenectady, N. Y.
Journal box, 948,037—Samuel T. Bale, Philadelphia, Pa.
Locomotive engine, 948,066—Howard D. Taylor, Reading, Pa.
Car coupling attachment, 948,096—Jas. W. Jackson, Capron, Va.
Sleeping car berth, 948,128—Lars J. Berg, Chicago, Ill.
Air intake for cars, 948,144—Hosmer W. Leeds, Chicago, Ill.
Train service coupling, 948,150—Ira B. Turner, Philadelphia, Pa.
Electric locomotive, 948,154—Wm. E. Woodard, Schenectady, N. Y.
Uncoupling device for car coupler, 948,205—Jas. R. Carmer, Wilmington, Del.
Locomotive automatic stoker, 948,220—Stanton D. Griffin, West Point, Miss.
Car seat, 948,309—Frederic W. Butt, Brooklyn, N. Y.
Coupling for train pipes, 948,312—Robert W. Dixon, East Orange, N. J.
Journal brass, 948,316—Frank J. Finning, Nashua, N. H.
Superheater, 948,331—Henry W. Jacobs, Topeka, Kan.
Turn table, 948,352—Henry R. Stickney, Portland, Me.
Train stop and signal actuating mechanism, 948,361—Jno. F. Webb, Jr., New York, N. Y.
Car coupling, 948,399—Jas. V. Munger, Portland, N. Y.
Car coupling, 948,400—Jas. V. Munger, Portland, N. Y.
Bell operating mechanism for railway cars, 948,403—F. J. Roche, Somerville, Mass.
Electro-pneumatic valve mechanism for air brake and train-stopping systems, 948,404—Jean F. Webb, Jr., New York, N. Y.
Electric pneumatic valve mechanism for air brake, 948,405—Jean F. Webb, Jr., New York, N. Y.
Car coupling, 948,458—Jas. V. Munger, Portland, N. Y.
Car coupling, 948,459—Jas. V. Munger, Portland, N. Y.
Universal controlling valve, 948,571—W. C. Arp, F. F. Hildreth and F. N. Rumbley, Terre Haute, Ind.
Car coupling, 948,606—Jno. L. Daddow, Portsmouth, Va.
Car side construction, 948,656—Jerome G. Bower, Chicago, Ill.
Hose coupling, 948,667—Egbert H. Gold, Chicago, Ill.
Car door, 948,690—Thos. M. Cole, Conway, Ia.
Car coupling mechanism, 948,765—Archer Lewis, Lewisham, N. S. W., Australia.
Flexible steam pipe connection, 948,858—Geo. W. Henry, Jr., Philadelphia, Pa.
Extension car step, 948,874—Ulysses E. Crofut, Jr., Scranton, Pa.
Locomotive ash-pan, 949,017—Harry A. Hoke, Altoona, Pa.
Elevated railway, 949,020—William C. Lawson, Roanoke, Va.
Train-pipe coupling, 949,046—Howard W. Thomas, Charleroi, Pa.
Device for use in producing burnt-clay ballast, 949,141—George M. Bennett, Kenosha, Wis.
Automatic train-stop, 949,445—Knut W. Carlgren, Salt Lake City, Utah.
Superheater, 949,147—Francis J. Cole and Henry B. Oatley, Schenectady, N. Y.
Locomotive ash-pit, 949,162—Otto Spaeth, Chicago, Ill.
Car ventilating system, 949,212—Peter B. Bogart, Milwaukee, Wis.
Car-lift, 949,228—Frank C. Greene, Cleveland, Ohio.
Thermostatic controller for car-heating systems, 949,285—James F. McElroy, Albany, N. Y.
Spring-plank for car trucks, 949,292—James H. Baker, Pittsburg, Pa.
Steam heat regulator, 949,286—Jas. F. McElroy, Albany, N. Y.
Register-operating car-step, 949,299—Frederick Langharst, Evans City, Pa.
Electric locomotive, 949,347—Ernst F. W. Alexanderson, Schenectady, N. Y.
Wardrobe-hanger for sleeping-cars, 949,356—Joseph A. Halderman, Chicago, Ill.
Hand-car, 949,418—John C. Dunlop, Minier, Ill.
Car-brake, 949,471—Jesse H. Hand, Ann Arbor, Mich.
Bracket for freight-car doors, 949,484—Henry Kappele, Stamford, Conn.
Refrigerator car, 949,491—Robert F. McGregor, Philadelphia, Pa.
Dump-car door, 949,494—Spencer Otis, Chicago, Ill.
Vehicle-brake, 949,652—Joseph H. Hotchkiss and Arthur P. Lane, Denver, Colo.
Grain-door for freight cars, 949,659—Peter S. Ratzlaff, Buhler, Kans.

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ARTICULATED LOCOMOTIVES ON THE MOFFAT ROAD.

The Denver, Northwestern & Pacific Ry., better known as the "Moffat Road," purchased a Mallet articulated locomotive in the fall of 1908 and placed it in service on the four per cent grades and ten degree curves for which, together with its frequent tunnels and snow difficulties, this road is famous. The engine has been a great success as a pusher of rotary snow plows, the service in which it is used about eight months in the year. On account of the seriously adverse conditions, the performance of this locomotive and the two others of the same class which have since been placed in service over the same mountains by the Moffat road, have attracted some attention. An accident to one of the two engines lately purchased, which, as far as we know, is the first accident of its kind since the first articulated locomotive was placed in service in this country, is worthy of discription on account of its bearing on the question of safe speed limits for this type of engine. As yet this question has not been decided by the mechanical heads of the Atchison, Topeka & Santa Fe Ry., which road operates the only articulated locomotives yet designed for passenger service.

Recently one of the three articulated locomotives operated by the Moffat road, while descending one of the heavy grades of the system, was allowed by the engineer to attain two high a speed before being steadied by an application of the brakes. Awakening to the situation too late, the engineer was unable to check the speed of the train by means of either the water or air brake or by reversing. The engine left the track at a curve and plunged off the fill over which the train was running. Were it possible to accurately estimate the speed of the train at the curve, some valuable data would be available. As it was, the engine crew and the head brakeman were all killed. The rest of the train crew gave estimates of the speed which varied from fifty to eighty miles per hour. It is probable that the train was running at a speed considerably less than fifty miles per hour, however, and this being the case the speed would not have been dangerous for a rigid frame engine. The excessive leverage exerted by the boiler of the articulated locomotive is unparalleled in any other design. The flanges of the rear drivers and the trailer must bear the brunt of the attack when, in curving, the swing of the boiler is governed by its fixed position in line with the rear engine frames. The increased length of the boilers necessary to secure capacity in the later types aggravates this condition until it seems highly important that some data be secured on the subject. The flexible boiler proposed some time ago, if materialized, would obviate the difficulties of the nature mentioned above, and would seem the only solution of the problem of designing a high speed passenger articulated locomotive. Meanwhile the greatest of caution should be used in the operation of the present designs.

Incidentally, George Thompson, superintendent of motive power of this railway, has found that, contrary to general opinion, the articulated locomotive will slip as badly as any other design, except that it does not start slipping as easily. The forward set of drivers is usually the first to slip on account of its finding the slippery rail first. The relief of the back pressure on the high pressure cylinders then causes the rear set of drivers to slip, and unless the throttle is closed both sets of drivers will continue to slip. Having had a great deal of trouble with sand as an antidote, possibly owing to difficulty in keeping it dry in the mountain districts, Mr. Thompson found that water piped from the tender tank proves much better in producing results. His engineers now operate water valves instead of sanding devices. Mr. Thompson's personal opinion as to the utility of the articulated locomotive is best expressed by his statement that an order has been placed for several additional engines of this type.

CRANES.

The crane is probably one of the oldest mechanical devices with which we are familiar and yet it is only within the last decade and with the use of electricity as a source of power that it has become an important and highly developed machine in our shops and industrial works. The name presumably comes from the bird of that name which with its long neck presents a flexibility of operation unexcelled by any of our modern devices. The primitive crane consisted of a pole used to pry up a rock or to raise water from a well, and it is hard to recognize some of our large modern machines for the transference of materials as the descendant of this simple piece of apparatus. In its various forms, the crane plays a large part in lightening the work of man today; we can imagine, for instance, the joy which a half dozen modern American cranes would have brought to the builders of the pyramids. Without our unloading and transfering cranes, it would be impossible to handle the immense amount of freight which is now handled at large railway and steamship terminals, but in this respect we have not made use of them as fully as have European countries. At Hamburg for instance, there are one thousand cranes for unloading purposes in charge of the harbor authorities. The German development of electric cranes has established one motor for each movement as the best practice, and the motors at Hamburg operate on 550 volts, direct current. Bremen, Antwerp and Glasgow have also made great strides in equipment for handling freight traffic; Bremen having expended over thirty million dollars in these improvements. At San Francisco, in our own country, practically no conveying machinery is employed except man, and when we consider the growing importance and amount of Oriental traffic passing through her gates it seems surprising that so little has been done to facilitate its movement. The general practice in English freight stations and warehouses seems to be in favor of the installation of jib cranes, generally hydraulic, to serve all the floor space, their idea being that the saving of one man's labor justifies the investment of $5,000 in mechanical labor-saving appliances. Handled freight in Chicago costs about 49 cents a ton, and as freight traffic in the United States has increased 400 per cent in the last twenty years the economical handling of freight by means of transfer cranes is an important problem.

Practically every shop of any size is well equipped with transverse cranes, which probably handle general work as efficiently as could be expected, and there is little criticism to be made of them. However, many shops are not equipped with the smaller cranes as abundantly as they should be; under balconies, over the smaller machines where the lifting of a casting perhaps taxes the strength of the operator and decreases his efficiency. In such places a small air crane running on a jib of ten or fifteen feet radius can be installed at a small expense and will more than pay for itself in a short time. Where a number of such cranes are employed the valves and fittings should be examined from time to time for leakages as small leakages of this sort throughout a large plant will show up in dollars and cents at the power house. Small electric cranes are somewhat more expensive to install and are probably no more efficient than the air crane. The increasing use of the magnet opens up a larger field for cranes in the casting and scrap yards. The installation of a traveling crane and magnet facilitates the speed and cost of handling scrap to a great extent and at one modern up-to-date shop the scrap material is handled in this way for about nine cents a ton. One of the latest uses of the magnet crane has been to raise a number of kegs of nails from a sunken steamer; an instance which shows that the number of uses for this class of machinery is increasing daily.

NEW PRINCIPLE OF COMBUSTION IN LOCOMOTIVE PRACTICE.

On page 91 of the Railway Master Mechanic for March there appeared a description of a device which, when applied to a locomotive, prevents the formation of all smoke while at the same time it increases the efficiency in fuel consumption to a great extent. A demonstration of the operation of a locomotive equipped with the apparatus, which is called the "Doylair" system, was carried out to the satisfaction of a number of railway mechanical men in Chicago, March 25. The engine during this demonstration hauled a light train consisting of five gondolas and an observation car about forty miles through the suburbs of Chicago. While the locomotive was not working under much of a load, still the conditions of operation allowed of a fair opinion on its operation. In this case the necessary appliances have been rigged onto a small American type locomotive of ancient date which is owned by the company exploiting the devices, but which is in daily operation on the tracks of the Chicago Junction Ry. A feature of the use of the device is the elimination to a great extent of the need for expert firing. The fireman's care of the fire consists in simply filling and keeping full a fuel magazine and in maintaining the proper distribution of the draft. In equipping a large freight or passenger locomotive to use the principal involved, the apparatus consists of a turbine fan or blower, a magazine to be inserted in the fire box and a device for partially closing the tubes at the front tube sheet. The installation of the apparatus would not appear difficult in the case of any of the modern designs of locomotives.

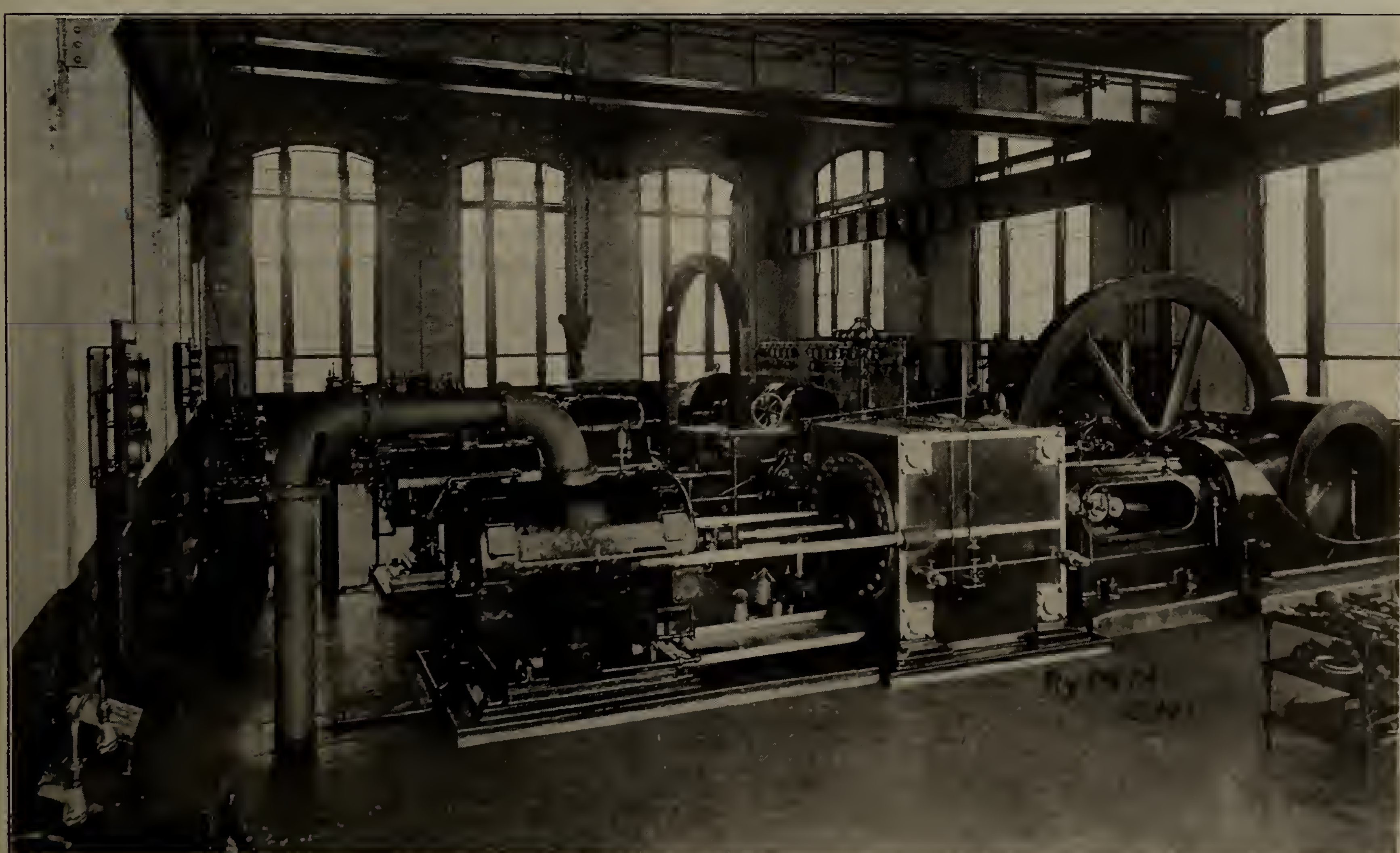
While the emission of smoke is not generally considered a serious evil in the operation of steam locomotives anywhere except in congested districts, still smoke is generally admitted an evidence of poor combustion and its prevention always carries with it an increase in fuel efficiency. If, as claimed for this apparatus, full steaming capacity may be maintained without the emission of smake and there may be obtained, at the same time and without undue complication of parts, an elimination of the necessity for the so-called expert work on the part of the fireman, a studious consideration of the subject would seem warranted. Incidentally the successful use of the apparatus described can not help but reduce boiler maintenance expense by preventing the introduction into the fire box of cold air contingent to present methods of firing.

Water Supply for Macon Shops, Central of Georgia Ry.

Among the advantages peculiar to electric pumping, there is the possibility of locating the delivery apparatus, practically unattended, directly at the intake site, and at any reasonable distance from the source of power, the control station, and the point of delivery. A good example of such flexilbility in disposing the links of a small water supply system is the motor-driven pumping equipment for the locomotive and freight car repair shops of the Central of Georgia Ry. at Macon. The installation of this plant has resulted in assuring a generous supply of water at all times, for general use and fire protection service, besides substantially reducing the cost of each thousand gallons, compared with the price when the supply was purchased.

The present private water supply system of the Macon shops comprises a motor-driven pumping station on the bank of the Ocmulgee river, nearly a mile from the shops and power plant, from which it derives its power supply, and to which in return it delivers 600,000 gallons of water per 24 hours, against a head of 55 feet. No attendant is maintained at the pump house, the machinery being controlled from the power plant in the shop group of buildings, in accordance with automatic indicating and recording devices.

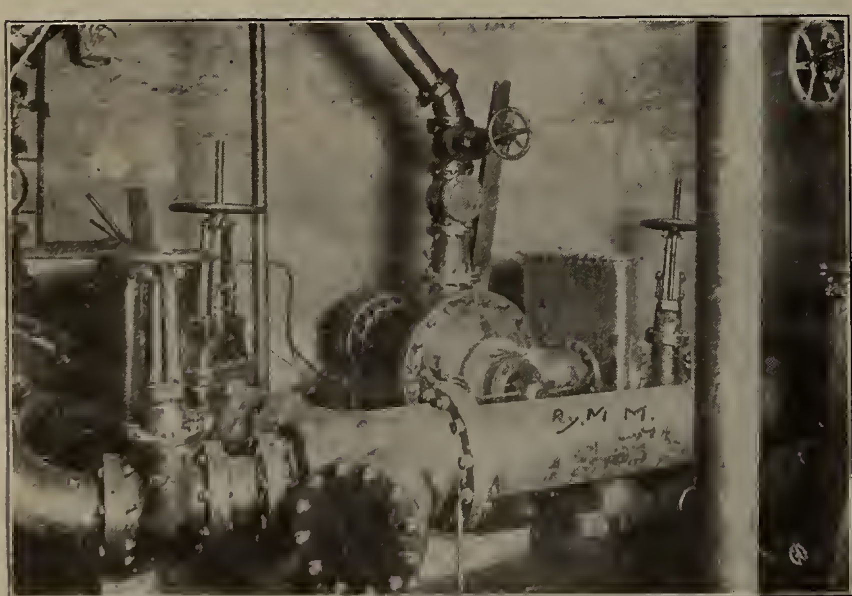
The duty required of the pumping plant is the supply of water for general use about the shops and property, fire protection for the buildings, condensing water for the power plant boilers, and water for the locomotives; all aggregating about 600,000 gallons daily. Chemically, the water of the Ocmulgee river is quite good from a boiler standpoint, but during flood seasons it carries large quantities of sediment and sand, which must be allowed to precipitate out before the fluid can be employed industrially. The presence of this foreign matter in the intake water during certain seasons of the year dictated the selection of impeller pumps for this installation, and the operation under these severe conditions has been entirely satisfactory.



Steam Pumping Station, Macon Shops, Central of Georgia Railway.

The river water is first lifted into a reservoir at the shop site, from which it is distributed by gravity flow to its several destinations. From the reservoir, the raw water is used in the power station condenser, and that portion of the condenser overflow which is needed is then filtered and treated for boiler use. The pump house on the bank of the Ocmulgee river, 4,200 feet distant from the shop, is a circular structure containing three motor-driven, horizontal-shaft, single-stage turbine pumps, each having a capacity of 1,200 gallons per minute. Each pump is direct connected to a 40-H. P., 2,000-volt, three-phase, 60-cycle Westinghouse induction motor running at 1,120 R. P. M. The pumps are fitted with bronze impellers and bronze diffusion veins, securing improved durability and efficiency. The suction line is led in from a screened intake well, while the pumps discharge into a 16-inch main leading to the reservoir at the shop, whose level is 55 feet above the normal stage of the river.

The pump motors are controlled from the power house, independent supply circuits being provided for each machine. This arrangement was found to be simpler and very little more expensive than the scheme of installing automatic starters at the pumping station, with control circuits to the power house. The starting panels for the motors are equipped with ammeters, indicating the current consumed by each unit, while in the main circuit there is included a Westinghouse graphic recording wattmeter which registers the total power consumed. As a rough but constant relation obtains between the water discharged by a turbine pump and the power taken to drive it, the graphic meter record thus affords a convenient means of totaling the amount of water pumped by the plant. The starting panels carry a graphic gauge showing the water level in the reservoir, and by watching this, the power house attendant is able to regulate the delivery of the pumps to the supply rate required. A motor-driven valve in the main entering the reservoir is also operated from a controller at the power station, completing the



Electrically Driven Pumps, Macon Shops.

concentration of control of the entire pumping station at these panels.

In the power plant, the circulation pumps draw from the reservoir directly, and the overflow from the condensers is then taken, as needed, through filtration equipment supplying water for the engine terminal and shops. In the settling basin the water is treated with sulphate of alumina, precipitating the suspended matter.

The general service pumps comprise a duplex simple steam pump, shown in one of the illustrations, with capacity for delivering 700 gallons a minute, and a turbine pump direct connected to a direct current motor, having the same rated delivery. The steam pump is pressed into service when its exhaust can be employed to advantage in heating water for the plant boilers or for filling the locomotives. When this exhaust steam cannot be thus fully utilized, it is found, of course, more economical and convenient to run the electric pump. The control of this equipment is all automatic.

The installation of the plan was made under the direction of F. F. Gaines, superintendent of motive power, and E. M. Rhett, electrical engineer.

The Air Brake Association

The 17th annual convention of the Air Brake Association will be held at Indianapolis, Ind., May 10 to 13, 1910. The Dennisson Hotel has been selected as headquarters by the executive committee.

The subjects and committees selected are as follows:

Air brake instruction, examination and rating—Thos. Clegg, Geo. A. Wyman, H. H. Burns, H. A. Wahlert, T. F. Lyons.

Air pump piping, fittings and connections—Geo. W. Kiehm, John S. Barner, F. F. Coggin.

Best arrangement of air pump and main reservoir capacity for 100-car train service—P. J. Langan, E. H. Dewson, Wm. G. Kaylor.

Brake cylinders and connections and recommendations for overcoming troubles due to cylinder leakage—W. P. Garabrant, L. M. Albers, S. H. Draper.

Inspection and cleaning of triple valves and brake cylinders—C. P. McGinnis.

Past year's developments in air brakes—W. V. Turner.

Questions and answers on New York brake experiment.—T. F. Lyons, O. E. Moore, Wm. Owens, N. A. Campbell.

Questions and answers on Westinghouse equipment—S. G. Down, S. J. Kidder, S. W. Dudley.

Recommended practice—S. G. Down, Geo. R. Parker, L. M. Carlton, Geo. B. Culver, H. A. Wahlert.

Swedish Iron

The livlier demand in Sweden for Lancashire iron has continued during the last quarter of 1909, and it has, contrary to what was expected, been possible to maintain the material rise in prices, which was necessitated by the great strike. The works are fully employed with orders, and many of them experience considerable difficulty in executing them as fast as the buyers desire. The demand has somewhat subsided during the last few weeks, but this is generally the case at the turn of the year, and no special importance is attached to this fact. The price of charcoal, which greatly influences the Lancashire market, continues very high, and although the supply may be larger than is generally expected, it is not likely that the vendors, with the present good state of the timber market, will lower their demands. The production of Lancashire iron has been materially reduced during 1909, and the quantities available for the present year are expected to just cover the demand. The steel works are fully employed for some months to come with orders which accumulated during the strike, and new orders keep coming in satisfactorily. The large contracts recently decided upon by the English navy may help in procuring for the Swedish makers of good tube material some welcome orders. In various quarters cheaper stuff is substituted for Swedish steel, but it is noted with satisfaction that it is making fresh inroads in other directions. The rational methods of manufacture which have now been adopted at the large Swedish works have, of course, increased their competitive power. Shipments have been lively during the last few months of the old year, and those of blooms, pig, and rolled wire cuttings, and nails had already in November considerably exceeded the quantities for the previous year.

Locomotive and Car Shops of the Isthmian Canal Commission

The annual report of the Isthmian Canal Commission for the fiscal year ending June 30, 1909, contains some interesting data on the motive power department of the Panama Railroad. We extract from it the following:

In the scheme of reorganization the mechanical division of the Panama Railroad was placed under the supervision of the second division of the chief engineer's office. At the beginning of the year shops were in operation at Gorgona, Empire and Paraiso, with a master mechanic in charge at each point having jurisdiction over the field repair shops connected with them at neighboring points. There was also an electrical subdivision under an electrical engineer.

During the year the shops at Paraiso were closed, the heavy work formerly done there transferred to Gorgona and Empire, and the running repairs to cars and locomotives transferred to Pedro Miguel engine house. The work of the electrical subdivision was consolidated with the work of the Gorgona shops, and both were placed in charge of the electrical engineer. All heavy repairs to equipment other than steam shovels and steel cars, as well as manufacturing work, are performed at the Gorgona shops, while heavy repairs to steam shovels and steel dump cars are made at Empire shops.

At Gorgona extensions were made to the machine shop, boiler shop, and to the planing mill. A new car shop was constructed for the more efficient handling of car repairs, and a lye vat with shed built for cleaning engine parts.

Gorgona Shops, Panama Canal.

Old French Construction Locomotive in Foreground, American Locomotive in Background, Gorgona Shops.

Oil fuel has been adopted at various stationary plants alnng the line, and has added much to the efficiency of the shops. In the blacksmith shop connected with the Gorgona establishment the installation of oil furnaces has doubled the heating capacity, which, together with improved equipments, has increased the output with a reduction in the number of blacksmiths. Similar improvements made in the foundry have reduced the cost of castings. During the year 4,586,342 pounds of iron castings, and 333,416 pounds of brass castings were turned out. Extensive repairs have been made to the Lidgerwood flat cars, as hard usage has necessitated practically rebuilding the larger portion of those on hand. Other equipment has been kept in good condition.

The electrical subdivision has control of all electric lighting on the Isthmus, except that in Cristobal and Colon, which is operated by the Panama Railroad. The Panama Railroad power plant at Balboa was transferred to the commission in July, 1908. An additional 400-kilowatt generator was added to the Empire plant and electric lighting extended to Paraiso, Pedro Miguel and Miraflores. The power plant at Gorgona was increased by the addition of one 100-kilowatt generator, permitting the installation of 1,399 lamps, thus extending the system over the entire settlement of Gorgona and neighboring labor camps. At Gatun a 50-kilowatt generator was installed and electric light furnished to that settlement.

At the Empire shops extensions were made during the year to the boiler shop, the master mechanic's office, and the electric lighting plant. With the closing of the Paraiso shops, a considerable portion of the machinery was transferred to these shops.

Cost keeping, instituted in 1907, has been continued with a view to enabling a comparison of the cost of work between any two periods, thereby securing greater economy and efficiency. In work so extensive it is very difficult to secure a system which will satisfactorily meet all requirements, but improvement is already evident, and by the new system of accounts, effective July 1, 1909, together with forms adopted for reporting expenditures to the examiner of accounts, who is charged with keeping the general books of the commission and the classification of costs, it is anticipated that still better results will be obtained.

During the year a few additions, some of which were authorized in the previous year, have been completed at Gorgona shops, the most important of which are as follows:

Locomotive Department.—Extension to machine shop, 30 by 90 ft., equipped with set of test-gauge pumps, reservoirs, and benches of sufficient capacity to handle all repairs to air-brake equipment, and the testing of same upon completion. Extension to boiler shop, 90 by 100 ft., affording storage place for steel plates. Construction of engine house, 50 by 150 ft.; sand house, 10 by 40 ft.; and office for night foreman, 15 by 15 ft., to provide for the more economical and efficient hostling and light repair of locomotives at this point. Construction of lye-vat shed, 25 by 50 ft., for cleaning engine parts.

Car and Foundry Department.—Construction of new car shop, 110 by 600 ft., for the more efficient handling of car repairs. This shop has a capacity of 36 cars and, with the old shop, will enable repairs to be made to 48 cars under cover at one time. Extension to planing mill, 84 ft. long, to afford cover for additional machines installed and also for material being prepared for car work and miscellaneous manufacturing. This shop is shown in the accompanying photograph, which is published by courtesy of Mr. C. R. Packard, of the mechanical department.

By the installation of additional machinery considerable progress was made in the line of more efficient and economical handling of work. The use of oil as fuel in the shop power plant has enabled a reduction in the number of boilers used to be made from four to three, has lessened the amount of repairs needed, and has decreased the cost of operation about $200 per month for labor.

Through mechanical improvements in the erecting shop and the installation of a drop table pit the blocking that formerly required three days in overhauling locomotives can be done in as many hours.

In the blacksmith shop, since the installation of oil as fuel, there have been installed nine oil furnaces, of which five were manufactured at the shops, which give the shops double the heating capacity provided by its former equipment. Special attention has been given to equipping the blacksmith shop with dies and formers for use in machine forging; and in the manufacture of various repair parts in large quantities, for which dies and formers are on hand for use in machine forging, a machine and one operator can produce as much as formerly would have required the services of ten blacksmiths on hand forging. In the manufacture of grab irons (for repairs to cars), the blacksmith labor has been reduced from about 11 to 2 cents when made in large lots. The effect of this equipment on the shop output is shown by the following: The highest output of forgings in the previous year for one month, with a pay roll of $5,632, was 176,861 lbs. This year the greatest output for one month was 329,589 lbs., with a pay roll of $3,828—an increase in output of 152,728 lbs., or 86.4 per cent, with a reduction in pay roll of $1,804, or 32 per cent. Assuming that the pay rolls for both years were equal, this would make an increased capacity of the shop on the run of work handled of 174 per cent.

In the foundry, by the installation of two power molding machines, the molding cost of castings, such as grate bars, cast washers, etc., has been reduced over 46 per cent.

The following table shows the cost of foundry operations during the past three years:

	Iron.		Brass.	
Fiscal year.	Yearly output. Pounds.	Average cost per pound.	Yearly output. Pounds.	Average cost per pound.
1906-7	3,599,798	$0.0391	202,424	$0.1835
1907-8	4,279,237	.0359	216,947	.1951
1908-9	4,586,342	.029	333,416	.1651

The variation in cost of brass castings is due to changes in price of raw materiials and different compositions of castings required, as well as to varying output, there being little change in price due to varying labor cost.

Fourteen hundred and thirty-nine patterns were made during the year, of which 1,080 were for iron castings and 359 for brass castings.

The Gorgona shops cover an area of about 21 acres and contain nearly 7 miles of track, of which 4,694 ft. were laid during the fiscal year covered by this report.

Included under the operation of these shops are the Tabernilla, San Pablo and Santa Cruz engine houses and repair shops. The Santa Cruz shop was abandoned in June, 1909, on account of the completion of work in that vicinity.

In July, 1908, the lighting and power plant of the Panama Railroad at Balboa was turned over to the commission and placed under the electrical subdivision of the mechanical division. With this plant and the commission electric power plants the electrical subdivision has under its control the operation of all electric lighting on the Isthmus, except that in Cristobal and Colon, which is operated by the Panama Railroad. The Balboa plant consisted of two direct-current generators of 125 and 325 kilowatts capacity, respectively, these generators being all connected to single-acting compound engines, steam being supplied by five vertical boilers. During the year there were installed in this plant two cross-compound air compressors of 2,500 cu. ft. capacity each, and two water-tube boilers of 250 horse-power each. About 2,000 lights were installed for operation from this plant during the year, and pole lines were extended from Balboa to Corozal and adjacent labor camps.

At the Empire power plant there was added one 400-kilowatt generator, direct connected to a cross-compound engine. The pole line was extended from Paraiso to Miraflores, and the towns of Pedro Miguel, Miraflores, and the near-by labor camps, as well as the Cocoli shops, were completely wired. Eight thousand eight hundred and fifty-one lights were installed during the year for operation from the Empire power plant.

The addition to the Gorgona power plant during the year consisted of one 100-kilowatt 240-volt direct-current generator, direct connected to a tandem compond engine. One thousand three hundred and ninety-nine lights were installed at Gorgona and the neighboring labor camps during the year, to be operated from the Gorgona plant.

At Gatun one 50-kilowatt generator; direct-connected to a simple horizontal engine, was installed, and the town wired for 1,277 additional lights. The pole line between Gatun and Cristobal for the transmission of power from the Gatun handling plant to Cristobal has been 75 per cent completed.

The cold-storage plant at Cristobal and the hospital at Colon were rewired throughout, and about 1,000 lights were installed in commission buildings in the vicinity of these towns.

The total output of the Balboa, Empire and Gorgona plants during the year was 3,703,407 kilowatt hours, at an average cost of $0.033 per kilowatt hour.

Additions were made to the fire-alarm systems at Ancon, Balboa, Culebra, Empire, Gorgona, Cristobal and Colon, and a fire-alarm system for Gatun has been ordered.

During the year trouble developed due to missed holes in blasting operations. The electrical subdivision was requested to make tests upon caps, blasting batteries and blasting operations in general, and, as a result thereof, ascertained that with non-uniform caps, wired in series, blasting batteries will explode the weaker caps, leaving the stronger caps, or those requiring a higher current, unexploded. Numerous tests showed that out of 100 caps wired in series an average of only 60 to 70 per cent would be exploded, even when wired direct to a 100-kilowatt 240-volt generator. Experiments were then made by wiring caps in parallel and connecting same to power lines. One hundred caps connected to a 5-kilowatt 110-volt transformer would invariably explode. The electrical subdivision installed 45 blasting spurs, 1,000 ft. apart, between Bas Obispo and Pedro Miguel. On each of these blasting spurs was mounted a 5-kilowatt transformer, with a switch box and secondary leads. From the switch boxes No. 4 triple-insulated wire was laid on the ground in the cut, and all blasting operations were then performed by wiring caps in parallel and connecting to those leads of No. 4 wire. This procedure eliminated all trouble with missed holes. Blasting batteries are now used only for springing holes.

During the year the following additions to the Empire shops were made:

	Feet.
Extension to boiler shop	50 by 224
Extension to master mechanic's office	10 by 50
Extension to electric light plant building for the accommodation of new engine and generator	33½ by 29

About one-half mile of new track was laid during the year and 500 ft. of track relaid and ballasted. The equipment of the shops was increased during the year. When the Paraiso shops were closed a considerable portion of the machinery located there was transferred to Empire shops.

During the year 34,680 ft. of air line were distributed and connected up in connection with canal excavation; an 8-in. air line was laid from Balboa to the Ancon quarry, a distance of about 1 mile, and 2,700 ft. of 2-in. pipe was connected and laid for compressed air for the electrical plant at Miraflores.

The work of the mechanical division has not been handicapped to any great extent during the year by shifting employes. Improvement in the class of skilled labor secured was noticeable, and notwithstanding the conditions under which our shop work is carried on, such as higher wage scale, an efficiency of labor, in general, less than that in the United States, and the necessity of performing work as quickly as possible in view of the emergency character of a large part of the shop work, the shop prices compare favorably with those in the United States. During the year 3,642 manufacturing orders were completed at an average cost of $156.03 each.

With the closing of the Paraiso shops in the early part of the fiscal year, Mr. E. C. Harrington, master mechanic at that point, was transferred elsewhere, and upon the resignation of Mr. E. C. Cummings, master mechanic of the Gorgona, in June, 1909, the Gorgona shop organization was consolidated with that of the electrical subdivision, as stated above. There were no further changes in the personnel of this division during the year, which consisted on June 30, 1909, of the following: Mr. George D. Brooke, superintendent of motive power and machinery; Mr. E. J. Banta, mechanical engineer; Mr. A. L. Robinson, electrical engineer and master mechanic, Gorgona shops; Mr. W. O. Johnson, master mechanic, Empire shops; Mr. C. H. Mead, master car builder; Mr. J. H. Flynn, chief draftsman; Mr. R. E. Lindsay, chief boiler inspector; Mr. F. W. Doty, chief clerk; Mr. James Stokoe, testing engineer; Mr. J. E. Johnson, inspector of pumping plants.

The Editor's Gas Engine

That the life of an editor is not wholly one of pleasure and recreation, particularly so when he mixes up with a gasoline engine, is evidenced by the following experience, and the resultant protest from the editor of the Vermontville (Mich.) *Echo*.

"The editor of a country newspaper has trials and tribulations that would send an ordinary individual to the 'bughouse' and you can no doubt imagine the state of mind of the wielder of the quill when some delinquent subscriber calls at the office

Plow and Equipment, Moffat Road.

and after an unlimited amount of hot air and the most pleasant smile imaginable announces that he will call in a few days and settle, then walks around the corner and deliberately drops dead. This is but one of the many little incidents that go to make up the life of the country editor, and he takes them all good naturedly, but when it comes to the gasoline engine in the back room buttin' in and trying to make things unpleasant the limit is about reached and ye editor just sits in the office chair and cusses.

"Just to enliven things up a bit the *Echo* office engine got a cranky streak on last Wednesday, and the more we cranked it the crankier it got, until finally the atmosphere around our ordinarily peaceful sanctum took on a rather bluish hue. It is one of the best engines made and cannot go wrong, so the directions say, but somehow or other we did not hold our mouth righ and it just would not run. It is a water-cooled, high-pressure, non-stinker, doubler-action, single-barrel, anti-profanity instigator.

"At first we thought the Tropic of Capricorn had slipped into the kingrow, and sure the exhaust was bent. We unscrewed the umbilicus, drew the range finder out, greased the pug tongue, bent the dowhangadingus, and even put it together again. Everything looked right, and we cranked it for an hour or two to see if it wouldn't combust audibly, but it wouldn't. Then, thinking that oil had accumulated in the duffopus so that the guyascutus couldn't coalesce with the noncompus mentis, we took out the doofunny, wiped the synovial fluid from the pendemonius, and removed the oil. This made everything look all right. The engine should have said, 'kapett, kapeet,' right along now, but it merely said 'p-r-r-r,' and that was all.

"There is a tea-cannister annex screwed on top of the main duodenum that runs up through the roof that usually says 'kapunk' at each explosion, but which was maintaining a discreet silence all this time. We resolved to go up on the roof and investigate this. Here we found that fuzzy wuzzy (worms) from the big willow tree near the *Echo* office had built their

Articulated Locomotive with Rotary Plow Crew, Moffat Road.

nest and plugged up the 'kapunker'. This solved the mystery. When it tried to 'kapeet' inside the 'kapunker' outside was cramped up stiffer than the right leg of the Goddess of Liberty. After adjusting the 'outside kaplunker,' which released the 'inside kapeeter,' confidence was immediately restored.

"A gasoline engine is just as simple as hoeing turnips when you get next to its curves. But our experience is that no gasoline engine can 'kapeet' when it is banged up in the snozzle."—*Gas Power.*

Snow Difficulties Eight Months in the Year

The Denver, Northwestern & Pacific Ry., which operates from Denver, Colo., 214 miles northwest through a mountainous territory and over high altitudes, is compelled to fight snow eight months in the year. As shown in the accompanying photographs, rotary snow plows are used for the purpose. For the past two years the power for pushing the plows has been developed by locomotives of the Mallet

Rotary Plow in Cut, Moffat Road.

Cut Made by Rotary, Moffat Road.

Clearing a Siding, Moffat Road.

articulated type, although one of the photographs shows a rotary with two consolidations coupled to it.

During the eight months of snow troubles, a rotary plow is sent over the divide ahead of each passenger train, and the snow, which is continually drifting into the cuts across the tracks on the side hills, is not allowed to harden. The articulated locomotive furnishes an ideal power for the rotary plow, as it develops its maximum capacity at slow speeds, and therefore does not necessitate bucking methods so disastrous in many instances.

Speaking of some of his power difficulties, George Thompson, superintendent of motive power, states that his men found thirty-two feet of snow in one of the passes in the middle of the balmy month of June last year. At times during the severest weather, he states, the thermometer registers as low as fifty degrees below zero in the higher and exposed sections of the road. At such times the engines are double crewed and pooled besides, the crews refusing to make more than one trip each during the cold snap.

The maximum grade of the road is four per cent. The maximum curvature is about ten degrees. The combination of these features with the cold weather and snow involves difficulties of operation which would cause the average trunk line railroad official to sit up and take notice.

Brake Manipulation in General Freight Service*

In the design of any brake equipment the starting point is always the weight of the vehicle to which the brake is to be applied. Given the weight of the vehicle, the problem then reduces simply to choosing the proper size brake cylinder which, with a predetermined maximum brake cylinder pressure and leverage ratio will give the desired percentage of braking power. The process is clearly a simple one when applied to any given car and the method of procedure applied to cars of various weights will insure uniformity of results. However, it must necessarily follow that a brake equipment designed in this way for one car will not be proper for another car of a different weight from the first. The greater the difference in the weights of the cars, the greater will be the difference in the equipments required.

Underlying this proposition are fixed principles to which we must work if the best results are to be obtained, and once a set is determined upon for any design they must be continued as uniformity is fundamentally important. Of course, it must

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* From a paper by W. V. Turner, Mech. Engr., Westinghouse Air Brake Co., before the Western Railway Club.

Rotary in Six Feet of Light Snow, Moffat Road.

Clearing Line After Drifting Storm, Moffat Road.

not be understood that departures from a proper basis will render a design inoperative, but it will not be as good as it should be in increasing proportions as it departs from the true starting point.

First: The thing to be fixed upon is the percentage of braking power permissible.

Second: The pressure to be used as a power base.

Third: Either the leverage or the size of the brake cylinder to be used. (If the size of cylinder is determined upon, this will fix the leverage; if the leverage is determined upon, this will fix the size of cylinder.)

Regarding the first consideration, namely, percentage of braking power, experience has confirmed that 70 per cent of the light weight of car on 60 pounds cylinder pressure (60 per cent on 50 pounds cylinder pressure) is the practically perfect basis for a freight car, and for reasons that are too obvious to require statement; but it should be added that reason confirms the experience.

Regarding the second: This is important in two respects—first, that it must be an obtainable pressure; second, that it is universally applicable and adopted.

Regarding the third: This resolves itself into the question of how many times the cylinder power can be multiplied in a practical way, and is determined by the possible "lost motion" of the car, and the permissible increase of piston travel due to shoe wear, as the greater the number of times the cylinder value is multiplied, the more quickly will shoe wear lengthen the travel of the brake piston.

With the exception of the strength of materials, no other factors enter into the design, but those cited are vital and *must* be considered, and cannot be slurred over, nor can any one of them be omitted from the consideration and allowed to fix itself, for all others are so intimately related that they may be termed the one law of brake design.

It is often thought that an increase or decrease of the brake pipe pressure carried affects the design, but this is not the case, as this will only increase or decrease the braking power in an exact ratio to the change of pressure.

Assuming that sound principles and good judgment have been employed in designing the fixed apparatus of an air brake, namely, the triple valve, reservoirs, brake cylinders, etc., and that these operate perfectly as individual units, and particularly in the laboratory where no moving vehicles are to be considered, and, consequently, neither variations in power developed in the different cylinders, nor difference in time complicate the results of manipulation. It is necessary before discussing the actual manipulation of the brake to point out some of the factors which affect the operation and the manipulation of the brakes on the train as a whole. These may so change the original design as to make smooth manipulation and operation impossible. It appears to be thought by many that the brake being automatic in its action should also be automatic in compensating for any lack of knowledge or for neglect on the part of those who use it, but this is not the case, and is as impossible of accomplishment as to run a locomotive without steam. The operation of the brake is according to fixed laws and conditions over *which the engineer of all men has the least control.*

Rotary Plow with Two Consolidations in a Valley of the Moffat Road.

As an elaboration of the principal factors involved would take up more time than has been at my disposal since being called upon to give this paper and, undoubtedly, more than is at our disposal this evening, I cannot do more than state them and summarize the effects.

Percentage of Braking.

First: The percentage of braking power, so called. This has usually been figured at 70 per cent on the light weight of the car, and this is certainly sufficient for the car when empty, but manifestly is reduced for the load in ratio to the difference in the weight of the car when empty and the car and load together. For example: If the braking power of a 40,000 pound car of 100,000 lbs. capacity is 70 per cent when empty, it will be less than 19 per cent when loaded.

Pressure.

Second: The cylinder pressure obtained in the designs. This is supposed to be uniform for any given reduction, and if the proper cylinder volume is maintained, it will be approximately so, but if the cylinder volume varies on the different vehicles, the pressure obtained will correspondingly vary, being less than normal for increase of volume and greater than normal for decrease of volume. Moreover, it is intended in the design that a low cylinder pressure be obtained for light reductions and a high cylinder pressure for heavy reductions, and this is the natural result, but lack of maintenance often brings about the opposite to this, for if the cylinder volume is small, a very high pressure will be obtained with a comparatively light reduction, while a low cylinder pressure will be obtained for a heavy one, and to avoid the results contingent upon this requires a knowledge of conditions and the exercise of a judgment possessed only by the few.

Piston Travel.

Third: Piston travel is such a factor in brake operation that its variation varies every operation of the brake as far as the developing power is concerned, for not only is the piston travel responsible for the variation in the cylinder pressure pointed out above, but it also varies the time required to obtain the braking power expected to be developed from a given brake pipe reduction. In other words, it is possible to obtain several times the braking power on one car as compared with another, due only to variation in piston travel, and it does not require a very vivid imagination to picture what this means to brake manipulation as far as producing shocks are concerned, and it will also be seen that this is a factor over which the engineer has absolutely no control. Moreover, this variation in piston travel may be such as to entirely change the percentage of braking power expected to be obtained from the design for a given reduction, thus causing excessive braking power on some cars and too little on others, which is both prolific of shocks, due to surging, and of flat wheels, due to cars being dragged or bumped "off their feet."

Time.

Fourth: The time element is a very serious factor as affecting both the application and release of the brakes. In applying the brakes the starting takes place very quickly throughout a short train, therefore, there is no running in or out of slack, and, consequently, little or no shock, but in the long train, there is a considerable interval of time between the starting of the brakes on the head end and rear end of the train. In fact, the brakes on the head end may have fully applied for the reduction before they commence to apply on the rear end of the train, and unless great care and judgment is exercised to prevent bunching of the train, very serious results are likely to occur when the brakes apply at the rear and the reaction of the draft gear can stretch the train. Again, the rise of cylinder pressure is very different in the long train than in a short one, for the cylinder pressure cannot rise at any greater rate than the brake pipe pressure is being reduced, and as this varies with the length of train, particularly at the rear end, it will be seen that the time factor must be considered with every brake manipulation.

As to the release of the brakes, the time element also must be taken into account, for, obviously, there must be an interval of time between the release of the brakes at the head and rear end. This is certain even where the reduction has not been made below the equalizing point, but when the equalizing point has been passed, this difference is increased to such an extent that the engineer very often opens the throttle and accelerates the head end of the train while retardation is still taking place at the rear, and this even after he had thought he had allowed time enough. If it is important that the train be stretched before brakes are applied, it is doubly so before the brakes are released.

Loads and Empties.

Fifth: Perhaps the most serious factor involved in freight train control is that arising from hauling loads and empties mixed, and this without considering any of the other factors enumerated above, but when considered in conjunction with them, the situation is certainly more serious than most people seem to think. As was pointed out, the braking power varies inversely, as the load and as the cars are now designed to carry about three times their weight, it will be seen that while the brake shoe pressure remains the same as for the light car the percentage of braking power, so called, to weight has been reduced to one-fourth of what it was or is on the light car. If now we consider what must be the result of difference in cylinder pressure obtained and the time in which it is obtained on the empty and loaded car, it will be seen that with the present equipment, the only salvation against shocks and break-in-twos is (1st) to keep the train stretched—(2nd) to make at least initial reduction light in order that only a low power will be developed until the slack has adjusted itself—and (3rd) under no circumstances to release the brakes, unless the slack condition of the train permits, until a stop be made. The usual custom is to haul the loads ahead and the empties behind, and this is certainly more proper than hauling the empties ahead and the loads behind, for in case of a shock, with the empties behind, the result is at worst a parting of the train, while with the loads behind, the result is a buckling, which will be disastrous, particularly on parallel track roads. A better method of hauling loads and empties in the same train is to alternate them; thus avoiding great differences of braking power, due to variation in weight of train at any section of the train. This, however, involves switching, etc., which renders such a method impracticable. A better method still is to haul loads and empties in different trains. This again is impracticable on many roads. Thus, the proposition reduces to one of proper inspection and maintenance, instruction and discipline, which involves considerable intelligence and experience, or failing this, the proposition reduces to a cheerful acceptance of the consequences.

It will be seen that all these factors are so intimately related that one involves the other to a considerable degree with the possible exception of loads and empties. Therefore, any neglect of one affects the other and conversely any great thought or consideration of the one improves the other. This relationship existing and time being limited, it will probably serve the purpose to consider two of these factors only at greater length, namely,

First: As to piston travel.

Second: As to braking power most desirable for freight cars under present operating conditions.

Piston Travel.

Piston travel may be divided into theoretical (under certain conditions standing travel closely approximates the theoretical travel) and actual travel (as under running conditions the travel differs from that obtained when the vehicle is standing). The theoretical travel is that which the brake cylinder piston is allowed to move in order to give proper shoe clearance, plus the movement due to the necessary difference between th diameter of the pins and holes. Thus the theoretical travel equals the shoe clearance times the total leverage plus the travel due to difference in the diameter of the pins and holes.

The actual travel is comprised of the above plus that resulting from lost motion due to loose fitting brasses, play between boxes and pedestals, brake beam deflection and unusual temporary strains; in fact, to anything that produces or increases lost motion. I wish particularly to call attention to the practice of hanging brake beams from what amounts to a spring suspension, that is, to the car body or the truck frame above the springs. In such cases the shoes are drawn toward the rail by the pull of the wheel with consequent lengthening of piston travel. This is a most serious evil and where it exists the piston travel must be quite frequently adjusted to compensate for shoe wear, or the brake piston will strike the cylinder head; and in any case where excessive false travel is likely to develop a very low ratio of leverage should be employed.

The difference between the actual and the theoretical travel is the false travel, which, serious as it is, receives less consideration than any other thing in car design.

The theoretical piston travel is commonly called standing travel, and is defined as the distance the brake cylinder piston is forced outward in applying the brakes when the cars *in not in motion.*

The actual piston travel is generally called the running travel and is defined as the distance the brake cylinder piston travels outward in applying the brakes when the car *is in motion.*

In studying the effects of piston travel, it must be remembered that in any application of the brakes, the brake cylinder pressure obtained depends upon two things; the ratio being the volumes of the cylinder and auxiliary reservoir, and the amount of brake pipe reduction. If the brake pipe pressure is reduced 10 pounds, the auxiliary reservoir will be reduced 10 pounds (slightly over); and the 10 pounds from the auxiliary reservoir going into the brake cylinder will create there a pressure depending on the volume of the cylinder and connecting passages as compared with that of the auxiliary reservoir. But the auxiliary reservoir volume does not chance, so we may say that of the two, the brake cylinder volume alone is responsible for the pressure obtained. Now that volume depends on the amount of piston travel, if the latter is short, the volume is small, and the 10 pounds auxiliary reservoir air will create a higher brake cylinder pressure than if the piston travel was longer and the cylinder volume thereby greater.

Braking Power.

When the automatic brake was being put to a practical application, that is, used for controlling trains, it was found that the amount of cylinder pressure and braking power obtained for a given reduction were very important factors to be considered. After considerable experience it was proven, even for the comparatively short trains of those days, that the highest permissible braking power should not greatly exceed 1 per cent per pound of cylinder pressure (e. g., 70 per cent on 60 lbs. cylinder pressure) if trains were to be handled without shocks in ordinary service operation, and also that the cylinder pressures obtained should not exceed 3¼ lbs. absolute per pound of brake pipe reduction; in other words, the auxiliary reservoir and brake cylinder should equalize at 50 lbs. from 70 lbs. initial; gage pressures (65 lbs. minus 15 for piston displacement). Accordingly a nominal braking power of something less than 60 per cent on 50 lbs. cylinder pressure was fixed upon as the proper braking power for freight cars and an auxiliary reservoir employed so proportioned as to give a proper brake cylinder pressure per pound of brake pipe or auxiliary reservoir reduction and a brake pipe pressure of 70 lbs. was fixed upon as the desired pressure from which to obtain the maximum service brake cylinder pressure, namely, 50 lbs. These principles, of course, implied that "all air" trains were being handled for the reason that the length of train is an important factor in producing shocks, as if only a few air brake cars were being used, the brakes could not be much of a factor in stretching the train. However, it became the custom to use only a number of the brakes in long trains, generally on the loads ahead, the brakes on the empties not being used. Therefore,, it was largely immaterial, under this condition of operation, what the nominal braking power was adopted for the empty cars, as, obviously, if the brakes were not used they could not stretch the train when being hauled behind loads. It was during this period that some roads increased the braking powers of freight cars from 70 to as high as 85 per cent based on 60 lbs. cylinder pressure, and, of course, the result when hauling empties behind loads, particularly on a level, did not manifest itself as they were generally behind the cars on which the brakes were being used. When, however, it became the rule to operate "all air trains" quite another set of conditions were created, for not only were the brakes used on empties but, as far as the operation of the brakes was concerned, the length of trains was doubled, which is a serious factor, as the interval of time in brake application, particularly when combined with great difference of braking power at the two ends of the train, permits of the slack actions that are responsible for shocks. Thus the breaking power of the empty cars became quite a factor in the handling of trains, for, obviously, the greater the breaking power of the empty cars became quite a factor in the handling of trains, for, obviously, the greater the breaking power of the empties as compared with the load for the same cylinder pressure obtained from the medium reduction, the greater would be the retardation of the empties over the loads with consquent shocks and possible break-in-twos, particularly if the slack was bunched when the brakes were applied. Because of these things, a return was made to the old rule of 60 per cent nominal braking power based on 50 lbs. cylinder pressure, and even this would be regarded as too high, if means were available for properly taking care of the car when loaded. If the braking power is made very great on the empty cars an approach will be made to the bad practice which was responsible for so many break-in-twos when employed, namely, hauling passenger cars with the brakes in use on the rear end of a freight train, or, what is perhaps even worse, permitting empty freight cars with short piston travel to be hauled behind loads.

Another thing that should be kept in mind is that a vital element in handling long trains without shock is the uniformity of the braking power both in time and amount, and as there is no such thing as uniformity in the amount of braking power when we consider loaded and empty cars with long and short piston travel and the various percentages of nominal breaking power employed, etc., nor of *time* when we consider that this is varied by length of train and brake pipe leaks, etc., it is important that we prevent the ill effects of these variations to as great a degree as possible, which can best be done by insuring that the braking power obtained be as low as controlling the loaded car will permit, and its attainment stretched over such a period of time by range of brake pipe reduction as will make sudden and severe strains unlikely. This is not only desirable but possible from the fact that all the braking power needed for controlling the loaded cars, even on grades, can be obtained by increasing the brake pipe pressure, which increases the ultimate braking power on all cars alike and without in any way interfering with the flexibility of the brake, i. e., without giving severe braking power for the initial brake pipe reduction, which it is important to avoid until the slack has had time to adjust itself. Moreover, this increase of brake pipe pressure does not widen the gap, already too great, between the ordinary service braking effort of the loaded and empty cars, while to increase the braking power on the empty cars does this to a serious degree. In other words, it does exactly opposite to what good engineering requires and what we are endeavoring to do, namely, bring about a uniformity of braking power on the empty and loaded cars.

In this connection, we might also mention that when it was found necessary to increase the stopping power of passenger trains, it was not done by increasing percentage of braking power per pound of cylinder pressure, which to obtain the increase desired, would have destroyed the flexibility of service features of the brake, but by increasing the pressure carried, thereby obtaining a cylinder pressure sufficiently high to give the desired increase of braking power. If this was the necessary procedure with passenger trains, how much more so with the long freight trains where the time and slack elements are of a much more variable and serious nature.

Use of Release and Running Positions.

I feel a few words should also be said regarding the use of release and running positions of the brake valves, for it is here that the engineer may start trouble, for which the high pressures and large main reservoirs and the long trains of today, it is very easy to overcharge the head end of the train as compared with the rear and with a short train to over-charge it throughout as compared with the adjustment of the feed valves. Many detrimental effects result from this, such as stuck brakes, flat wheels, cracked wheels, undesired quick action and where successive applications are made, as in grade work, in the brakes on the head cars doing practically all the work.

Another result which I would like to impress upon all is that a great many engineers think that because the gauge shows that the pressure has risen very rapidly, and higher than the auxiliary reservoir pressure is intended to be, that the brakes are released and consequently open the throttle, while, as a matter of fact, this is a condition that exists only on the first few cars of the train, the pressure of the rear not having yet increased sufficiently to force the triple piston to release position. In fact, twenty-five cars back from the engine, it cannot be told from a gauge whether the handle is in release or running position. With modern engine equipment, the brake valve should not be held in release position more than 15 seconds when releasing brakes is the object. The exceptions to this rule are when charging up a train, or under some conditions of grade work.

It will be seen from what I have said that brake manipulation and operation in freight service involves more than the judgment of the engineer in moving the brake valve handle back and forth. In fact, much more is dependent upon the condition of the train and the brakes than upon the manipulation by the engineer. Nay, more, it will be seen that conditions may often make judgment impossible and insure shocks and broke-in-two in spite of it. Comprehension and application should come *down* from the officials to the engineer and instruction and discipline *up* to the engineer through the car men and trainmen. Until this is done, we are trying to cure our troubles by pecking away at the effect instead of what is more logical and reasonable, namely, dealing with the cause.

In concluding this subject, I desire to mention some of the changed operating conditions which have made much more difficult the control of freight trains, then analyze a proposed change or two expected to improve conditions, after which offer a few suggestions, the adoption of which will greatly reduce shocks and break-in-twos.

First: Heavy and more powerful locomotives (often two of these used to a train)—increasing the difficulty of starting trains without shock—making long and heavy trains possible, this, self-evidently, making the control more difficult—also severe strains, are set up when the brakes are released on these heavy weights before it is possible to obtain the release of the brakes on the rear; also with freight trains bunching the slack (because the brakes on the engine, if in good order, will produce more retardation than those of the cars), then when the brakes take hold on the cars at the rear (generally empties), or, if for any other reason, the slack runs out, shocks are likely to result. With passenger trains, the reverse is true, as the cars are always being retarded more than the engine, and therefore the train is stretched.

Second: Cars of greater capacity, therefore, greater weight, and this without corresponding increase of the light weight, thus reducing the braking power when loaded to a greater extent than with the older cars. This condition creates a greater difference in braking power between the forward and rear end of the train when we have loads ahead and empties behind.

Third: Different percentages of braking power, some roads using 70 per cent and others as high as 90 per cent of the light weight; others again, intermediate percentages. These things all tend to make the braking power unequal (and, of course, the longer the train, the worse it will be, because the time element "cuts quite a figure"); so much so, that if we got together a combination of long train—loads ahead—empties behind—(and if these empties have short piston travel, the situation is aggravated to a remarkable degree), high percentage of braking power—slow speed and brake application (particularly if made by an engineer who does not or has not taken these things into consideration),—a break-in-two is to be expected.

Fourth: Different sizes of brake cylinders. And this has more effect than most people think. For one reason, because the total leverage will be varied by the weight of the car and size of cylinder, thus the piston travel, so important a factor with light or medium brake pipe reductions, will vary greatly for the same shoe wear—this is self-evident with cars under-cylindered or when equipped with brakes with which the service and emergency cylinder pressures are the same.

Fifth: Varying brake pipe pressure: This changes the time element, often resulting in a heavier or a lighter application than was intended.

Sixth: Varying brake pipe volume: Thus modifying the time of application and release; and this far beyond direct proportion. The effect of this will be seen when it is borne in mind that men who have been coupling up and handling a fixed and limited number of cars—therefore, an approximately constant volume—often fail to release the rear brakes of a long train before opening the throttle, or take into consideration the length of time it takes to get the air out or back into the brake system of long trains.

Seventh: "All air trains," and from a train handling standpoint this is one of the most important factors, as no matter what the make-up of the train, the brakes must be cut in within certain limits, therefore, if the train is so made up that excessive and damaging retardation takes places at the rear, the scheme of cutting out every other brake cannot be resorted to, as was done on some roads until recently, where "all air trains" were being handled. (By "all air trains" is meant that the brake pipe is charged with air from the engine to the rear of caboose.) Not only this, but it is plain that more knowledge, greater skill and constant thought is required on the part of all concerned to deal with conditions so variable as those involved in the make-up and the means of controlling the trains today. In other words, the human equation is more of a factor than ever before. This, I am happy to say, is beginning to be realized and soon, I hope, many will be convinced that more consideration must be given to the condition under which the brake operates, if the results due to lack of consideration are to be avoided, for it is a fact that there are proper and important conditions for the brake as for other mechanical devices, and there is more to it than simply attaching it to a car.

Eighth: In this connection, it may be well to mention that the many different styles of draft rigging have quite a bearing on the matter of shocks in trains; those possessing the greatest dissipating power with no recoil being, in my opinion, very necessary to meet the conditions of today, as the brakes and engineers can hardly be expected to compensate for all the changes that have taken place.

Ninth: Other things might be mentioned and elaborated upon—such as a greater number of parallel tracks, more yards and the frequency of trains, but I think the foregoing will help keep in mind the complexity of the problem when what follows is being considered.

Many schemes are proposed to alleviate these troubles; good, bad and different, most of them bad because they do not touch the root of the matter. In one detail they are nearly all alike, viz., in beginning with the engineer, while here is where they should end. The brake is a good servant, but a bad master, and it becomes rebellious when contending with impossible conditions and is somewhat sensitive to neglect.

A quasi-plausible scheme actually put in effect on a great railroad for a time (a short time only for the remedy was worse than the disease) and recently considered by another, was to reduce the pressure carried in the brake system to 50 or 55 pounds. There were three advantages to be gained by this, so it was said:

(1) That the braking power would not be so great for a service reduction and, therefore, that the severity of the shocks and break-in-twos would be reduced. This, however, would only hold true for heavy reductions, as, for instances, a 10-pound reduction would give the same cylinder pressure whether the brake pipe pressure be 70 lbs. or 55 lbs., other things being equal. And, as the shocks and break-in-twos will usually occur, if at all, by the time a 10-pound reduction has been made, it is plain that reducing the pressure would be of no help in this case; this, of course, applies to service applications.

(2) That undesired quick action will occur less frequently. This, however, will not necessarily follow, as, while undesired quick action due to friction caused by pressure on the slide valve may be reduced, yet undesired quick action due to slowness of reduction will be increased. Therefore, the gain in one direction is offset by a loss in the other, and I believe more than offset. Moreover, there should be no undesired quick action with 70 lbs. brake pipe pressure carried, and if there is, it can be corrected much more effectively by keeping the apparatus in a workable condition than by reducing the efficiency of the brake; which means in the last analysis its abandonment.

(3) That in the even of undesired quick action the maximum braking power possible to obtain with the lower pressure will be less than with the higher; and here we have the only reason that is even plausible. But even this can only be granted when it is assumed that we are compelled to choose between two evils, viz., (1) air brakes improperly maintained and operated, and, (2) a lower efficiency of the brake both in service and emergency applications. It is self-evident that the brake will be less efficient with an emergency application, but it may be necessary to point out that for service applications not only would the braking power of an equalized application be less, but the reserve for partial applications would be much less in one case than in the other. In other words, where with 55 lbs. brake pipe pressure the operator would have to use a reduction that would produce equalization to control his train and therefore eliminate any reserve and make a stop impossible; on the other hand, with the higher pressure the same reduction would give him the same train control and leave a reserve braking power equal to that already obtained, thereby making a stop possible if called for.

The above, I believe, covers all the arguments that can be advanced in favor of the lower pressure, and the analysis shows that they are by no means sound and certainly not sufficiently decisive to warrant the change. It may be said (but certainly not advanced as a reason) that 55 lbs. will control an empty train more effectively than 70 lbs., will a loaded train, and this may be granted, but it does not follow from this that the empty train with 70 lbs. has any surplus of control, and until this is proven, it would not appear wise to lower the braking power of the empty train simply because the loaded train is under-braked.

Moreover, *these other things* should be considered; that it will be difficult to secure the change of pressure when changing an engine from an empty train to a loaded train, and vice versa, and no doubt you would often find the loaded train carrying 55 lbs. and the empty train 70 lbs. of brake pipe pressure, and particularly I believe you would find that once the engineers were led to believe that 55 lbs. was a panacea for their troubles, it would be difficult to prevent their carrying the lower pressure when they should carry the higher—especially where the train was made up of loads and empties; also it should be considered whether it is trains composed of all empties that are breaking-in-two in the great majority of cases. I am of the opinion that you would find that it is where a long string of empties are behind loads that this occurs; if this is so, even a consideration of 55 lbs. cannot be permitted.

Another scheme actually put in practice by some roads is to put up the percentage of braking power on empty cars. This is done ostensibly to increase the braking power for the cars when loaded. There *may* be some excuse for roads doing this who have heavy grades to negotiate, for perhaps they consider it a choice between putting up with break-in-twos or risking runaways on the grades, or perhaps they have empties one way and loads the other, as, for example, the D. I. & R. 125 per cent, or perhaps again they are wise and do not haul empties and loads in the same train, knowing that by increasing the braking power on the empties they have made this more risky and impracticable than ever before. However, the other roads have to handle the cars, so somebody gets the effect.

As it is unequal braking power that is responsible for shocks, anything that tends to this is pertinent to the question of train control. It must be understood that as some look at it, it is a choice of two evils—braking power too low for grades, or too high for empties behind loads—but if they increase the braking power some one is going to have greater difficulty in smoothly controlling some classes of trains.

In this connection I may also point out that general recommendations and instructions apply to general conditions; particular and specific conditions, requiring and permitting considerable modification of such general recommendations to suit the case, and it is only with an intimate knowledge of and with particular reference to such cases that one can be specific.

There are other schemes no more effective or practical than this, their chief virtue being a *desire* to find some way to reduce shocks and break-in-twos. As these undoubtedly arise from unequal braking power in different parts of the train, which may be temporary, as, for instance, the brakes applying more quickly or with higher cylinder pressure at the head end of the train than at the rear; or permanently, as, for instance, when there are loads ahead and empties with short piston travel at the rear, I will point out that shocks or break-in-twos may be greatly reduced by:

(1) Forbidding the use of the straight air brake of the engine to bunch the slack of the train before applying the automatic brake. I am aware that you will quote Westinghouse Instruction Books against this rule, but these instructions, as well as many others, were given to suit conditions very different from those of today. It is a self-evident fact when conditions change, old rules and instructions become obsolete, or must be changed to suit the new conditions. A slight review of the instruction regarding the use of straight air to bunch the slack gently, may be sufficient to demonstrate this. This instruction given when only part "air trains" were the rule, was necessary, as if the brakes were applied on the braked cars before the slack was in from the unbraked cars behind the shock was sometimes equal to a collision. Now, if the slack is bunched with an "all air train," particularly with empties at the rear, the running out of the slack, as the brakes take hold at the rear, often results in a break-in-two and certainly in a shock which is damaging to both equipment and lading.

Personally, I doubt the advisability of using straight air at all for train control, as so much judgment and care is required to use it when and where it will do good and not harm. I mean now for making stops or slow-downs—for if it is applied heavily, a collision is often the result—if applied and released and the throttle opened, while the cars are bunching or still bunched at the rear, a break-in-two is in order. Of course, there are critical speeds and conditions when damage is more likely than at other times. Straight air on the engine is of great value when used at the proper time and place, but it was not intended to take the place of the automatic brake in controlling trains, nor to be used because *unfair conditions* impair the efficiency of the automatic brake.

(2) By placing loads at the head end of the train and shortening the piston travel, and the empties behind and lengthening

the piston travel,—bringing about a greater difference in cylinder pressure for graduating applications and thereby securing greater equality of braking power between loads and empties; at the same time the emergency pressure will be only slightly reduced.

(3) Alternating loads and empties.

(4) Applying the brakes before the slack is bunched, as, for instance, before the steam is shut off.

(5) Instructing engineers not to use emergency applications unless actual emergency exists; not, for instance, to consider every switch, water-tank, or coal chute as an emergency zone and apply the brakes accordingly.

(6) Not to use heavy initial service reductions, unless speed is low and stop intended.

(7) Do whatever is necessary and possible to secure uniform application of brakes.

(8) Do all possible to insure that it is the engineer that is controlling the application of the brakes and not the brake pipe leakage, and in general that the brakes are maintained in such condition that the anticipated operation is possible and obtained. Give the engineer a chance.

(9) Avoid, if possible, applying or releasing brakes when passing over "Hog-backs" or around curves.

(10) Avoid releasing the brakes before the brakes have ceased to apply during a reduction.

(11) Avoid, whenever possible, applying the brakes again after a release while the brake pipe pressure is higher at the head end than at the rear, in other words, equilibrium of pressures should be established throughout the train, as otherwise the head brakes will apply and those at the rear will not—therefore, the cars may be bunched and if the brakes at the next reduction take hold, this in conjunction with the recoil of springs will produce severe shocks.

(12) Avoid releasing brakes at speeds below ten miles per hour unless the locomotive is equipped with "ET" or the forward cars with "K" triple valves, as otherwise brakes releasing at the head end permits the retardation still existing at the rear to stretch the train—sometimes beyond the strength of the car connections.

(13) Avoid, whenever possible, having too many cars at the rear which are levered for a high braking power, as, for instance, cars (of which there are many in service) upon which the braking power is calculated at 90 per cent on 60 lbs. cylinder pressure—it is obvious that this aggravates the already existing inequality of braking power between loads and empties and is in effect the same as attaching so many passenger cars to the rear end of a freight train, which no one who expected smooth operation would do, unless the brakes on these rear cars were alternately cut out.

(14) Locate the places where accidents of the kind under consideration most often occur and advise extra precautions, for, undoubtedly, you will find that there are certain track or signal conditions, which, in conjunction with an application or release of the brakes (to say nothing of the starting of trains), tend to produce shocks, and this, added to the already numerous factors tending in the same direction, often result in a "break-in-two." I think you will find that a number of your men are cognizant of this fact and have these places pretty well "spotted" and are governed accordingly and, therefore, do not have near the trouble that some others do who either cannot reason back from effect to cause or are careless. To these latter a little information and advice may mean a close approach to the results obtained by others who learn by experience. I think I can illustrate what I mean by this paragraph by calling to your mind how necessary it is that an engineer, new to a division, become acquainted with the track, etc., before the best results can be expected. In other words, other things being equal, his proficiency depends largely upon his knowing the condition under which he operates.

(15) At speeds of over 20 miles per hour make a light preliminary reduction, followed by continuous heavy reductions when speed is reduced to, say, 8 miles per hour and stop intended. At low speeds, when stop is intended, make a continuous full reduction. The reason for this is to keep the slack bunched, as the brake will naturally be applying with greater power on the head end than at the rear, therefore tending to keep a steady push toward the engine.

(16) If slow-down only is desired, it is better to make a light reduction, far enough back, than a heavy one to accomplish the same result in less distance; in the former case, when the release is made (even if at slow speed) there should not be braking power enough to cause slack, while in the latter case the reverse is true.

(17) Enforce the rule that with long trains the engine must be cut off from the train whenever an accurate stop is imperative, as for coal and water, and insist that, after again coupling to the train that sufficient time be allowed for the brakes to release before trying to start the train.

(18) A terminal inspection that will discover and send to the repair track all cars, particularly draft gear, that are likely to cause trouble on the road. There is no doubt that a great number of break-in-twos are due to defective brakes and draft gear being allowed to leave terminals, and it is hardly a question whether it is wiser to take chances than to adopt a safer method. Of course, it is only a matter of time before the inevitable happens, but each thinks it possible that the car will reach the next terminal. Plainly, as long as chances are taken in these matters, even the best of care on the part of those operating the train on the road cannot prevent a great many break-in-twos.

As stated, the difference in braking power is held to be the cause of shocks, etc., and the foregoing include at once the reason why and how it can, in a large measure, be overcome and uniformity more closely approached. It is plain that to do this involves both effort, expense and inconvenience, but my railroad experience taught me this was unavoidable and to be expected in railroad operation, and I may say that in the matter under consideration, what has been outlined permits of a choice between what *exists* and *what we desire*, to determine which the benefits versus the cost will be the governing considration.

In conclusion, it may be well to state that the cause of break-in-twos may be traced to the method of handling the brakes—to the condition and class of draft gear and brake equipment—to the make-up of the train and the kind of train service—it being understood that the human equation is a qualifying factor at all times. All these causes taken singly or collectively are such at times as to make a break-in-two difficult if not impossible to avoid.

"Break-in-twos" are caused by greater braking power at the rear than at the forward part of the train. This class of break-in-two often causes much inconvenience and some loss, but as it is a separation and not a collision the danger of serious accident is not great, unless following trains are too close.

"Buckling" is caused by greater braking power at the forward end of the train than the rear. This occurrence not only means inconvenience and loss but that the danger of serious accident to both the train to which it occurs and to others of either direction is very great, as the cars may be scattered over the different tracks.

I have gone into this part of the subject somewhat fully, if not completely, because I should at least do so sufficiently to permit of your weighing both sides of the question.

TABLE No. 1

TRACTIVE POWER OF SIMPLE LOCOMOTIVES. BOILER PRESSURE 100 POUNDS; MEAN EFFECTIVE PRESSURE, 85 PER CENT. OF 100 POUNDS=85 POUNDS

CYLINDERS — Diameter of Driving Wheels.

Diam.	Stroke	30"	32"	34"	36"	38"	40"	42"	44"	45"	48"	49"	50"	51"	52"	53"	54"	55"
9"	14"	3200	3000	2800	2700	2500	2400	2300	2200	2100	2000	2000	1900	....	....	....	....	....
10"	14"	4000	3700	3500	3300	3100	3000	2800	2700	2600	2500	2400	2400	....	....	....	....	....
11"	14"	4800	4500	4200	4000	3800	3600	3400	3300	3100	3000	2900	2900	....	....	....	....	....
9"	16"	3700	3400	3200	3100	2900	2800	2500	2500	2400	2300	2300	2200	2200	2100	2100	2000	....
10"	16"	4500	4300	4000	3800	3600	3400	3200	3100	3000	2800	2800	2700	2700	2600	2600	2500	....
11"	16"	5500	5100	4800	4600	4300	4000	3900	3700	3600	3400	3400	3300	3200	3200	3100	3000	....
12"	16"	6500	6100	5800	5500	5200	4900	4700	4500	4300	4200	4000	3900	3800	3800	3700	3600	....
13"	16"	7700	7200	6800	8400	6000	5700	5500	5200	6000	4800	4700	4600	4500	4400	4300	4300	....
10"	18"	....	4800	4500	4300	4000	3800	3700	3500	3300	3200	3100	3100	3000	2900	2900	2800	2800
11"	18"	....	5800	6400	5200	4900	4600	4400	4200	4000	3900	3800	3700	3600	3600	3500	3400	8400
12"	18"	....	6400	6500	6100	5800	5500	5200	5000	4600	4600	4500	4400	4300	4200	4100	4100	4000
13"	18"	....	8100	7600	7200	6800	6500	6200	5900	5600	5400	5300	5200	5100	5000	4900	4800	4700
14"	18"	....	9400	8800	8300	7900	7500	7100	6800	5500	6200	6100	6000	5900	5800	5700	5600	5500
15"	18"	....	10800	10100	9600	9100	8600	8200	7800	7500	7200	7100	6900	6800	6000	6500	6400	6300
16"	18"	....	12200	11500	10900	10300	9800	9300	8900	6500	8200	8000	7800	7700	7500	7400	7300	7100
12"	20"	....	....	7200	6800	6400	6100	5800	5600	5300	5100	5000	4900	4800	4700	4600	4500	4500
13"	20"	....	....	6500	8000	7600	7200	6800	6500	6200	6000	5900	5800	5600	5500	5400	5300	5200
14"	20"	....	....	9800	9300	8800	8300	7900	7600	7200	6900	8600	6700	6500	6400	6300	6200	6100
15"	20"	....	....	11300	10600	10100	9600	9100	8700	8000	6000	7800	7700	7500	7400	7300	7100	7000
15"	20"	....	....	12800	12100	11500	10900	10400	9900	9500	9100	8900	8700	8500	8400	8200	8100	7900
17"	20"	....	....	14500	13600	13000	12300	11700	11200	10700	10200	10000	9600	9600	9400	9300	9100	9000
18"	20"	....	....	16200	15300	14500	13800	13100	12500	12000	11500	11200	11000	10800	10600	10400	10200	10000
14"	22"	....	....	....	....	....	....	8700	8300	8000	7500	7500	7300	7200	7000	6900	8600	6700
15"	22"	....	....	....	....	....	....	10000	9600	9100	6800	8600	8400	8300	8100	7900	7800	7700
16"	22"	....	....	....	....	....	....	11400	10900	10400	10000	9600	9600	9400	9200	9000	8900	8700
17"	22"	....	....	....	....	....	....	12900	12300	11700	11300	11000	10800	10600	10300	10200	10000	9800
18"	22"	....	....	....	....	....	....	14400	13800	13200	12600	12400	12100	11900	11700	11400	11200	11000
19"	22"	....	....	....	....	....	....	16100	15300	14700	14100	13800	13500	13200	13000	12700	12500	12300
14"	24"	....	....	....	....	....	....	....	9100	8700	8300	8200	8000	7600	7700	7500	7400	7300
15"	24"	....	....	....	....	....	....	....	10400	10000	9600	9400	9200	9000	6800	8700	8500	8300
16"	24"	....	....	....	....	....	....	....	11900	11400	10900	10700	10400	10200	10000	9800	9700	9500
17"	24"	....	....	....	....	....	....	....	13400	12800	12300	12000	11800	11600	11300	11100	10900	10700
18"	24"	....	....	....	....	....	....	....	15000	14400	13800	13500	13200	13000	12700	12500	12200	12000
19"	24"	....	....	....	....	....	....	....	16700	16100	15300	15100	14800	14500	14200	13900	13700	13400
20"	24"	....	....	....	....	....	....	....	16500	17700	17000	16700	18300	16000	15700	15400	15100	14800
21"	24"	....	....	....	....	....	....	....	20400	19600	18700	18400	16000	17700	17300	17000	16700	16400
22"	24"	....	....	....	....	....	....	....	22400	21500	20600	20200	19800	19400	19000	18600	18300	16000
23"	24"	....	....	....	....	....	....	....	24500	23500	22500	22000	21600	21200	20800	20400	20000	19600
17"	25"	....	....	....	....	....	....	....	14500	13900	13300	13000	12800	12500	12300	12100	11800	11500
18"	26"	....	....	....	....	....	....	....	16300	15600	14900	14600	14300	14000	13800	13500	13300	13000
19"	26"	....	....	....	....	....	....	....	18100	17300	16800	16300	16000	15600	15300	15100	14600	14500
20"	26"	....	....	....	....	....	....	....	20100	19200	18400	18100	17700	17300	17000	16700	16400	16100
21"	26"	....	....	....	....	....	....	....	22200	21200	20300	19900	19500	19100	16800	16400	18000	17700
22"	26"	....	....	....	....	....	....	....	24300	23300	22300	21900	21400	21000	20600	20200	19800	19500
23"	26"	....	....	....	....	....	....	....	26600	25400	24400	23900	23400	22900	22500	22100	21700	21300
24"	26"	....	....	....	....	....	....	....	....	....	....	....	25500	25000	24500	24000	23600	23100
25"	26"	....	....	....	....	....	....	....	....	....	....	....	27600	27100	26800	26100	25600	25100
26"	26"	....	....	....	....	....	....	....	....	....	....	....	29900	29300	28700	28200	27700	27200
17"	28"	....	....	....	....	....	....	....	....	....	....	....	13800	13500	13200	13000	12700	12500
18"	28"	....	....	....	....	....	....	....	....	....	....	....	15400	15100	14800	14500	14300	14000
19"	28"	....	....	....	....	....	....	....	....	....	....	....	17200	16800	16500	15200	15900	15600
20"	28"	....	....	....	....	....	....	....	....	....	....	....	19100	18700	18300	16000	17700	17300
21"	28"	....	....	....	....	....	....	....	....	....	....	....	21000	20600	20200	19600	19400	19100
22"	28"	....	....	....	....	....	....	....	....	....	....	....	23100	22600	22200	21700	21300	20900
23"	28"	....	....	....	....	....	....	....	....	....	....	....	25200	24700	24200	23800	23300	22900
24"	28"	....	....	....	....	....	....	....	....	....	....	....	27400	26900	26400	25900	25400	24900
25"	28"	....	....	....	....	....	....	....	....	....	....	....	29800	29200	28600	28100	27500	27000
26"	28"	....	....	....	....	....	....	....	....	....	....	....	32200	31500	30900	30400	29800	29300
27"	28"	....	....	....	....	....	....	....	....	....	....	....	34700	34000	33400	32700	32100	31500
28"	28"	....	....	....	....	....	....	....	....	....	....	....	37300	36600	35900	35200	34600	33900
18"	30"	....	....	....	....	....	....	....	....	....	....	....	16550	16200	15900	15600	15300	15000
19"	30"	....	....	....	....	....	....	....	....	....	....	....	16400	18100	17700	17400	17000	16700
20"	30"	....	....	....	....	....	....	....	....	....	....	....	20400	20000	19600	19300	18900	16800
21"	30"	....	....	....	....	....	....	....	....	....	....	....	22500	22100	21700	21200	20900	20500
22"	30"	....	....	....	....	....	....	....	....	....	....	....	24700	24200	23800	23300	22900	22500
23"	30"	....	....	....	....	....	....	....	....	....	....	....	27000	26500	26000	25500	25000	24600
24"	30"	....	....	....	....	....	....	....	....	....	....	....	29400	28800	26300	27700	27200	26700
25"	30"	....	....	....	....	....	....	....	....	....	....	....	31900	31300	30700	30100	29500	29000
26"	30"	....	....	....	....	....	....	....	....	....	....	....	34500	33800	33200	32500	31900	31300
27"	30"	....	....	....	....	....	....	....	....	....	....	....	37200	36400	35700	35100	34400	33800
28"	30"	....	....	....	....	....	....	....	....	....	....	....	40000	39200	38500	37800	37100	36400
29"	30"	....	....	....	....	....	....	....	....	....	....	....	42900	42000	41200	40500	39700	39000
30"	30"	....	....	....	....	....	....	....	....	....	....	....	45900	45000	44100	43300	42500	41700
19"	32"	....	....	....	....	....	....	....	....	....	....	....	19700	19300	18900	16000	18200	17900
20"	32"	....	....	....	....	....	....	....	....	....	....	....	21600	21400	21000	20600	20200	19800
21"	32"	....	....	....	....	....	....	....	....	....	....	....	24000	23500	23100	22700	22200	21800
22"	32"	....	....	....	....	....	....	....	....	....	....	....	26400	25800	25300	24900	24400	23900
23"	32"	....	....	....	....	....	....	....	....	....	....	....	28800	28200	27700	27200	26700	26200
24"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
25"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
26"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
27"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
28"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
29"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
30"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
20"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
21"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
22"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
23"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
24"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
25"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
26"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
27"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
28"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
29"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
30"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
20"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
21"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
22"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
23"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
24"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
25"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
26"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
27"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
28"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
29"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
30"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

Diam.	Stroke	56"	57"	58"	59"	60"	61"	62"	63"	64"	65"	66"	67"	68"	69"	70"	71"	72"
9"	14"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
10"	14"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
11"	14"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
9"	16"	....	....	....	....	....	....	....	....	....	....	....	....	....	....			
10"	16"	....	....	....	....	....	....	....	....	....	....	....	....	....	....			
11"	16"	....	....	....	....	....	....	....	....	....	....	....	....	....	....			
12"	16"	....	....	....	....	....	....	....	....	....	....	....	....	....	....			
13"	16"	....	....	....	....	....	....	....	....	....	....	....	....	....	....			
10"	18"	2700	2700	2600	....	....	....	....	....	....	....	....	....	....	....	....	....	....
11"	18"	3300	3200	3200	....	....	....	....	....	....	....	....	....	....	....	....	....	....
12"	18"	3900	3900	3800	....	....	....	....	....	....	....	....	....	....	....	....	....	....
13"	18"	4600	4500	4500	....	....	....	....	....	....	....	....	....	....	....	....	....	....
14"	18"	5400	5300	5200	....	....	....	....	....	....	....	....	....	....	....	....	....	....
15"	18"	6100	6000	5900	....	....	....	....	....	....	....	....	....	....	....	....	....	....
16"	18"	7000	6900	6800	....	....	....	....	....	....	....	....	....	....	....	....	....	....
12"	20"	4300	4300	4200	4100	4100	....	....	....	....	....	....	....	....	....	....	....	....
13"	20"	5190	5000	5000	4900	4800	....	....	....	....	....	....	....	....	....	....	....	....
14"	20"	6000	5800	5700	5600	5600	....	....	....	....	....	....	....	....	....	....	....	....
15"	20"	6800	6600	5600	6500	6400	....	....	....	....	....	....	....	....	....	....	....	....
15"	20"	7800	7600	7600	7400	7300	....	....	....	....	....	....	....	....	....	....	....	....
17"	20"	8800	8600	6500	8300	8200	8100	7900	7800	7700	7600	7400	....	....	....	....	....	....
18"	20"	9600	9700	9500	9300	9200	9000	8900	8700	8600	8500	6400	....	....	....	....	....	....
14"	22"	6600	6400	6300	6200	6100	6000	5900	5800	5700	5600	5600	5500	5400	5300	5200	5200	5100
15"	22"	7500	7400	7300	7100	7000	6900	6800	6700	6000	6500	6400	6300	8200	6100	6000	5900	5900
16"	22"	6500	8400	8300	8100	8000	7800	7700	7600	7500	7400	7300	7100	7000	6900	6800	6700	6700
17"	22"	9700	9500	9300	9200	9000	8900	8700	6800	8400	8300	8200	8100	8000	7800	7700	7600	7500
18"	22"	10800	10600	10400	10300	10100	9900	9800	9600	9500	9300	9200	9000	8900	8800	8700	8500	8400
19"	22"	12100	11600	11500	11400	11300	11100	10900	10700	10500	10400	10200	10100	9900	9600	9600	9500	9400
14"	24"	7100	7000	5900	6800	6700	6800	6400	6400	8300	6200	6100	6000	5900	6800	5700	5600	5600
15"	24"	8200	8100	7900	7800	7700	7500	7400	7300	7200	7100	7000	6900	6800	6700	6800	6500	6400
16"	24"	9300	9200	9000	8900	8700	8600	8400	8300	8200	8000	7900	7800	7700	7600	7500	7400	7300
17"	24"	10500	10300	10200	10000	9600	9700	9500	9400	9200	9100	8900	8800	8700	8600	8400	8300	8200
18"	24"	11800	11600	11400	11200	11000	10900	10700	10500	10300	10200	10000	9900	9700	9600	9400	9300	9200
19"	24"	13200	12900	12700	12500	12300	12100	11900	11700	11500	11300	11200	11000	10800	10700	10500	10400	10200
20"	24"	14600	14300	14100	13800	13600	13400	13200	13000	12800	12600	12400	12200	12000	11800	11700	11500	11300
21"	24"	16100	15800	15500	15200	15000	14800	14500	14300	14100	13800	13600	13400	13200	13000	12900	12700	12500
22"	24"	17600	17300	17000	15700	15500	16200	[illegible]	15700	15400	15200	15000	14700	14500	14300	14100	13900	13700
23"	24"	19300	18900	18600	18300	18000	17700	17400	17100	16900	16800	16400	16100	15900	15600	15400	15200	15000
17"	25"	11400	11200	11000	10800	10600	10500	10300	10100	10000	9800	9700	9500	9400	9300	9100	9000	8900
18"	26"	12800	12600	12300	12100	11900	11700	11500	11400	11200	11000	10900	10700	10500	10400	10200	10100	10000
19"	26"	14300	14000	13800	13500	13300	13100	12900	12700	12500	12300	12100	11900	11700	11600	11400	11200	11100
20"	26"	15800	15500	15300	15000	14700	14500	14300	14100	13800	13600	13400	13200	13000	12800	12600	12500	12300
21"	26"	17400	17100	16800	16500	16200	16000	15700	15500	15200	15000	14800	14500	14300	14100	13900	13700	13500
22"	26"	19100	16800	18400	18100	17900	17500	17300	17000	16700	16500	16200	16000	15700	15500	15300	15100	14900
23"	26"	20900	20500	20200	19800	19500	19200	18900	16800	18300	18000	17700	17500	17200	17000	16700	16500	15300
24"	26"	22700	22300	21900	21600	21200	20900	20500	20200	19900	19600	19300	19000	18700	18400	18200	17900	17700
25"	26"	24700	24200	23800	23400	23000	22600	22300	21900	21000	21300	20900	20600	20300	20000	19700	19500	19200
26"	26"	25700	26200	25800	25300	24900	24500	24100	23700	23300	23000	22600	22300	22000	21600	21300	21000	20700
17"	28"	12300	12100	11900	11700	11500	11300	11100	10900	10700	10600	10400	10300	10100	10000	9600	9700	9600
18"	28"	13800	13500	13300	13100	12900	12600	12400	12300	12100	11900	11700	11600	11300	11200	11000	10900	10700
19"	28"	15300	15000	14800	14600	14300	14100	13900	13800	13400	13200	13000	12800	12600	12500	12300	12100	11900
20"	28"	17000	16700	18400	16100	15900	15600	15400	15100	14900	14700	14400	14200	14000	13800	13800	13400	13200
21"	28"	18700	16400	18100	17800	17500	17200	16900	16700	16400	16200	15900	15700	15500	15200	16000	14600	14600
22"	28"	20600	20200	19900	19500	19200	18900	18600	18300	18000	17700	17500	17200	17000	16700	16500	16200	16000
23"	28"	22500	22100	21700	21300	21000	20600	20300	20000	19700	19400	19100	18800	16500	18300	16000	17800	17500
24"	28"	24500	24100	23600	23200	22800	22500	22100	21600	21400	21100	20800	20500	20200	19900	19600	19300	19000
25"	28"	26600	26100	25600	25200	24600	24400	24000	23600	23200	22900	22500	22200	21900	21600	21200	20900	20600
26"	28"	28700	28200	27700	27300	26900	26400	26000	25500	25100	24800	24400	24000	23700	23300	23000	22600	22300
27"	28"	31000	30400	29900	29400	28900	28400	28000	27500	27100	26700	26300	25900	25500	25200	24800	24500	24100
28"	28"	33300	32700	32200	31600	31100	30600	30100	29600	29200	28700	28300	27800	27400	27000	26600	28300	25900
18"	30"	14800	14500	14200	14000	13800	13500	13300	13100	12900	12700	12500	12400	12200	12000	11600	11700	11500
19"	30"	16400	16200	15900	15600	15400	15100	14900	14600	14400	14200	14000	13800	13800	13400	13200	13000	12800
20"	30"	18200	17900	17600	17300	17000	16700	16500	16200	16000	15700	15500	15300	15000	14800	14600	14400	14200
21"	30"	20100	19800	19400	19100	18600	16500	18200	17900	17600	17300	17100	16800	16800	18300	16100	15900	15600
22"	30"	22100	21700	21300	20900	20600	20200	19900	19600	19300	19000	18700	16400	18200	17900	17700	17400	17200
23"	30"	24100	23700	23300	22900	22500	22100	21800	21400	21100	20800	20500	20200	19900	19600	19300	19000	18800
24"	30"	26300	25800	25300	24900	24500	24100	23700	23300	23000	22700	22300	22000	21600	21300	21000	20700	20400
25"	30"	28500	28000	27500	27000	28600	26100	25700	25300	25000	24600	24200	23800	23400	23100	22800	22400	22200
26"	30"	30800	30200	29700	29200	28700	28200	27800	27400	26900	26500	26100	25700	25400	25000	24600	24300	24000
27"	30"	33200	32600	32100	31500	31000	30500	30000	29500	29000	28600	28200	27700	27300	26900	25600	25200	25800
28"	30"	35800	35100	34500	33900	33400	32800	32300	31700	31200	30700	30300	29600	29400	29000	28600	28200	27800
29"	30"	38300	37600	37000	36300	35700	35200	34600	34000	33500	33000	32500	32000	31600	31100	30700	30200	29600
30"	30"	41000	40300	39600	38900	38300	37600	37000	36400	35900	35300	34600	34300	33800	33300	32800	32300	31900
19"	32"	17600	17300	17000	16700	16400	16100	15900	15600	15400	15100	14900	14700	14500	14300	14100	13900	13700
20"	32"	19500	19100	16800	16500	18200	17900	17600	17300	17000	16800	16500	16300	16000	15600	15600	15400	15100
21"	32"	21400	21100	20700	20400	20000	19700	19400	19100	16800	18500	18200	17900	17700	17400	17200	16900	16700
22"	32"	23500	23100	22700	22300	21900	21600	21200	20900	20600	20300	20000	19700	19400	19100	16800	16800	18300
23"	32"	25700	25200	24800	24400	24000	23600	23200	22900	22500	22200	21800	21500	21200	20200	20600	20300	20000
24"	32"	28000	27500	27000	26500	26100	25700	25300	24900	24500	24100	23800	23400	23000	22700	22400	22100	21800
25"	32"	30400	29600	29300	28800	28300	27900	27400	27000	26600	26200	25800	25400	25000	24600	24300	23900	23600
26"	32"	32800	32300	31700	31200	30700	30200	29700	29200	28700	26300	27900	27400	27000	26600	26300	25900	25500
27"	32"	35400	34800	34200	33600	33100	32500	32000	31500	31000	30500	30000	29600	29200	28700	28300	27900	27500
28"	32"	38100	37400	36800	36100	35800	35000	34400	33800	33300	32800	32300	31800	31400	30900	30500	30000	29600
29"	32"	40800	40100	39400	38800	38100	37500	36900	36300	35700	35200	34700	34100	33600	33100	32700	32200	31800
30"	32"	43700	42900	42200	41500	40800	40100	39500	38900	38300	37700	37100	36600	36000	35500	35000	34500	34000
20"	34"	20700	20300	20000	19600	19300	19000	18700	18400	18100	17600	17500	17300	17000	16800	16500	16300	16100
21"	34"	22800	22400	22000	21600	21300	25900	20600	20300	19900	19600	19300	19000	18600	16500	18200	16000	17700
22"	34"	25000	24600	24100	23700	23300	23000	22600	22200	21900	21500	21200	20900	20600	20300	20000	19700	19500
23"	34"	27300	26900	28400	25900	25500	25100	24700	24300	23900	23500	23200	22600	22500	22200	21900	21600	21300
24"	34"	29700	29200	28700	28200	27700	27300	26900	26400	26000	25600	25200	24800	24500	24100	23600	23500	23100
25"	34"	32300	31700	31100	30600	30100	29600	29100	28700	28200	27600	27400	27000	25600	26200	25800	25500	25100
26"	34"	34900	34300	33700	33100	32600	32000	31600	31000	30500	30000	29600	29200	28800	28300	27900	27500	27100
27"	34"	37600	37000	36300	35700	35100	34500	34000	33400	32900	32400	31900	31400	31000	30500	30100	29700	29300
28"	34"	40500	39800	39100	38400	37600	37200	36600	36000	35400	34800	34300	33800	33300	32800	32400	31900	31600
29"	34"	43400	42600	41900	41200	40500	39900	39200	38600	38000	37400	36800	36300	35700	35200	34700	34200	33800
30"	34"	46400	45600	44600	44100	43400	42600	42000	41300	40700	40000	39400	38800	38200	37700	37100	36600	36100
20"	36"	21900	21600	21100	20800	20400	20100	19800	19500	19200	18900	16800	18300	16000	17800	17500	17300	17000
21"	36"	24100	23700	23300	22900	22500	22100	21600	21400	21100	20800	20500	20200	19900	19600	19300	19000	16800
22"	36"	26500	26000	25600	25100	24700	24300	23900	23500	23200	22800	22500	22100	21800	21600	21200	20900	20600
23"	36"	28900	28400	27900	27500	27000	25600	26100	25700	25300	24900	24600	24200	23800	23500	23200	22800	22500
24"	36"	31600	30900	30400	29900	29400	28900	26500	28000	27600	27100	26700	26300	25900	25600	25200	24900	24500
25"	36"	34200	33600	33000	32400	31900	31400	30900	30400	29900	29400	29000	28600	28200	27700	27300	27000	26800
26"	36"	36900	36300	35700	35100	34500	33900	33400	32600	32300	31600	31300	30900	30400	30000	29600	29100	28700
27"	36"	39600	39100	38500	37800	37200	36600	36000	35400	34900	34300	33800	33300	32800	32300	31900	81400	31000
28"	36"	42800	42100	41400	40700	40000	39300	38700	38100	37500	36900	36400	35800	35300	34800	34300	33800	33300
29"	36"	45900	45100	44400	43600	42900	42200	41500	40600	40200	39600	39000	38400	37800	37300	36800	36200	35700
30"	36"	49200	48300	47600	46700	45900	45100	44400	43700	43000	42400	41700	41100	40500	39900	39300	38800	38300

Diam.	Stroke	73"	74"	75"	76"	77"	78"	79"	80"	81"	82"	83"	84"	85"	86"	Stroke	Diam.
9"	14"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	14"	9"
10"	14"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	14"	10"
11"	14"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	14"	11"
9"	16"														....	16"	9"
10"	16"														....	16"	10"
11"	16"														....	16"	11"
12"	16"														....	16"	12"
13"	16"														....	16"	13"
10"	18"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	18"	10"
11"	18"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	18"	11"
12"	18"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	18"	12"
13"	18"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	18"	13"
14"	18"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	18"	14"
15"	18"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	18"	15"
16"	18"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	18"	16"
12"	20"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	20"	12"
13"	20"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	20"	13"
14"	20"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	20"	14"
15"	20"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	20"	15"
15"	20"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	20"	16"
17"	20"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	20"	17"
18"	20"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	20"	18"
14"	22"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	22"	14"
15"	22"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	22"	15"
16"	22"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	22"	16"
17"	22"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	22"	17"
18"	22"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	22"	18"
19"	22"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	22"	19"
14"	24"	6500	5400	6300	5300	5200	5100	5100	5000	4900	4900	4800	4800	4700	4700	24"	14"
15"	24"	8300	6200	6100	6000	6000	5900	5800	5700	5700	5600	5500	5500	5400	5300	24"	15"
16"	24"	7200	7100	7000	6900	6800	6700	6000	6500	5500	6400	6300	6200	6200	6100	24"	16"
17"	24"	8100	8000	7900	7800	7700	7600	7500	7400	7300	7200	7100	7000	6900	6900	24"	17"
18"	24"	9100	8900	8800	8700	8600	8500	6400	8300	8200	8100	8000	7900	7800	7700	24"	18"
19"	24"	10100	10000	9800	9700	9600	9500	9300	9200	9100	9000	8900	8800	8700	8600	24"	19"
20"	24"	11200	11000	10900	10700	10600	10500	10300	10200	10100	10000	9800	9700	9600	9500	24"	20"
21"	24"	12300	12200	12000	11800	11700	11500	11400	11200	11100	11000	10800	10700	10600	10500	24"	21"
22"	24"	13500	13300	13200	13000	12800	12700	12500	12300	12200	12000	11900	11800	11600	11500	24"	22"
23"	24"	14600	14600	14400	14200	14000	13800	13700	16500	13300	13200	13000	12900	12700	12600	24"	23"
17"	25"	8800	8600	6500	8400	8300	8200	8100	8000	7900	7800	7700	7600	7500	7400	26"	17"
18"	26"	9800	9700	9600	9400	9300	9200	9100	9000	8800	8700	8600	8500	6400	8300	26"	18"
19"	26"	10900	10800	10600	10500	10400	10200	10100	10000	9900	9700	9600	9500	9400	9300	26"	19"
20"	26"	12100	12000	11800	11600	11500	11300	11200	11100	10900	10800	10700	10500	10400	10300	26"	20"
21"	26"	13400	13200	13000	12800	12700	12500	12300	12200	12000	11900	11700	11600	11600	11800	26"	21"
22"	26"	14700	14500	14300	14100	13900	13700	13500	13400	13200	13100	12900	12700	12600	12400	26"	22"
23"	26"	16000	15800	15600	15400	15200	15000	14800	14600	14400	14300	14100	13900	13800	13600	26"	23"
24"	26"	17400	17200	17000	16700	16500	16300	16100	15900	15700	15500	15300	15100	15000	14800	26"	24"
25"	26"	18900	18700	16400	18200	17900	17700	17500	17300	17100	16900	16600	16400	16200	16100	26"	25"
26"	26"	20400	20200	19900	19700	19400	19200	18900	18700	16400	18200	18000	17800	17600	17400	26"	26"
17"	28"	9400	9300	9200	9100	8900	8600	8700	8600	6500	8400	8300	8200	8100	6000	28"	17"
18"	28"	10600	10400	10300	10100	10000	9900	9800	9700	9500	9400	9300	9200	9100	9000	28"	18"
19"	28"	11600	11600	11500	11300	11200	11000	10900	10700	10600	10500	10400	10200	10100	10000	28"	19"
20"	28"	13000	12900	12700	12500	12400	12200	12100	11900	11800	11600	11600	11300	11200	11100	28"	20"
21"	28"	14400	14200	14000	13800	13600	13500	13300	13100	13000	12800	12700	12500	12400	12200	28"	21"
22"	28"	15800	15600	15400	15200	15000	14800	14600	14400	14200	14100	13900	18700	13600	13400	28"	22"
23"	28"	17300	17000	16800	16800	16400	16200	16000	15800	16800	15400	15200	15000	14800	14700	28"	23"
24"	28"	18800	16500	18300	18100	17800	17600	17400	17200	16900	16700	16500	16300	16100	16000	28"	24"
25"	28"	20400	20100	19800	19600	19300	19100	18800	16800	18400	18100	17900	17700	17500	17300	28"	25"
26"	28"	22000	21700	21400	21200	20900	20600	20400	20100	19900	19600	19400	19200	18900	18700	28"	26"
27"	28"	23800	23400	23100	22800	22500	22200	22000	21700	21400	21200	20900	20700	20400	20200	28"	27"
28"	28"	25600	25200	24900	24600	24200	23900	23600	23300	23000	22800	22500	22200	22000	21700	28"	28"
18"	30"	11300	11200	11000	10900	10800	10600	10500	10400	10200	10100	10000	9900	9700	9600	30"	18"
19"	30"	12600	12500	12300	12100	11900	11800	11700	11500	11400	11200	11100	11000	10900	10700	30"	19"
20"	30"	14000	13000	13800	13400	13300	13100	12900	12800	12600	12500	12300	12200	12000	11900	30"	20"
21"	30"	15400	15200	15000	14800	14600	14400	14300	14100	13900	13700	13600	13400	13300	13100	30"	21"
22"	30"	16900	16700	16500	18300	16100	15900	15700	15500	15300	15100	14900	14700	14500	14400	30"	22"
23"	30"	16500	18300	16000	17800	17500	17300	17100	16900	16700	16500	16300	16000	15900	15700	30"	23"
24"	30"	20200	19900	19600	19400	19100	18900	18600	18400	18200	18000	17700	17600	17300	17100	30"	24"
25"	30"	21600	21500	21200	21000	20700	20400	20200	19900	19700	19400	19200	19000	18600	16500	30"	25"
26"	30"	23800	23300	23000	22700	22400	22100	21600	21600	21300	21000	20800	20500	20300	20100	30"	26"
27"	30"	25500	25100	24800	24500	24100	23800	23500	23200	22900	22600	22400	22100	21900	21600	30"	27"
28"	30"	27400	27000	28600	28300	26000	25600	25300	25000	24700	24400	24100	23800	23500	23200	30"	28"
29"	30"	29400	29000	28600	28200	28000	27600	27200	26800	26500	26200	25800	25500	25200	25000	30"	29"
30"	30"	31400	31000	30600	30200	29600	29400	29100	28700	28300	28000	27700	27300	27000	26700	30"	30"
19"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	32"	19"
20"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	32"	20"
21"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	32"	21"
22"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	32"	22"
23"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	32"	23"
24"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	32"	24"
25"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	32"	25"
26"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	32"	26"
27"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	32"	27"
28"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	32"	28"
29"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	32"	29"
30"	32"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	32"	30"
20"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	34"	20"
21"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	34"	21"
22"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	34"	22"
23"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	34"	23"
24"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	34"	24"
25"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	34"	25"
26"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	34"	26"
27"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	34"	27"
28"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	34"	28"
29"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	34"	29"
30"	34"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	34"	30"
20"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36"	20"
21"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36"	21"
22"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36"	22"
23"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36"	23"
24"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36"	24"
25"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36"	25"
26"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36"	26"
27"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36"	27"
28"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36"	28"
29"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36"	29"
30"	36"	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36"	30"

FIGURES IN TABLE ARE CALCULATED FOR A PISTON SPEED OF 250 FEET PER MINUTE AND UNDER. FOR HIGHER SPEEDS MULTIPLY BY FACTORS GIVEN IN TABLE NO. 9.

The number of things mentioned show the complexity of the problem and many say that no one can take all these things into consideration. This may be so, but they exist and must be dealt with as a condition and not a theory, and in proportion as they are taken into consideration will improvement be made, and, what is also important, the responsibility will be placed where it belongs, which is the first step toward desired results.

It will be seen that there are four elements involved in every brake operation, namely: 1st, time; 2d, amount of reduction or change of pressure in the brake pipe; 3d, amount of cylinder pressure obtained, and, 4th, percentage of braking power. That is, a given pressure in the cylinder gives a certain braking power; all the rest are variable. For instance, the time required to reduce the brake pipe pressure a certain amount is varied by incrasing or decreasing the length of the train because this changes the volume of air in the brake pipe. The amount of reduction required to obtain a given cylinder and the cylinder pressure obtained from a given decrease in reservoir pressure is varied by the ratio of the brake cylinder in the reservoir, which ratio in effect increases or decreases the size of the brake cylinder. Plainly, then, all these elements must be kept in mind when considering the relationship existing between the different elements that the cause of the results obtained can be deduced.

The control of trains has become a much more complicated problem than heretofore, much knowledge of all the conditions involved is necessary, and the best talent available will be taxed to the limit to get the most economical efficiency and yet strangs as it may seem, these things are realized only by the few.

The air brake has advanced in the past year or two from being considered chiefly a safety appliance that was required by law to be applied, to an absolute necessity in the handling of freight and passenger trains, and its operation must be properly understood to make it a dividend earning asset.

Motor Cars in Zero Weather

A notable performance was made with a No. 16 Fairbanks-Morse motor car on the Chicago Great Western R. R., between Oelwein and Council Bluffs, in February, taking a party of officials on a trip of inspection.

The run was as follows:

February 17th, Oelwein to Clarion, 106 miles.

February 18th, Clarion to Hayfield and double back to Austin, 125 miles.

February 19th, Austin to Ft. Dodge, 114 miles.

February 20th, Fort Dodge to Council Bluffs, 135 miles.

The concluding part of this trip was made in the most severe blizzard of the year, with the thermometer 12 degrees below zero and the snow driting and piling up on the track.

TABLE No. 17
CLASSIFICATION OF LOCOMOTIVES.
[WHYTE'S SYSTEM]

040	4 WHEEL SWITCHER	062	6 COUPLED & TRAILING
060	6 WHEEL SWITCHER	082	8 COUPLED & TRAILING
080	8 WHEEL SWITCHER	044	FORNEY 4 COUPLED
0100	10 WHEEL SWITCHER	064	FORNEY 6 COUPLED
0440	ARTICULATED	046	FORNEY 4 COUPLED
0680	ARTICULATED	066	FORNEY 6 COUPLED
0880	ARTICULATED	242	COLUMBIA
2440	ARTICULATED	262	PRAIRIE
2680	ARTICULATED	282	MIKADO
2880	ARTICULATED	2102	10 COUPLED
2442	ARTICULATED	244	4 COUPLED
2862	ARTICULATED	264	6 COUPLED
2882	ARTICULATED	284	8 COUPLED
240	4 COUPLED	246	4 COUPLED
260	MOGUL	266	6 COUPLED
280	CONSOLIDATION	442	ATLANTIC
2100	DECAPOD	462	PACIFIC
440	8 WHEEL	444	4 COUPLED DOUBLE ENDER
460	10 WHEEL	464	6 COUPLED DOUBLE ENDER
480	12 WHEEL	446	4 COUPLED DOUBLE ENDER
042	4 COUPLED & TRAILING	266	6 COUPLED DOUBLE ENDER

Tractive Power Tables for Simple Locomotives

The American Locomotive Company has completed and arranged in tabular form a number of sets of calculations on the tractive power of simple locomotives. These tables, several of which are reproduced herewith, are extremely useful to the mechanical officials in the calculation of new power requirements.

Table No. 1 is calculated from formula $\frac{d^2xLx85.}{D}$ This table includes all the combinations of cylinder diameters,

Fairbanks-Morse Railway Motor Car.

strokes and wheel diameters used in ordinary practice. It can be used for any boiler pressure by simply dividing the required tractive power by the ratio of the boiler pressure it is desired to use to 100 pounds pressure, as for instance, 2 for 200 lbs., 1.75 for 175 lbs. and 1.6 for 160 lbs. pressure. Then the proper size cylinders and driving wheels can be found directly from the table, or by multiplying the figures in the table by the proper ratio the desired tractive power can be at once obtained. In this manner the use of very voluminous tractive power tables for different pressures is avoided.

Tables Nos. 5 to 18 show tractive power of locomotives with boiler pressures of 150 to 220 lbs., inclusive. These tables are calclated from the formula $\frac{d^2xLx.85\ P.,}{D}$ in which D=diameter of cylinders in inches; L—length of stroke in inches; P=boiler pressure in pounds per sq. inch; D=

TABLE No. 11
CYLINDER VOLUMES IN CUBIC FEET. (FOR ONE CYLINDER ONLY.)

Diam.	Stroke (in inches)												
	12	14	16	18	20	22	24	26	28	30	32	34	36
10 "	.55	.64	.72	81	90	..	....	...	....	....	...	....	....
10½"	.601	70	.80	.90	1.00	...	....	....	....	..	....	..	..
11 "	.66	.77	.88	.99	1.10	1.21	....	.	...	..	....	....	...
11½"	.721	.84	.96	1 08	1.20	1.32	....	...	...	...	....	....	...
12 "	.78	91	1 04	1.17	1 30	1.43	1.56	...	....		..	....	....
12½"	.849	.99	1.13	1.27	1.41	1.55	1 69	..	.	...	...	...	.
13 "	...	1.07	1.23	1.39	1.54	1 69	1.85	....	...	....	...	...	.
13½"	....	1.16	1.33	1.49	1.66	1.82	1.99	....	....	...	...	...	
14 "	....	1.24	1.42	1.60	1.78	1.95	2 13	....	....	...	....	....	..
14½"	....	....	1.53	1.72	1.91	2.10	2.29	....	...	...	....	....	
15 "	....	....	1.63	1.84	2.04	2.24	2.45	2.65	....	....	....	...	.
15½"	....	....	1 74	1.96	2.18	2 4	2.62	2.84	....	....	....	....	
16 "	....	....	1 85	2.08	2 32	2.55	2.78	3 02	...	..	....	....	
16½"	...	...	..	2.23	2 47	2 72	2.97	3.23	....	...	....	....	.
17 "	...	.	..	2.38	2.64	2 90	3 17	3 43	3 69	.	...	....	..
17½"	....	.	.	2.5	2.78	3.06	3.34	3.72	3.98	..	...	...	..
18 "	...	.	..	2.65	2.94	3 23	3.53	3.82	4.12	.	.	....	..
18½"	....	....	....	...	3.11	3 42	3.73	4.04	4.35	....	....	....	....
19 "	...			..	3.28	3 61	3.94	4 26	4.59	4 92	..	....	.
19½"	....			....	3.46	3.80	4 15	4.50	4.81	5.19	..	....	
20 "	...	.		.	3 64	4.00	4.37	4 73	5.10	5.46	.	....	.
20½"	.	.		.		4 20	4 58	4 96	5.34	5.73	...	...	....
21 "	.	.	.			4 40	4 80	5.20	5.60	6 00	6.42	....	..
21½"	.	..	...			4 62	5.04	5 46	5 88	6.30	6.72	..	...
22 "		.	.	..		4 84	5.28	5 72	6.16	6 60	7.05	..	....
22½"	.				.		5 52	5.98	6 44	6 90	7 36	.	....
23 "		.		.		.	5 76	6.21	6 72	7.20	7 68	8 18	....
23½"		..			..		6 02	6.52	7 02	7 52	8 02	8 52	..
24 "	.	.	.	..	...		6 27	6 79	7.31	7 83	8.38	8 90	...
24½"	..			...	..			7 10	7 65	8 2	8 75	9 30	..
25 "		.	.	....	..	...		7 38	7 95	8.52	9 08	9.65	10 21
25½"	.	.	..	....	....	...		7 68	8 27	8.86	9.45	10.04	10.63
26 "	.	.	.	.	..	...	.	7 98	8 60	9.21	9 83	10.44	11 08
27 "	.	.	....	.	.		.	8 61	9 27	9 93	10 59	11.26	11.92
28 "	.	..	..	..	..				9 97	10 68	11.30	12.10	12.82
29 "	....	....	...	.	...	..			10.70	11 46	12 22	13 00	13 76
30 "	....	...	...	..	...	...	..		11 45	12 27	13 09	13.90	14.72
31 "	....	.	...	.	..	..		.		13.10	13.97	14 84	15.71
32 "	....	.	....	..	.	...			....	13.96	14.90	15 84	16.76
33 "	...	.	..	.	.	....	.	.	..	....	15.82	16.82	17.81
34 "	....	..	..	..	....	.		.	...	....	16.82	17.87	18.92
35 "	....	.	...	..	...	....	..	.	.	..	17 81	18 92	20 10

TABLE No. 8.

TRACTIVE POWER OF SIMPLE LOCOMOTIVES. BOILER PRESSURE, 220 POUNDS; MEAN EFFECTIVE PRESSURE, 85 PER CENT. OF 220 POUNDS=187 POUNDS

Diameter of Driving Wheels.

Diam.	Stroke	30″	32″	34″	36″	38″	40″	42″	44″	46″	48″	49″	50″
15″	20″	28050	26290	24750	23370	22140	21040	20030	19120	18290	17530	17170	16830
16″	20″	31910	29920	28160	26590	25200	23940	22790	21760	20810	19950	19540	19150
17″	20″	36030	33770	31790	30020	28440	27020	25730	24560	23490	22520	22060	21610
18″	20″	40490	37870	35640	33660	31890	30290	28850	27540	26340	25240	24730	24230
16″	22″	....	....	....	....	....	....	25070	23930	22890	21940	21490	21060
17″	22″	....	....	....	....	....	....	28300	27020	25840	24770	24260	23780
18″	22″	....	....	....	....	....	....	31730	30290	28970	27770	27200	26650
19″	22″	....	....	....	....	....	....	35360	33750	32280	30940	30310	29700
16″	24″	....	....	....	....	....	....	....	26110	24970	23930	23440	22970
17″	24″	....	....	....	....	....	....	....	29480	28190	27020	26470	25940
18″	24″	....	....	....	....	....	....	....	33040	31610	30290	29670	29080
19″	24″	....	....	....	....	....	....	....	36820	35220	33750	33070	32400
20″	24″	....	....	....	....	....	....	....	40800	39020	37400	36640	35900
21″	24″	....	....	....	....	....	....	....	44980	43020	41230	40390	39580
22″	24″	....	....	....	....	....	....	....	49360	47220	45250	44330	43440
17″	26″	....	....	....	....	....	....	....	31930	30540	29270	28680	28100
18″	26″	....	....	....	....	....	....	....	35800	34250	32820	32150	31500
19″	26″	....	....	....	....	....	....	....	39890	38150	36570	35820	35100
20″	26″	....	....	....	....	....	....	....	44200	42270	40520	39690	38890
21″	26″	....	....	....	....	....	....	....	46730	46610	44670	43750	42880
22″	26″	....	....	....	....	....	....	....	53480	51160	49030	48020	47060
23″	26″	....	....	....	....	....	....	....	58450	55910	53580	52490	51440
20″	28″	....	....	....	....	....	....	....	47600	45530	43640	42740	41890
21″	28″	....	....	....	....	....	....	....	52480	50200	48110	47120	46180
22″	26″	....	....	....	....	....	....	....	57600	55090	52800	51720	50680
23″	28″	....	....	....	....	....	....	....	62950	60220	57710	56530	65400
24″	28″	....	....	....	....	....	....	....	68540	65560	62830	51550	60320
20″	30″	....	....	....	....	....	....	....	....	....	46750	45790	44880
21″	30″	....	....	....	....	....	....	....	....	....	51550	50490	49480
22″	30″	....	....	....	....	....	....	....	....	....	56570	55410	54300
23″	30″	....	....	....	....	....	....	....	....	....	61830	60570	59350
24″	30″	....	....	....	....	....	....	....	....	....	67320	65440	64630
20″	32″	....	....	....	....	....	....	....	....	....	49870	48850	47670
21″	32″	....	....	....	....	....	....	....	....	....	54980	53860	52780
22″	32″	....	....	....	....	....	....	....	....	....	60340	59100	57920
23″	32″	....	....	....	....	....	....	....	....	....	65950	64600	63310
24″	32″	....	....	....	....	....	....	....	....	....	71810	70340	68930
25″	32″	....	....	....	....	....	....	....	....	....	77920	76330	74800
20″	34″	....	....	....	....	....	....	....	....	....	52990	51900	50860
21″	34″	....	....	....	....	....	....	....	....	....	58410	57220	56080
22″	34″	....	....	....	....	....	....	....	....	....	64110	82800	61540
23″	34″	....	....	....	....	....	....	....	....	....	70070	68640	67260
24″	34″	....	....	....	....	....	....	....	....	....	76300	74740	73240
25″	34″	....	....	....	....	....	....	....	....	....	82790	61100	79470
20″	36″	....	....	....	....	....	....	....	....	....	58100	54950	53850
21″	36″	....	....	....	....	....	....	....	....	....	81850	60590	59370
22″	36″	....	....	....	....	....	....	....	....	....	67890	66500	65180
23″	36″	....	....	....	....	....	....	....	....	....	74200	72680	71220
24″	36″	....	....	....	....	....	....	....	....	....	80790	79130	77550
25″	36″	....	....	....	....	....	....	....	....	....	87660	85870	84150

Diam.	Stroke	51″	52″	53″	54″	55″	56″	57″	58″	59″	60″	61″	62″	63″	64″	65″	66″	87″	68″
15″	20″	16500	16180	15870	15580	15300	15020	14760	14510	14260	14020	....	....	....	....	....	....	....	....
16″	20″	18770	18410	18060	17730	17410	17090	16800	16500	16220	15960	....	....	....	....	....	....	....	....
17″	20″	21190	20780	20390	20010	19650	19300	18960	18630	18310	18010	17720	17430	17150	16880	16620	16370	....	....
18″	20″	23760	23300	22860	22440	22030	21640	21260	20890	20530	20190	19860	19540	19230	18930	18640	18360	....	....
16″	22″	20650	20250	19870	19500	19150	18810	18470	18160	17850	17550	17270	16990	16720	16450	16200	15960	15720	15490
17″	22″	23310	22860	22430	22020	21610	21230	20850	20500	20150	19810	19490	19170	18870	18570	18290	18010	17740	17480
18″	22″	26130	25630	25150	24680	24230	23800	23380	22980	22590	22210	21850	21500	21160	20820	20500	20190	19890	19600
19″	22″	29120	28560	28020	27500	27000	26520	26050	25600	25170	24750	24350	23950	23570	23200	22850	22500	22160	21840
16″	24″	22530	22090	21680	21280	20890	20510	20150	19810	19470	19150	18830	18530	18230	17950	17570	17400	17150	16890
17″	24″	25430	24940	24470	24030	23580	23160	22750	22360	21980	21620	21260	20920	20590	20260	19950	19650	19360	19070
18″	24″	28510	27960	27430	26930	26440	25960	25510	25070	24640	24230	23840	23450	23080	22720	22370	22030	21700	21380
19″	24″	31770	31150	30570	30030	29460	28930	28420	27930	27480	27000	26560	26130	25720	25310	24920	24540	24180	23830
20″	24″	35200	34530	33870	33250	32640	32060	31490	30950	30430	29920	29430	28950	28490	28050	27620	27200	26790	26400
21″	24″	38810	38060	37340	36650	35990	35340	34720	34120	33540	32990	32440	31920	31410	30920	30450	29990	29540	29110
22″	24″	42590	41770	40980	40230	39490	38790	38110	37450	36820	36200	35610	35030	34480	33940	33420	32910	32420	31940
17″	26″	27550	27020	26510	26020	25550	25090	24650	24220	23810	23420	23030	22660	22300	21950	21620	21290	20970	20660
18″	26″	30890	30290	29720	29170	28640	28130	27640	27160	26700	26250	25820	25410	25000	24610	24230	23870	23510	23170
19″	26″	34410	33750	33110	32500	31910	31340	30790	30260	29740	29250	28770	28310	27870	27420	27000	26590	26200	25810
20″	26″	38130	37400	36690	36010	35360	34730	34120	33530	32960	32410	31880	31370	30870	30390	29920	29460	29030	28600
21″	26″	42040	41230	40450	39700	38980	38290	37620	36960	36340	35740	35150	34580	34040	33500	32990	32480	32000	31530
22″	26″	46140	45250	44400	43580	42790	42020	41290	40570	39880	39220	38580	37960	37350	36770	36200	35650	35120	34610
23″	26″	50430	49450	48520	47630	46760	45920	45120	44340	43580	42870	42160	41480	40820	40180	39560	38960	38390	37820
20″	28″	41070	40280	39510	38790	38060	37400	36740	36110	35500	34910	34340	33780	33240	32720	32220	31730	31260	30800
21″	28″	45270	44400	43560	42760	41980	41230	40510	39810	39130	38480	37860	37240	36650	36080	35520	34980	34460	33960
22″	26″	49690	48730	47810	46930	46070	45250	44460	43690	42950	42240	41540	40870	40220	39600	38990	38400	37820	37270
23″	28″	54310	53260	52250	51290	50360	49460	48600	47780	46940	46170	45410	44670	43970	43280	42610	41960	41340	40730
24″	28″	59130	58000	56900	55850	54830	53850	52910	52000	51120	50270	49440	48640	47670	47120	46390	45690	45010	44350
20″	30″	44000	43150	42330	41560	40800	40070	39370	38690	38030	37400	36790	36190	35620	35060	34520	34000	33490	33000
21″	30″	48510	47570	46880	45820	44980	44170	43400	42650	41930	41230	40560	39900	39270	38650	38060	37480	36920	36380
22″	30″	53240	52210	51230	50280	49370	48480	47640	46810	46020	45250	44510	43790	43100	42420	41770	41140	40530	39930
23″	30″	58190	57070	55990	54960	53960	52990	52060	51170	50290	49460	48650	47870	47100	46370	45660	44960	44290	43640
24″	30″	63360	62140	60970	59840	58750	57700	56690	55710	54760	53860	52970	52120	51290	50490	49710	48980	48230	47520
20″	32″	46930	46030	45160	44320	43520	42740	41990	41270	40560	39890	39240	38610	37990	37400	36820	36280	35720	35200
21″	32″	51740	50750	49780	48870	47980	47120	46300	45500	44720	43980	43260	42560	41890	41230	40600	39980	39390	38810
22″	32″	56790	55700	54640	53640	52660	51720	50810	49930	49080	48270	47480	46710	45970	45250	44560	43880	43230	42590
23″	32″	62070	60870	59720	56620	57560	56520	55530	54580	53650	52780	51900	51060	50240	49460	48700	47960	47250	46550
24″	32″	67580	66280	85020	63830	62660	61550	60470	59420	58410	57450	56510	55590	54710	53850	53020	52220	51440	50690
25″	32″	73330	71920	70560	69260	68000	66780	65610	64480	63390	62340	61320	60320	59360	58440	57540	56660	55820	55010
20″	34″	49860	48910	47980	47090	46240	45410	44620	43850	43100	42390	41690	41020	40370	39740	39130	38530	37960	37400
21″	34″	54980	53920	52900	51920	50980	50070	49190	48340	47520	46730	45960	45220	44500	43810	43130	42480	41850	41230
22″	34″	60340	59170	58060	56990	55950	54950	53980	53050	52150	51300	50450	49630	48840	48080	47340	46620	45930	45260
23″	34″	65950	64680	63450	62290	61150	60060	59000	57990	57000	56060	55140	54250	53390	52550	51740	50960	50200	49460
24″	34″	71810	70420	69090	87820	66580	65400	64250	63140	62070	81040	60040	59070	68130	57220	56340	55490	54660	53860
25″	34″	77920	76410	74970	73590	72250	70960	69710	68510	67350	66240	65150	64100	63080	62090	81140	60210	59310	58440
20″	36″	52800	51780	50800	49880	48960	48080	47240	46420	45630	44880	44140	43430	42740	42070	41420	40800	40190	39600
21″	36″	58210	57090	56010	54980	53980	53010	52080	51180	60310	49480	48670	47880	47120	46390	45670	44980	44310	43660
22″	36″	63890	62660	61480	60340	59240	58180	57170	56180	55230	54310	53420	52560	51720	50910	50130	49370	48630	47920
23″	36″	69830	68480	87190	65950	64760	63590	62480	81400	60360	59360	58380	57440	56530	55640	54790	53960	63150	52370
24″	36″	76040	74560	73160	71810	70500	69240	68030	66850	65720	64630	63570	82540	81550	60590	59650	58750	57880	57030
25″	36″	82500	80910	79380	77920	76500	75130	73820	72540	71310	70130	68980	87860	66780	65740	64730	63760	62800	51880

Diam.	Stroke	69″	70″	71″	72″	73″	74″	75″	76″	77″	76″	79″	80″	81″	82″	83″	84″	85″	86″	Stroke	Diam.
15″	20″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	20″	15″
16″	20″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	20″	16″
17″	20″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	20″	17″
18″	20″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	20″	18″
16″	22″	15280	15040	14830	14630															22″	16″
17″	22″	17230	16980	16740	16510															22″	17″
18″	22″	19320	19040	18770	18510															22″	18″
19″	22″	21520	21210	20920	20620															22″	19″
16″	24″	16650	16410	16180	15950	15740	15520	15320	15120	14920	14730	14540	14360	14180	14010	13840	13670	13510	13360	24″	16″
17″	24″	18800	18530	18270	18010	17780	17520	17290	17070	16840	16630	16420	16210	16010	15810	15620	15440	15260	15090	24″	17″
18″	24″	21070	20770	20480	20190	19920	19650	19390	19130	18880	18640	18400	18170	17950	17730	17520	17310	17110	16910	24″	18″
19″	24″	23480	23140	22820	22500	22190	21890	21600	21320	21040	20770	20510	20250	20000	19750	19520	19280	19060	18840	24″	19″
20″	24″	26020	25640	25280	24930	24590	24260	23930	23620	23310	23010	22720	22440	22160	21890	21620	21370	21120	20870	24″	20″
21″	24″	28680	28270	27870	27490	27110	26740	26390	26040	25700	25370	25050	24740	24430	24130	23840	23560	23280	23010	24″	21″
22″	24″	31480	31030	30590	30170	29750	29350	28960	28580	28210	27850	27490	27150	26820	26490	26170	25860	25560	25260	24″	22″
17″	26″	20360	20070	19790	19510	19250	18990	18730	18490	18250	18010	17790	17560	17350	17130	16930	16720	16530	16340	26″	17″
18″	26″	22830	22500	22190	21880	21580	21280	21000	20730	20460	20190	19940	19690	19450	19210	18980	18750	18530	18320	26″	18″
19″	26″	25430	25070	24720	24380	24040	23720	23400	23090	22790	22500	22220	21940	21670	21400	21140	20890	20650	20410	26″	19″
20″	26″	28180	27780	27390	27010	26640	26280	25930	25590	25260	24930	24620	24310	24010	23710	23430	23150	22880	22610	26″	20″
21″	26″	31070	30630	30200	29780	29370	28970	28590	28210	27840	27480	27140	26800	26470	26150	25830	25520	25220	24930	26″	21″
22″	26″	34100	33620	33140	32680	32230	31800	31380	30960	30560	30170	29790	29410	29050	28700	28350	28010	27680	27360	26″	22″
23″	26″	37270	36750	36220	35720	35230	34750	34290	33840	33400	32970	32550	32150	31750	31360	30980	30610	30260	29900	26″	23″
20″	28″	30350	29920	29500	29090	28690	28300	27920	27560	27200	26850	26510	26180	25860	25540	25230	24930	24640	24350	28″	20″
21″	28″	33460	32990	32520	32070	31630	31200	30790	30380	29990	29600	29230	28860	28500	28160	27820	27490	27160	26850	28″	21″
22″	26″	36730	36200	35690	35200	34710	34240	33790	33350	32910	32490	32080	31680	31290	30900	30530	30170	29810	29470	28″	22″
23″	28″	40140	39560	39010	38470	37940	37430	36930	36450	35970	35510	35060	34620	34190	33780	33370	32970	32590	32200	28″	23″
24″	28″	43710	43080	42480	41880	41310	40750	40210	39680	39170	38660	38180	37700	37230	36770	36330	35900	35480	35070	28″	24″
20″	30″	32520	32050	31610	31160	30740	30320	29920	29530	29140	28770	28400	28050	27700	27360	27030	26710	26400	26090	30″	20″
21″	30″	35860	35340	34840	34360	33890	33430	32990	32550	32130	31720	31310	30920	30540	30170	29800	29450	29110	28770	30″	21″
22″	30″	39350	38790	38240	37710	37190	36690	36200	35730	35260	34810	34370	33940	33520	33110	32710	32320	31940	31570	30″	22″
23″	30″	43010	42390	41800	41220	40650	40100	39570	39050	38540	38050	37560	37090	36640	36190	35750	35330	34910	34510	30″	23″
24″	30″	46830	46160	45510	44880	44280	43660	43090	42520	41970	41430	40900	40390	39890	39400	38930	38470	38020	37570	30″	24″
20″	32″	34690	34190	33710	33240	32790	32340	31910	31500	31080	30690	30300	29920	29550	29190	28840	28490	28160	27830	32″	20″
21″	32″	38250	37700	37170	38650	38150	35660	35180	34720	34270	33830	33400	32980	32580	32180	31790	31410	31040	30680	32″	21″
22″	32″	41970	41370	40790	40220	39670	39140	38620	38110	37610	37130	36660	36200	35760	35320	34890	34480	34070	33680	32″	22″
23″	32″	45880	45220	44580	43970	43360	42770	42210	41650	41110	40580	40070	39570	39080	38600	38140	37680	37240	36810	32″	23″
24″	32″	49950	49240	48550	47870	47210	46570	45950	45350	44760	44190	43630	43080	42550	42030	41520	41030	40550	40080	32″	24″
25″	32″	54210	53430	52680	51940	51230	50540	49870	49210	48570	47950	47340	46750	46170	45610	45060	44520	44000	43490	32″	25″
20″	34″	38860	36330	35820	35320	34840	34370	33910	33460	33030	32600	32190	31790	31400	31010	30640	30270	29920	29570	34″	20″
21″	34″	40640	40050	39490	38940	38400	37880	37380	36890	36410	35950	35490	35040	34610	34190	33780	33380	32990	32600	34″	21″
22″	34″	44600	43980	43340	42740	42150	41580	41030	40490	39970	39450	38950	38460	37990	37530	37070	36630	36200	35780	34″	22″
23″	34″	48750	48050	47370	46710	46070	45450	44840	44260	43680	43120	42570	42040	41520	41010	40520	40040	39570	39110	34″	23″
24″	34″	53080	52320	51580	50860	60170	49490	48830	48190	47560	46950	46360	45780	45210	44660	44120	43600	43090	42590	34″	24″
25″	34″	57590	56770	55970	55190	54440	53700	52980	52290	51610	50950	50300	49670	49060	48460	47870	47300	46750	46210	34″	25″
20″	36″	39020	38470	37930	37400	36880	36390	35900	35430	34970	34520	34080	33660	33240	32830	32440	32050	31680	31310	36″	20″
21″	36″	43030	42410	41810	41230	40670	40120	39580	39060	38560	38060	37580	37110	36650	36200	35770	35340	34930	34520	36″	21″
22″	36″	47220	46550	45890	45260	44630	44030	43450	42870	42320	41770	41240	40730	40230	39730	39250	38790	38340	37890	36″	22″
23″	36″	51610	50880	50180	49460	48780	48120	47480	46860	46250	45660	45080	44510	43960	43430	42910	42390	41900	41410	36″	23″
24″	36″	56200	55390	54620	53860	53120	52400	51700	51020	50360	49710	49080	48470	47870	47280	46710	46160	45620	45090	36″	24″
25″	36″	60980	60110	59260	58440	57640	56860	56100	55370	54650	53940	53260	52590	51940	51310	50690	50090	49500	48930	36″	25″

Figures in table are calculated for a piston speed of 250 feet per minute and under. For higher speeds multiply by factors given in table No. 9

TABLE No. 9.

Wheel Diameters and Revolutions per Mile.

Piston Speed, Feet per Minute, at Ten Miles per Hour.

Stroke	30″ 672.2	31″ 650.5	32″ 630.2	33″ 611.0	34″ 593.2	35″ 576.5	36″ 560.2	37″ 545.0	38″ 530.6	39″ 517.2	40″ 504.4	41″ 491.9	42″ 480.3	43″ 469.3	44″ 458.4	45″ 448.2	46″ 438.4	47″ 429.1	48″ 420.1	49″ 411.6	50″ 403.3	51″ 395.4	52″ 387.6	53″ 380.5	54″ 373.4	55″ 366.7	56″ 360.1	57″ 353.8	58″ 347.7	59″ 341.8	60″ 336.1
12″	224.0	216.8	210.1	203.7	197.7	192.2	166.7	161.6	176.9	172.4	168.1	163.9	160.1	156.4	152.8	149.4	146.1	143.0	140.0	137.2	134.4	131.6	129.3	128.8	124.4	122.4	120.0	117.9	115.9	113.9	112.0
14″	261.1	252.9	245.0	237.6	230.8	224.1	217.8	211.4	206.3	201.1	196.2	191.2	186.7	182.5	178.2	174.0	170.4	166.6	163.4	180.1	156.8	153.7	160.8	147.9	145.8	142.6	140.0	137.5	135.2	132.9	130.7
16″	298.8	289.1	280.1	271.8	263.7	256.3	249.1	242.8	238.0	229.9	224.3	218.6	213.5	208.8	203.8	199.2	194.9	190.8	186.8	163.0	179.3	175.8	172.4	169.2	155.9	163.0	160.0	157.3	154.8	152.0	149.4
18″	336.1	325.2	315.1	305.5	296.6	288.2	280.1	272.5	265.3	258.6	252.2	245.9	240.1	234.8	229.2	224.1	219.2	214.5	210.0	205.8	201.6	197.7	193.9	190.2	168.7	163.3	180.0	178.9	173.6	170.9	168.0
20″	373.4	361.3	350.1	339.3	329.5	320.2	311.1	302.7	294.5	287.3	280.1	273.3	266.8	260.7	254.6	249.0	243.5	238.3	233.3	226.8	224.0	219.6	215.4	211.3	207.5	203.7	200.1	196.5	193.1	189.8	186.7
22″	...	...	...	...	...	...	...	...	...	...	...	...	...	286.8	280.2	273.9	268.0	262.3	256.7	251.5	246.5	241.7	237.0	232.6	227.8	224.5	220.1	218.3	212.5	208.9	205.4
24″	...	...	...	...	...	...	...	...	...	...	...	...	...	312.9	305.8	298.8	292.3	286.1	280.1	274.4	268.9	263.8	258.5	253.7	249.0	244.5	240.1	235.9	231.8	227.9	224.1
25″	...	...	...	...	...	...	...	...	...	...	...	...	...	338.9	331.0	323.7	316.6	309.7	303.5	297.2	291.2	285.8	280.1	274.6	270.4	264.8	260.1	255.5	251.2	246.8	242.7
28″	...	...	...	...	...	...	...	...	...	...	...	...	...	365.0	358.4	348.8	341.0	333.8	328.8	320.1	313.7	307.5	301.6	295.9	291.2	285.1	280.1	275.1	270.5	285.8	261.4
30″	...	...	...	...	...	...	...	...	...	...	...	...	...	391.0	382.0	373.5	365.3	357.5	350.0	343.0	336.0	329.5	323.1	317.0	311.1	305.5	300.1	294.8	289.8	284.7	280.0
32″	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	358.5	351.4	344.7	338.2	332.8	325.9	320.1	314.5	309.1	303.7	296.7
34″	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	380.8	373.4	366.2	359.3	353.6	346.3	340.1	334.1	328.4	322.7	317.4
36″	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	380.5	373.4	366.7	360.1	353.8	347.7	341.8	336.1

Stroke	61″ 330.6	62″ 325.3	63″ 320.1	64″ 315.1	65″ 310.2	66″ 305.5	67″ 301.0	68″ 296.8	69″ 292.2	70″ 288.1	71″ 284.0	72″ 280.1	73″ 278.2	74″ 272.6	75″ 268.9	76″ 265.3	77″ 261.9	78″ 258.5	79″ 255.3	80″ 252.1	81″ 249.0	82″ 245.9	83″ 243.0	84″ 240.1	65″ 237.3	86″ 234.5	87″ 231.6	88″ 229.2	89″ 226.6	90″ 224.1	Stroke
12″	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12″
14″	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14″
16″	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	16″
18″	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	18″
20″	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	20″
22″	202.0	199.0	195.6	192.6	189.6	186.6	183.9	181.4	178.6	176.1	173.6	171.2	168.8	166.5	164.3	162.1	160.0	158.0	156.0	154.1	152.2	150.3	148.5	146.7	145.0	143.3	141.7	140.1	138.5	136.9	22″
24″	220.4	217.0	213.4	210.1	206.6	203.6	200.6	197.7	194.6	192.1	189.2	186.7	184.1	181.7	179.3	176.9	174.6	172.3	170.2	168.1	166.0	163.9	162.0	160.1	158.2	156.3	154.5	152.6	151.1	149.4	24″
25″	238.7	235.0	231.1	227.6	224.0	220.6	217.3	214.2	211.0	208.1	205.1	202.3	199.5	196.8	194.2	191.6	189.1	186.6	184.4	182.1	179.8	177.6	175.5	173.3	171.4	169.4	167.4	165.5	163.6	161.8	26″
28″	257.1	253.0	248.9	245.0	241.2	237.8	234.0	230.7	227.2	224.1	220.9	217.8	214.8	211.9	209.1	206.2	203.7	201.0	198.6	196.1	193.7	191.3	189.0	186.7	184.5	182.4	180.3	178.3	176.2	174.3	28″
30″	275.5	271.0	266.7	262.5	258.5	254.5	250.8	247.1	243.5	240.1	236.6	233.4	230.2	227.1	224.1	221.0	218.0	215.4	212.7	210.1	207.5	204.9	202.5	200.0	197.7	195.4	193.2	191.0	188.8	186.7	30″
32″	293.8	289.2	284.5	280.0	275.7	271.2	267.5	263.6	259.7	256.1	252.4	249.0	245.5	242.2	239.0	235.8	232.8	229.7	226.9	224.1	221.3	218.6	216.0	213.3	210.9	208.4	206.0	203.7	201.4	199.2	32″
34″	312.2	307.3	302.3	297.8	292.9	288.3	284.3	280.0	275.9	272.1	268.2	264.5	260.8	257.3	253.9	250.5	247.3	244.2	241.1	238.1	235.1	232.2	229.5	226.7	224.1	221.4	218.9	216.4	214.0	211.8	34″
36″	330.6	325.3	320.1	315.1	310.2	305.5	301.0	296.8	292.2	288.1	284.0	280.1	276.2	272.5	268.9	265.3	261.9	258.5	255.3	252.1	249.0	245.9	243.0	240.1	237.3	234.5	231.8	229.2	226.6	224.1	36″

SPEED FACTORS.

Figures in Tractive Power Tables are Calculated for a Piston Speed of 250 Feet per Minute. For Other Speeds Multiply by Factors Below.

Piston Speed (Feet per minute).	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	875	700	725	750	775	800	850	900	950	1000	1100	1200	1300	1400	1500	1600
Speed Factor	1.00	.976	.954	.932	.908	.886	.863	.840	.817	.795	.772	.750	.727	.704	.680	.660	.636	.614	.590	.570	.550	.530	.517	.487	.480	.435	.412	.372	.337	.307	.283	.261	.241
Per Cent. of Horse Power	60.4	65.1	69.1	73.5	77.2	80.7	63.7	86.4	89.0	91.4	93.5	95.3	96.8	98.0	98.7	99	99.7	99.9	100	100	100	100	100	100	100	100	100	99	97.8	96.8	95.7	94.7	93.5

TABLE No. 5

TRACTIVE POWER OF SIMPLE LOCOMOTIVES. BOILER PRESSURE, 190 POUNDS; MEAN EFFECTIVE PRESSURE, 85 PER CENT. OF 190 POUNDS=161.5 POUNDS

Cylinders Diam.	Stroke	30″	32″	34″	36″	38″	40″	42″	44″	46″	48″	49″	50″
9″	14″	6160	5720	5390	5090	4820	4580	4360	4160	3980	3820	3740	3660
10″	14″	7540	7070	6650	6280	5950	5650	5380	5140	4920	4710	4810	4520
11″	14″	9120	8550	8050	7600	7200	6840	6510	6220	5950	5700	5580	5470
9″	16″	6980	6540	6160	5810	5510	5230	4980	4760	4550	4360	4270	4190
10″	16″	8610	8080	7600	7180	6800	6460	6150	5870	6620	5380	5270	5170
11″	16″	10420	9770	9200	8690	8230	7820	7440	7110	6800	6510	6380	6250
10″	18″	9690	9080	8550	8080	7650	7270	6920	6610	6320	6060	5930	5810
11″	18″	11720	10990	10340	9770	9260	8790	8380	7990	7650	7330	7180	7040
12″	18″	13950	13080	12310	11630	11010	10460	9970	9510	9100	8720	8540	8370
12″	20″	15500	14530	13680	12920	12240	11630	11070	10570	10110	9690	9490	0300
13″	20″	18200	17060	16050	15160	14360	13640	12990	12400	11860	11370	11140	10920
14″	20″	21110	19780	18620	17580	16660	15820	15070	14380	13760	13180	12920	12660
15″	20″	24220	22700	21380	20190	19120	18170	17300	16520	15800	15140	14830	14530
16″	20″	27560	25840	24320	22960	21750	20670	19690	18800	17970	17230	16870	16540
17″	20″	31110	29170	27450	25930	24560	23340	22220	21210	20290	19450	19050	18670
18″	20″	34880	32700	30780	29070	27540	26160	24910	23780	22750	21800	21360	20930
14″	22″	....	....	....	....	....	....	16580	15830	15140	14510	14210	13930
15″	22″	....	....	....	....	....	....	19030	18170	17380	16660	16320	15990
16″	22″	....	....	....	....	....	....	21660	20670	19770	18950	18560	18190
17″	22″	....	....	....	....	....	....	24440	23330	22320	21390	20950	20530
18″	22″	....	....	....	....	....	....	27410	26160	25020	23980	23490	23020
19″	22″	....	....	....	....	....	....	30540	29150	27880	26720	26170	25650
15″	24″	....	....	....	....	....	....	....	19820	18960	18170	17800	17440
16″	24″	....	....	....	....	....	....	....	22550	21570	20670	20250	19840
17″	24″	....	....	....	....	....	....	....	25460	24350	23340	22860	22400
18″	24″	....	....	....	....	....	....	....	28540	27300	26160	25630	25120
19″	24″	....	....	....	....	....	....	....	31800	30420	20150	28550	27980
20″	24″	....	....	....	....	....	....	....	35240	33700	32300	31050	31010
21″	24″	....	....	....	....	....	....	....	38850	37160	35610	34880	34180
17″	26″	....	....	....	....	....	....	....	27580	26380	25280	24760	24270
18″	26″	....	....	....	....	....	....	....	30920	29580	28350	27770	27210
19″	26″	....	....	....	....	....	....	....	34450	32950	31580	30940	30320
20″	26″	....	....	....	....	....	....	....	38170	36510	34990	34280	33590
21″	26″	....	....	....	....	....	....	....	42080	42060	38580	37790	37030
22″	26″	....	....	....	....	....	....	....	46190	44180	42340	41480	40640
20″	28″	....	....	....	....	....	....	....	41110	39320	37680	36910	36180
21″	28″	....	....	....	....	....	....	....	45330	43350	41550	40700	30880
22″	28″	....	....	....	....	....	....	....	49740	47580	45600	44660	43770
20″	30″	....	....	....	....	....	....	....	....	....	40380	39550	38760
21″	30″	....	....	....	....	....	....	....	....	....	44510	43610	42730
22″	30″	....	....	....	....	....	....	....	....	....	48850	47860	46900
20″	32″	....	....	....	....	....	....	....	....	....	43070	42190	41340
21″	32″	....	....	....	....	....	....	....	....	....	47480	46510	45580
22″	32″	....	....	....	....	....	....	....	....	....	52110	61050	50030
20″	34″	....	....	....	....	....	....	....	....	....	45760	44820	43930
21″	34″	....	....	....	....	....	....	....	....	....	50450	49420	48430
22″	34″	....	....	....	....	....	....	....	....	....	55370	54240	53150
20″	36″	....	....	....	....	....	....	....	....	....	48450	47460	46510
21″	36″	....	....	....	....	....	....	....	....	....	53420	52330	51280
22″	36″	....	....	....	....	....	....	....	....	....	58620	57430	56280

Cylinders Diam.	Stroke	51″	52″	53″	54″	55″	56″	57″	58″	59″	60″	61″	62″	63″	64″	65″	66″
9″	14″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
10″	14″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
11″	14″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
9″	16″	4160	4030	3950	3880	....	....	....	....	....	....	....	....	....	....	....	....
10″	16″	6070	4970	4880	4790	....	....	....	....	....	....	....	....	....	....	....	....
11″	16″	8130	6010	5900	5790	....	....	....	....	....	....	....	....	....	....	....	....
10″	18″	6760	5590	5490	6380	5280	6190	6100	5010	....	....	....	....	....	....	....	....
11″	18″	6900	8760	6640	6510	6400	8280	6170	6060	....	....	....	....	....	....	....	....
12″	18″	8210	8050	7900	7750	7810	7470	7340	7220	....	....	....	....	....	....	....	....
12″	20″	9120	8940	8780	8610	8460	8310	8160	8020	7880	7750	....	....	....	....	....	....
13″	20″	10760	10490	10290	10110	9920	9750	9580	9410	9250	9100	....	....	....	....	....	....
14″	20″	12410	12170	11940	11720	11610	11300	11100	10910	10730	10550	....	....	....	....	....	....
15″	20″	14250	13970	13710	13460	13210	12980	12760	12530	12320	12110	....	....	....	....	....	....
16″	20″	16210	15900	15600	15310	15030	14760	14500	14250	14010	13780	....	....	....	....	....	....
17″	20″	18310	17950	17810	17200	16970	16670	16370	16090	15820	15550	15300	15050	14810	14590	14360	14140
18″	20″	20520	20130	19740	19380	19030	18690	18360	18050	17740	17440	17160	16880	16610	16350	18100	15860
14″	22″	13650	13390	13140	12890	12660	12430	12220	12010	11800	11810	11420	11230	11050	10880	10710	10550
15″	22″	15670	15370	15070	14800	14530	14280	14020	13780	13550	13320	13160	12890	12680	12490	12230	12110
16″	22″	17830	17490	17160	16840	16540	16240	16960	15680	15410	16160	14910	14870	14440	14210	13990	13780
17″	22″	20130	19740	19370	19010	18670	18330	18010	17700	17400	17110	16830	16560	16300	16040	15800	15560
18″	22″	22570	22130	21720	21320	20930	20550	20200	19850	19510	19190	18870	18570	18270	17980	17710	17440
19″	22″	25150	24660	24200	23750	23320	22910	22500	22110	21740	21380	21030	20690	20360	20040	19730	19430
15″	24″	17090	16770	16450	16150	15860	15570	15300	15040	14780	14530	14290	14060	13840	13630	13420	13210
16″	24″	19450	19080	18720	18370	18040	17720	17410	17110	16820	16540	16270	16010	15750	15500	15270	15030
17″	24″	21960	21810	21140	20750	20370	20000	19650	19310	18080	18670	18360	18060	17780	17500	17230	16970
18″	24″	24620	24150	23690	23260	22830	22420	22030	21650	21280	20920	20590	20260	19930	19620	19320	19030
19″	24″	27430	26910	26460	25910	25440	24980	24550	24120	23710	23320	22940	22570	22210	21860	21530	21200
20″	24″	30400	29810	29250	28710	28190	27680	27200	20730	26280	25840	25410	25010	24610	24230	23850	23490
21″	24″	33520	32870	32250	31650	31080	30520	29990	29470	28970	28490	28020	27670	27130	26700	26300	25900
17″	26″	23790	23340	22890	22470	22070	21670	21290	20920	20570	20220	19890	19570	19260	18970	18670	18380
18″	26″	26670	28160	25670	25200	24730	24290	23860	23460	23060	22670	22300	21940	21600	21260	20930	20610
19″	26″	29730	29150	28600	28070	27560	27070	26590	28130	25690	25270	24840	24440	24060	23680	23320	22970
20″	26″	32930	32300	31890	31110	30540	29990	29460	28960	28460	27990	27530	27090	26660	26240	25840	25450
21″	26″	36310	35610	34040	34290	33670	33060	32480	31920	31380	30860	30350	29860	29390	28930	28490	28060
22″	26″	39850	39080	38340	37630	36950	36290	35650	35040	34440	33870	33310	32780	32260	31750	31260	30790
20″	28″	35460	34780	34130	33490	32890	32300	31730	31180	30660	30150	29650	29170	28710	28260	27830	27410
21″	28″	39160	38350	37620	36930	36260	35610	34980	34380	33800	33230	32690	32160	31050	31160	30680	30110
22″	28″	42920	42090	41300	40530	39790	39080	38400	37730	37090	36470	35880	35300	34740	34190	33670	33160
20″	30″	38000	37270	36570	35890	35240	34610	34000	33410	32850	32300	31770	31260	30760	30280	29820	29360
21″	30″	41890	41090	40310	39570	38850	38150	37490	36840	36210	35610	35030	34460	33910	33390	32870	32370
22″	30″	45980	45100	44240	43430	42640	41880	41140	40430	39750	39080	38440	37820	37220	36640	36080	35530
20″	32″	40530	39750	39000	38280	37590	36910	36270	35640	35040	34450	33890	33340	32810	32300	31800	31320
21″	32″	44690	43830	43000	42200	41440	40700	39980	39290	38630	37980	37360	36760	36180	35610	35060	34530
22″	32″	49050	48100	47200	46320	45480	44670	43880	43130	42400	41690	41000	40340	39700	39080	38480	37900
20″	34″	43070	42240	41440	40670	39930	39220	38530	37870	37230	36610	36010	35430	34860	34320	33790	33280
21″	34″	47480	46570	45690	44840	44030	43240	42480	41750	41040	40360	39700	39060	38440	37840	37250	36690
22″	34″	52110	61110	50140	49220	48320	47460	46630	45820	45050	44290	43570	42870	42190	41530	40890	40270
20″	36″	45600	44720	43880	43070	42280	41530	40800	40100	39420	38760	38130	37510	36910	36340	35780	35240
21″	36″	50270	49310	48380	47480	46620	45790	44080	44210	43460	42730	42030	41360	40700	40060	39450	38850
22″	36″	55180	54120	53090	52110	61160	50250	49370	48520	47690	46900	46130	45390	44870	43970	43290	42640

Cylinders Diam.	Stroke	67″	68″	69″	70″	71″	72″	73″	74″	75″	76″	77″	78″	79″	80″	81″	82″	83″	84″	85″	86″
9″	14″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
10″	14″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
11″	14″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
9″	16″																	....	....	....	....
10″	16″																	....	....	....	....
11″	16″																	....	....	....	....
10″	18″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
11″	18″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
12″	18″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
12″	20″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
13″	20″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
14″	20″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
15″	20″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
16″	20″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
17″	20″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
18″	20″	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
14″	22″	10390	10240	10090	9950	9810	9670	....	....	....	....	....	....	....	....	....	....	....	....	....	....
15″	22″	11920	11760	11590	11420	11260	11100	....	....	....	....	....	....	....	....	....	....	....	....	....	....
16″	22″	13580	13380	13180	12990	12810	12630	....	....	....	....	....	....	....	....	....	....	....	....	....	....
17″	22″	15320	15100	14880	14670	14460	14260	....	....	....	....	....	....	....	....	....	....	....	....	....	....
18″	22″	17180	16930	16680	16450	16210	18170	....	....	....	....	....	....	....	....	....	....	....	....	....	....
19″	22″	19140	18850	18590	18320	18060	17810	....	....	....	....	....	....	....	....	....	....	....	....	....	....
15″	24″	13020	12820	12640	12460	12280	12110	11950	11790	11830	11480	11330	11180	11040	10900	10770	10640	10510	10380	10260	10140
16″	24″	14810	14590	14380	14170	13980	13780	13560	13410	13230	13060	12890	12720	12560	12400	12250	12160	11950	11810	11670	11540
17″	24″	18720	16470	16230	16000	16780	15560	15340	15140	14940	14740	14550	14360	14180	14000	13830	13660	13500	13340	13180	13030
18″	24″	18740	18470	18200	17940	17690	17440	17200	16970	16740	16530	16300	18100	15900	15700	15500	15320	15130	14950	14780	14600
19″	24″	20880	20580	20280	19990	19710	19430	19160	18910	18600	18410	18170	17940	17710	17490	17270	17060	16850	16660	16460	16270
20″	24″	23130	22800	22470	22150	21840	21530	21240	20950	20670	20400	29130	19870	19630	19380	19140	18910	18680	18450	18240	18030
21″	24″	25550	25140	24770	24420	24070	23740	23410	23100	22790	22460	22200	21920	21630	21370	21100	20840	20590	20350	20110	19870
17″	26″	18110	17850	17590	17340	17090	16850	16620	16400	16180	15970	15760	15560	15360	15170	14980	14800	14620	14450	14280	14110
18″	26″	20310	20010	19720	19440	19160	18900	18640	18380	18140	17910	17670	17440	17220	17010	16800	16590	16390	16190	16010	15820
19″	26″	22620	22290	21970	21650	21350	21050	20770	20480	20210	19940	19680	19440	19190	18950	18710	18480	18260	18050	17830	17620
20″	26″	25070	24700	24340	23900	23650	23330	23010	22700	22390	22160	21810	21530	21260	21000	20730	20480	20240	20000	19760	19530
21″	26″	27640	27230	26830	26450	26080	25720	25360	25020	24690	24300	24050	23740	23440	23140	22860	22580	22310	22050	21780	21530
22″	26″	30330	29890	29450	29030	28620	28220	27840	27460	27000	28740	26390	26050	25720	25400	25090	24780	24480	24190	23910	23630
20″	28″	26990	26600	26210	25840	25480	25120	24780	24440	24120	23800	23490	23190	22890	22610	22330	22060	21790	21530	21280	21030
21″	28″	29760	29330	28900	28490	28090	27700	27320	26950	26590	26240	25900	25570	25240	24930	24620	24320	24020	23740	23460	23180
22″	28″	32660	32190	31720	31270	30820	30400	29980	20670	29180	28800	28430	28060	27700	27360	27020	26690	26370	26050	25750	25450
20″	30″	28920	28500	28090	27690	27300	26920	26550	26190	25840	25500	25170	24850	24530	24230	23930	23630	23350	23070	22800	22530
21″	30″	31890	31420	30970	30520	30090	29680	29270	28870	28490	28110	27750	27390	27050	26710	26380	25060	25740	25440	25140	24850
22″	30″	35000	34490	33990	33500	33030	32570	32120	31890	31270	30850	30450	30060	29680	29310	28950	28600	28250	27920	27590	27270
20″	32″	30850	30400	29960	29530	29130	28710	28330	27930	27560	27200	26850	26500	26170	25840	25520	25210	24910	24610	24320	24040
21″	32″	34020	33520	33030	32560	32100	31650	31220	30800	30390	29990	29600	29220	28850	28400	28140	27790	27460	27130	26810	26500
22″	32″	37330	36780	36250	35730	35230	34740	34260	33800	33350	32910	32480	32070	31660	31260	30880	30500	30140	29780	29430	29080
20″	34″	32760	32300	31830	31360	30940	30510	30090	29680	29280	28900	28520	28160	27800	27460	27120	26780	26460	26150	25840	25540
21″	34″	36140	35610	35090	34590	34110	33630	33170	32720	32290	31860	31450	31050	30650	30270	29900	29530	29180	28830	28490	28160
22″	34″	39670	39080	38520	37970	37430	36910	36410	35910	35430	34970	34520	34070	33640	33220	32810	32410	32020	31640	31270	30900
20″	36″	34710	34200	33710	33220	32760	32300	31860	31430	31010	30000	30200	20820	29440	29070	28710	28360	28020	27690	27360	27040
21″	36″	38270	37710	37160	36630	36110	35610	35120	34650	34190	33740	33300	32870	32460	32050	31650	31270	30890	30520	30170	29810
22″	36″	42000	41380	40780	40200	39630	39060	38550	38030	37620	37030	36550	36080	35620	35170	34740	34320	33900	33500	33110	32720

FIGURES IN TABLE ARE CALCULATED FOR A PISTON SPEED OF 250 FEET PER MINUTE AND UNDER. FOR HIGHER SPEEDS MULTIPLY BY FACTORS GIVEN IN TABLE NO. 9

diameter of driving wheels in inches. They include the sizes of cylinders and driving wheels in most general use, but do not have the wide range of table No. 1.

Table No. 9 gives the number of revolutions of driving wheels per mile, piston speeds at 10 miles per hour, and speed factors for calculating tractive power at various piston speeds. The piston speeds given in this table are for 10 miles per hour, and for higher speeds are to be increased accordingly.

The factors given at the bottom of the tables were calculated from indicator tests of locomotives, and are the percentages by which the maximum tractive power given in tables 1, 5 and 8 are to be multiplied, in order to get the tractive power corresponding to increase the piston speed. Horse power factors are also given by which the horse power for any piston speed may readily be determined.

Table No. 11 includes all the combinations of cylinder diameters and strokes, the diameters ranging from 10 to 26 inches by half inches, and from 26 to 35 inches in even inches. This table will be found quite convenient in determining ratios of heating surface based on cylinder volumes.

TABLE No. 13
HEATING SURFACE OF TUBES, OUTSIDE (IN SQUARE FEET)

O. S. Diam. of Tubes.	Circum. in Inches.	Feet (in length).								
		7	8	9	10	11	12	13	14	15
1½"	4.7124	2.749	3.142	3.534	3.927	4.319	4.712	5.105	5.497	5.890
1¾"	5.4978	3.207	3.665	4.123	4.582	5.040	5.498	5.956	6.414	6.872
2 "	6.2832	3.665	4.189	4.712	5.236	5.760	6.283	6 807	7.330	7.854
2¼"	7.0686	4.123	4.712	5.301	5.890	6.480	7.069	7.658	8.247	8.836
2½"	7.8540	4.581	5 236	5.890	6.545	7.199	7.854	8.508	9.163	9.817
5 "	15.708	9.163	10.472	11.781	13.090	14.399	15.708	17.017	18.326	19 635
5¼"	16.493	9.621	10.995	12.369	13.744	15.118	16.493	17.867	19.242	20.616

O. S. Diam. of Tubes.	Circum. in Inches.	Feet (in length).								
		16	17	18	19	20	21	22	23	24
1½"	4 7124	6.283	6.676	7.068	7.461	7.854	8.247	8.640	9.033	9.424
1¾"	5.4978	7.330	7.789	8.247	8.705	9.163	9.621	10.079	10.537	10.996
2 "	6.2832	8.378	8.901	9.425	9.948	10 472	10.995	11.519	12 042	12 446
2¼"	7.0686	9.425	10 013	10.602	11.191	11 781	12.370	12.959	13.548	14.138
2½"	7.8540	10 472*	11 127	11.781	12.435	13.090	13.744	14.398	15.053	15.708
5 "	15.708	20.944	22.253	23.562	24 871	26 180	27.489	28.798	30.107	31 416
5¼"	16.493	21.990	23.365	24.739	26.114	27.488	28.862	30.236	31 610	32.984

O. S. Diam. of Tubes.	Circum. in Inches.	Inches (in length).														
		¼	½	¾	1	2	3	4	5	6	7	8	9	10	11	12
1½"	4.7124	008	016	024	033	065	.098	131	.164	.196	.229	262	.295	327	.360	.393
1¾"	5.4978	009	019	028	038	076	115	153	191	.229	267	305	.344	.382	.420	.458
2 "	6.2832	011	022	033	044	087	131	175	218	.262	.305	.349	.393	436	.480	524
2¼"	7 0686	012	024	037	049	.098	.147	196	.245	.295	.344	.393	442	.491	.540	589
2½"	7.8540	014	027	041	.055	109	.164	218	.272	.327	.382	.436	.491	.545	600	.655
5 "	15.708	.027	054	.082	.109	.218	.327	.436	.545	.654	.763	.872	981	1.09	1.199	1.308
5¼"	16 493	.029	057	.087	.114	.229	.344	.458	.573	.687	.802	.916	1.031	1.145	1.26	1.37

TABLE No. 14
WEIGHT OF TUBES

O. S. Diam. of Tubes	Thickness		Area Sq. In.		Weight Lbs. Per Foot of Water Displaced		Weight Per Foot		
	B. W G.	Inch	Ext.	Int.	Atmos. Press. 62°	200 Lbs. Press. 388°	Charcoal Iron	Brass	Copper
1¼"	15	072	1.23	96	533	.465	94	98	1.03
	14	083		92			1.07	1 12	1 18
	13	095		88			1.21	1 27	1 33
	12	109		.83			1.37	1.44	1 51
	11	12		80			1.50	1 56	1.64
1½"	13	095	1.77	1.35	767	669	1.47	1.54	1 62
	12	109		1.29			1.67	1 75	1 84
	11	12		1.25			1.83	1.91	2.01
	10	.134		1.19			2.02	2.11	2.22
1¾"	13	.095	2.41	1.91	1.04	908	1.74	1.82	1 91
	12	109		1.84			1.98	2.06	2.16
	11	12		1.79			2.16	2.26	7 37
	10	134		1.72			2.39	2.50	2.62
2 "	13	095	3.14	2.57	1.361	1.187	2.00	2 09	2.19
	12	109		2.49			2.28	2.38	2.50
	11	12		2.43			2.49	2.60	2.73
	10	134		2.36			2.76	2.89	3.03
2¼"	12	109	3.98	3.24	1.727	1.507	2.58	2.69	2.82
	11	12		3.17			2.82	2.95	3.10
	10	134		3.08			3.13	3.27	3.43
2½"	11	12	4 9	4 00	2.13	1.857	3.16	3.30	3.46
	10	134		3.91			3.50	3.66	3.84
	9	148		3.81			3.83	4 02	4 22
5 "		3/16	19.64	16 80	8.50	7.42	9.94	10.22	10.91
5¼"		3/16	21 64	18.66	9.37	8.17	10 35	10.6	11 15
5⅜"		3/16	22 69	19 64	9.82	8 57	10.68	10.98	11.71
5½"		3/16	23.76	20.63	10.28	8 98	10 96	11.27	12.02

Weight of Water (Cubic Feet)—62.33 lbs. at atmospheric pressure 62°; 54.4 lbs. at 200 lbs. gauge pressure 388°. Weights for iron tubes are obtained by adding an allowance for overweight above calculated weight based on actual weights for 2" diam

Table No. 13 will be found very convenient in calculating the outside heating surface of locomotive tubes. It is used by merely adding together the figures obtained for the feet, inches and fractions of an inch. For instance: A 2-inch tube which is 18 feet, 10½ inches long (between flue sheets) has a heating surface of 9.425 + 0.436 + 0.022 = 9.883 square feet.

Table No. 14 is used for determining the relative weights of iron, brass and copper locomotive tubes; also the calculations of boiler weights and the amount of water displaced.

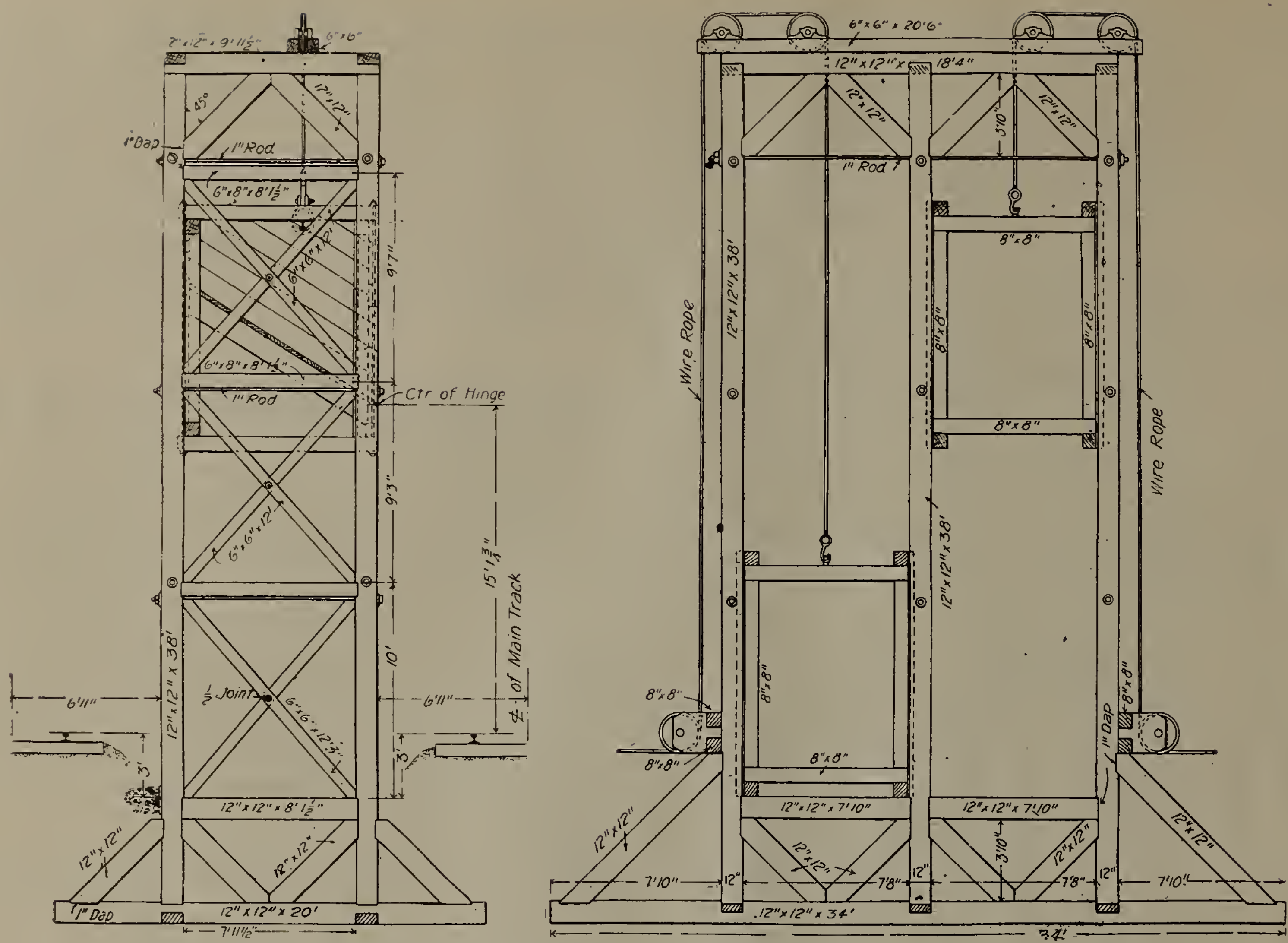
Table No. 17 gives the American method of classification by means of numerals to represent the wheel arrangement which has come into very general use in the United States. It is often used in connection with a hyphen and figures to represent the total weight in thousands of pounds. For example, an Atlantic locomotive weighing 176,000 pounds would be classified as a 442-176 type. If the engine is compound, the letter C should be substituted for the dash; thus, 442 C 176 type. If tanks are used in place of a separate tender, the letter T should be used in place of the dash. Thus a double-end suburban locomotive with two-wheeled leading truck, six drivers and six-wheeled rear truck, weighing 214,000 pounds, would be a 266 T 214 type.

Novel Coaling Stations, B. & L. E. R. R.

On the Bessemer and Lake Erie R. R. several novel coaling stations have been installed at different points, which are of simple and unique construction. The device employs the locomotive to be coaled to do its own hoisting and the details of construction are noted in the accompanying illustration, Fig. 1, and drawing, Fig. 2. It may be stated that the construction consists of an upright framework of timbers of one square foot cross section serving as guides for the pocket. There is a hoisting sheave at the top and another at the bottom, and the movable pocket which has a capacity of five tons has an inclined bottom, its top being at a convenient height for unloading the coal from a gondola car on the side track.

The lowering of the apron permits the coal to push the gate open, but the coal in the pocket must all be discharged before the gate closes by its own weight, thus permitting the raising of the apron. The hoisting cable is of such length that when the loop at its end is hooked over the pilot beam of the locomotive, the pocket will be hoisted to the proper height by the time the engine has pulled ahead far

Novel Coaling Station.



Drawing of Novel Coaling Station, B. & L. E. R. R.

enough to bring the tender opposite the pocket. As soon as the latter is emptied the locomotive backs up and lets it down again to the level of the track, where it is again reloaded from the coal cars. This style of coaling station would, of course, only be useful at points where a large modern plant would not be used to capacity. As a home-made labor saver it seems a great convenience.

Report of Committee on Railway Electrification before New York Railroad Club

This committee was appointed to make a review of the subject of "Electrification of Steam Railroads," and formulate a report for the Annual Electrical Night, on March 18, 1910. The report was to contain such general data as would be of interest to railroad men, and suggestions were to be made as to the direction in which it would be desirable to have further investigation and information.

Your committee has made a careful study of this subject in the effort to look at it from all sides. It finds that there are some mooted questions as to system and details, and that there are many points upon which the average layman is somewhat misinformed and the meaning of which he has not a true conception. It has been thought wise, therefore, in this report, to make a review of the whole subject, though this may involve saying things which have been said before. The only excuse for this is to give railroad men, so far as your committee is able, a broad and comprehensive view of the present status of the electrification of steam railroads.

Some railroad companies operate electric urban and interurban lines. Under these circumstances, it probably would be very interesting to include a discussion of such lines in this report, but space and time forbid, and it was decided to limit to a discussion of the electrification of steam railroads as applied to terminals and trunk line operation.

History.

The committee, at the outset, had in mind the giving of a somewhat detailed history of electrification as it has been applied to various propositions, but finds that there are a number of histories in various publications which are more elaborate than it could hope to include in a report of this character. It was therefore decided that the only thing of this nature that the committee could do would be to detail the important steps attending the application of electricity for traffic purposes.

The first successful installation in this country was made in Richmond, Va., in 1888, from which came the familiar trolley systems seen in our streets and highways.

In 1893 the Intramural Railway, at the Chicago World's Fair, first demonstrated the availability of electricity for heavier traction purposes than street trolleys. The distinctive feature of this installation was the first use of the third rail.

In 1895 the Metropolitan Elevated Railroad of Chicago was built, thus utilizing the principle which had been demonstrated by the Intramural.

In 1898 a considerable step was made when the multiple-unit system was first put into use by the South Side Elevated Railway of Chicago. This installation displaced steam locomotives, which course was afterwards followed by the elevated railroads of New York City.

In the meantime some small electric locomotives had been used for mining, industrial, and other purposes, but the first important installation of electric locomotives was by the Baltimore & Ohio Railroad in its Baltimore tunnel in 1895.

The next important electrical installation was by the Long Island R. R. in 1905, which was quite extensive in point of distance, and in point of supplanting steam equipment.

In 1906 an important installation was made on the West Jersey & Sea Shore R. R. between Atlantic City and Philadelphia. The distinguishing feature of this installation was that it was the first approach towards main line express service.

In 1906 the electric installation in the terminals of the New York Central & Hudson River R. R. was put in operation. This, together with the New York, New Haven & Hartford R. R. installation, which was finished in 1907, is the heaviest and most complex situation which has yet been taken care of by electric traction.

In 1907, the first installation of the multiple-unit high voltage, single phase system, as applied to former steam railroad practice, was made on the Rochester Division of the Erie Railroad.

The first railroad to be built for the handling of both freight and passenger business entirely by electricity was the Spokane & Inland Empire R. R., which was put in operation in 1907. This is probably the most extensive installation that there is in the country at present, handling both freight and passenger business. It is probable that the ability to utilize water-power formed quite a determining factor in the conclusions as to the use of electricity rather than steam.

In 1908 the Grand Trunk Ry. electrified that portion of its railroad through the Sarnia tunnel. This installation was put in for the purpose of handling mixed freight and passenger business, and it accomplishes the handling of heavier trains, and the elimination of the smoke and other nuisances attending the operation of a long tunnel.

In 1909, the Cascade tunnel of the Great Northern Ry. was electrified. The distinguishing feature of this installation was the use of the three-phase system.

It is expected that during the present calendar year the Pennsylvania Terminal installation in New York City will be put into operation—thus bringing into operation another important application of electricity.

It is to be noted that the installations above recited affecting steam operations were applied on account of special circumstances surrounding each case and that none of them involve heavy transcontinental trunk line service for any extended distance.

Flexibility.

A great variety of service is permitted by reason of the flexibility of the electric system. Locomotives may be used independently, or motors may be applied directly to the cars. Locomotives or motor cars may be coupled in a variety of ways, and operated by means of the multiple-unit system, from one point in the train, which applies in any system of electrification. Public streets and highways may be occupied, if necessary, and operation in tunnels cease to be objectionable. Trains may be shorter and more frequent, or they may be of any size that business conditions dictate consistent with mechanical considerations. A distribution of driving wheels throughout the whole train permits high acceleration, which in turn permits increased schedule speed without excessive increase in maximum sped. All of these features have a varying weight according to the circumstances of the particular problem at hand.

Effect of Weather Conditions.

Electric service has been found to be but slightly affected by snow or other weather conditions. It is well known, however, that a steam locomotive loses a serious part of its steaming capacity in cold weather, not to speak of the care, and consequent expense, necessary in such weather to keep the locomotive. while idle, in condition to operate. With steam, the problem is to keep the locomotive hot, whereas, with electricity, the problem is to keep it cool.

Use of Equipment.

It is a fact that the electric locomotive will have much less idle time, under the same conditions, than the steam locomotive. If desirable, the electric locomotive can be designed for practically continuous operation over any length of run. Many of the repairs, and almost all of its inspections can be made without the necessity of having to run the electric locomotive into the round-house, thus rendering unnecessary a large part of the roundhouse handling, and the possibility of having the continuous and immediate use of a locomotive, barring accidents, is very great. It should be noted, however, that while the electric locomotive is capable of almost continuous use, conditions frequently make such use impracticable. In the first place, much of the lost time of locomotives—particularly freight locomotives—is due to traffic and schedule conditions; and, second, while frequent visits to the roundhouses may not be necessary, it may be desirable in order to increase reliability.

Power Capacity.

The maximum evaporating power of a locomotive boiler is constant, and, therefore, the maximum tractive effort cannot be maintained as the speed increases, and upon a long grade the element of human physical capacity enters in the person of the fireman. The electric locomotive, on the contrary, granting that the power house is large enough and that the distribution system is arranged for it, can draw all the current that it needs to produce its minimum tractive effort. This feature, however, is somewhat counterbalanced by the fact that the amount of power that can be delivered at a given point depends upon the carrying capacity of the distribution system, which, in turn, is fixed at the time of installation. In case of a serious congestion, or accident to the power supply, the electric system is not as flexible as a steam system, composed of independent steam units.

Cleanliness.

It is only necessary to mention this feature to call attention to the increased attractiveness of the electric train whether running in the open or in a tunnel. In addition, the absence of destructive gases prolongs the life of station buildings and other structures, and preserves their attractiveness.

Collateral Advantages.

The absence of smoke and gas allows the utilization of property usually occupied solely by station buildings for additional purposes, such as office buildings, and many other purposes which will in itself produce additional net revenue. The current can also be used for the purpose of furnishing electric lighting and power for any purpose. Schedule conditions will usually allow switching, and perhaps some other portion of the traffic, to be done at times of light load.

Increase of Facilities.

When a road finds its trackage inadequate for its traffic, it must, of necessity, seek means to increase its facilities. The deficiency may be removed, depending upon what the cause is by adding to the number of tracks, by removing a "throat" or point of congestion, by reducing objectionable grades, by substituting tunnels for grades, by substituting open cuts for tunnels, by introducing locomotives of greater capacity, by the installation of signal systems, and by other means.

In addition to these various methods for the increase of facilities there is no question that electrification should always be considered. No general conclusions can be given, but not only are there numerous cases where carefully made estimates indicate electrification as the proper method to adopt, but several existing installations have accomplished expected results. This method of increasing facilities is especially applicable when a nearby water power can be developed at reasonable cost as compared with the cost of steam power.

Increase of Earnings.

Net earnings can be increased by reducing the cost of operation, or by increasing gross earnings without a corresponding increase in operating cost. Under cost of operation, there is included in this discussion fixed charges as well as usual operating expense.

Under favorable circumstances the flexibility and attractiveness of electric service tend to increase passenger traffic, and, consequently, gross earnings. The abolishment of the time-table by more or less uniform train schedules, and the stopping of trains or cars frequently to suit the convenience of passengers, both develop the riding habit. This increase should only be counted on, however, after determining that the population exists, and that the necessity or possibility of its more frequent riding will follow. This would seldom, if ever, be a sole argument for electrifying a trunk line, and suburban communities now have such a superb steam service that it is questionable whether the gross earnings would be greatly increased by electrification. This is especially true where there are existing parallel trolley lines which handle the strictly local service. It should be emphasized, however, that the mere substitution of electricity for steam will not accomplish a very great increase in gross earnings, but that by changes in schedule and stops, the service must be made more convenient and attractive to the desired patrons. Inattention to this feature is preventing some roads at present from realizing the full possible returns upon their electrification.

Under present conditions, it would not seem probable that the electrification of a trunk line railroad would produce any increase in gross earnings resulting from freight business, except, possibly, a slight increase in parcel business, which would be of such small consequence as not to have much influence in the problem. It would seem, therefore, that any pecuniary benefit to the freight business must come from decreased cost of operation.

It is unfortunate that your committee can present no comparable figures on which to base conclusions. Various statements as to operating expense are heard from time to time. It is probable, however, that this absence of data is an indication of the present state of the art. Your committee considered a large amount of data found in various magazines and technical journals, practically all of which, however, must be used with a feeling of uncertainty for the reason that all of the conditions surrounding their preparation are not given. Therefore, the committee formulated a plan by which essential information could be obtained of existing electrification. It found, however, that almost without exception, the men who were responsible for the operation of the properties did not think that conditions were sufficiently settled to permit them to publish data that would be just to either steam or electrical operation. Your committee is prepared to say, therefore, that no data which would apply in a general way is available. It is still necessary to wait before authoritative data, and useful information, from operating properties, can be obtained for publication.

Legislative Enactment.

The operation of a steam railroad in the heart of a large city is of necessity attended by features not always ideal. On account of the cost of land, and other conditions, the amount of space for roadway is likely to be cramped, and closely pressed by city and private property. The emission of smoke and gases from the locomotives, especially if a subway or tunnel is involved, often leads the community to demand that the railroad abolish the objectionable features. This demand, in its essentials, may be reasonable enough, and if by calm and considerate discussion it can be shown that conditions are unnecessarily bad, the public has a right to expect the railroads to provide a reasonable remedy. Unfortunately, however, the discussion is sometimes fanned into a condition where hostility and acrimony become the chief features. As a consequence, the public may make demands, the difficulty, expense and result of which it has no conception, and the railroad is compelled to refuse anything like the full extent of the demands because it knows it cannot afford to do otherwise.

In this connection, the following are a few broad considerations which common sense and equity present:

(1) A railroad has a charter franchise or special privilege from the commonwealth, and, therefore, belongs to a class of activities which must especially consider the interest of the public.

(2) A railroad is also a business venture organized to make money, and those responsible to the stockholders must conduct its affairs so as to serve their best ultimate interest.

(3) A nuisance, for example, smoke, incident to the operation of a property, whether factory, railroad, store, or what not, may be deplored, but all sources of such nuisances must be treated alike, and it should also be determined how far removing the nuisance might endanger the industry itself and cause its failure.

(4) It is only fair to assume that men who have worked in the public eye, at any particular business, for a number of years, are men of integrity, and well informed as to their business. Action should be taken, therefore, by the community only when advised by well-informed persons, and after comprehensive consideration.

(5) There are not two sides to this problem. The interests of the railroads and those of the public are one.

Cost Attending Installation.

This committee feels that it is advisable to discuss somewhat the question of costs for the purpose of drawing attention to the various costs, direct and indirect. It is a fact that some of these costs are not always fully considered in studying the problem.

Under direct cost there should be included the cost of new cars, locomotives, power houses, substations, etc., the cost of changes in old equipment, investments in land, water power transmission lines, working conductors, etc. These are the costs which are usually estimated by engineers and frequently given as the so-called Cost of Electrification.

Contingent cost includes those uncertain costs, some of which can be anticipated, others not, frequently running into figures considerably above the estimated cost, and which, added to the direct cost, make the burden of electrification so serious. It covers the cost of changes in right-of-way, buildings, bridges, overhead crossings, changes in signal systems, telephone and telegraph, etc., and the interruption of service with the direct loss entailed, the addition to the claim account due to accidents, particularly in connection with temporary construction, amortization of equipment and facilities, like coal, wood and water stations. If the electrification is for a small section of a large system, the equipment is simply shifted to other parts, but this expense is large nevertheless.

All changes that would increase the value of the road not necessitated by electrification, but merely made for convenience at the same time, should not be charged to the electrification.

There are, in addition to the direct and contingent costs, other costs which must be taken into consideration. These are due to the possible necessity at an early date for changes in apparatus as the art improves, requiring a complete substitution before it has served its natural time.

Systems of Electrification.

The following systems are now in use:

(1) Direct current, third rail or overhead, 600 to 1,200 volts.
(2) Alternating current, high potential—three phase.
(3) Alternating current, high potential—single phase.

The storage battery, and gasolene-electric systems, have not up to this time been proposed for heavy work, but merely as adjuncts to steam and other electric systems, and therefore will not be further considered in this report.

So far as the purely technical features are concerned, it may be asserted positively that any given electrification problem can be solved by any one of the three methods mentioned above, and the results will be reliable.

The difficulty of choosing a system for a given electrification arises from the fact that one system which may be adapted to a particular situation may not be as suitable for trunk line work with its variety of freight and passenger service. When it becomes necessary to electrify either a whole system, or an extended part of it, the difficulty of choice of system will vanish for the reason that the settlement will be wholly on the basis of cost of operation, including fixed charges. So far, electrification has generally been applied in trunk line steam railroad service only where physical restrictions, such as tunnels or heavy grades, occur. In such places, as soon as it was determined whether the problem was a local or an extended one, the question of system was soon solved.

The direct current railway motor is better than the single phase railway motor of today, but for long distance work, the distribution system for single phase system is simpler than the direct current system.

The three phase system (requiring two overhead wires—used by the Great Northern R. R. in Cascade Tunnel) employs a constant speed induction motor, which is very sturdy and simple mechanically. Unfortunately, the two overhead wires or third and fourth rails (if temporary low voltage must be used in city streets, tunnels, railroad yards, and the like) would, in many cases, render this system objectionable. Moreover, this motor cannot work on direct current so that a combination of alternating and direct current systems could not be arranged should it be necessary. In problems where a constant speed is desirable this system will have a strong position.

The principal systems of electrification used in the United States, are the direct current system and the high potential, single phase system. Frequently, the difference in the estimated cost between these systems, considering both first cost and cost of operation, is so light that the decision cannot be made on a cost basis alone.

It seems to be acknowledged that for extended trunk line work a high voltage working current is desirable. It is in this service that the single phase system which permits the use of an 11,000 volt current, or higher, has peculiar advantages. It cannot be predicted, however, that a high voltage direct system cannot be developed for this work. So far, 1,200 volts is the highest that has been used in this country, though higher direct current voltages have been proposed.

It should be emphasized that these systems must be compared in all their aspects because no one system in all its parts is superior. As stated above, there is no difficulty in selecting a system for either a purely local situation, or for an extended electrification, but the difficulty arises when a comparatively small zone must be electrified, and a system chosen which can be economically extended later.

Advantages.

(1) Increasing the capacity of a given terminal by the elimination of switching movements, where multiple units are used, and increasing the scheduled speed of trains without increasing maximum speed by the higher acceleration possible with electric power; also increasing the capacity of the line and permitting shorter block signal spacing.

(2) Avoidance of smoke and steam nuisance, making unobjectionable tunnels, subways and underground stations, and reclaiming the aerial space above tracks for offices, stores, warehouses, hotels, or other buildings; also a saving in deterioration of metallic structures because of the corrosive products of combustion in steam locomotives.

(3) Uniform power over grades and greater tractive power of electric locomotives of equal weight with steam locomotives including tender, making heavier trains possible over mountain divisions. Locomotives may be used in multiple without increasing the cost for enginemen.

(4) Economy of operation under conditions favorable to electric traction, such as frequent multiple-unit train service or cheap electric power as compared with the higher cost of locomotive coal.

(5) Electrical operation has proved itself reliable.

(6) Electric power is not a source of danger to the traveling or general public.

Disadvantages.

(1) A large investment for re-equipping the railroads with the new power which can only be justified by definite financial or economic results.

(2) Increased danger to employes or the railroad due to the presence of the third rail or the overhead conductor, especially in yards or terminals.

Features to Be Considered.

The following features with reference to present conditions should be considered, having in view future electrification:

(1) The signal systems should be designed with a view of meeting the restrictions involved in electrification work.

(2) Bridges, yards, and terminal platforms, should be designed to conform to the clearances necessary for the installation of working conductors.

(3) Locomotives and cars should be designed to conform to electrification clearances.

(4) The lighting system of cars should be designed for economical use on electrified roads. This applies also to the heating systems.

(5) Steam, water, air, and gas-pipes, in yards, and at stations, should be laid out to avoid current collectors on future electric equipment and working conductors, also bonded to avoid electrolysis.

Conclusions.

(1) No general information is available on the basis of which steam railroads, as a whole, would be justified in electrifying terminals or main lines, solely on the grounds of economy.

(2) Careful investigation is necessary to decide if electrification of terminals and suburban districts would be warranted in order to increase earnings.

(3) More attention should be given to the possibilities of electrification in connection with heavy grades, and at other places where an increase in facilities is needed.

(4) It is not likely that conclusive data on the economy of electrification will be available until electrification is extended over a complete steam locomotive stage.

(5) The electrification for passenger terminal and suburban service is now more or less settled as to method, but for freight and general trunk line service it is in the experimental stage.

(a) The types of locomotives for various service have not been determined, though progress has been made.

(b) The method of secondary distribution (working conductors), needs much development. The third rail is thoroughly reliable and efficient, but unsuitable for complicated switch work. In its present form it has only been used for

(c) The overhead system for high voltage working conductors also needs much development. Few, if any, are satisfied with present designs, and many changes are proposed.

(6) The steam railroad men and electrical engineers should work together in as close harmony as is possible so as to produce results that will be as free from mistakes and experiments as is possible in any developing art.

(7) Each problem must be studied on its merits and a decision can only be made after careful study of the conditions pertaining to each situation.

(8) The electrification of large freight terminals has not as yet been attempted, nor satisfactorily worked out, therefore it is necessary to proceed with caution in this matter and the problem must be exhaustively studied and new developments made before it would be justifiable to make such an installation. The electrification of any large freight terminal would involve a number of roads, and cannot be undertaken independently, without the co-operation of all

the railroads affected, on account of the relations existing among the various roads in the interchange of freight traffic.

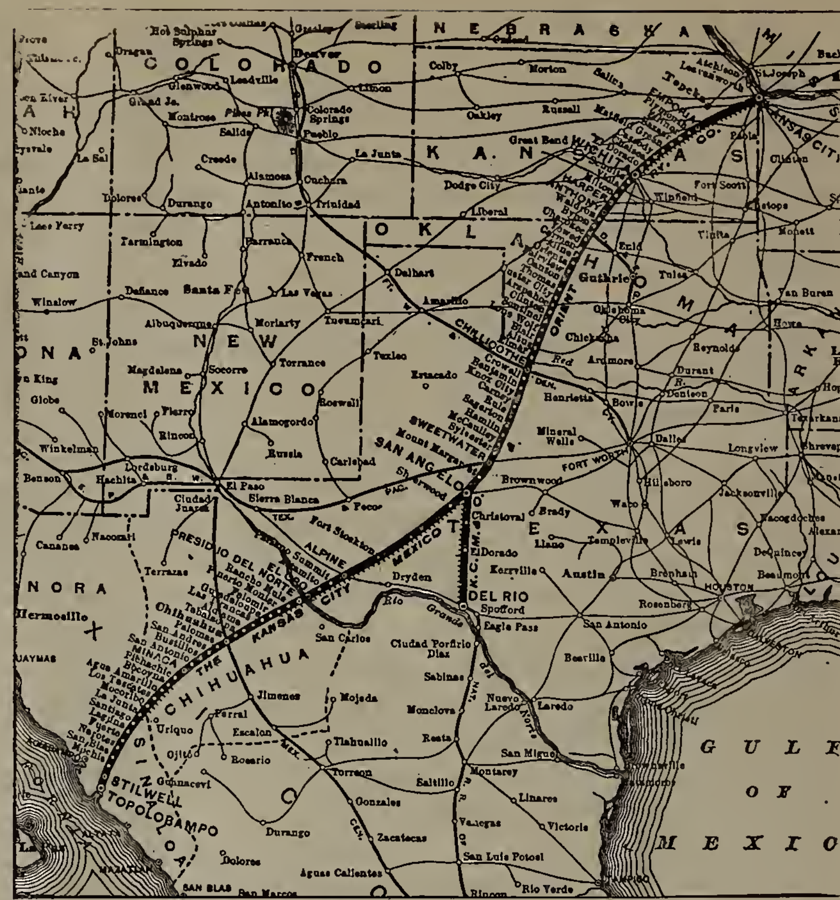
Committee.

W. J. Harahan, Chairman; J. H. Davis, L. C. Fritch, Edwin B. Katte, Wm. McClellan, C. O. Mailloux, H. M. Warren, G. W. Wildin.

Car and Locomotive Shops of the Kansas City, Mexico and Orient Ry.

With about half of the total mileage of 1,109 ready for operation and with the construction of the other half well along toward completion, the Kansas City, Mexico & Orient Ry. has found it necessary to construct at once shops for car and locomotive repairs. Wichita, Kan., was selected as the proper location for the general repair shop and most of the necesary land has been purchased, the plans completed and the contract placed with the Westinghouse, Church, Kerr Co. of New York. It was the intention of those concerned to have the shops open for duty in the middle of the coming summer, but on account of unavoidable delay the work has not progressed far enough to warrant such expectation.

The accompanying illustrations give the essential features of the general layout, the construction of the erecting shop and a map of the system. Mr. F. Mertsheimer, superintendent of motive power, is a well-known railway shop authority and, no doubt, the Wichita shops, when completed, will include the materialization of many of Mr. Mertsheimer's personal ideas.



Map of Kansas City, Mexico & Orient Ry.

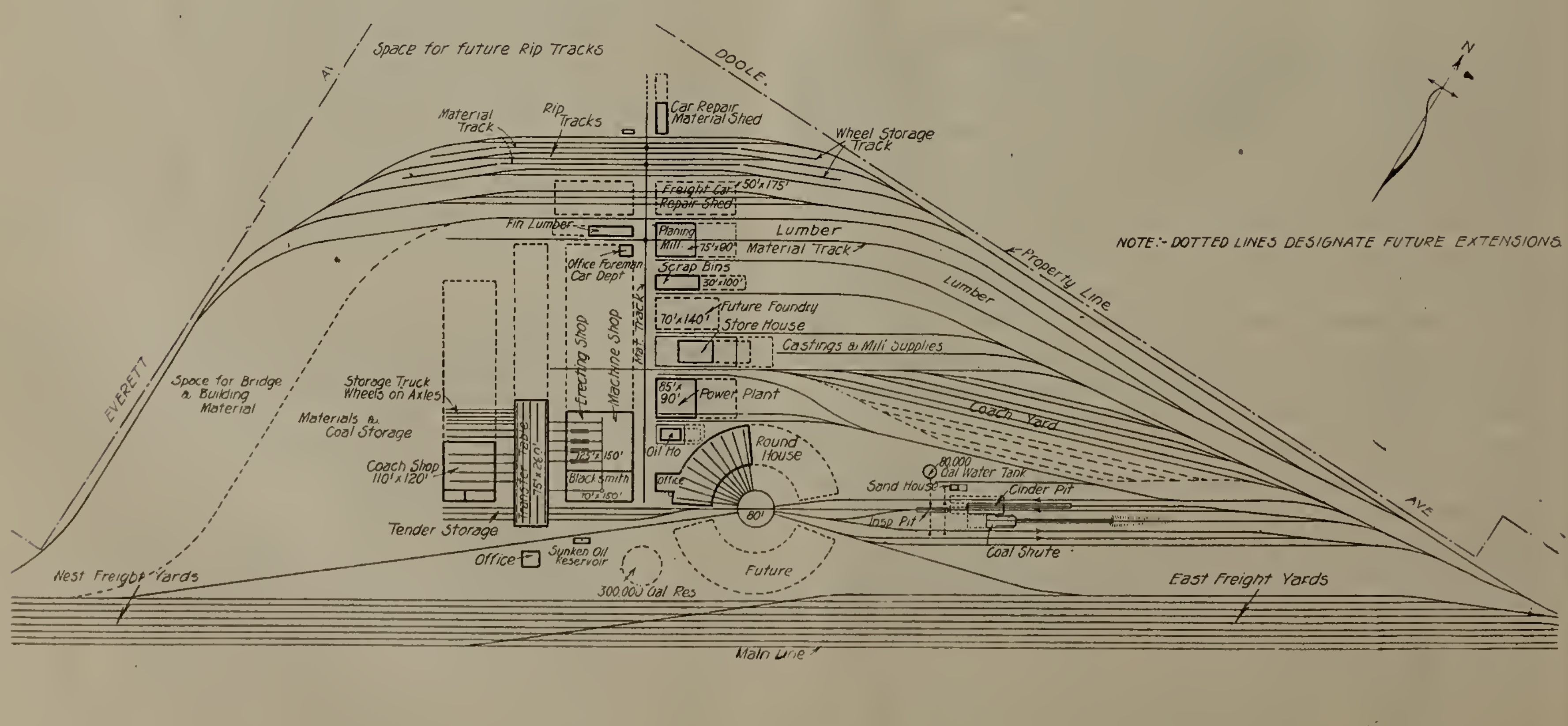
Lubrication and Lubricants*

By Charles F. Mabery.

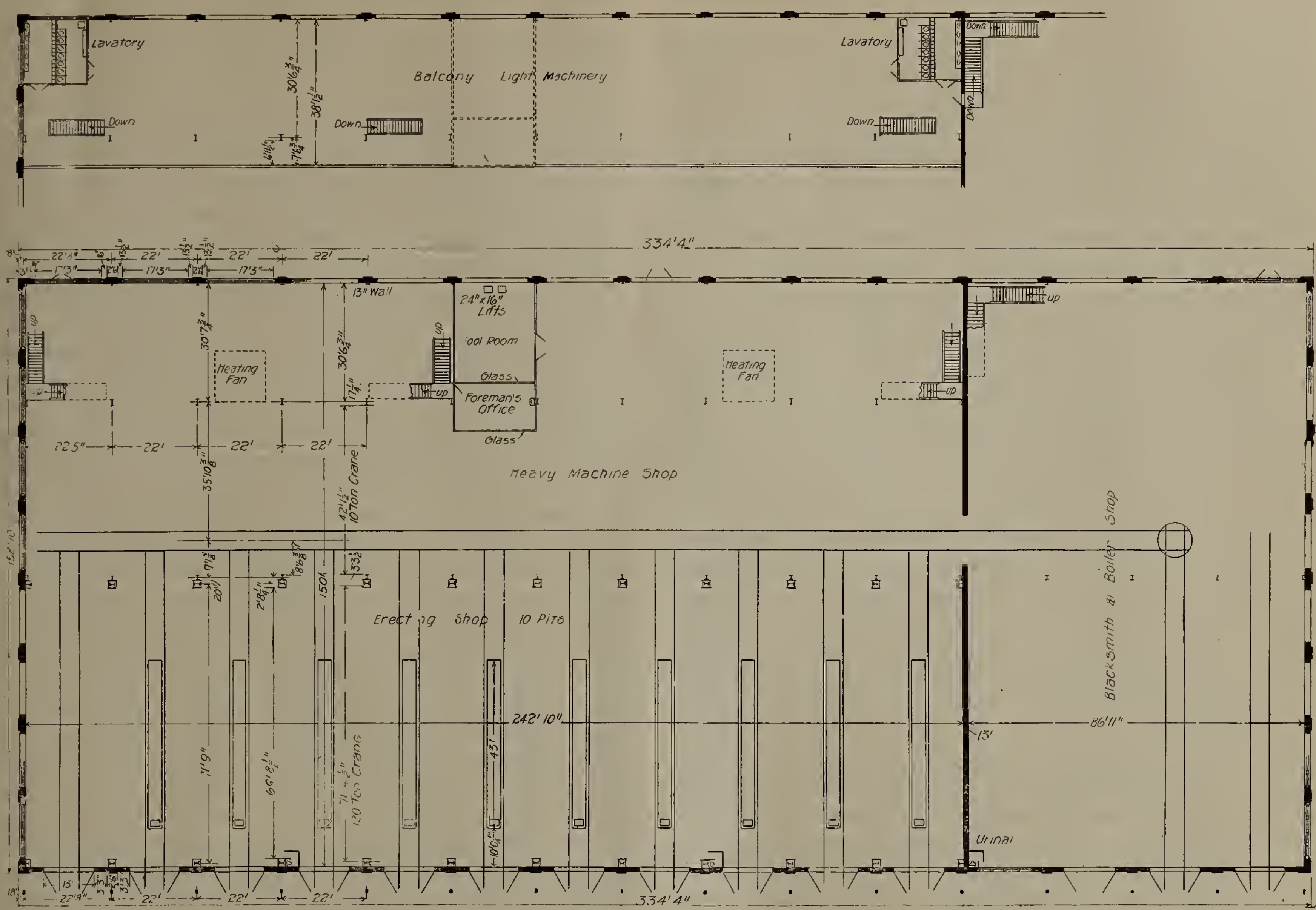
Next to the conservation of the world's fuel supply there is probably no subejct of great importance in the manufacturing world than the control of waste power caused by imperfect lubrication and needless friction. Notwithstanding the increasing interest in more economical methods, the immense losses from this source are scarcely appreciated. In his recent work on lubrication and lubricants, Archbutt stated that with considerably more than half the 10,000,000 h. p. in use in the United Kingdom of Great Britain, 40 to 80 per cent of the fuel is spent in overcoming friction, and that a considerable proportion of this power is wasted by imperfect or faulty lubrication. On account of the great abundance of cheap fuel in the United States doubtless the conditions here are even less desirable. It is safe to state that losses from this source in this country are from 10 to 50 per cent of the power employed. Not infrequently in factories where the annual expense for lubrication amounts to thousands of dollars, lubrication experts find a loss of 50 per cent, or greater.

The manufacturer often knows very little concerning the

*From a paper read before the American Society of Mechanical Engineers.



Preliminary Layout of Wichita Shops, K. C., M. & O. Ry.

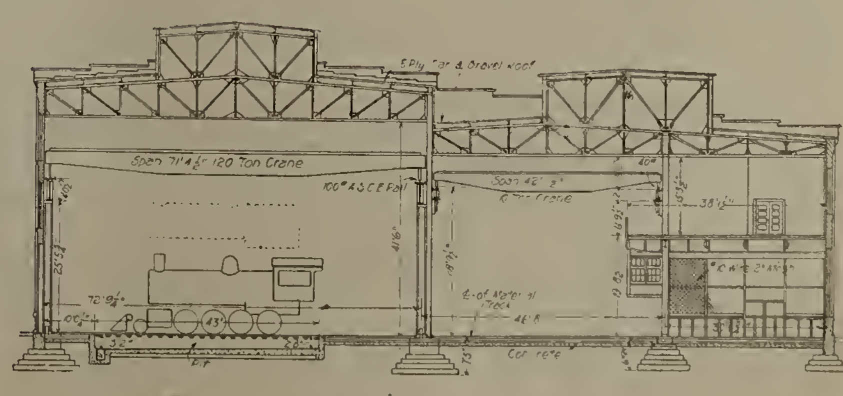


Plan of Erecting and Machine Shop, K. C., M. & O. Ry.

economic qualities of the lubricants he receives; in using them, too much is left to "rule-of-thumb" methods with little knowledge of the actual conditions of friction, the action of metallic surfaces under the dynamic stress of the transference of power, or such modified action as is produced by the intervention of a lubricating film. For example, the different effects on a journal of a soft and hard bearing may be sufficient to cause a considerable loss of power if improperly selected, and yet may escape attention. In the earlier tentative study of the conditions depended on for the results described in this paper, under such loads as 100, as 150 lbs. per sq. in. of bearing surface, the grades of babbitt in ordinary use were found much too soft and yielding to sustain such work under the necessary conditions of speed and oil feed; only a very hard alloy of exceptional composition could be used. The one selected of approximately the composition, tin, 90; copper, 2; antimony, 8, gave results entirely satisfactory. Then since it was desired to maintain such conditions of load and speed that any oil could be broken down at any moment, it was found necessary, not only that the journal and bearing be milled to mechanically true surfaces, but that by continued operation and repeated careful milling, even a higher degree of permanent evenness be maintained. If such be the essential conditions in precise quantitative observations, similar precautions are evidently necessary in factory operations.

In the earlier days of machinery lubrications before the introduction into the trade of products from petroleum, the manufacturer had little concern about viscosity and other physical constants of lubricants, for, dealing with simple oils or greases of definite composition, he could be sure of obtaining what he desired within the capacity of the materials at his disposal. Then, in the days of higher prices of manufactured products and less severe competition, imperfect lubrication was of less consequence than in more recent times when every detail of cost and loss should properly receive careful attention. and, furthermore, the principles of friction and the importance of its control were only imperfectly understood in the earlier days of lubrication. Modern high speeds and excessively heavy loads had not then to be provided for in the applications of power in manufacturing operations, or in transmission or transportation.

The discovery that the heavy hydrocarbons in petroleum possessed the qualities requisite for lubrication—viscosity, durability and stability under varying conditions of speed and load—was the beginning of a new era in lubrication. Methods of treatment and refining, with little or no knowledge of the hydrocarbons of which the lubricating oils were composed, and



Section Through Erecting Shop, K. C., M. & O. Ry.

developed entirely along empirical lines, were slow in producing suitable products. The earlier methods have undergone no fundamental changes even to the present time, except in the introduction of heavier hydrocarbons from crude oil territory more recently developed. Even since the more recent introduction of heavy lubricants from Texas and California petroleum the belief still prevails that only compounded oils can be relied on for heavy work. But with care in distillation and treatment, it is certain that heavy lubricants, well adapted for bearings and cylinders, may be prepared from those crude oils, and large quantities of such lubricants are now widely in use.

All experimenters with lubricating oils who have given thoughtful attention to the essential needs of lubrication have been impressed by the superiority of an ideal solid lubricant, i. e., one that should embody an equivalent of the desirable qualities of the liquid products with a greatly superior wearing quality, a low coefficient of friction, and readily convertible into a form that can conveniently be applied to the various forms of journals and bearings. Soapstone, asbestos, natural graphite, etc., do not, altogether, possess these fundamental qualities of the liquid products. Greases compounded with graphite are useful on low-speed bearings and under heavy work. Natural graphite serves an excellent purpose on cast-iron bearings, acting as a surface evener of the porous metal. On finer surfaces care is necessary that it does not collect in such quantities as seriously to scratch or abraid the journal and bearing.

Of all the solid bodies available for lubrication, graphite possesses the desirable unctuous quality and great durability. For general use in lubrication, graphite must be in its purest condition and in a state of extreme subdivision. Whether, in such a condition as the deflocculated form, the ultimate molecules or atoms have a certain freedom of movement or whatever explanation may be suggested of its unctuous quality, the fact remains that it possesses this quality in very high degree. Such graphite is now produced by processes discovered, perfected, and placed on a manufacturing basis by Dr. Edward G. Acheson of Niagara Falls as a part of his great work in the development of electrochemical processes. Besides his immense output of pure graphite for general commercial use, Dr. Acheson has succeeded in converting it into a new form, a deflocculated condition, that meets the requirements of an ideal solid lubricant. This deflocculated form greatly surpasses ordinary graphite in unctuous quality, and its adaptability for prolonged suspension in water and oils renders it especially applicable to frictional conditions. Furthermore, the readiness with which it forms coherent films on journals, its great wearing qualities and the ease of the application, constitute a lubricant of extremely high efficiency.

Acheson graphite can be produced from any substance that contains carbon in a non-volatile form. Under the extreme temperatures of the electric furnace any and all other elements are readily volatilized. Even carbon itself is freely vaporized and its peculiar appearance in the burning carbon-monoxid is depended on as an indicator of suitable conditions in furnace operation, much as the drop in the manganese flame which shows the disappearance of carbon in the Bessemer converter.

As commercial products two forms of graphite are produced, the unctuous and the deflocculated modifications, the first form accompanying the production of carborundum in furnaces charged with carbon and sand, the second obtained from a charge of coal and coke alone. The first form is leafy in structure, coherent, and extremely unctuous or greasy to the touch; it is segregated and not readily disintegrated. The second form is also unctuous in a high degree but very pulverulent and capable of extreme subdivision; it is readily converted into a deflocculated condition. This form in water forms the commercial "Aquedag," or aqueous Acheson deflocculated graphite. In combination with oils it is known as "Oildag."

This deflocculated graphite has peculiar properties; it remains suspended indefinitely in water, but is quickly precipitated by impurities. On account of its extreme subdivision a very small amount suspended in water serves for efficient lubrication. From numerous and long-continued trials it appears that 0.35 per cent serves an adequate purpose and that a larger proportion is superfluous. It is certainly remarkable that such a small quantity of graphite is readily distributed by water between a journal and bearing while sustaining a load of 70 lb. per sq. in. of bearing surface, and that under high speed conditions it maintains an extremely low coefficient of friction.

Proper lubrication of bearing surfaces involves careful consideration of the metals composing the journal and bearing, since the influence of the metals employed has an effect even in the intervention of the best lubricating film. The materials in common use for construction of bearings include cast iron, steel, and alloys of variable composition included under the general terms, bronze and babbitt. In high speed work cast iron bearings must be used with extreme care. In the accurate adjustment necessary in machine testing of lubricants, we have found it impossible to prevent injury to the journal when using a cast iron bearing. Results obtained by the use of bronze have not been altogether satisfactory. However, properly selected babbitt for a steel journal seems to fulfill the desired conditions most satisfactorily and it possesses a wide range of applicability. As mentioned above, satisfactory lubrication is possible only when the journal and bearing are properly machined to true surfaces, kept smooth, accidental scratches worked out, and bare spots avoided. Successful lubrication demands constant skilled attention to the condition of journals and bearings, and no factory supervision affords more desirable returns. Lubrication consists in reducing friction to the lowest increment of the power in use. A lubricant is an unctuous body that readily forms a continuous, coherent, durable film capable of holding apart rolling or sliding surfaces, and itself interposing the least possible resistance. The economic problem in lubrication depends on the use of such a lubricant under suitable conditions.

The lubricants in commercial use include water, oils, greases and solids. Under oils are classified the great variety of light spindle, heavy engine and cylinder products, either unmixed hydrocarbons from petroleum or compounded oils, tallow, wool grease, etc. The greases may be generally classified under a few heads depending on their consistency, which is derived from the proportion of lime or soda soaps or oleates with the hydrocarbon oil as a carrier. The solid greases have already been referred to.

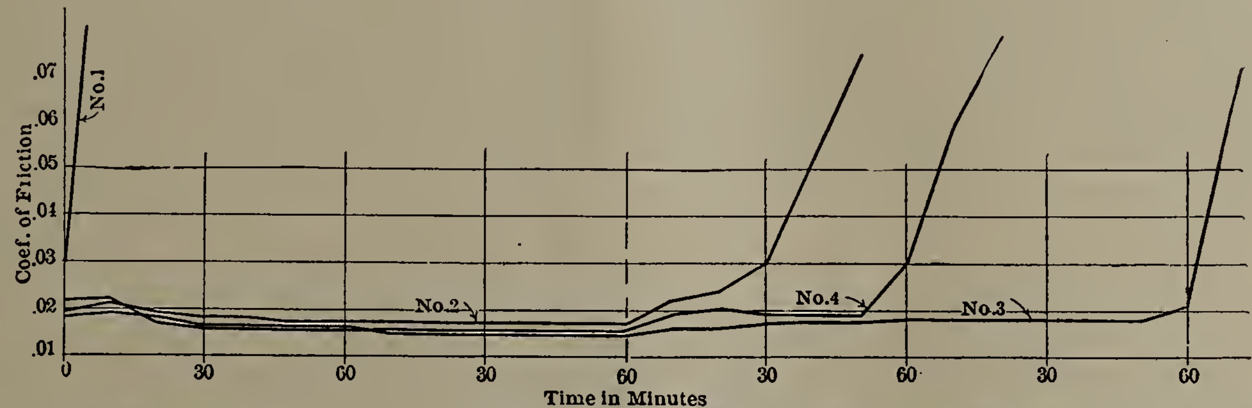
Water in itself possesses no oiliness whatever but under certain conditions in cylinders it is found to assist in imparting to the metallic surfaces an extremely smooth condition which serves materially to reduce the friction. A practical knowledge of hydrocarbon lubricants should include a knowledge of the source, that is, the crude oil from which the lubricant is prepared, since there is a wide difference in composition and properties of the oils from different oil fields. Methods of refining petroleum oils have very much to do with the quality of the products. In general terms, inferior products are obtained when the process of distillation is conducted in such a way as to produce decomposition; the best products are obtained only by careful distillation and careful treatment is refining, whereby the hydrocarbons in the refined products obtained have essentially the same composition as in the original crude oil.

An examination of various lubricants in the trade frequently reveals a condition of the oils indicating improper refining. For example, it does not need the application of extremely delicate tests to show the presence of free alkali, of sodium sulphate, or of sodium salts of organic acids, any one or all of which may be injurious to metallic surfaces. One of the most exacting duties of the refiner is the treatment with caustic soda in such a manner as to remove all acid products and at the same time to avoid such an excess of caustic as will form an emulsion, which is one of the "terrors" in a refinery. An examination of a great variety of oils in the trade, such for instance as the spindle oils in use in automobile service, indicates that the best refined oils are those that contain a minute trace of alkali.

The ordinary methods of testing lubricating oils include determinations of the viscosity, the specific gravity, the flash and the fire temperatures. Another important property of these oils, termed oiliness or greasiness, is not so readily determined by analysis; in fact, there seems to be no accurate method for its determination; yet it is readily distinguishable and has much to do with the efficiency of all lubricating oils. Concerning the most efficient methods of testing lubricating oils various opinions are expressed by different authors. Redwood, in his work on petroleum and its products, asserted that the viscosity of an oil is the best guide to its lubricating value since it enables the consumer to select oils similar to those that have afforded him the best practical results. He alludes to the close relationship between viscosity and the laws of friction of liquids. In comparing the use of viscosity with observations on the behavior of lubricants on a frictional testing machine, he states that he was unable to obtain satisfactory results with any machine at his disposal. His conclusions in general were that in the present state of our knowledge the indications afforded by testing machines are wholly misleading, and this led him to attach especial importance to a good system of testing viscosity. He refers to the opinion of Thurston that any oil should be tested on a machine under the conditions of load and speed similar to those of the use for which the oil is intended.

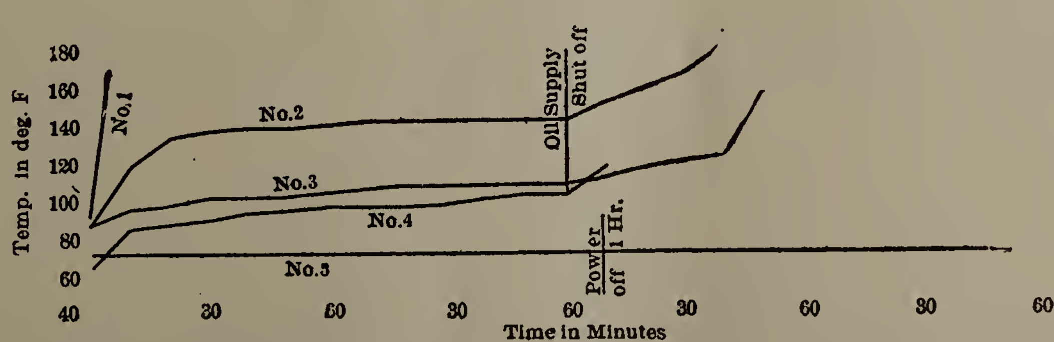
Referring to the work of Ordway and Woodbury in 1884 with an apparatus constructed to apply pressures of 40 lbs. per sq. in.; to those of Tower carried on under what he terms great pressures—100 to 600 lb. per sq. in.—in an oil-bath system of lubrication; and also referring to the opinions of others on these results, Redwood presents the view that the agreement between machines and actual practice is extremely slight, his final conclusion being that viscosity affords the most valuable tests of lubricating at our disposal. Inasmuch as Redwood's opinion on machine testing is a result of his observations during several months on the Ingram and Stafer machines, in which the speed is 1,500 r. p. m., and that the friction is gaged by the number of revolutions necessary to carry the temperature to 300 deg. fahr.; it is not difficult to understand his conviction that in his experience testing machines do not afford results comparable with those of actual practice.

The value of viscosity as a distinguishing property of lubricating oil is recognized by all who have given attention to the subject, but all are not agreed as to the extent of its practical reliability. Archbutt suggests that the quality of oiliness or greasiness is nearly of as much importance as viscosity. Although, as mentioned above, there is no precise method whereby oiliness can be determined, it is not difficult to recognize it nor to distinguish the marked differences in this respect shown by different oils and greases. Archbutt calls attention to the fact that at very low speeds the friction of a cylindrical journal should be proportional to the viscosity of the oil; but at higher speeds, and consequently increased temperatures, the relation of friction to speed ceases; the viscosity is diminished with a corresponding change in the carrying power of the journal. While fully appreciating the value of the information to be



Curves of Friction—Oil and Oildag—Varying Feeds. Pressure 150 Lb. per. Sq. In.; R. P. M. 445. Fails Spindle Oil.

No. 1 Oil alone	6 Drops per Minute	No. 3 0.35 per cent graphite	8 Drops per Minute
No. 2 " "	8 " " "	No. 4 " " "	4 " " "



Temperature Curves for Lubricants of Varying Viscosity, with and without Graphite. Pressure 150 lb. per sq. in.; R.P.M. 444

No. 1 Auto cylinder oil (alone)	6 Drops per Minute	No. 3 Fuel oil + 0.35 per graphite	8 Drops per Minute
No. 2 " " " + 0.35 per cent graphite	4 " " "	No. 4 Kerosene " " " "	8 " " "
		No. 5 Water " " " "	8 " " "

Figures 1 and 2.

obtained by chemical analysis, Archbutt insists that the oiliness of a lubricant is of especial importance under heavy loads and high speeds. He suggests that it is advantageous for an engineer to test oil for himself on a machine without depending altogether on analytical data of phyisical tests obtained from the expert. Hurst also mentions that a broader knowledge of the practical working of oils is necessary than can be obtained from chemical or physical tests alone. He maintains that the test of an oil from a journal under the practical conditions of its use show conclusively its adaptability to such use.

The principal points to be observed in mechanical tests are the effects of speed, load, temperature, and the frictional effects due to viscosity and oiliness. The measurements on which depend the quality of the oil include the frictional resistance, the temperatures, and the endurance of the oil film. Doubtless the numerous machines that have been constructed for testing oils have certain merits and advantages. In the wide range of work carried on in this field during the past year, a part of the results of which are presented in this paper, the machine devised by Professor Carpenter were used. In its sensitive adjustment, durable efficiency, and the wide range of possible tests, this machine in continuous use during this period on light and heavy oils, greases and graphite, has fulfilled all requirements.

This machine has an accurate adjustment for recording the speed, and a long lever arm with a vernier attachment graduated to tenths of a pound for recording the friction. The load is applied by a powerful spring worked by a cam and lever, the limit of the machine being 6,000 lb., total load. Careful calibration of the spring showed it to be properly adjusted.

In projected area the bearing in use is approximately 8 sq. in.; the journal is about 3 in. in circumference, nearly equal to 1 ft. in linear extension. A cast iron frame babbitted and machined down to a true surface was used for the most part in this work. Even after careful machining some continuous frictional work was necessary on the babbitt surface to bring it to the proper conditions of constant results. The hard form of babbitt mentioned above gave satisfactory results, and there was little difficulty in keeping the surfaces in suitable condition after they were once obtained. For measuring temperatures a thermometer was inserted in a hole in the bearing, extending close to the journal.

Tests made at steam temperature—210 deg. fahr.—were carried on in a hollow cast iron babbitted bearing, with steam attachments by which it was found that the desired temperature could readily be maintained. The lubricant is run in from a sight-feed cup through a small hole close to one side of the bearing with careful regulation of the flow for proper adjustment of the feed oil.

For delivery of the lubricant over the entire face of the bearing two channels or grooves are run diagonally across the babbitt face from the inlet hole, giving equal and even distribution; these channels must be carefully gaged for an even flow, otherwise dry spots or streaks appear on the journal accompanied by a sudden greatly increased friction indicated on the friction bar. This detail of operation requires careful and constant attention, for on it depends the continuous regularity of the friction curve. In this respect this method of observation is extremely sensitive, and is one of the important elements in frictional tests. Partial exposure of the journal enables the operator to observe the formation of the film, its comparative thickness and any irregularity due to an imperfect condition of the journal or bearing, or improper lubrication.

Accurate testing of the mechanical efficiency of oils with the precise quantitative observations possible on the Carpenter machine, including the various classes of lubricants under consideration in this paper, presented an extensive fiield of labor, especially since there are no general standards of comparison under any conditions of operation. Such constants must of necessity be based on arbitrary data, nevertheless if they are accurately determined on a standard machine, with the conditions of the journal and bearing selected,—the load and speed,—the constants on this machine may be readily ascertained on any other equally efficient machine. In duplicate tests made with the same bearing and under the same conditions the results were closely concordant. At the outset it should be clearly understood that these tests must be performed with a scientific accuracy of exact quantitative observations with close supervision of all details. The work then becomes the regular routine of any scientific investigation which involves long series of observations, after it is ascertaned by preliminary trial what conditions are necessary in testing any given oil. Of course for commercial benefit these conditions should be as close as is practicable to the factory conditions of use.

The results to be described of the use of water, kerosene, and fuel oil as vehicles of graphite, present novel and interesting features. Under certain conditions, as mentioned above in steam cylinders, it is well known to engineers that water alone serves as a lubricating film. Since on journals is serves no purpose, the lubricating qualities of aqueous suspended graphite must be wholly due to graphite, the same is true of kerosene and other fuel oils.

Fig. 1, load 150 lb. per sq. in., 445 r. p. m., gives the effect no spindle oil of a variable feed. In one test the oil alone the oil supply was regulated with the object of breaking the oil at the beginning of the test, and also its behavior was noted, under an oil supply that enabled it to perform its functions as a lubricant. The effect of graphite on the lubricating quality of the oil is also shown in Curve 3 and Curve 4, Curve 3 representing a feed of 8 drops per min., Curve 4 representing a feed of 4 drops per min. The diminished coefficient in Curve 4, as compared with Curve 2, represents the lubricating effect of graphite, and this effect is still further shown by the increased endurance test in Curve 4; it will also be observed that besides showing diminished friction, Curve 4 is based on an oil supply due to the graphite, one-half that of Curve 2 of the oil alone.

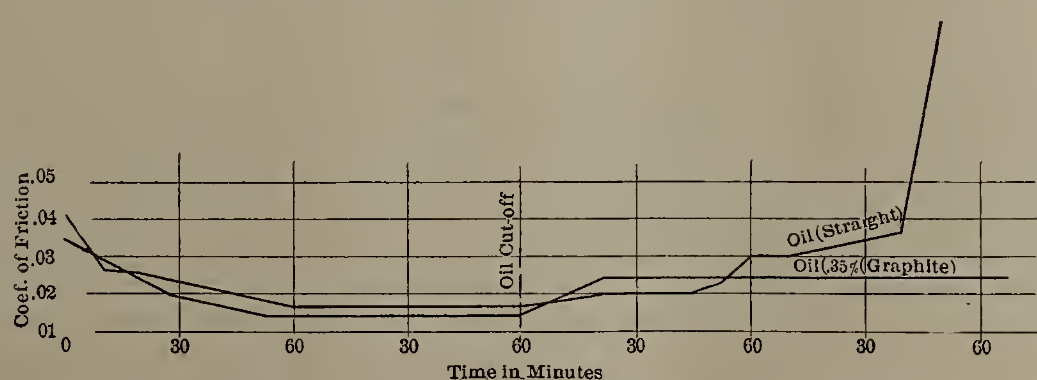
In Fig. 2 curves are shown which represent the temperatures recorded in tests of friction. The load is given as 150 lb. per sq. in. for the automobile oil, fuel oil and kerosene, and 70 lb. per sq. in. for water. The speed was 444 r. p. m. in all but the test with water, where it was 446 r. p. m. The test of the automobile oil alone showed an immediate rise in temperature, corresponding to the breaking point of the oil, which is shown in the friction test. It is interesting to compare this temperature with that of Curve 2, automobile oil and 0.35 per cent graphite, in which the temperature rises within twenty minutes to a definite point and then continues in a nearly straight line with little variation to the point where the oil supply was shut off at the end of two hours. Curve 3, representing the temperatures of fuel oil and graphite, also shows a very slight variation after 30 min., when the stable conditions of lubrication were established. A difference in temperatures of approximately 25 deg. is shown between the curves of the automobile and fuel oils, which must represent the larger escape of energy in the form of heat from the bearing, due to the greater internal resistance of the automobile oil. The temperatures of kerosene with graphite, as shown in Curve 4, are approximately 10 deg. lower than those in the fuel oil, approximately 35 deg. Beaumé, and that of kerosene, approximately 45 deg. Beaumé, the difference in temperatures of these two curves is a good example of the accuracy in observation possible in these tests. Perhaps the most striking featurs on this chart is the curve presenting the temperatures for water and graphite; here, as in the curve of friction for water, this curve is shown for only four hours, but the test actually extended through a period of 15 hours, during which time there were several stops in which, as shown on this chart, the temperature at the start was the same as that at the time of interruption. It will be observed that this chart shows an extremely low temperature, 65 deg., practically the same as the room temperature, which it never exceeded by more than 5 deg., and that it is essentially a straight line from start to finish. In this use of water as a vehicle for the graphite there is nothing to interfere with the best work that the graphite is capable of performing.

Among the various classes of lubricating oil examined in this work considerable attention has been given to the behavior of heavy engine and cylinder oils, both straight hydrocarbon oils and compounded oils. A special form of bearing was constructed, consisting of a cast iron frame with a hollow chamber for introducing steam, and a babbitted face using the exceptionally hard babbitt previously described. In some of these tests a bronze bearing similarly constructed, but maintaining the bronze face, was employed. But in general it was observed that the results were less satisfactory with the bronze than with the babbitt bearings, in testing not only the heavy oils but other classes of oils examined. Hard babbitt seems to possess certain peculiar qualities adapted to the various details and variations in speeds, loads, and temperatures, which are not found in the same degree in the bronze alloys. To show the results obtained in testing cylinder oils, charts are here presented on two commercial products, Galena cylinder oil, and "600 W" cylinder oil.

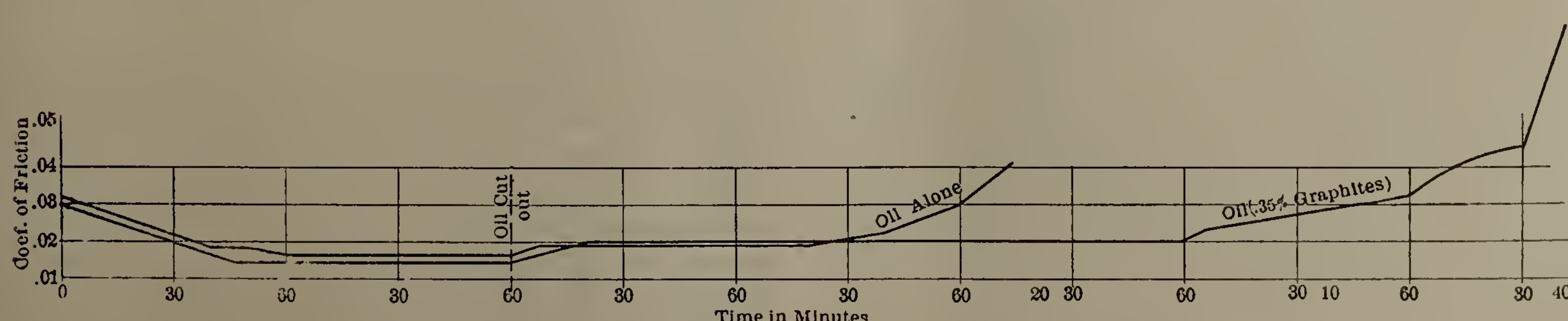
Figure 3 presents results obtained in tests of the "600 W" cylinder oil, with and without graphite. On account of the greater viscosity the straight oil showed at the beginning a considerably higher coefficient and the tests continued one hour before the oil had reached normal conditions, which it maintained until the feed was stopped and doubtless would have continued indefinitely. After the oil was shut off lubrication was maintained with some slight irregularity and increased friction during 1 hr. 40 min., the point at which it broke. Similar conditions are observed in the curve which expressed the variation in the coefficient of friction of this oil with 0.35 per cent graphite; it begins the test with a somewhat lower friction, reaching normal conditions sooner than the straight oil, continues in a straight line to the point where the supply is stopped, and then still continues in a straight line with somewhat increased friction. The endurance curve would doubtless have continued for a considerably longer time but the power was shut off at the point where the curve terminates. A marked influence of graphite on the behavior of this oil is plainly apparent in a comparison of these curves.

In applying tests to the Galena cylinder oil, with and without graphite, the same feed, load and pressure were used as with the preceding oil and the tests were made on a babbitt bearing. In viscosity this oil is somewhat less than the preceding oil, the specific gravity somewhat higher. Both curves in Fig. 4 begin with slightly lower coefficient at 0.03, and this difference is maintained until the oil is shut off and for 1½ hours on the endurance test. To reach normal conditions the straight oil ran for 1 hr., the oil with graphite 45 min. After the feed was stopped, the curves proceed regularly with slightly increased friction, the oil alone practically breaking in 1½ hours, the oil with graphite proceeding with perfect regularity for three hours, changing slightly during the next hour and breaking at the end of 4½ hr. The test represented in Figs 3 and 4 are not intended to present the comparative efficiency of these particular oils but to demonstrate the application of this method of testing and also to compare the effects of deflocculated graphite.

The results presented in this paper, with references to the uses of graphite as a solid lubricant, indicate that in the deflocculated form it can readily be applied with great economic efficiency in all forms of mechanical work. One of its most characteristic effects is that of a surface-evener, by forming a veneer, equalizing the metallic depressions and projections on the surfaces of journal and bearing; and being endowed with a certain freedom of motion under pressure, it affords the most perfect lubrication. In automobile lubrication the great efficiency of graphite, in increasing engine power, in controlling temperatures, and in decreasing wear and tear on bearings, has been brought out in a series of tests conducted by the Automobile Club of America. In connection with the reduction in friction of lubricating oils by graphite the extremely small pro-



"600 W" Cylinder Oil, With and Without Graphite. Babbitt Bearing; 8 Drops per Minute; 1200 Lb. Pressure; Temperature 210 Deg. Fahr.; Viscosity 150 at 212 Deg. Fahr.: Specific Gravity 0.903; Flash 530 Deg. Fahr.



Galena Cylinder Oil With and Without Graphite. Babbitt Bearing; 8 Drops per Minute; 1200 Lb. Pressure; Temperature 210 Deg. Fahr.; Viscosity 116 at 212 Deg. Fahr.; Specific Gravity 0.947; Flash 266 C.

Figures 3 and 4.

portion necessary is worthy of note; the proportion used in this work is equivalent to one cubic inch of graphite in three gallons of oil. The curve of temperature for Aquadag, an increase but slightly above that of the surrounding atmosphere, demonstrates an important economic quality of controlling temperatures in factory lubrication, thereby avoiding the danger of highly heated bearings, which are frequently the cause of fires.

In the observations described in this paper, and in fact in all the work that has been done in this field, there is not a more impressive example of the efficiency of graphite in lubrication than that presented in the curves of friction and temperature of water and graphite; for water serving merely as a vehicle and completely devoid of lubricating quality, the graphite is permitted to perform its work without aid and with no limiting conditions.

Steel Car Construction*

By C. R. Harris.

A student of car construction during the past three years could not have failed to notice an increasing force tending towards the replacement of pressed steel parts by rolled structural shapes. To the speaker it has always seemed very unfortunate that the evolution from the wooden underframe freight car to the steel structure of to-day should have been so strongly influenced by a mechanic, who was firstly a fabricator of pressed steel and later a designer of freight cars. Had the guiding mind in this transition been first trained as a bridge engineer or schooled as a ship builder, we should have no such numbers of pressed steel cars to which the future may point as an illustration of misdirected effort and a waste of money and energy.

The duty of a freight car is to carry merchandise from one location to another. Unfortunately, commercial demands are not evenly distributed and it not infrequently happens that empty cars must be transported over the roads from one location to another. In other cases cars are designed and built for special purposes with the deliberate intention of carrying them unloaded in one direction. The most common example is the refrigerator car, the tank car and the so-called battleship or hopper coal cars, although in some sections of the country the latter are available for ore in one direction and coal in the opposite direction.

The first and most important function of a car requires that it shall be so built that the contents of the car are safely transported. In other words, it must be sufficiently strong to carry the load imposed upon it; it must be designed to successfully withstand the hard usage incidental to its transfer and do so for a sufficient length of time, so that the revenue derived from the freight hauled will pay for the car, its repairs, the interest on the principal involved and the pro rata share of all other expenses connected with the management and operation of the railroad. But inasmuch as the weight of the car is a non-productive element with a minus sign, and must at times be carried empty, the weight must be kept as low as possible, consistent with safety. While light weight with strength is desirable, this lightness must be gotten without the use of expensive materials and excessive labor, otherwise the interest on the equipment investment will more than overbalance the saving due to light constructions.

The first cost of plates for making pressed parts is practically the same as the cost of rolled structural sections. To the former must now be added the cost of fabrication, no small part of which is the interest and maintenance equipment; a single 1,000-ton press representing an investment of about $25,000. On the other hand, structural sections are generally ready for the car builder as delivered from the mill. This evening I hope to show that not only has money been misspent upon the fabrication of pressed steel, but that after such fabrication had been performed, a structure was erected which is inferior to one built from rolled sections.

Rolled structural shapes have already driven pressed steel practically out of the field in hopper cars.

About all that is left in the line of pressed parts is the hopper doors, the stakes, connections and fillers. The posts have an inertia of 3.007 with a section modulus of 1.21 with a finished weight of 7.82 pounds per foot. The weight of steel in the completed posts for each car is 985 pounds, and the weight of the steel from which the posts are pressed is 1,028 pounds. In other words, the posts on each car produce 42.3 pounds of scrap, for the removal of which the purchaser pays good money.

Here is a hopper car which shows one additional step in the process of evolution towards the structural car and away from the pressed steel car. You will note the most striking feature is the substitution of rolled shapes for pressed sections to form side posts.

The channel as used here is about the poorest structural section rolled to resist stress in the direction produced by a granular load.

The average weight of the side posts is 7.59 pounds per post, which is 2.9 per cent lighter than the finished pressed post and 7.2 per cent lighter than the steel from which the pressed post is manufactured. This difference, added to the much lower cost of fabrication, makes the structural post a much cheaper proposition. The structural post has a decided disadvantage in being much weaker to resist side pressure and side swiping, although the cars stand up well in service.

A sectional view of the usual pressed steel hopper car post is shown in Figure 1. The depth from side sheet to outside of the post is 3½ inches, extreme width 7¼ inches, and pressed from $\frac{5}{16}$ inch steel plate, assuming that there is no thinning of material due to pressing the inertia of the section about an axis parallel to the side sheet and through the center of gravity is about 3.007, the weight of blank steel for a finished post 6 feet, 11⅜ inches long is 57.12 pounds, the weight of the finished post is 54.77 pounds or 7.82 pounds per foot of length, the resulting scrap amounts to 2.35 pounds per post.

When the building of wooden ships ceased and steel displaced wood for marine service, the ship builder had special shapes rolled to meet his particular needs. Ship channels, bulb angles and deck beams then came into existence. With the exception of ship channels these shapes are too large and too heavy for general use in car work. From the previous data respecting hopper car posts there is evidently little chance for any of the regular rolled sections to better to any great extent the pressed steel post. If there be no better standard rolled sections available for use, we must content ourselves with either one of the two schemes previously outlined or designed, and shoulder the extra first cost to produce a structural section which will meet the requirements for car service.

Figure 2 shows a suggestion for a special structural shape for hopper car posts. An end view of the rolled section, a front, side view and sectional view as applied to cars, is shown. The stress caused by a granular load in a hopper car is maximum at the point where the rivets fasten the post, side sheet and side sill together; from that point to the top of the post the bending moment decreases to zero. If a post be made of uniform section and of sufficient strength to withstand the maximum bending moment there is large waste of material. In the suggestion shown in Figure 2, an attempt has been made to overcome this objection and still hold to structural shapes. The shape of the rolled section is shown by the end view; the front, side view and section show the

*From a paper before the New England Railway Club.

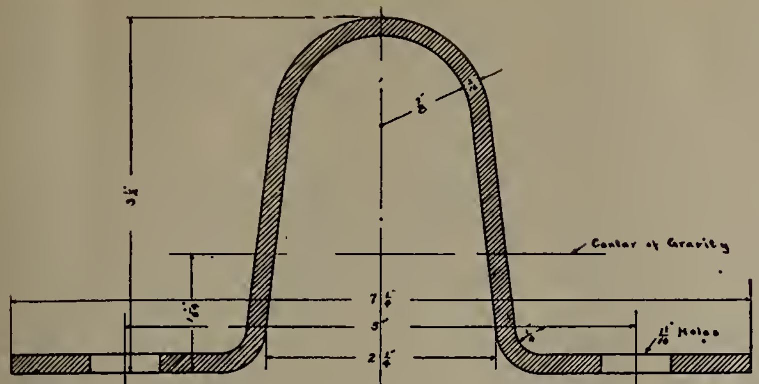


Fig. 1—Pressed Steel Post for Hopper Cars.

lower end of the post and reinforcement plates to provide sufficient strength for the maximum bending moment and to allow the use of sufficiently large rivets to make a safe fastening; the latter consideration is very important, owing to the fact that these rivets are in tension. By referring to the sectional drawing you will note that the rivets do not pass through the post proper, but that the edge of the head of the rivet is over the rolled section. The reinforcement plates could be either rolled or pressed; for commercial reasons the latter proposition would be used in practice. Please note that the reinforcement plates are pressed so that there is $\frac{1}{32}$ inch clearance between the hopper sheet and the pressing; this will not be the case after the rivets are driven and is done to insure a positive contact between the hopper sheet and the flange of the side post. One-half inch rivets are shown to fasten the post to the side sheets, although there is sufficient flange width to take $\frac{5}{8}$ inch if desired.

A comparison of this post with the pressed-steel post is interesting. The inertia of the post proper about an axis parallel to sides of the car is 2.249. In combination with the reinforcement plates the inertia is raised to 3.057. The weight of the post is 5.95 pounds per foot and of the reinforcement plates 2.98 pounds per foot. A completed post 6 feet, $11\frac{3}{8}$ inches long as shown would weigh 49.25 pounds, which is 7.85 pounds less than the steel will weigh for the pressed post. In other words, material for the pressed post is 15.9 per cent heavier than the structural post, and the completed pressed-steel post is 11.1 per cent heavier than the proposed structural post.

The structure post without reinforcements has a section modulus of 1.24 and at the reinforcement of 1.54. Taking the modulus as a basis, the structural post at the reinforcement is 27 per cent stronger than the pressed post, and without the reinforcement 2.4 per cent stronger.

If the car be designed with 18 posts, the saving in material amounts to 141.3 pounds per car; for 1,000 cars 70.65 tons, which at $35 per ton would make a saving on material alone for 1,000 cars amounting to $2,472.75. The car itself would weigh 99 pounds less if equipped with this post. In addition to the above-mentioned saving, there is a lessened manufacturing cost which includes the making of drawings for dies, the patterns and the machining of the same, cost of fuel for heating the blanks, the wages of the pressmen, interest and depreciation on the press and the cost of shearing the post after it leaves the press. These items are for first cost. The extra weight hauled over the road is there for the life of the car, and to what that amounts you, gentleman, are better prepared to say than I am. The pressed-steel post has 251.52 square inches of surface per foot of length exposed to the action of the elements to cause corrosion, while the structural post has 122.9 square inches per foot of length. In other words, the pressed post exposes a surface to corrosion 100 per cent greater than the structural post.

There is one more point to be considered in connection with this suggestion. Cars do get side swiped. Will this post stand for this type of abuse as well as the pressed one? Personally I believe it will. The pressed post is very easily dented and has less strength to resist a force in that direction than the bulb of the rolled section. The place where side swiping is most evident is at the sills, and here the rolled post is strongly reinforced.

The Cambria Steel Co. has recently started to roll a post to replace the pressed post. The section is practically the same as the pressed post except that the outer edge has been thickened to balance the flanges. This post is shown in Figure 3.

The $\frac{3}{16}$ inch post has an inertia of about 2.00 and a modulus of about 1.38 with allowance for $\frac{11}{16}$ inch rivet holes. The Cambria post is 15 per cent lighter than the pressed post and 12.3 per cent stronger. Comparing it with the proposed bulb post as rolled and without the reinforcements it is $12\frac{1}{2}$ per cent heavier and 10.1 per cent stronger.

The weights of the Cambria posts for $\frac{3}{16}$ inch, $\frac{1}{4}$ inch, $\frac{5}{16}$ inch and $\frac{3}{8}$ inch flanges are respectively 6.7, 8.5, 9.65 and 11.8 pounds per foot.

On a car which had been in service less than six months, I recently noticed a 5-inch pressed-steel end sill diagonal brace made from $\frac{3}{8}$ plate with $1\frac{3}{4}$ inch flanges. This piece of pressed steel weighs 9.89 pounds per foot with the least radius of gyration of .309 and with a factor of safety of 5 is capable of sustaining a load of 13,300 pounds. As actually used on the above-mentioned car it also furnished a support for stringers which subjects the piece to a bending moment in addition to its liabiltiy to be subjected to stress caused by the use of the push pole.

A 5-inch 6.5-pound channel has an area of 1.95 square inches with a least radius of gyration of .498, and when used as a similar strut is capable of sustaining a load of 11,700 pounds.

A $3\frac{1}{2}$ x 3 x $\frac{5}{16}$ angle weighs 6.6 pounds per foot with an area of 1.93 square inches and a least radius of gyration of .63. Under the same conditions as above cited it is able to sustain a load of 12,352 pounds. Owing to the better ability of the angle to carry the load imposed by the stringer, the angle is undoubtedly the stronger section and is 33.2 per cent lighter in weight. The substitution of the angle for the pressing on 1,000 cars would result in a saving of $959.70 for steel alone at $1.75 per pound.

When used as bolsters pressed steel will undoubtedly much longer survive the assaults of the advocates of structural steel as a car unit than it will in any other application.

In Figure 4 the lower right-hand view shows a very common type of bolster which has successfully withstood the service imposed upon it. The lower left-hand section shows a bolster which failed in service. It was built of two pressed diaphragms manufactured from $\frac{3}{16}$ inch steel plate with a

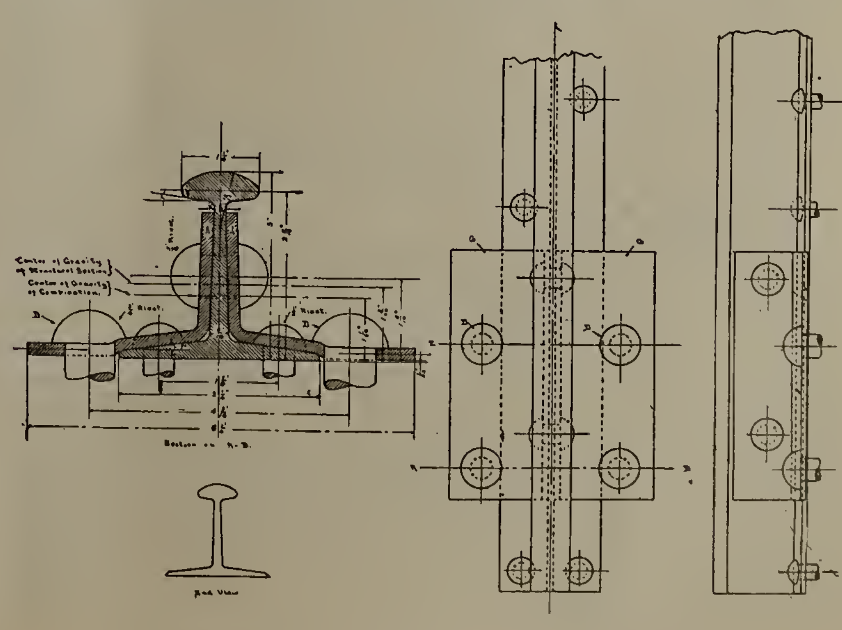


Fig. 2—Proposed Structural Post for Hopper Cars.

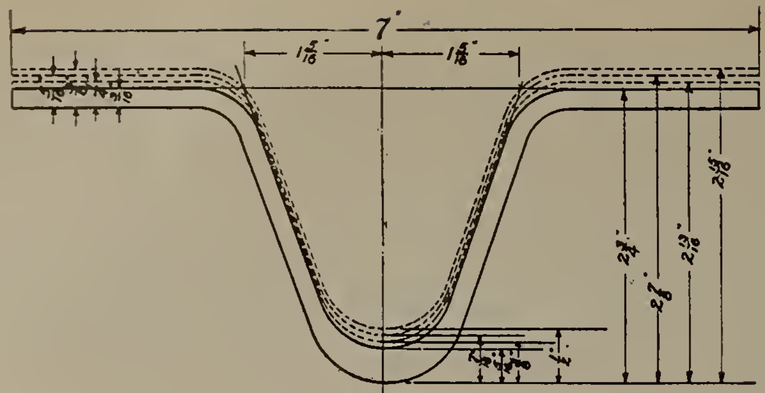


Fig. 3.

channel for a tension member and the compression members were reinforced by a 3/8 inch plate. A bolster is subjected to two different kinds of strain: one due to the weight of car and its load when the side bearings are not in contact, the second one due the same car and its load when the side bearings are in contact. Under the former conditions the bolster is subjected to strain as a beam fixed at one end, carrying a distributed load due to the contents of car directly over it and a fixed concentrated load at the point where the bolster fastens to the side sill. Under the second condition the bolster must act as a strut and the load is liable to be applied suddenly as the car takes a curve and with the added momentum of a moving mass due to the side bearing clearance. It was in the application of this load that this bolster failed by crushing over the side bearing.

The bolster was used on a 100,000 pounds capacity car and the car was so designed that the bolsters might under special conditions each carry one-half of the total imposed load. What proportion of 55,000 pounds might be transferred for the bolster to carry as a strut, is hard to say.

The maximum allowable weight for a car and its load equipped with 5½ x 10 journals is about 160,000 pounds. Allowing 10,000 for the weight of trucks, the total allowable weight of car and load is 150,000 pounds or about 35,000 pounds for each half of each bolster. It is probably fair to assume that the bolster should be capable of sustaining as a strut a quiescent load of 50,000 pounds. By referring to the section on the screen you will notice that this load is carried to two bolster webs and that the webs are in turn subjected to two different stresses. Pressed steel must always have rounded corners and to help the pressmen these are generally made with as long radii as possible. In this case 1 inch; under our hypothetical loading each plate carries 25,000 pounds which acts about the point "A" subjecting the thin plate to a bending moment of 25,000-inch pounds. The top side bearing is about 9½ wide and it is probably fair to assume that the load is distributed over about 12 inches in length of the bolster web, which distance would be gradually increased as the bolster crushed under the load. It does not need any mathematics to show that no such load can possibly be carried by the plate. When the webs act as struts each plate will have to carry 25,000 pounds, and assuming that the load can be distributed in width over 18 inches of the plate with a factor of safety of six, it will sustain a load of only 5,400 pounds where we are obliged to carry 25,000 pounds.

If a stiffener be introduced of the design shown, the bending moment at "A" is eliminated and the web plates are united and act together. This connection is probably sufficient to make 12 inches of the webs effective, which would make the bolster able to sustain a load of 72,000 pounds. A section of the bolster taken parallel to the car floor after the introduction of the stiffener is shown in the upper right-hand corner.

The upper drawing before you shows a type of cross bearer which is not uncommonly used on pressed-steel car. Please note that the flange of the diaphragm of the cross bearer has been cut away at the point where the flange of the center sill laps over the cross bearer.

This cross bearer is composed of two units, one diaphragm pressing of ¼ steel and one pressed brace of 5/16 steel. The inertia on the section AB about an axis through the center of gravity is 956, on the section CD about an axis through the center of gravity is 876.

As a substitute for the pressed-steel cross bearer I would suggest the type shown by the lower drawing. This cross bearer has a 3/16 web plate; on the face nearest to the observer is riveted to both top and bottom edge a 2½ x 2½ x 3/16 angle; to the opposite face at the ends is riveted similar sized angles which furnished the connections for fastening the respective ends to the center sills and to the side sills such a cross bearer would have an inertia about an axis through the center of gravity of the greatest section of 876, and is as strong as the pressed-steel cross bearer and 26.9 per cent lighter, by its use on 1,000 cars with steel at $1.75 per pound the saving in material would amount to $2,800. This comparison is hardly fair to pressed steel as the cutting away of the upper flange of the diaphragm is a case of faulty design rather than a weakness of the pressed process.

Comparing the structural cross bearer with a pressed-steel cross bearer having a full flange gives somewhat different results. If the structural cross bearer be built with ¼ covered plates instead of 3/16 inch, the inertia of the greatest section about an axis through the center of gravity is 1,169 with a weight of 122 pounds. Such a structural cross bearer would be 19.5 per cent lighter than the pressed one and 7.8 per cent stronger. The saving on material alone on 1,000 cars would amount to $2,000.

There are a great many different kinds and types of pressed steel undrframes which have been used for various types of cars. The drawings shown in figure 5 illustrate a common, successful type and a suggestion for a substitute structural steel center and side sills. In every case the inertia of all sections, is taken about an axis through the center of gravity. First referring to the side sill you will note that the inertia of the pressed sill is 691 at the deepest part, at the bolster 126, with the least radius of gyration of 3.32, the area of the section at the bolster is 11.39 square inches and between the trucks 14.86 square inches and weighs 1,497 pounds.

The substitute structural side sill as illustrated has an inertia between trucks of 742, at the bolster 148, with the least radius of gyration of 3.84, area of bolster section 10.04 square inches, of deepest section of 12.79 square inches and would weigh 1,445 pounds.

The pressed center sill has an inertia between trucks of 1,416, at the bolster of 272 with a least radius of gyration of 3.84. The

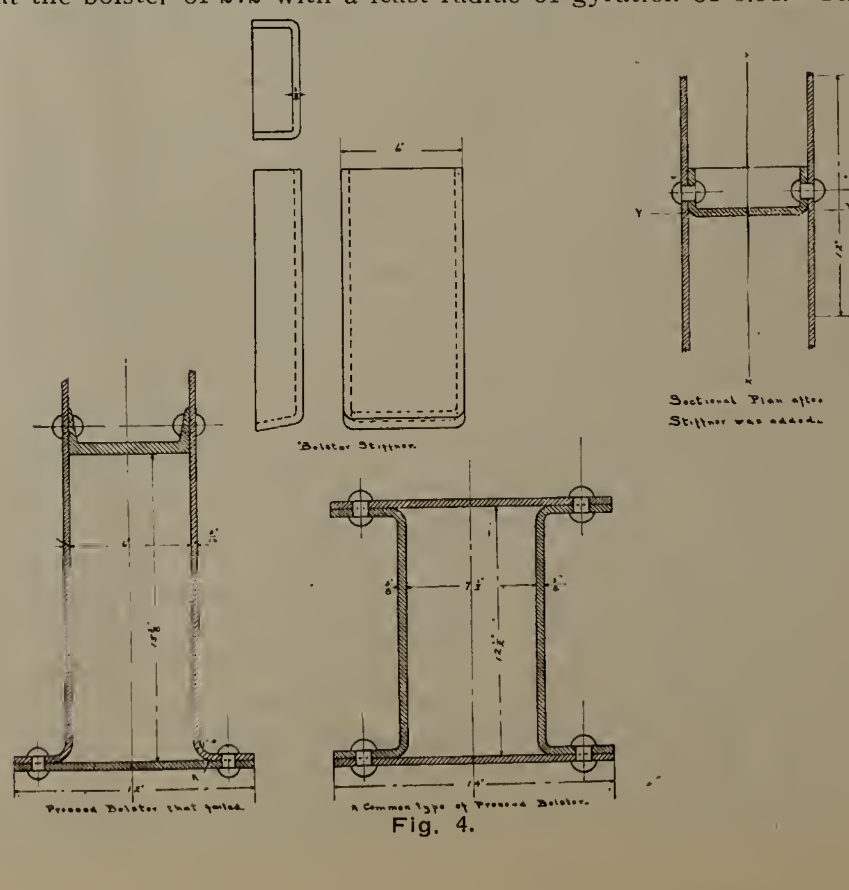


Fig. 4.

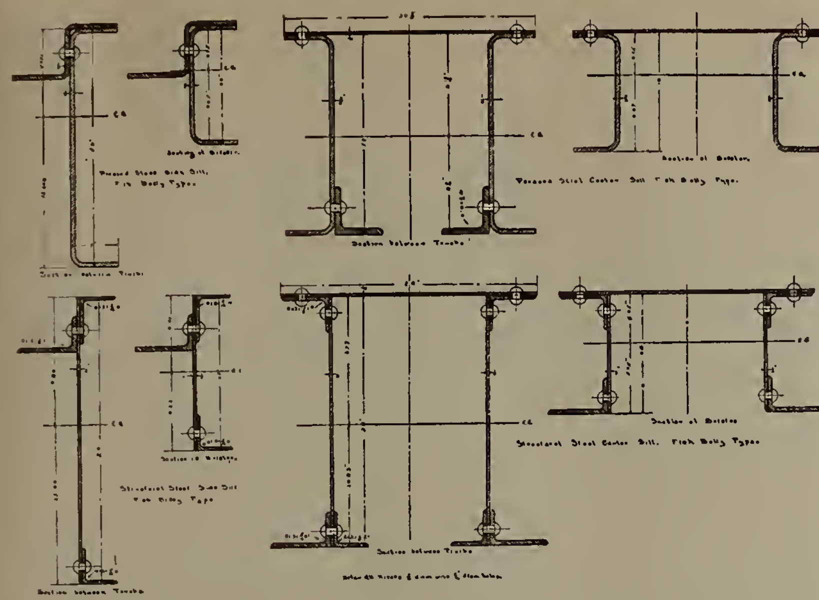


Fig. 5.

area of the section at the bolster is 18.14 square inches and between trucks of 30.92 square inches and will weigh 2,927 pounds.

The proposed substitute structural steel center sill has an inertia between trucks of 1,629, at the bolster of 283 with a least radius of gyration of 4. The area of the section at the bolster is 17.61 square inches and between trucks 25.56 square inches. The weight of this still would be 2,518 pounds.

As illustrated, the structural side sill is 3.4 per cent lighter than the pressed side sill and is 2.5 per cent stronger between trucks and 26 per cent stronger at the bolster. The structural center sill is 15.4 per cent lighter than the pressed center sill, is 8.5 per cent stronger between trucks and 13.4 per cent stronger at the bolster.

A car built with pressed sills as shown would probably be provided with about 14 cross bearers made from ¼-inch steel plate, 7 inches deep with 3-inch flanges. Such a cross bearer would require a piece of plate for fabrication 12 inches wide and 4 feet long. A cross bearer of these dimensions would have an inertia of 14.26 and a section modulus of 4.07.

The structural steel designer would use either a 6-inch or a 7-inch channel. A 6-inch channel has an inertia of 13, a section modulus of 4.3 weighing 8 pounds per foot, while a 7-inch channel has an inertia of 21.1, a section modulus of 6 with a weight of 9.75 pounds per foot. Personally, I believe the 6-inch rolled channel a better and stronger section than the 7-inch channel pressing.

For the purpose of illustration, suppose two underframes be constructed of the before-mentioned sections. One of pressed steel and the second one of structural sections. From the data already before you it is evident that with proper fastenings the structural underframe will be capable of sustaining a somewhat larger load than the pressed-steel underframe, and owing to the greater depth of girders will have less deflection.

Granting that these are facts, the question naturally arises what is to be gained by replacing well-established practice by a newer and less used form of material.

A railroad is an instrument for making dividends; the size of the dividends depends upon the difference between receipts and expenditures; a factor of the expenditure is the cost and maintenance of equipment and the cost of hauling the equipment over the road; both of these are directly dependent upon amount and weight of the material entering into the construction of the car, plus the cost of fabrication.

Without going into too many details I am assuming that the small connections and minor details are alike on both underframes. On the structural underframe, web stiffeners which form the connections for the cross bearers and extra rivets over the corresponding pressed members are taken into consideration.

The pressed steel underframe parts as illustrated will weigh complete 6,489 pounds. The corresponding structural sections as shown will weigh 5,959 pounds. In other words the structural underframe parts are 8.1 per cent lighter than the pressed-steel underframe parts or inverting the ratio, the pressed-steel underframe parts are 8.9 per cent heavier than the corresponding structural parts. With steel at $1.75 per pound on 1,000 cars the money difference on material amounts to $9,725. In addition to the saving on material, there is also a reduction in shop costs due to cutting out the press work and the associated expenditures.

Of course the pressed-steel advocate will come back with the time-worn argument that the structural construction requires about 50 per cent more rivets, and rivets must be shunned whenever possible. There is no doubt about structural construction requiring more rivets, but I fail to see any argument against structural steel for that reason. All parts must be fastened together with rivets whether they are made from pressed steel or from structural steel, and the larger part of these rivets must be driven by hand hammers. In fabricating the structural units the riveting will all be done by hydraulic riveters and under any predetermined pressure. Driven in this manner they will surely long outlast any hammer driven rivets used to fasten pressed-steel car parts together. These items principally affect the first cost which is incidental and only a factor in the choice of type. In addition to the first cost, sight must not be lost of the constant use of money due to repairs to keep the cars in service. The structural car is much more easily repaired and no more subject to breaks as a result of abuse.

Another good example of pressed-steel construction is shown in Figure 6. In order to make economical use of the material the pressings have been reinforced at the outer edges. When pressed steel is reinforced in this manner, I fail to see the argument for the use of pressed steel. To my mind this construction completely knocks the pins out from under the pressed-steel proposition.

The lower drawing in Figure 6 shows a structural substitute for pressed construction. This comparative design of center sills is a good illustration of the greater flexibility of structural steel. On car work the designer is handicapped by the restriction of the depth of the center sill over the trucks. Structural steel has so much greater range of combinations that pressed steel must be at a disadvantage at this point.

Any one connected with the operating end of a railroad realizes the desirability of having cars which do not drop at the end sills. Structural steel better meets the requirements at this point that any other material yet used for the purpose and with use of somewhat less material.

A complete car of the design shown would probably be

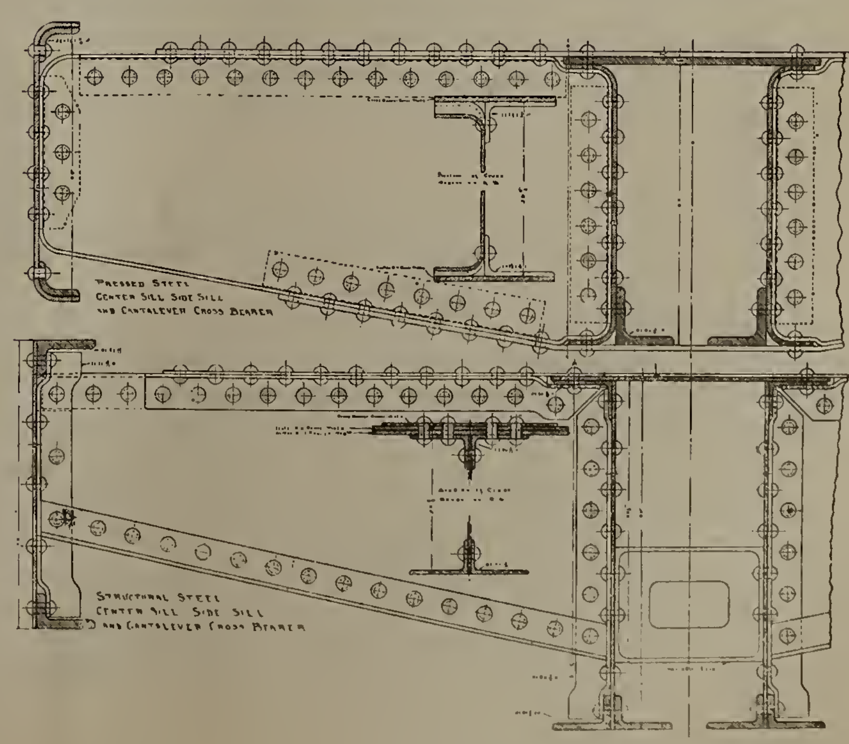


Fig. 6.

equipped with eight intermediate pressed cross bearers about 9 inches deep with 3-inch flanges and over the truck wheels four more about 6 inches deep. The former would have a section modulus of 9.9 and the latter of 2.1. There are no channels which exactly meet these pressing in strength. An 8-inch, 11.25-pound channel has a modulus of only 8.1; a 9-inch, 13.25-pound channel has a modulus of 10.5, or 6 per cent too large. A 4-inch, 5.25-pound channel has a modulus of 1.9 and a 5-inch, 6.5-pound one has a modulus of 3, or 18 per cent too much. I have chosen to use on the hypothetical car respectively a 9-inch, 13.25-pound and 5-inch, 6.5-pound channel. The remaining parts of the two cars are supposed to be of equal weight.

For the most advantageous use of material, car builders need a special channel with wide flanges similar to the ship channel but of lighter section. A united effort of the car purchasers could undoubtedly prevail upon the steel mills to produce about five sizes of such channels to cover different conditions of use.

For car builders' use I would suggest a series of channels with 3-inch flanges, having all other dimensions the same as the standard channel now universally rolled and having a depth of 5, 6, 7, 8 and 9 inches. Such a series of channels would give ample bearing surface for stringers and sufficient flange width for bolt holes without much reduction in strength due to the removal of material for the bolt.

To return to the car before us, the total weight of parts shown and mentioned on the pressed-steel car is 12,287 pounds, for the structural 11,630, or the pressed-steel parts are 5.6 per cent heavier than the structural parts. In money this amounts, at 1.75 cents per pound, to $11,498 on 1,000 cars.

Even with the angle stiffeners the use for car work of so thin a web plate is open to criticism, and the next slide shows a structural substitute for the last pressed car which will weigh practically the same as the pressed car and conforms more nearly to the standard practice of American construction.

Pressed steel to the average man simply means that an article has been fabricated from sheet steel and the chances are that he never thinks of the means or methods by which such fabrication is accomplished. To the car man it always raises the question, has the article been hot pressed or cold pressed? Both processes are constantly used and the choice of method depends partly upon the size and shape of the steel from which the final article is to be produced and partly upon the completed object itself.

The cold working of metals has a decided effect upon their physical characteristics. The most common examples are wire and the twisting of square rods for reinforced concrete construction. In both instances there is an internal change in the molecular condition which increases the tensile strength although the elastic limit must be excelled in each case. This increase in the tensile strength is obtained by a reduction in the ductility and a consequent reduction in the elongation.

Upon large hydraulic presses the car builder depends for pressing of sheet metal into shapes for the erection of cars. Before you is a picture of the latest development of this type of machine, having with the accumulator a capacity of 1,000 tons. Such a machine is used for only the heaviest class of work, handling both hot and cold sheets.

One of the most difficult of the cold pressings for car construction is the shaping of side and center sills. These pieces are about 40 feet long and pressed in three operations. It is in keeping these three changes in line in order to produce a straight sill that the skill of the pressman is taxed. Of course operations on pieces of this length are done cold, and the question naturally arises: does the performance of this work have any effect on the strength of the completed piece? In our youth and in emergencies we have all broken a piece of wire by bending it back and forth. The first time the wire was bent corresponds to the operations performed to shape a sill. Does the effect on the sill correspond to the drawing of the wire, or to the youthful expedient to sever it? Personally I think the analogy is closer to the latter condition.

The dies for both cold and hot pressings are made from cast iron with an occasional one having steel wearing strips. The rapidity of wear of pressing dies is surprising to one unfamiliar with the process, and owing to their cost they are used often times longer than they should be. In other words the pressings are allowed rather large limits of error.

In hot-pressed work there is still another factor which introduces an element of uncertainty respecting the size and shape of the finished product. Allowance must be made for the shrinkage of the pressing after being shaped in the die. If the normal temperature to which the plates are heated before pressing be 1,500 degrees Fahr., a cross bearer 4 feet long will decrease in length on cooling .468 of an inch, practically $\frac{7}{16}$ inch. If some of the plates be heated to only 1,000 degrees Fahr., the contraction would amount to only .312 of an inch. Or if the plate be heated to 1,800 degrees Fahr. the decrease in length amounts to .561 of an inch. In other words, there is the possibility that four-foot pressing will vary ¼ inch simply by the difference in the temperatures to which the plate is raised before pressing; now add the error due to wear of the dies and you have the maximum error.

That this variation is not all on paper can easily be verified by a visit to the erection shop. Here you will find husky foreigners wielding 20-pound sledges to bring shapes together which have a tendency to part company. The sledge is surely an effective persuader, but what does it do to the strength of the material?

The foregoing remarks have been directed solely upon the car designed to carry 50 tons or more for a load. For cars of less capacity the advantage of structural shapes is even more marked. Cars built to carry 40 and 30-ton loads can safely be designed with center and side sill fashioned from standard rolled sections without additional cost save for punching.

The actual loss of steel plate and of pressmen's labor, due to tearing of the steel in the dies is a large item and not fully appreciated unless one is actually associated with the production. This loss to be sure is generally when the dies are first tried and few pieces are spoiled after the work is well started, but somebody must pay for whatever loss there may be, and I know of no car builder who is in the business for fun.

It often happens that a railroad wishes quick delivery of cars and here the advantage is entirely with the structural car. The breaking of a single die will often hold up the track for two or three weeks with resulting loss to the car manufacturer and inconvenience to the purchaser of the equipment.

For some purposes and for some car parts nothing can probably be found to equal or to replace pressed steel, and I do not wish to be understood as going on record as an opponent of pressed steel for all conditions of service or for all uses. What has been noted in connection with freight cars respecting cost of dies and use of pressed steel can be applied to passenger car construction with even greater force. I have in mind one order of passenger cars where it took 200 tons of metal for the dies, with the usual expenses incidental to preparing work for the foundry and an unusual amount of machine work after they came from the foundry, but in spite of that, many parts can be better designed from pressed steel than from any other material, and it is useless to look for a substitute.

In making a decision between the use of pressed steel and structural steel the following considerations must enter into the discussion:

Structural steel can be purchased at the same price as plate steel.

From structural steel a car can be built of equal strength to the pressed steel car and of no greater weight, and if properly designed will even weigh less.

The actual labor cost of erection is no greater than with pressed steel.

The structural car stands abuse equally well, is more easily repaired and therefore maintenance is less.

In addition to the first cost of steel which is practically alike for both types of cars, to the cost of the pressed car must be added the interest on the investment for presses, for furnaces and auxiliaries, the cost of maintenance of the same and of high water pressure mains and oil mains, the cost of running the pumps for both services, the labor of the pressman, the foundry cost for making dies, the machine-shop labor, interest on machine tool equipment and maintenance of same, the patternmaker's time and cost of lumber for patterns, the expense of producing die drawing and an increase of the general expense due to the added equipment and the large floor area devoted to presswork and allied industries.

Some pressing must be done for structural cars, but it is so small in amount and can be so largely done on bull-dozers that it need not be considered as a separate item of any great moment.

Personals

C. W. Van Buren has been appointed the master car builder of the eastern lines, Canadian Pacific Ry. His office is at Montreal.

J. M. Burke has been appointed district master mechanic of the Atlantic division, Canadian Pacific Ry. His office is at Brownsville Jct., Me.

F. F. Patterson succeeds F. W. Bailey as a district master mechanic, western division, Canadian Pacific Ry., office at Moose Jaw, Sask.

Chas. Schneider succeeds W. J. Leonard as the master mechanic of the Florida Ry., with office at Alton, Fla.

At a meeting of the board of directors of the Illinois Central R. R., held in New York, March 7, 1910, W. L. Park was elected vice president with headquarters at Chicago. He has charge and supervision of the transportation, maintenance, motive power, construction, purchasing and pension departments.

F. S. Anthony, a master mechanic of the International & Great Northern R. R., has been promoted to superintendent of machinery, with office at Palestine, Tex.

J. J. Sheahan succeeds F. S. Anthony as a master mechanic of the International & Great Northern R. R. with office at Palestine, Tex.

D. B. McKenna succeeds W. E. Looney as the foreman of the car department of the International & Great Northern R. R. with office at Palestine, Tex.

R. M. Luse has been appointed the master mechanic of the Jamestown, Chautauqua & Lake Erie Ry., with office at Jamestown, N. Y.

John Horton succeeds F. B. Haynes as the master mechanic of the New York & Pennsylvania Ry., with office at Canisteo, N. Y.

W. B. Gaskins temporarily succeeds J. H. Race as the master mechanic of the Oregon Short Line R. R. with office at Pocatello, Idaho.

W. A. Cary has been appointed superintendent of shops of the South Georgia & West Coast Ry., with office at Quitman, Ga. He succeeds C. E. Croom who held the title of master mechanic.

As noted above, J. J. Sheahan has resigned as master mechanic of the Southern at Knoxville, to become division master mechanic of the International & Great Northern at Palestine, Tex. This occasioned several changes on the Southern. N. N. Boyden was transferred from Atlanta to succeed Mr. Sheahan; George Akans from Birmingham to Atlanta to succeed Mr. Boyden, andw E. M. Sweetman from Sheffield to Birmingham to succeed Mr. Akans. F. J. Johnson, general foreman at Knoxville shops, was appointed master mechanic, succeeding Mr. Sweetman, at Sheffield, and E. L. Chollman, general foreman at Greensboro, N. C., was transferred to Knoxville with the title of shop superintendent.

R. G. Cox succeeds A. J. Dunn as the master mechanic of the Virginia & Southwestern Ry., with office at Bristol, Tenn.

New Literature

The Rockwell Furnace Co. of New York has issued catalogue No. 8 dealing with forge shop furnaces, operating on oil or gas fuel.

* * *

The 1910 "Blue Book" of the Scully Steel & Iron Co., Chicago and New York, is a well gotten up catalogue of all the "Scully" products and is worthy of a place on the desk of any person interested in them. It is about 4½x7 inches in size and is bound in a flexible, blue leather cover, making it very convenient as a book to be carried in the pocket.

* * *

The Standard Electric Time Co., of Waterbury, Conn., has issued catalogue 32, which sets forth the very complete line electric time systems, master and secondary clocks, tower clocks and time stamps manufactured by this company.

* * *

The Adams Company of Dubuque, Iowa, has issued a number of circulars, with a suitable binder, dealing with squeezers, universal molding machines, snap flasks, grinders, milling attachments and gear hobbers.

* * *

Fairbanks-Morse & Co. of Chicago has recently put forth two very attractive catalogues descriptive of the marine engines manufactured by this company. Catalogue 112B deals with the heavy duty, four-cycle type, while catalogue 113 takes up the two-cycle engine. The latter engine is especially adapted to launches and power boats and is built with from one to six cylinders. The heavy duty engine is a very carefully built and tested engine and is reliable to a high degree.

Among the Manufacturers

DECALCOMANIE LETTERING.

A new method of lettering cards, signs, etc., has been developed by Palm, Fechteler & Co., of New York, which has been called "Decalcomanie." The use of this method has become fairly well known in small sign work but the idea of using it for larger work is new. This lettering is made with aluminum leaf over which is painted the gold color. The finished work is nearly the same, as far as looks and service is concerned, as gold leaf work.

Locomotive cabs and tenders, it is said, can be decorated by this system of lettering quicker and better than by means of hand work. In appearance, the work is usually somewhat better than hand work, as the letters are furnished with a clean cut black edge. The application is simple and does not require expert work.

COLLAPSIBLE STEEL HORSE.

An interesting collapsible steel horse or trestle has recently been placed on the market by the S. M. Hildreth Company, 2 Rector Street, New York.

The horses are made in several sizes of angle iron throughout. They are strong, rigid and are not easily breakable. The collapsible feature is a valuable one where space is limited, as in storage they take but little room. The light weight is a feature which appeals to the machinist or wood worker.

CAMPBELL GRAPHITE LUBRICATING SYSTEM.

The Campbell Graphite Lubricating System, shown in the accompanying illustration, was patented by a locomotive engineer on the Iron Mountain System, and is now controlled and marketed by Adreon Manufacturing Company, of St. Louis and Chicago. The merit of the device caused its sale by the patentee, while regularly engaged as a locomotive engineer, to sixteen railroads and it is now in liberal use by forty railroads, over 1,000 engines having been equipped. Briefly, this system assists the value oil in producing an easier working engine. The frictional surfaces of valves and cylinders are to some extent rough, under which conditions the valve oil cannot be expected to perform its full function. Graphite fills up the small imperfections, glazing over the surfaces and rendering easier the operation of the reverse lever. It is an unquestioned fact that a properly lubricated machine will produce the maximum power for the coal burned. The cup shown in the illustration is bolted to the boiler in the cab and operated by the engineer. He has at all times control over the quantity of graphite to be used. The Campbell system has been tested out very carefully under all conditions and its use effects a very important saving by reducing wear and tear on valves, pistons, cylinders and packing, in addition to reducing the consumption of valve oil. The Adreon Manufacturing Company is willing to furnish one or more of these devices for test and can submit to mechanical officials letters bearing on the merit of the device.

The application is as follows: A cup holding about one pound of graphite is placed in the locomotive cab, convenient to the engineer, and is connected up by means of a ⅜-inch pipe with main reservoir. Another ⅜-inch pipe extends from cup to special dividing tee to be located directly back to the center of cylinder saddle, from which ¼-inch pipes extend, and are tapped into each relief valve. In case the engine has no relief valve, tap the oil plug on top of the chests and connect the ¼-inch pipes, putting a check valve as near to the oil plug as possible in order to avoid back pressure. With the lever handle in running position a charge of about one-half teaspoonful of dry graphite is projected to the valves by shifting the handle from running to charging or application position and on the return of handle another application can be made immediately if desired.

Campbell Graphite Lubricator.

When beginning the use of the Campbell system, three or four applications should be made for every 30 miles for a period of 10 days. After several trips the wearing surfaces will be well glazed, when one application every 40 to 50 miles should suffice to keep the valves and cylinder in smooth condition, and enable the engineer to handle the reverse lever with about half the usual effort and with half the usual consumption of valve oil.

Double Circular Saw.

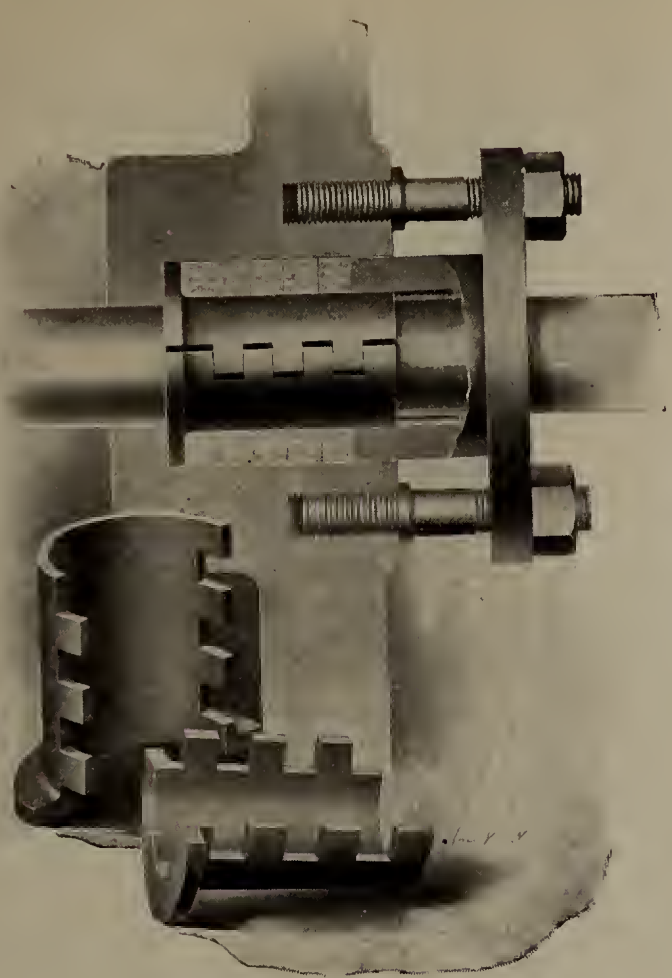
DOUBLE CIRCULAR SAW.

A very useful tool, especially good in the pattern shop of the car department on railways, is made by the J. A. Fay & Egan Co., of 145-165 W. Front St., Cincinnati, Ohio. It is a combined ripping and cross-cutting machine, constructed on lines distinctly different from other machines of the same kind. Both saw arbors are carried on a revolving frame, and it is easy to take off or put on saws without disarranging the table. Two saws up to 16-inch diameter, one on each arbor, can be carried at the same time and the frame revolved, or if only one saw is used, it may be as large as 20-inch diameter. The table is made in two sections, a moving sections 44x16 inches moving easily on frictionless rollers, and a stationary section 44x20½ inches, the latter having an extension so that material up to 20 inches in width can be ripped. The moving section of the table has sufficient motion to edge or cut off material up to 35 inches and will open to permit the use of a 2-inch grooving head. The whole table can be tilted by a hand wheel to an angle of 45 degrees from the saw.

A gauge registers the angle to which the table is tilted. The ripping fence may be set to take stock up to 20 inches wide and used on either right or left section of table; a micrometer adjustment is provided on this fence, which is used when certain adjustments are too fine to be made by hand. The miter cut-off fence is used on the sliding table and covers a range from 45 degrees back of the fence to 60 degrees in front. This fence is furnished with a stop-rod, to be used for stock of various lengths. This saw is one of the latest productions of the shops of the above named firm.

UNIVERSAL FLEXIBLE PACKING.

A new flexible rod packing well adapted to locomotive works is shown in the accompanying illustration. The packing is made of a special anti-friction metal. A description and method of application is essentially as follows:



*Universal Flexible Packing.

Universal flexible packing is composed of a metallic tube or sleeve to engage around the rod within the stuffing-box, and is formed of two like semi-circular sections, provided with interlocking tongues or lugs, which are capable of yielding circumferentially to take up wear, contraction and expansion by means of play or clearance at the tongue extremities and also capable of preventing possible leakage of steam, air or water by interlocking or closely engaging laterally. The tubular section is compressed around the rod by soft or fibrous packing, surrounding the same within the stuffing-box, and is held in contact with the rod by the pressure of the gland extension against the soft packing, which forms a perfectly steam, air and water-tight joint capable of being maintained for a very long period of time with little or no attention, and which can be applied to any kind of stuffing-box without alteration or inconvenience, and without disconnecting any parts. Each of the tube sections is provided at the inner extremities with a small shoulder or flange to engage the fibre packing and prevent possible displacement by the pressure acting endwise on the metallic sections. It is always best to tighten the packing up with a wrench when first applied in order to properly set it, and then ease off until finger tight.

The packing is made by the Universal Flexible Packing Co., Pittsburg, Pa.

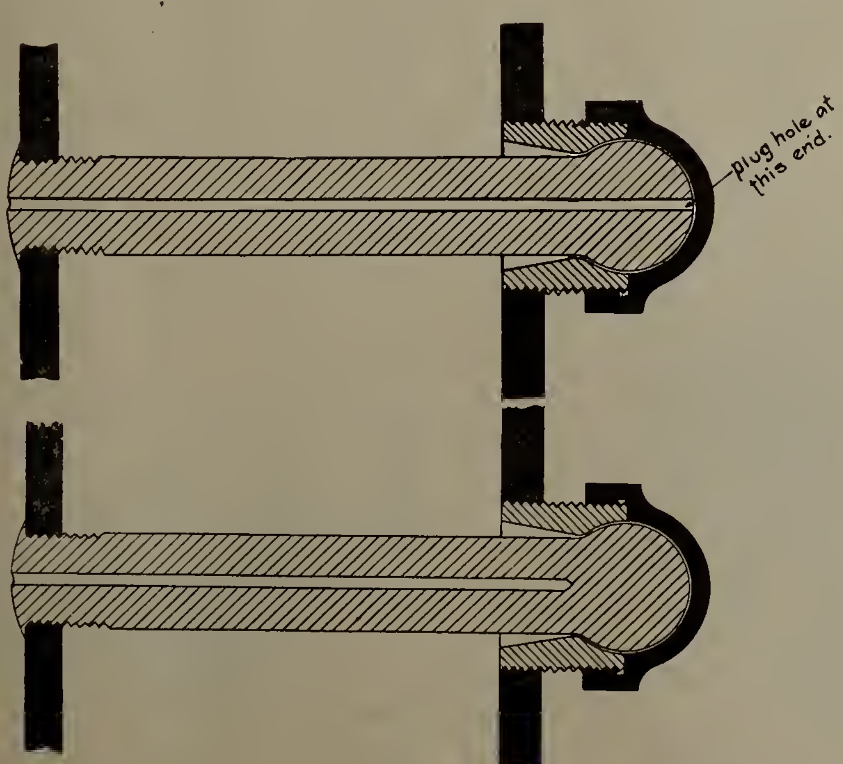
COMBINATION FLEXIBLE AND HOLLOW STEM STAYBOLT.

By John Hickey.

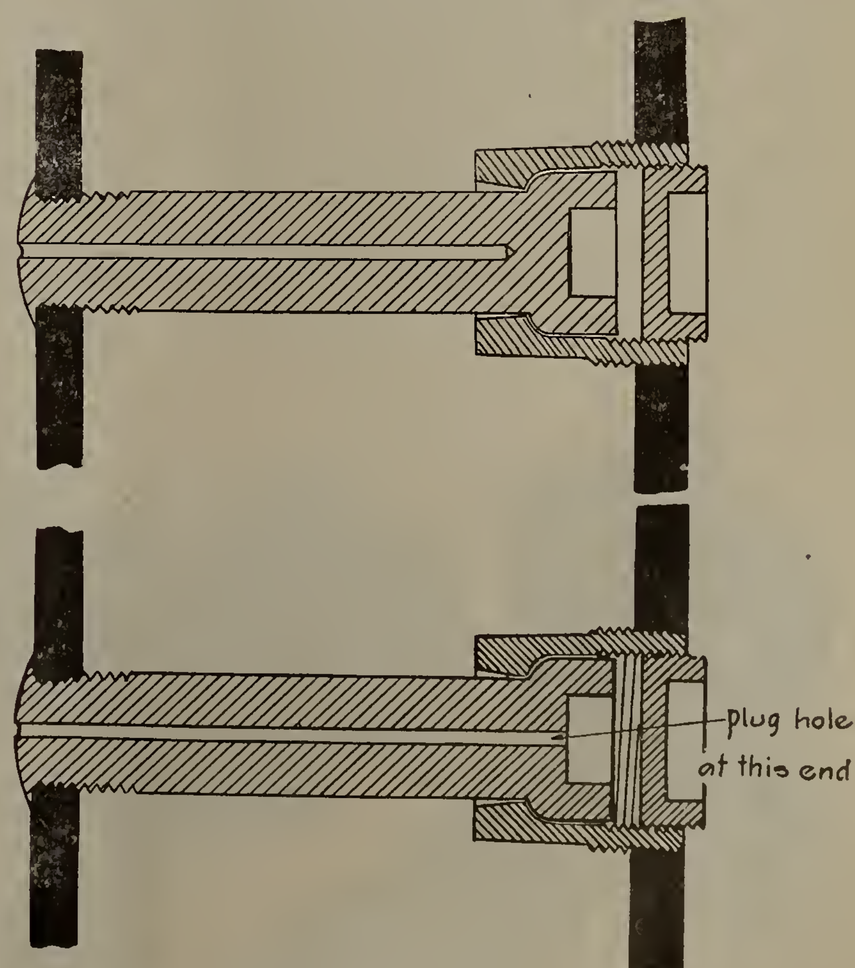
The purpose of the inventors of flexible bolts to arrange a staybolt attachment at the outer sheet, which would, without straining the metal, respond freely to the expansion and contraction movement of the inner or fire sheet, is commendable, but we must not overlook the fact that any influence interfering with or retarding the free movement of the head would immediately convert it to the condition of a rigid stay. In other words, the vibratory strain would be thrown on the metal as in the ordinary staybolt.

The formation of scale or the precipitation of other impurities in the water is liable at any time to interfere with the free action of the flexible head and thus bring about rigid conditions which it is desirable to avoid. It is, therefore, quite as necessary that the flexible stay be covered by regulation staybolt inspection, the same as the solid bolt, and as a measure of safety, this point should not be neglected.

It is impossible to detect broken flexible bolts by hammer sound, owing to the style of the flexible head attachment to the outer sheet. This leads to the necessity of removing the caps covering the heads in order to determine those actually broken. Removing and replacing those parts for the purpose of inspection means much labor and expense and is likely to cause delay to power. To avoid this trouble the hollow staybolt iron is recommended to be used for the stems of the flexible staybolts. Both service and laboratory tests have repeatedly demonstrated that the hollow-rolled iron possesses over 50 per cent greater endurance than solid iron, and if introduced



Falls Hollow Stem in Connection with Tate Flexible Stay.



Falls Hollow Stem in Connection with Acme Flexible Staybolt.

in connection with the flexible head, it will not only add to the life of the stay, but will in itself completely solve the question of inspection. With the use of the hollow stem a fully broken stay will not only be readily disclosed, but a fracture amounting to one-half its diameter will promptly make itself known.

STANTON COACH AND WINDOW WASHER.

A window and coach cleaner which combines a bristle brush with a sprayer is manufactured by Geo. R. Stanton, 1302 Main St., Decatur, Ill. The device consists of a brass or copper tied bristle brush through which is entered a patent brass sprayer. The sprayer is attached to a cold drawn steel tube handle with a ground water valve and hose connection at the lower end.

In operation the handle is attached to a hose leading from the hot or cold water supply. The water passes up through the handle and is prevented from running back down the handle into the sleeves of the operator by a specially designed gooseneck at the sprayer. The water can be regulated, of course, to merely dampen the surface or to thoroughly flush it. The handles are supplied in any length and they are said to be as light and convenient to handle as are those made of wood while they are much more durable.

AMERICAN GRAVITY COUPLING.

The American Gravity Coupling, a tender hose connection shown in accompanying illustration, is controlled and marketed by the Adreon Manufacturing Company of St. Louis and Chicago, and has met with a remarkably quick recognition by motive power officials. It can be coupled and uncoupled instantly, and cannot be injured, as it guides itself into position when started. It has the same binding force as a threaded union with the additional advantage that it will tighten with vibration, which is the reverse of the threaded type. It is provided with a strainer and the engine crew should not hesitate to clean the strainer when necessary, as it can be done at ordinary station stops . The coupling will last indefinitely as there are no threads to be stripped. All binding pressure is against a yielding rubber gasket which is round, and can be turned over when necessary, presenting a new face. The couplings are made of malleable iron galvanized, insuring durability. They are furnished in all sizes in common use on locomotives. This device has not been on the market over a year and is now purchased exclusively by several of the most prominent railroads after thorough investigation and test.

Tank Hose Connection, Gravity Coupling.

PAINT FOR STEEL STRUCTURAL WORK.

Engineers have almost abandoned the idea of using any material other than steel for bridges and towers. Railway officials are constructing steel box cars, passenger coaches and mail cars, almost entirely of steel, and, if it is not used in the body, the underframing and spans between the trucks are of steel, doing away with chains and wooden sills, which have been in use heretofore. This, of course, assures great strength, durability, and safety, as well as economy.

Many far-seeing men have anticipated just such a revolution in construction, because of the scarcity of timber and the great development of our steel industry. The use of improved machinery for shaping, shearing and punching the malleable material has also aided in this revolution. These same men who have led and encouraged the adoption of steel construction have been alarmed for some time as to a preserver for these perishable and expensive structures. They know that it is imperative, that it receives, both at the shops and after completion, a coating of some kind, that will arrest and prevent rust. This coating must be nearly as durable as the steel upon which it is applied, must be very flexible, must contract and expand as well as withstand all climatic conditions, sulphurous fumes and gases. Such a material must be had, otherwise the expensive work would be a failure and would add a most dangerous condition of an all important structure.

After years of experience and experiment, directed by the best paint manufacturers, it is said that nothing has ever been discovered that is a better preserver than red lead mixed thoroughly with the best aged linseed oil, although imported Ceylon graphite, ground and cut for the brush with pure oil, has been a strong competitor of the lead pigment. These paints may be dried with any good Japan dryer where quick drying is necessary, but it is rarely that outside steel structural work demands a quick drying paint if any durability is to be expected from such application.

It has been proven that the best pigments, such as white lead, red lead, or the best oxide of any color or kind, whether mixed in oil, or ground, can only last during the life of the vegetable or linseed oil, namely. Tests of from three to five years have proven this beyond question; at the end of that time, such paint begins to crack, part and disintegrate generally, because of the loss of the binder. The binder in paints has caused the greatest trouble as to its durability and preserving qualities; all vegetable oils contain an acid and are more or less destroyers causing rust to set up after disintegration, by allowing the oxygen to enter through the cracks and crevices to combine with the indestructible acid which the oil contains.

Now there is endless proof that any and all paints in which linseed oil is used as a binder perish. Many substitutes have been presented, but none has ever proven as good as linseed oil, so the paint heretofore mentioned has given the best satisfaction up to date.

Of late, a paint manufactured by a peculiar and strange process has come to notice. The pigment of this paint is composed of pure pig lead from the mines—not red or white lead, but lead converted into a flour of the finest grade, and flake graphite, floured in a ball mill. This mixture is amalgamated with other unknown ingredients and converted into a solution at from 300 to 350 degrees F. by great agitation in a mill of large capacity. During this process each and every ingredient composing the pigment seems to loose its identity and a new substance is formed which resembles sheet lead. However, it is the oil or binder used with this paint which is of the greatest importance. This oil is made by dissolving the purest carbon into a solution and is non-inflamable; pigment being suspended in this

Smith Hose Clamp Tool.

material so that it may be carried in the brush when applied. It is as durable as the pigment itself, will carry the different colors, such as olive green, maroon or slate color, and in applying the pigment the oil remains on top, and any color which may be desired floats on this oil, but under all circumstances the metallic pigment adheres to the steel magnetically and cannot be removed or destroyed by gases, sulphurous fumes or chemicals of any kind. If the color is removed the bright metallic finish appears, which is proof of the metallic coating.

Steel coated with this paint has been subjected to the greatest destroyer of paints or steel and the steel was entirely destroyed while the paint remained in perfect condition, showing a rubber or cloth like sheet, where the steel had been entirely eaten away. Fire has been built upon wood and cloth painted with this material, and afterward there were no signs of flash, a perfect shield impervious to oxygen being formed over the wood and cloth.

This paint can be used to advantage for the preservation of wooden bridges and ties, especially in hot districts where they are so apt to be fired by sparks from a locomotive. The Rabok Manufacturing Co. of St. Louis, Mo., is the maker of this paint, and it seems to have kept up and anticipated great strides of progress and improvement. The paint was produced after years of experimenting to fill the wants of the government in the preservation of the gun carriages, wharfs, piers and submarine boats, where it is now being used.

NEW DEVICE FOR CLAMPING HOSE TO FITTINGS.

The clamping of air brake, steam and air signal hose to its fittings is a source of considerable expense in shop and yard repair work. Several elaborate and efficient machines have been designed and placed upon the market for the purpose of cheapening the operation. But in every case these machines are designed for the purpose of cheapening the operation of present style clamps only.

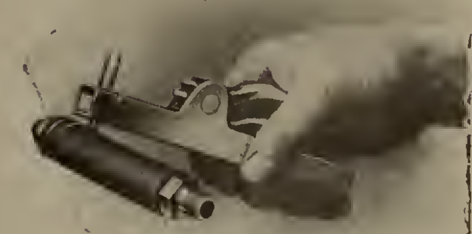
T. B. Burnite.

A tool has been designed and placed upon the market by the Burnite Machine Company, of Denver, Colo., which not only performs the clamping operation, but it manufactures, at the same time, a cheaper and more efficient clamp. The device is so simple as to cause considerable comment. Its use has caused greater comment—all in its favor. It has been adopted by the Denver & Rio Grande, Colorado & Southern, Denver, Northwestern & Pacific, and the Denver Tramway Company. While only in the market a short time, the tool has been purchased in quantities by the above railroads, which, it will be noted, have mechanical headquarters in or near Denver. It is only in this territory that the tool has been demonstrated. The manufacturers are willing to send a tool for trial purposes to any railroad interested.

The operation of the tool is shown in the accompanying illustrations. No. 14 wire is cut into 10-inch lengths (with the tool) and is formed by a "U" by one operation of the handle. The shaped wire is then placed about the hose and gripped by a cam. A pressure on the handle then draws the ends through the loop and another operation cuts them off. The tool is used on any sized hose and weighs about three pounds. The price is set at $5.00 each with a liberal discount for cash or quantities. It is suggested that while the tool will find its principal field in the repair shop, car inspectors would find daily use for it.

Forming the Wire.

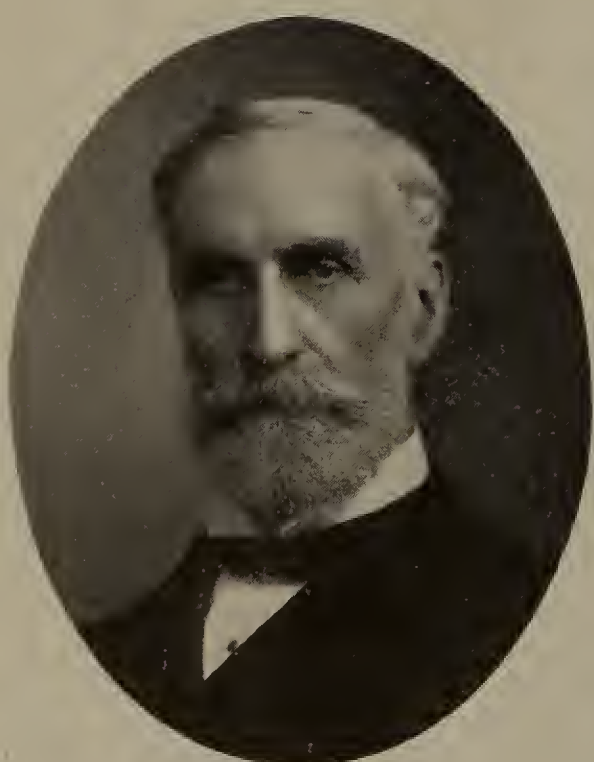
Bending Ends After Tightening.



Cutting Off Ends After Clamping.

TO DIE NO MORE.

As previously reported, Fayette Brown, known in Cleveland and throughout the United States as one of the most successful manufacturers and iron operators in the country, died January 20th, at his home, 3210 Euclid Ave. Since last June, Mr. Brown had been in poor health, suffering from the effects of a heat prostration. He was eight-seven years old, but up until his last illness had retained an active interest in many of Cleveland's largest manufacturing establishments. Mr. Brown had been a member of the firm of Mygatt & Brown, bankers, general manager of the Jackson Iron Co., president of the Union Screw Co., of the Brown Hoisting Machinery Co., National Chemical Co., G. C. Kuhlman Car Co., chairman of the Stewart Iron Co., and a member of the firm of H. H. Brown & Co., iron ore dealers. He was also a director of the Cleveland Trust Co., and the National Commercial Bank. In the social life of Cleveland, he was prominent; a member of the Union Club, the Golf and Country Clubs, president of the Castalia Sporting Club, the Winous Shooting Club, the Point Mouillie Shooting Club, the West Huron Shooting and Fishing Club and the Munising Trout Club. He was born in North Bloomfield, Trumbull County, Ohio, Dec. 17, 1823. He was the son of Ephraim Brown, one of the first settlers in Bloomfield township. He was one of nine children, and was educated in the public schools of Gambier, Ohio, and later attended Jefferson College, Pennsylvania. His first venture into the business world was at the age of eighteen, when he secured employment as a clerk in a dry goods establishment of an elder brother in Pittsburg. In 1845 he became a member of the firm. He came to Cleveland in 1851, as a member of the firm of Mygatt & Brown, bankers, in which concern he had previously become interested. In 1857, Mr. Mygatt retired from the firm and Mr. Brown conducted the business until the outbreak of the Civil war in 1861. He then accepted an appointment as paymaster in the Union army, resigning in 1862 with the rank of major. Returning to Cleveland he became general agent and manager of the Jackson Iron Co. While spending a vacation at the Castalia Sporting Club, near Castalia, O., last June, Mr. Brown was taken suddenly ill, suffering of heat prostration. He was hurried to Venice and brought to Cleveland on a special train. Members of his family last night said he had never recovered from the effects of this illness. Mr. Brown is survived by two sons, Alex. E., who is vice president and general manager of the Brown Hoisting Machinery Co., and H. H. Brown, of H. H. Brown & Co. He also leaves two daughters, Misses Florence C. and Mary L. Brown, both of Cleveland. Mrs. Cornelia Brown, to whom he was married in 1847, died several years ago.



Fayette Brown.

THE SELLING SIDE.

C. C. Steinbrenner, who, as announced previously, was elected vice-president of the Galena-Signal Oil Co., February 10, was born in Cleveland, Ohio, on September 20, 1863, and was educated at the public schools of that city. From 1877 to 1880 he served as printer's apprentice in the German Baptist Publication Society of Cleveland and attended night school at the Spencerian Business College, where he studied bookkeeping and stenography under the founder of that system. In the spring of 1881 he was employed as stenographer and assistant clerk in the office of motive power department, C. & P. division of the Pennsylvania Railroad. On account of the removal of this office to Wellsville, Ohio, he resigned in the fall of the same year to accept a position as clerk in the office of the county auditor at Cleveland. In the spring of 1882 he returned to the C. & P. Railroad at Wellsville as assistant shop clerk, which position he resigned in the following September to become assistant clerk in the office of the superintendent of machinery, C. C. C. & I. Railway, at Cleveland. In 1885 he was promoted to be secretary to that official and stenographer to the general attorney of the C. C. C. & I. In 1890 he was moved to Indianapolis and promoted to be chief clerk, motive power department, C. C. C. & St. L. Railway. He resigned that position in May, 1893, and moved to Chicago to become chief clerk, motive power department, of the Illinois Central R. R. He resigned that position in the following December to accept the position of auditor railway department for the Galena-Signal Oil Co., which he held until his election to the vice-presidency on February 10th.

C. C. Steinbrenner.

Burton W. Mudge & Co., Commercial Nat. Bank Bldg., Chicago, advices that effective February 1st, 1910, it assumed the exclusive handling of the Garland ventilator, for both passenger and freight equipment, as well as the Garland heating and refrigerating appliances on the latter.

McCord & Co., Chicago, have purchased the window fixture and accessory business of the Grip Nut Co., Chicago, and will conduct the business in the future. All correspondence referring to these specialties should be addressed to the McCord Co., Old Colony building, Chicago.

Announcement has been made that the contract for the construction of the manufacturing plant and steam shovel works of the American Locomotive Company at Gary, Ind., has been awarded. The cost is to be $3,000,000. There will be twelve buildings and a power house. The company's site is a mile east of Gary and comprises 200 acres. The construction will begin within a few weeks. The plant when in operation will employ 3,000 men.

At a special meeting of the stockholders of the Pullman Company held on March 21 it was voted to issue $20,000,000 worth of new stock. The distribution will take place on April 30. When the new issue is out, it will make the total capital $120,000,000. The actual paid in capital of the company consists of $36,000,000 paid for in cash and $20,000,000 issued in exchange for the old Wagner company. In the last 12 years the stockholders of the Pullman Company have received in free stock and dividends, $151,966,365. The value of the stock is reckoned at average quotations. To make this last distribution of $20,000,000, the company had on July 31, a surplus of $9,995,918 and a reserve for depreciation of $8,808,848, making a total of $18,804,706. With accumulated earnings, no difficulty will be experienced in bringing the sum available for distribution up to $20,000,000.

The Browning Engineering Co., Cleveland, Ohio, is frequently called upon to furnish good operators for its locomotive cranes. At the present time the concern has more openings than men and wants the names of such operators as are available.

The Ward Equipment Company, New York, has found it necessary because of the volume of business to increase the floor space used for offices and warerooms. It has rented all the stores and offices at 139-143 Cedar street, which will be arranged for general offices and stock-rooms.

The William Cramp Ship & Engine Building Co. has announced that it has bought the Federal Steel Castings Co., of Chester, Pa. The purchase price was not given. The capacity of this works is 1,000 tons per month. The entire output will be furnished to the well-known ship yard in Philadelphia.

The United Equipment Co. has been incorporated in New York City to manufacture and deal in steel underframes, etc.; capital, $10,000. Incorporators, Louis H. Washburn, Hamilton M. Lewis, John Harshaw, all of No. 2 Rector St., New York.

Mr. Lewis L. Clarke has been elected a director of the American Locomotive Co. to succeed his father, the late Dumont Clarke. At the same meeting Mr. C. B. Denny, treasurer, was also elected secretary, vice Mrr. S. T. Calloway, resigned. Mr. J. O. Hobby, assistant treasurer, was also elected assistant secretary.

The Commonwealth Edison Co., Chicago, has bought 109 acres of land on which to build new generating stations. One or two stations are to be established at once; it is planned to build a group of stations to have a combined capaeity of about 350,000 horsepower.

The Cutler-Hammer Co., Milwaukee, Wis., makes a magnet with which steel cargoes are being rescued from the bed of the Mississippi river. A barge load of kegged nails is now being raised near New Orleans; a load of eotton ties near Natchez and a load of woven wire near Pittsburg will be raised later.

On May 1 the Griffin Wheel Co. will move its general offices from the Western Union building, Chicago, where they have been located since November, 1888, to the twelfth floor of the new McCormick building, corner Michigan avenue and Van Buren street.

Due to the fact that it is receiving many steel passenger equipment cars for use on its various lines, the Pennsylvania Railroad is to offer for sale a large number of its wooden passenger cars. The Pennsylvanian Railroad announced in 1906 that all future additions to its passenger equipment would be built of steel and since that time some 630 cars have been built or are in course of construction. In addition, about 250 cars will be ordered for 1910 delivery. With this large number of cars now on hand the company is able to operate solid all-steel trains on its lines of densest traffic and it is, therefore, possible to dispose of much of its wooden passenger equipment. The first consignment which is to be disposed of consists of 140 coaches, 13 dining cars, 5 cafe cars, 39 postal cars, 1 baggage car, 22 combined passenger and baggage cars, and 4 baggage and mail cars.

The Robins Conveying Belt Co. announces that arrangements have been made for the removal of its executive offices and sales, engineering and purchasing departments to the twenty-sixth and twenty-seventh floors and both towers of the Park Row building, New York. Its occupancy of the new quarters was completed March 12th, 1910. This suite is the one occupied by the company up to two years ago, when its general offices were removed to the works at Passaic, New Jersey, and a branch office opened in the terminal buildings at 30 Church street, New York. The office at the Church street address will now be discontinued and combined with the other offices in the Park Row building.

Richard C. Oliphant, president of the Trenton Malleable Iron Company, died at his home in Trenton, N. J., on March 4. He was born in Uniontown, Pa., in 1852. His family has been identified with the iron industry for many years, his grandfather having established the first hot blast furnace in this country. He is survived by his wife and two sons, Ross Gould and Donald Creigh Oliphant.

The A. P. Witteman Company, of Philadelphia, with works at Chester, Pa., has taken over the equipment of the Portsmouth Forge Company, Portsmouth, N. H. They will remove such of the equipment as they may be able to use at the Chester plant and will offer the remainder for sale. To accommodate the additional equipment plans are being prepared for a new forge shop and an addition to the machine shops at Chester.

The Griffin Wheel Co., Chicago, has bought 17 acres of land in Salt Lake City, Utah, and contemplates building a new plant at that place.

A. S. Henry has been elected a vice-president and Scott R. Hayes has been appointed general sales agent of the Railway Steel-Spring Co., New York.

F. O. Bailey, who has been connected with the Hicks Locomotive & Car Works, Chicago, for several months, has been made sales manager of that company, with office in the Fisher building, Chicago.

Owing to the increased demand for second-hand contractors' equipment, the Barron & Cole Company, New York, have opened a special department to handle this line. Geo. E. Ray, formerly of the Russell Contracting Co., New York, has been made manager of the new department.

W. A. Peddle, formerly assistant signal engineer of the New York Central & Hudson River and the Boston & Albany, has been appointed signal engineer of the Hall Signal Co., New York. He will have charge of the estimating and circuit department and the construction work east of Buffalo, N. Y., and Pittsburg, Pa.

Lewis L. Clarke, president of the American Exchange National Bank, has been elected a director in the American Locomotive Company, to succeed his father, the late Dumont Clarke. C. B. Denny, formerly treasurer, has been elected secretary and treasurer. J. O. Hobby, assistant treasurer, has been elected assistant secretary and treasurer.

Railway Mechanical Patents Issued During March

Triple valve for air brake mechanism, 950,375—Frank Y. Dibble, Ely, Nev.

Air brake release valve, 950,425—John A. Anthony, Charleston, S. C.

Locomotive engine seat and cabinet, 650,441—John J. Ekstrand, Des Moines, Iowa.

Spark arrester and draft regulator for locomotives, 950,447—Ralph J. Harle, Tanta, Egypt.

Draft-gear, 950,472—Harry C. Buhoup, Chicago, Ill.

Draft appliance for railway cars, 950,485—William Kelso, Pittsburg, Pa.

Brake shoe, 950,486—Otto A. Koenig, Kansas City, Mo.

Car roof, 950,487—James Masker, Hammond, Ind.

Draft gear for railway cars, 950,488—William R. Matthews, Pittsburg, Pa.

Draft gear for railway cars, 950,489—William R. Matthews, Pittsburg, Pa.

Draft appliance for railway cars, 950,490—William R. Matthews, Pittsburg, Pa.

Car wheel, 950,509—Leonard G. Woods, Pittsburg, Pa.

Track-Sanding Device, 950,531—John Gapp, Scranton, Pa.

Air brake, 950,539—William B. Mann, Baltimore, Md.

Journal box, 950,554—Thomas R. McKnight, Aurora, Ill.

Draft gear, 950,570—Charles A. Lindstrom, Pittsburg, Pa.

Attachment for hydraulic wheel presses, 950,573—Martin M. Moran, Ogden, Utah.

Guard for brake beams, 950,632—Frederick T. De Long, Chicago, Ill.

Brake-lever strut, 950,640—Lemuel Porter, Chicago, Ill.

Air-brake governor, 950,642—Ulysses S. Smith, Sacramento, Cal.

Draw bar, 950,643—Jacob E. Troup, Perry, Iowa.

Brake beam, 950,653—William P. Bettendorf, Davenport, Iowa.

Feed water heating device, 950,666—Charles Forth, Boston, Mass.

Safety device for railway cars, 950,726—John F. Miller, Edgewood, Pa.

Combined automatic and straight air brake, 950,736—Walter V. Turner, Wilmerding, Pa.

Electric pump governor, 950,737—Walter V. Turner, Edgewood, Pa.

Car seat, 950,745—Edward G. Budd, Philadelphia, Pa.

Car door, 950,788—Walter S. Williams, Clinton, Ill.

Interchange coupling device, 950,812—Robert E. Adreon, St. Louis, Mo.

Car roof, 950,947—Peter H. Murphy, Pittsburg, Pa.

Passenger car, 951,040—Walter S. Adams, Philadelphia, Pa.

Car truck, 951,043—William L. Austin, Philadelphia, Pa.

Internal-combustion locomotive, 951,062—Archibald H. Ehle, Philadelphia, Pa.

Car coupling, 951,188—Robert E. L. Janney, Chicago, Ill.

Automatic air and steam connection, 951,196—Herkimer L. Miner, St. Louis, Mo.

Trap for sander devices, 951,207—Harry Vissering, Chicago, Ill.

Tank car, 951,239—Myers A. Garrett, Chicago, Ill.

Car truck, 951,253—Basil Magor, New York, N. Y.

Valve setting mechanism for locomotives, 951,258—John L. Randolph, Woburn, Mass.

Grain door, 951,281—John A. King, Chicago, Ill.

Nut locking device for rail joints, 951,291—Albert D. Simpson, Brighton, Iowa.

Draft rigging, 951,326—Carl Metterhausen, Chicago, Ill.

Brake shoe, 951,350—Henry H. Urquhart, Paducah, Ky.

Railway lantern, 951,422—William R. Lawson and Jonathan Howe, Harriman, Tenn.

Car replacer, 951,532—Albert C. Kelley, Slocomb, Ala.

Valve gear, 951,536—Harry O. Lawrence, St. Louis, Mo.

Resonant cab signaling system, 951,546—Harold D. Patterson, Mount Vernon, N .Y.

Uncoupling lever, 951,541—Walter P. Murphy, St. Louis, Mo.

Pressure retaining device for air-brakes, 951,566—John C. Huxhold, Chicago, Ill.

Dumping car, 951,669—Charles R. Whipple, Worcester, Mass.

Mechanical stoker, 951,712—Charles W. Willey, Birnie, Manitoba, Canada.

Spark arrester for locomotives, 951,726—Thomas H. Densmore, Grand Valley, Ontario, Canada.

Grain door for cars, 951,809—Cyrus O. French, Kansas City, Mo.

Car brake, 951,820—James W. Lamoreaux, Massillon, Ohio.

Rack rail locomotive system, 951,842—Charles A. Pratt, Chicago, Ill.

Reinforced brake head for solid beams, 951,865—Charles H. Williams, Jr., Chicago, Ill.

Brake beam, 951,866—Charles H. Williams, Jr., Chicago, Ill.

Dump door operating mechanism, 951,884—Otto W. Meissner, Montreal, Quebec, Canada.

Car coupling, 951,896—Stephen Winter, Bridgeport, Conn.

Dumping car, 951,933—Anton Becker, Columbus, Ohio.

Railway car underframe, 951,934—Jerome G. Bower, Chicago, Ill.

Direct air brake system, 951,987—Arthur Doan, Oakland, Cal.

Locomotive spark extinguisher, 951,994—John Player, Schenectady, N. Y.

Car stake socket, 952,003—Clayton T. Eaid, William H. Eaid and Phillip S. Crotty, Olympia, Wash.

Gondola car, 952,026—Anton Becker, Columbus, O.

Underframe for cars, 952,027, 952,028 and 952,062—Anton Becker, Columbus, O.

Air-brake-system signaling apparatus, 952,070—Simon P. Cota, Dickinson, N. D.

Car wheel lathe, 952,084—Albert C. Stebbins, Plainfield, N. J., and Willard T. Sears, Philadelphia, Pa.

Car door hanger, 952,120—William R. Kilner, Greenfield, Pa.

Air-brake, 952,299—William S. Bilbrey, West Point, Ga.

Grain-car door, 952,319—James E. Faucett, Kenmare, N. D.

Ladder for box cars, 952,463—John McGlade, Newton, Miss.

Brake head and shoe, 952,553—Charles H. Williams, Jr., Chicago, Ill.

Locomotive ash chute and flusher, 952,559—William J. Brown, Brown, Chicago, Ill.

Beam for brake-beams and bolsters, 952,581—Albin P. Rissler, Chicago, Ill.

Friction draft-gear, 952,672—John A. Jackson, Chicago, Ill.

Buffer-block, centering device, and carry-iron for car-couplings, 952,696—Ira O. Wright, Baltimore, Md.

Safety car step or running-board, 952,728—Elijah C. Dodson, De Leon, Tex.

Angle-cock for train-pipes, 952,743—Charles Jenkins, Aspinwall, Pa.

Brake-operating mechanism, 952,759—John A. Schuchardt, Sr., and John A. Schuchardt, Jr., New Castle, Del.

Air-brake system, 952,794—Bernard Farmer, Chicago, Ill.

Locomotive-cylinder cock, 952,898—John E. Gleason, Havelock, Nebr.

Train-pipe coupling, 952,905—Joseph Hough, Swayzee, and William L. Turner, Sims, Ind.

Articulated compound locomotive, 952,909—John W. Kendrick, Chicago, Ill.

Car-brake, 952,924—Thomas H. Morgan, McCartney, Pa.

Nut-lock, 952,942—John R. Perkins, Jackson, Miss.

Splice-bar, 952,959—Albert W. Stricker, Lake Benton, Minn.

Car-brake, 952,990—Moore C.: Hinton, W. Va.

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WATER SOFTENING.

The treatment of water in the railway field is a problem with which the engineering and mechanical departments are about equally concerned. The location of water supply primarily and its relocation from time to time is one of the prerogatives of the engineering department, but the results of the use of different qualities of water evidence themselves in the affairs of the mechanical department to the promotion or limitation of efficiency. Developments in the treatment of water within recent years have been so rapid that it would seem that all mechanical men should be more or less interested. We are publishing on another page of this issue an article dealing with different methods and systems of water treatment, each of which has been very successful in the promotion of efficiency in locomotive service.

Among the arguments customarily advanced in favor of the plan of water treatment are the following: A reduction of maintenance cost in the locomotive department. A material reduction of the number of engine failures and a consequent reduction of embarrassment in the transportation department, and an increased efficiency in the combustion of fuel. An argument seemingly much more conclusive, however, is contained in the fact, perhaps self-evident conceding the reduction in maintenance, that there must be a material saving of interest on capital invested in motive power due to shorter and less frequent periods of shopping. In other words, an availability of more power on account of a similar total in the aggregate time of disability per dollar invested.

The fact that boiler pressures have been limited by problems of maintenance will scarcely be denied. Admitting that pressures upward of two hundred pounds per square inch result in greater economies in the use of steam, maintenance costs have been found to offset this saving to the extent that the general opinion is now in favor of pressures not to exceed one hundred and eighty pounds in any service. While we do not presume to advance the opinion that a general restoration of high pressures would result from the proper treatment of feed water alone, it is safe to assert that if the difficulties of maintenance can be to a great extent obviated by water purification, the greatest objection to the use of the higher pressures will be neutralized and the benefits derived therefrom will be a clear gain in efficiency.

SHOP WINDOWS.

What a difference you will find in the lighting facilities of different shops; some shop windows and skylights seem to be there for the purpose of showing you how closely they can be made to resemble a brick wall—in other words, they are never cleaned, or if they are, it is done superficially. Machines which are located near windows are often allowed to throw off fine particles of oil in such a way that they strike the windows and the dirt collecting on the latter makes the cleaning of the windows difficult; all of which could be avoided by using a shield on that part of the machine which throws the oil. Panes will become broken and the vacancy is filled with cardboard, paper or an old pair of overalls, decreasing the lighting surface and letting in cold in the winter. Of course, it is not expected that shop windows can be kept in the same condition as those of an office building, but windows are made to let in light and they should at least be allowed to do this. The labor for cleaning and keeping them in good condition is not costly, and as many shops are but poorly lighted at their best, every effort should be made to give workmen all the light possible and also to make the building look cheerful and well kept. On the other hand, there are windows on balconies and other places which, unless protected from the sun in some way during the summer, make the place almost unbearably hot and such windows should be provided with awnings, for money expended in increasing the comfort of the workmen will result in better efficiency and organization. If awnings are impracticable, a coat of thin white paint applied to the outside of the windows each spring and removed in the fall will help greatly to decrease the intensity of light and heat transmitted through them during the summer months.

GETTING TOGETHER.

On the whole, it seems that there is a growing tendency towards more fairness in the relations of employer and employee, and one of the strongest evidences of this is the effort being made by many of our large corporations to increase the happiness and knowledge of their employees. In the early days when our industries were comparatively small, the employer was in a position to know his men at first hand and to help them as he saw fit; then came the rapid growth of these same industries and the men in control became of the opinion that everything could be run as a machine. Now the reaction has come and we are learning that the value of a human touch between the men in control and the men who make an industry cannot be set down in dollars and cents. Nowhere is this more true than on our railways, for they have been the leaders in taking good care of their men, as instanced by the increasing number of roads which reward the faithfulness of superannuated employees with pensions varying in amount from $25 to $150 per month. Club houses for the use of employees, where men and their families may meet for amusement and instruction, have been built by some roads. These have been great factors in strengthening the organization and the spirit of loyalty. The recent establishment of a school of instruction for employees by the Harriman lines is a new departure and one that is well worthy of emulation by other lines, for it is an extension of the growing idea of making knowledge accessible to everyone.

In a number of shops, arrangements have been made to have a good practical speaker come in once every week and during the noon hour talk on some subject worth while; in such cases as have come under the writer's observation such meetings have proven both interesting and profitable. A large part of every man's work is a matter of routine and this is especially true in the shop; therefore if a man has his mind turned into a new and interesting channel for a half hour or so, he cannot help but return to work refreshed and better able to handle the job in hand. At one shop where such meetings are held, a portable organ is provided and a double quartet of the men enliven and add to the meeting considerably by their music. Such meetings only require a slight effort by those in charge to be a success. Much has been done and is being done to provide apprentices with proper instruction, but we believe that much may yet be done in giving the older employee who has passed the apprenticeship stage a chance to acquire more information; say an informal talk or lecture once or twice a month on the work of other departments of the road or some subject of general interest. In the larger shops mutual benefit associations for protection against sickness and accident, when organized with the co-operation of the officials, have proven very successful and are easily maintained by deducting the assessments from the pay checks of the members.

These are suggestions of what is being done and what may be done. In our large organizations of the present day the relations between groups should be the same as between individuals in former days; getting together perfects an organization and it may be noted that those who have done the most along this line have generally been the most successful.

FRONT-END CABS NOT OBJECTIONABLE.

A report has been circulated through the medium of the daily and semi-technical press to the effect that the Mallet articulated locomotives with front-end cabs now operating on the lines of the Southern Pacific Co., are a source of difficulty with engine crews owing to the reluctance of the latter to ride in the exposed position. We are authorized to state that while there was some speculation on the part of the men as to the safety of operating the new locomotives before they were placed in service, none of them have left the service on that account. Since the locomotives were placed in service there have been no complaints registered. The freedom of the cab from smoke and gases while running through tunnels and snow sheds has been found an advantage which is appreciated by the engine men. Mr. H. J. Small, general superintendent of motive power is, however, considering the use of a suitable tender to couple ahead of the cab, of such a height as not to interfere with the vision of the engine men and which will serve as a buffer in case of collision.

The design of a tender which can be pushed ahead of, rather than hauled behind an engine will entail the considerable study of those difficulties which have so often come before the American Railway Master Mechanics Association, and which have recently been brought forcibly to the attention of mechanical men on account of several serious accidents resulting from running tender first at high speeds. In the case of the Southern Pacific's locomotives, the problem will probably be simplified, however, by the fact that they are not operated in high speed service and possibly by the fact that only part of the fuel and water will be carried by the tender ahead.

Water Softening

The softening of boiler feed water has become an important item in the operation and maintenance of railway power in certain districts all over the country. While there is little variation in the principles of treatment, methods of application are materially different in the several plants on the market. A short history is given and a number of well-known systems are described in the following paragraphs.

It should be remembered that generally speaking railway water softeners are manufactured to operate either intermittently or continuously and are arranged to be charged at the top or at the bottom.

The L. M. Booth Co. Type F Softener.

In the softener manufactured by the L. M. Booth Co., New York, the chemicals for treatment, usually quick lime and soda ash, are prepared at ground level. Sufficient lime to last twelve hours is slaked in the lime tank and discharged through a screen into the chemical tank. The pieces of unburned lime, stones, etc., are caught on the screen and disposed of as convenient.

The soda ash is thrown directly into the chemical tank, where it is mixed by the action of the agitators with the lime and the proper quantity of water and thus made up to correct strength. Very thorough agitation in the chemical tank is necessary to keep the lime suspended in the mixture. The efficiency of this system of agitation is said to be particularly high, for the reason that the paddles work through the entire volume of the chemical tank and have a reciprocating motion.

From the chemical tank the chemicals are automatically measured and fed to the water by means of the apparatus illustrated herewith.

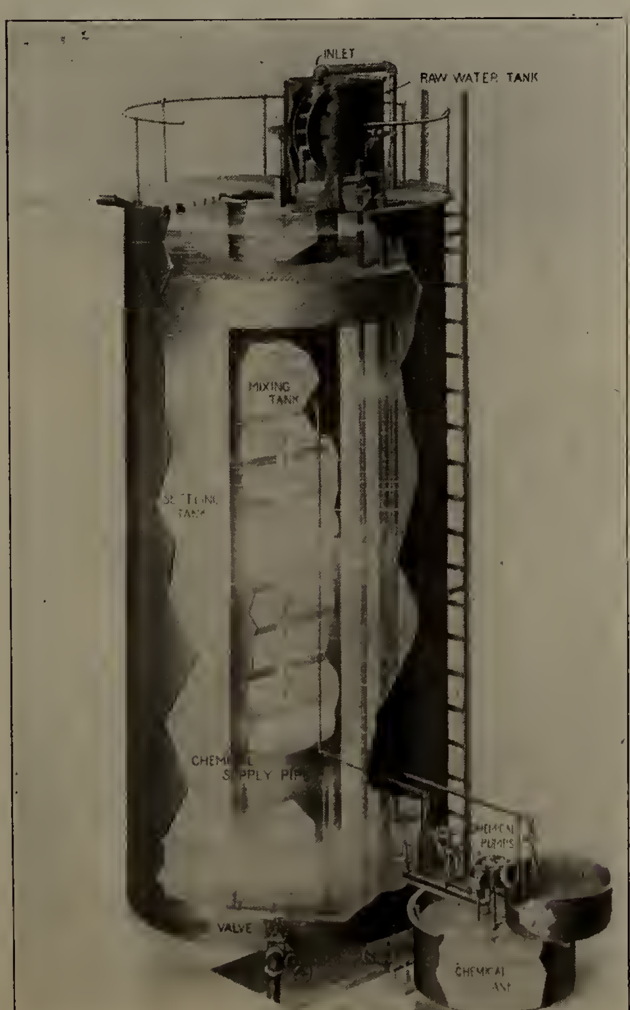
The raw water enters the softener through the inlet pipe, and is discharged onto the overshot water wheel located in the raw water tank at the top of the softener. This water wheel furnishes the power required for operating the paddles in the mixing tank, as well as that required to operate the chemical pumps and agitators in the chemical tank. The latter being at ground level, power is transmitted to them from the water wheel shaft by a link and lever.

After passing over the water wheel, the water flows through the raw water weir and chute into the top of the mixing tank, where it meets the chemicals which have been delivered from the measuring device through the chemical supply pipe. While passing slowly down through this mixing tank, the water and chemicals are thoroughly stirred together by the paddles shown. This insures uniform and complete softening, as every particle of water is brought into intimate contact with the chemicals, and also prevents waste of chemicals, as these cannot escape being dissolved and used. The time required for the water to pass through the mixing tank is sufficient for the chemical action; also to thoroughly coagulate the precipitate and prepare it for sedimentation.

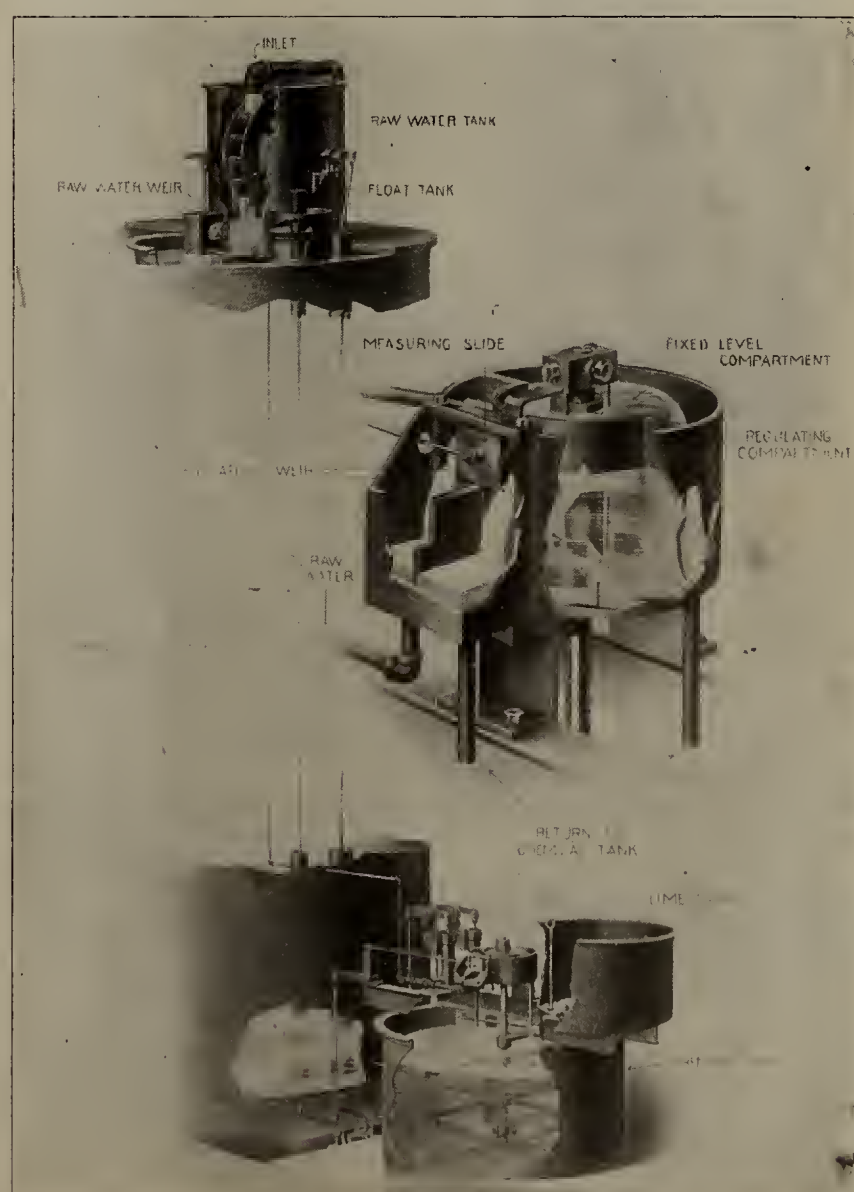
After leaving the mixing tank at the bottom, the water flows slowly upward in the settling tank while depositing the precipitate. The water flows through the wood filter to the outlet thoroughly softened, pure and ready for use. The precipitate deposited in the bottom of the settling tank is disposed of each day by opening the sludge valve for a few seconds.

The supply of chemicals is regulated in proportion to the amount of water entering the softener, as follows:

A uniform stream of chemical solution flows over the chemical regulating weir. A measuring slide, movable along the crest of this weir, divides the flowing solution into two parts, one of which is delivered to the raw water, while the other part drops back into the chemical tank. The position of the measuring slide determines the amount of chemicals



L. M. Booth Water Softener.



Details of Booth Softener.

fed to the water; the measuring slide is governed by a float in the float tank, the rise and fall of which is in direct proportion to the amount of water flowing into the softener over the raw water weir. This simple ratio is possible on account of the construction of this weir.

As shown in the illustration, the softener is working at half capacity. If a greater amount of raw water enters the softener, the measuring slide will be moved over to the right and cause a proportionately greater amount of chemical solution to be fed to the water. If the inflow of raw water lessens or stops, the measuring slide will proportionately move to the left, and partly or entirely cut off the chemical supply.

After the chemical solution has been correctly measured, as described, it flows from the regulating weir to a pump, and is lifted through the chemical supply pipe to meet the raw water in the top of the mixing tank.

The flow of chemicals over the regulating weir referred to above is maintained uniform by delivering into the regulating compartment a uniform amount of chemical solution through an orifice in the side of the inner or fixed level compartment. This orifice being always under the same head,

Kennicott Top Charge Railway Softener.

the amount of flow through it is unvarying. To maintain the fixed level in the inner compartment an excess of chemical solution is delivered into it, the excess overflowing back into the chemical tank.

It will thus be seen that the proportioning is all done at the regulating weir, the other parts merely serving to deliver the chemical supply to the weir to be measured, and, after it is correctly measured, to lift it to be mixed with the raw water.

The chemical solution in the regulating apparatus is kept constantly agitated by paddles mounted on an extension of the shaft that serves the chemical tank.

The Kennicott System of Continuous Water Softening.

The Kennicott system, manufactured by the Kennicott Co., Chicago, is very extensively used in the United States, particularly in the railroad field. It is, however, of general application. Railroad requirements are more severe than any except possibly municipal.

The general plan of working is very simple indeed, the feed of chemicals and all the necessary stirring being automatic. The turning on of the water starts everything in operation and shutting it off stops it. The hard water enters a box near the top of the apparatus and flows out through a slot in the bottom to a water wheel. (The slot is made of the proper size to discharge the maximum quantity of water which is to be treated.) The water wheel operates a stirrer in the lime water tank, and also a lift wheel for raising soft water to the lime water measuring box. It has been found economical to use soft water for making lime water, and by means of this lift-wheel soft water is raised with very little power, indeed, to the point of use.

Soda ash, enough for 6, 12 or 24 hours, is dissolved in a tank and is fed by a pipe controlled by a ball-float valve to a measuring box on a level with the lime water feed box. A float in the hard water box is connected by chains with swivel joint lift pipes in the feed boxes.

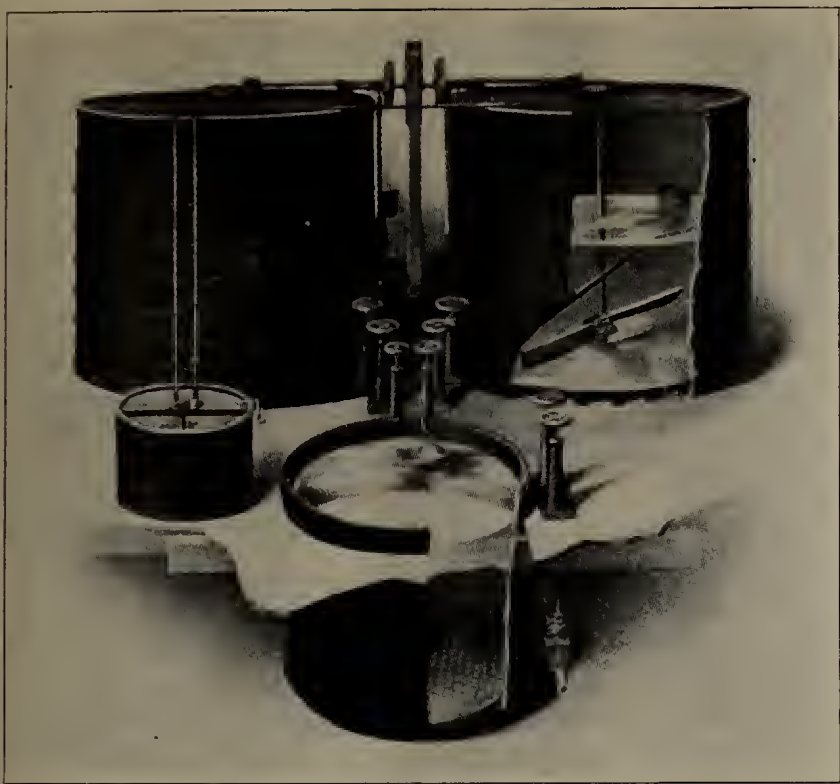
As the level of the water over the slot in the hard water box rises and falls, the lift pipes, which have openings in their upper ends proportional to the size of the slot in the hard water box, rise and fall also. The length of each chain is so adjusted that the head of water over all three slots is always the same. The sizes of the slots in the lift pipes are made adjustable by screw caps. It is thus a simple matter to change the proportions of chemicals to hard water at any time.

Kennicott Bottom Charge Railway Softener.

The soft water delivered to the lime water feed box passes through the slotted lift pipe, which connects with a pipe passing to the bottom of the central lime water tank. Here it passes up through the excess of lime cream, and is changed into saturated lime water, which, flowing upward, meets the mixture of hard water and soda solution which have come together at the point of discharge below the water wheel.

A very thorough stirring takes place at this point, and the mixture flows upward and passes over the rim of the mixing cylinder. It then starts down the annular conical space outside the lime water tank. In this cone the velocity of the water constantly decreases, and the sediment produced by softening the water gradually settles away from the descending current. Arriving at a point just above the sludge cone, the water turns upward again, passing through baffle plates and depositing nearly all of the rest of the suspended matter. It finally flows through a wood-fiber filter and passes over into the service tank.

These machines are so designed that they deliver water into elevated service tanks without repumping. They require



We-Fu-Go Intermittent Softener.

only one foundation, and the parts are well protected from freezing.

Tests prove that the conditions favoring uniform and complete softening are well taken care of in the Kennicott machine. The degree of softening is as high as with any machine, and the results are uniform when reasonable care is taken. The amount of labor actually necessary for operation is less than with any other machine with which we are familiar.

The novel and valuable features of the Kennicott machines are: (1) The proportional feeding device for chemicals. The slotted lift pipes are simple and easily adjustable. (2) The mixing arrangements inside the main tank. The Industrial mixer is a separate tank. (3) The conical down-take pipe, giving a descending water column of decreasing velocity, out of which the precipitate settles easily. Other machines have only a narrow cylindrical down-take pipe, or none at all. The base of the down-take cone is made of such area that there is no sudden increase of velocity when the current turns up again, but only a steady increase in the size of the passage all the way to the top. (4) The baffle plates not only steady the upward rise but assist in the final clarification and completion of softening in a way not always appreciated.

We-Fu-Go Intermittant System.

The We-Fu-Go water softener, manufactured by Wm. B. Scaife & Sons Co., Pittsburg, Pa., consists essentially of two or more treating and settling tanks, equipped with mechanical stirring devices operated by power, a small reagent or chemical mixing tank with mechanical stirring device and jet or other pump for introducing reagents into the tanks, and a filter.

The treating tanks are filled alternately with water; while a tank is filling the reagents are introduced and thoroughly mixed with the water by means of the mechanical stirring devices consisting of a specially designed paddle, revolved by power from an available line shaft, an engine or a motor. The paddle not only mixes the reagents with the water, but at the same time stirs up from the bottom the lime sludge of preceding putrification. This sludge floats in the water, hastens the chemical reaction, and causes the new finely divided precipitate to form large wooly flakes heavy enough to settle quickly as soon as the water stops moving. This mixing device is simple and efficient; with reasonable care it will not get out of order, it does not have to be cleaned to keep it in working condition, and it requires very little power.

After a tank is filled, the stirring device is stopped and the water permitted to stand, in order to allow the precipitate to settle to the bottom of the tank. The softened water is taken out of the tank by means of a hinged floating outlet pipe arranged to rise and fall with the level of the water, so that the water is always drawn from the top. The water at the top carries the least amount of floating sludge through the floating outlet pipe to the filters. The latter can, therefore, run the longest possible time without being cleaned. The rate of flow to the filters is automatically controlled so that they are supplied with water as fast as it is drawn from them. Either pressure or gravity filters may be used and in some cases no filter at all is necessary, depending on the water treated. While one tank is being filled, treated and settled, the other is supply treated water.

Pipe connections, through which to fill the tanks and to wash out sludge, are placed in the bottom. The washing of settling tanks needs to be done about once a week or when the sludge becomes so deep as to interfere with the operation of the paddles. To do this, it is necessary only to open the valves to the sewer and start the stirring device to mix up the sludge, which is soft enough to flow through the pipe into any sewer.

The We-Fu-Go Continuous System.

This system consists of a tower tank containing separate lime-reaction, soda-reaction and settling compartments, with mechanical stirring devices in the reaction compartments; tank for slaking lime and dissolving soda or other reagents; lime and soda solution tanks with mechanical stirring devices; pump of special design for introducing the solutions into the reaction compartments; electric or water motor or steam engine to furnish power for operating the mechanical stirring devices and solution pumps, and either mechanical gravity or pressure filters. With this system, under certain conditions where it is desirable to use a lime water instead of cream of lime, a patented saturator is used. This system is automatic and continuous in its operation. The treat-

We-Fu-Go Continuous Softener.

ment is automatically regulated by the quantity of water passing through.

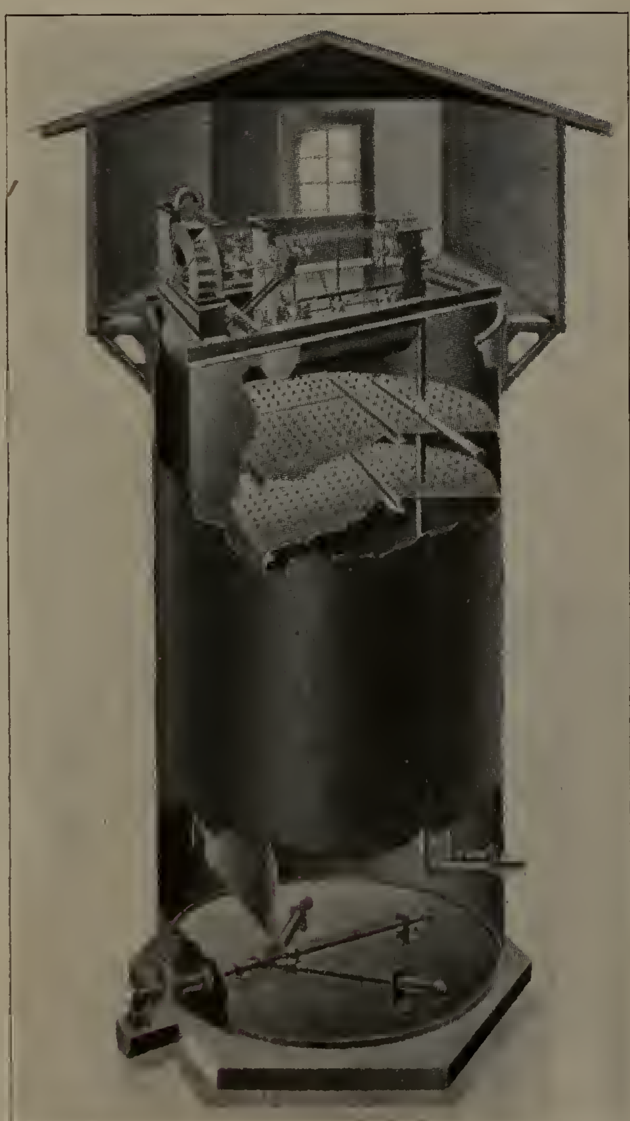
The water enters the lower compartment of the tower tank, where it is treated with the first reagent, then passes into the second compartment, where it is treated with the second reagent. Both compartments being fitted with mechanical stirring devices, insures thorough mixing of the reagents with the water, while the sludge of previous purification assists the precipitation.

From the second reaction compartment, the water passes into the upper settling compartment of the tower. From there it flows to the filters through a floating outlet pipe, which acts as a regulator for the water entering the system. The settling compartment can be made large enough to give storage of treated water.

This system can be equipped with excelsior (wood fibre), mechanical gravity or pressure filter, as conditions may warrant.

Bartlett Water Softener.

The Bartlett system, which is manufactured by the Northern Water Softener Co., Madison, Wis., is of the continuous type, the chemicals being automatically proportioned to the hard water irrespective of the amount of softened water used. However, its operation is different from that of the other continuous type softeners in that it treats the



Type B Bartlett Softener.

raw water at but one rate of flow, whereas all other continuous systems treat the hard water in varying amounts depending upon the quantity of softened water being withdrawn from the system.

As the volume of chemical used in treating water is very small compared to the amount of water treated, many variable factors enter into the proportionment when the chemical flow must vary between wide limits to accommodate itself to a varying quantity of hard water entering the softener. Although the hard water enters the system at but one rate, any amount of the softened water may be withdrawn.

The level of softened water in the soft water chamber automatically controls the flow of both hard water and chemical. When the softened water reaches a predetermined upper level in the soft water chamber the flow of both hard water and chemical are instantaneously stopped and when it reaches a predetermined lower level the full flow of both is instantaneously started. The automatic control is accomplished by means of a gravity operated float valve in the soft water chamber.

The rate of flow of hard water entering the system is maintained constant by means of a fixed opening at the end of the inlet pipe and a diaphragm pressure reducing valve which maintains a constant water pressure upon this opening irrespective of any variation in the pressure under which the water is delivered to the system. A constant chemical flow is maintained by keeping a fixed discharge opening a predetermined distance below the level of chemical.

The amount of hard water treated is always equal to the maximum treating capacity of the system, and when a smaller amount of water is being used from the system than is being softened the softener is at rest part of the time, the length of the periods of rest depending upon the rate at which soft water is being drawn from system. This method not only results in accurate chemical treatment and uniformly softened water, but allows the water undergoing treatment to remain at absolute rest in the reaction chamber, at times producing very effective sedimentation.

The chemicals are kept in agitation by means of paddles rotating in a semi-cylinderical bottom tank. This type of tank and paddles have the advantage of being able to produce a uniform suspension much quicker than the ordinary round tank with inclined paddles rotated on a vertical shaft. These paddles are connected to an overshot water wheel which is operated by the raw water entering the system. Each paddle carries a small bucket which elevates the chemical from the tank as the paddles revolve and dumps it into a small tank located above the chemical level. These buckets always elevate more chemical than is added to the water, the excess overflowing the small tank back into the main chemical solution, thus maintaining a constant level of chemical in this tank.

A fixed discharge orifice is placed in this constant level tank, through which flows a constant amount of chemical when the system is operating, due to the fixed level of chemical in the tank.

When the softener is operating, the hard water revolves the water wheel which agitates the chemicals and raises them to the constant level tank from where they flow to the reaction chamber. When the hard water is shut off the water wheel stops, which in turn shuts off the chemicals as no more are raised to the constant level tank.

The water and chemical, after being properly proportioned, flow into an inverted cone whose upper rim is above the highest level of water in the settling system. The water and chemical falling into this cone are thoroughly agitated and mixed, the reaction precipitating the hardening ingredients in insoluble flakes. The water, carrying this precipitated matter overflows the upper rim of the cone and falls into the downtake, located at the side of the settling tank. This downtake is made of sufficient size, so that the greater part of the chemical reaction is completed before the water reaches its lower end and enters the large settling chamber. As the water leaves the downtake, and starts in an upward direction, the heavier precipitated matter falls from the water to the bottom of the tank. As the water flows upward the chemical reaction continues and the precipitated solids become denser and slowly descend towards the bottom of the tank. Near the top of the settling chamber is a filter bed composed of wood-wool, which removes any remaining trace of suspended matter from the water before it enters the softened water storage chamber. At the bottom of the settling system is a spider sludge pipe containing four openings so arranged as to efficiently clean the sludge from the tank. When the sludge valve is opened the pressure of water within the tank forces the sludge through this pipe into a sewer or other place of disposal.

The softened water is drawn from the softened water chamber through a perforated horizontal pipe located just above the filter plates. Softened water is drawn through each perforation and in this manner the full value of the settling space is obtained.

In the Bartlett softener it is not necessary that any mechanical action take place at any predetermined place or time to proportion the chemical and water correctly, which eliminates any variation in the proportionment of the chemical and water through any delay of operation.

Eureka Water Softening Apparatus.

The Eureka apparatus, made by the Dodge Mfg. Co., Mishawaka, Ind., consists essentially of two portions, the smaller a lime saturating tank, and the larger, a decanting tank, for precipitation of the scale-forming constituents after being acted upon by the lime solution and re-agents.

Referring to the illustration, the water to be treated enters the top bank B and is divided under proper automatic control for delivery, a small portion to the saturator J, the greater portion to the decanting tank. On its way to the decanting tank the water passes over a wheel E whose rotation actuates stirrer arms in the saturator.

The saturator J, with its stirring apparatus, provides a continuous supply of saturated lime solution, which is fed with other re-agents, in proper proportions, under automatic control, from a small tank G into the central tank M of the decanter. Here the reaction takes place, the water passing downward and returning upward in the main body of the large tank, passing spirally among the slant settling plates N. On these spiral surfaces the scale-forming matters and other impurities are deposited in flakes which gravitate freely to the conical bottom of the main tank, whence they may be passed off into the sewer by occasional opening of the valve S. Any sediment forming at the bottom of the lime saturator tank may similarly be blown off through the valve U.

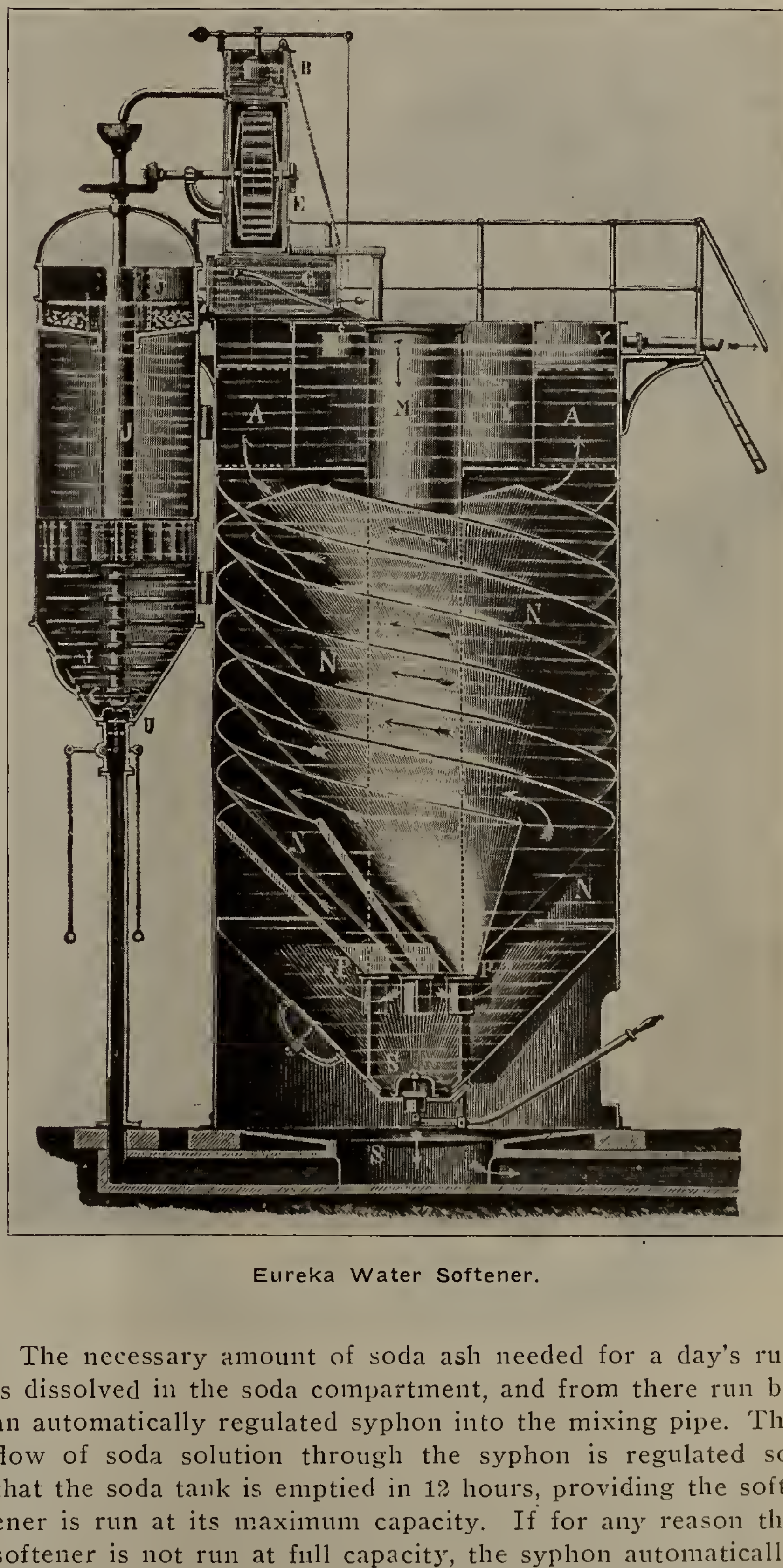
The water itself, continuing upward, passes through filtering material A into an annular space, whence it is drawn off as wanted, thoroughly softened and purified.

The whole operation is simple and entirely automatic, the apparatus holding itself always ready to deliver soft water in any quantity within its rated capacity, either steadily or intermittently. The water is treated cold by means of re-agents which may be bought in any market at trifling cost. All the attention required in its operation is to renew daily the lime and other re-agents in prescribed proportions, and to flush out the accumulated slush by opening the valve S and U. All of this requires only a few minutes of time on the part of some regular employe of the power department.

Description of "Reisert's" Type B Water-Softener.

This machine is built by the Reisert Automatic Water Purifying Co., 30 Church St., New York. Its main parts consist of a distributing tank, a reaction and settling tank with mixing pipe and gravel filter embodied and a Reisert lime saturator. These parts are connected into a compact apparatus. The distributing tank has three compartments, one for raw-water, one for soda ash solution and one for lime slaking. The water to be treated enters the raw-water compartment either by pressure or gravity and the water level in this compartment is always kept constant by means of a float valve. In this compartment the raw-water is divided into two portions. The main portion goes directly to the mixing pipe in the settling tank and the constant water level enables an exact regulation of this amount. A smaller portion, the exact amount being determined by the quantity of saturated lime water required, is run, by means of a regulating valve, to the bottom of the lime saturator through its center pipe.

The calculated amount of caustic lime needed for a day's run is slaked in the lime compartment and the milk of lime is drawn to the bottom of the lime saturator. The constant flow of water from the center pipe carries the lime particles upwards until the velocity of the water becomes so small, on account of the increasing cross-sections of the saturator, that the lime particles cannot follow. Consequently the lime water, which has become completely saturated, always enters the mixing pipe clear and of uniform saturation. The success of a water-softening apparatus depends practically upon the fact that the exact amount of lime required, neither more nor less, must always be delivered to the raw-water.

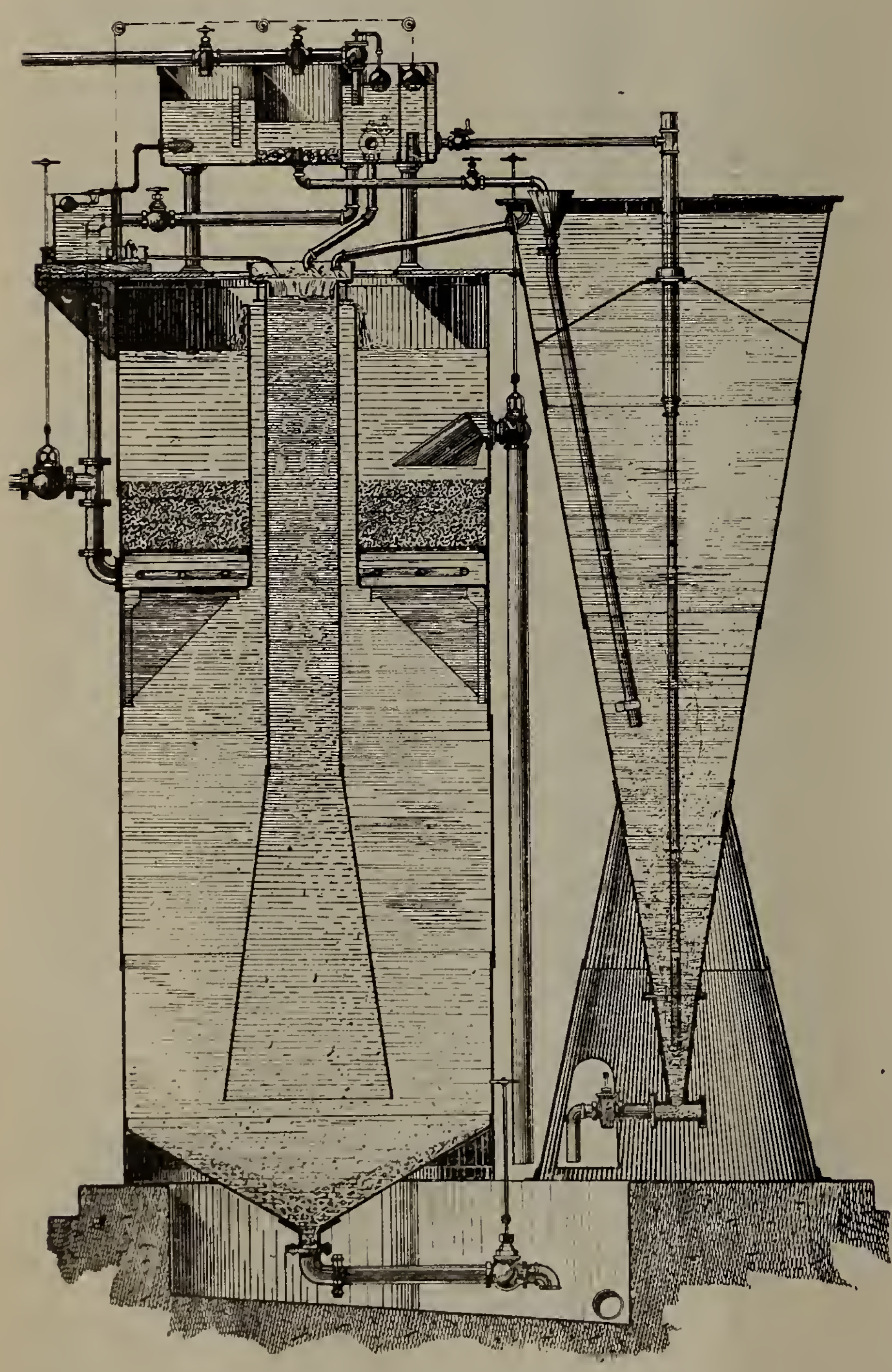


Eureka Water Softener.

The necessary amount of soda ash needed for a day's run is dissolved in the soda compartment, and from there run by an automatically regulated syphon into the mixing pipe. The flow of soda solution through the syphon is regulated so, that the soda tank is emptied in 12 hours, providing the softener is run at its maximum capacity. If for any reason the softener is not run at full capacity, the syphon automatically delivers a correspondingly smaller amount of soda solution and a graduated scale in the soda tank shows the attendant just how much soda is used. In the same manner, if the softener is not running at full capacity, the amount of lime water delivered to the mixing pipe is automatically regulated to be in direct proportion to the raw-water. In this way the softened water will always be of uniform composition and there is no danger of over or under-treatment, which is a very objectionable feature with most systems.

In the mixing pipe the raw-water is thoroughly mixed with the lime water and soda solution and is carried down to near the bottom of the settling tank, where most of the precipitated sediment is deposited. After leaving the mixing pipe the water is slowly carried upwards and overflows on the Reisert gravel filter, through which it runs by gravity to the soft water chamber and from there is discharged to the outlet pipe.

The sediment accumulating in the settling tank and lime saturator is drawn off from time to time by means of the sludge valves. The filter bed is washed out daily by reversing the flow of water, stirring up the filter material at the



Reisert's Water Softener.

same time by compressed air from an ejector. The daily work of the attendant is confined to charging the apparatus with chemicals and washing out the filter.

The construction of the machine is shown in one of the accompanying illustrations.

Methods of the Dearborn Drug & Chemical Works.

The originators of Dearborn methods being chemists and conversant with the fact that very few waters used as a steam boiler feed supply existed in which the kinds and quantity of solid matter present were alike, saw at once the necessity of inaugurating some system or plan whereby the differences in different waters could be determined, and the difference in their effects when used as a steam boiler feed supply, noted. A further knowledge of chemistry enabled them to foresee the cause of many troubles experienced in practice, and these only needed confirmation by actual experiment or investigation of the subject, by the comparison of the kinds and quantity of solid substances contained in the water with the results actually obtained.

Even though different waters being used in different plants are obtained from the same original source, for instance, one of the five Great Lakes, it is seldom the case that the waters in the condition in which they enter the boilers themselves are alike; as, in most plants the waters before entering the boilers either pass through heaters, purifiers, or both, or are mixed with various percentages of condensation from that obtained either in condensing plants or heating systems, consequently changing the kinds and quantity of substances which they carry and causing them to be not only different from the waters as they come from the original supply, but also very materially different from each other as they enter the boilers.

This being the case, the Dearborn company first of all established a scientific department, placing at the command of this department complete and proper laboratories for the analyses of waters, scales, etc., and for doing any analytical work which was necessary in order to furnish the required information to the scientific department to enable them, by using this information, together with information connected with the practical operation of the plant under consideration, to intelligently arrive at some definite conclusions as to the best method of procedure for the purpose of overcoming the troubles being experienced due to the feed water used.

But few months had elapsed before the Dearborn company was thoroughly convinced that it was progressing along the right lines, and the absolute necessity of such procedure confirmed. From that time on it has always maintained properly and thoroughly equipped laboratories for feed water treatment, these being at all times under the supervision of thorough analysts especially trained for the class of work which they were called upon to do. It was also very soon demonstrated that the theory originally advanced, to the effect that it was necessary to furnish preparations of different composition for waters carrying different kinds and quantities of solid matter, was correct; therefore, from that time hence it has deemed it necessary to insist that it have an analysis of the water, also of scale in many cases, together with a thorough understanding as to the general operative conditions under which the water was being used. With a thorough understanding of these conditions and from the analysis it can proceed intelligently to build up a preparation, using the reagents which were demanded by the different kinds of substances contained in the water in quantity corresponding to the quantity of substances, considering one substance at a time, determining the necessary amount of the particular reagent it demanded, and continuing along these lines until all substances found in the water had been considered, having then the reagents in the formula for the finished product in the same proportionate amount as the different substances existed in the water.

It has been demonstrated during the last quarter of a century of experience, that this is the only rational way of handling the subject, not overlooking, however, the information at hand regarding the conditions under which the water is being used. During a period approximating a quarter of a century any company meeting with success in its line from day to day will have many difficult problems submitted for solution, and the subject of treating feed waters under different conditions in different types of boilers, used in different types of service, must receive careful and intelligent consideration by experts who has been studying the subject for a sufficient period to enable them to be competent to handle the matter properly. For example, the treatment of waters in stationary boilers constitutes one phase of the subject; the treating of waters used in locomotive boilers another; and that of waters in sundry boilers for other purposes still another, all demanding special and careful consideration, as the conditions under which they are operating have a very much greater effect or bearing than is usually conceded.

The requirements for the successful handling or treating of waters for use in stationary and locomotive boilers are so separated that it has been found necessary, in order that the two phases of the subject may be handled intelligently and properly, to maintain a separate and individual department for each, the personnel of the stationary department made up of those conversant with stationary practice and the railroad department of those who are thoroughly conversant with the conditions under which the water is used and is to be handled, in both cases assisted by scientific and analytical departments.

The method of applying the treatment in any case has much to do with the results actually obtained, consequently this oft-times considered trivial matter must be given careful consideration.

The above thus far has referred more to the correct theories and methods generally than to the indivdual phase of the subject other than that of stationary practice. A few words pertaining to the theories and methods in connection with the treatment of water in locomotive practice will no doubt prove of interest. The mode of procedure in treating locomotive feed water is as follows:

Samples of waters to be treated are requested, obtained, and analyzed, and the preparations are first of all made to suit the conditions as shown by analysis.

The method of applying the treatment is very simple. It is applied to the locomotive tender, thereby obviating the necssity of maintaining a treating plant. Trouble caused from scale, pitting, and corrosion is overcome by applying the treatment at terminals only, thus relieving the engine crew of the trouble of looking after the treatment on the line.

To overcome trouble caused by priming or foaming a preparation is made that is applied each time the water supply in tender is replenished. Experienced engineers are furnished to install the treatment and instruct all concerned in the proper use of it.

The treatment prevents scale formation, pitting and corrosion, materially extending the life of flues and fire boxes, and on account of clean boilers, contributes much to economy in fuel consumption.

In preventing foaming conditions, the necessity of too frequent washing of boilers is obviated, which is expensive and very injurious to the boiler sheets. The wear and tear of valve gears, cylinder packing, etc., is also reduced, reducing greatly the cost of maintenance.

Too much cannot be said in favor of treating locomotive feed water, and the expense of treatment is insignificant as compared with the numerous benefits derived.

Summary.

The essential principles of water softening which any successful machine must meet, are as follows:

(1) The scheme for feeding chemicals in the continuous system must be very precise at all times, and capable of easy adjustment when necessary. The devices must be as simple as is consistent with precision.

(2) The chemicals and water must be very thoroughly mixed, and for a sufficient length of time under proper conditions, so that the softening is sure to be completed in the time allowed.

(3) In the case of a continuous softening machine, its internal construction should be such that the steady progress eddies. If the supply is delivered intermittently or the rate of water through the machine is certain. There must be no of pumping is variable, it is absolutely essential that the uneven flow be counteracted. There is a tendency toward short cuts in any case which the apparatus should be designed to meet.

(4) The apparatus should be so designed that clarification will be very complete, leaving an insignificant amount of work for the filters. This reduces the trouble and expense of operation.

(5) The time allowed for the completion of the chemical reaction must be sufficient. The apparatus, if continuous in operation, should hold four times the maximum hourly output reqired. If intermittent, the time for filling and emptying tanks must be added to the four hours standing. This makes the tank area in the intermittent system usually about twice that in the continuous system.

(6) The softened water should be perfectly clarified when discharged.

(7) Labor and superintendence must be cut down to a minimum.

Continuous and intermittent softening plants properly designed and conscientiously cared for, give first-class results. In order to get these results by the intermittent system it requires a larger plant, more labor and more power. Intelligent supervision is required for both kinds of softeners.

The continuous system has the advantages of simplicity and compactness, and is cheaper to operate, because it requires less power and less labor. The maintenance charges are less, if, as is usual, steel construction is used. Having few valves (one-fourth as many as in the intermittent system), there is little to get out of order.

Electric Car Lighting*

By J. R. Sloan.

The question of electrically lighting the passenger equipment of steam railroads is one that is becoming more and more important. When the equipment was first electrically lighted it was confined to the important trains of the leading railroad, but the public is now demanding that the service be extended to cover practically all classes of equipment on all roads. In other words, what was considered a luxury has now become almost a necessity.

The advantages of electric over other forms of lighting are well known and briefly are as follows:

First: Reduction in fire risk, due to absence of open flames.

Second: No vitiation of atmosphere, as the source of light is contained in a hermetically sealed glass bulb.

Third: Great decrease in heat generated by the lighting units on account of less total energy being consumed in the operation of the lamp and a greater percentage of that energy being utilized as light instead of appearing as heat.

Fourth: Improvements in illumination, as electric lights can be placed where the best effects may be obtained, while with other forms of illumination their location is practically determined by the construction of the car.

*From a paper read before the Central Railway Club.

Fifth: Improved appearance of car, as the fixture can be designed along more pleasing lines than is possible when using other illuminants.

While electric lighting, considering solely those items which go to making up the cost of producing the light, is undoubtedly more expensive than other forms of illumination, it is a question in the minds of many railroad officials, whether this cost is really very much greater when account is taken of the damages resulting from wrecked cars taking fire, both personal and property; when using other forms of illumination, such damage resulting directly from the use of these illuminants. However, this may be, the fact remains that the public are now demanding electric lights, and it remains for the railroads to determine how this demand can best be met.

There are three general systems that have been followed in electric train lighting steam passenger equipment, viz.: The straight storage, the head end and the axle generator systems.

The first, or straight storage system, is the most simple to install and requires less intelligent labor for it succesful operation. In this system each car is equipped with a set of storage batteries, generally 32, although cars having 12, 44 and 56 cells of battery have been used. These batteries are connected directly to the mains of the distributing switchboard, and consequently the lamp voltage and the brilliancy of the light is a function of the condition of charge of the battery, the lamp voltage varying from that of a fully shaped set to that of a discharged set, or the number of cells in series, times 2.1 volts, the E. M. F. of a charged cell, to 1.8 volts, the E. M. F. of a discharged cell. Thus, if there were 32 cells the lamp voltage would vary from 67.2 volts at full charge to 57.6 volts at end of discharge. This system is not, however, applicable, as a general proposition, on account of the following limitations:

First: The battery must be of such size that the demands upon it are well within its capacity. In considering this question of capacity of battery, it should be remembered that a decrease in temperature causes a temporary decrease in the battery capacity, this decrease being approximately at the rate of one-half per cent for each degree Fahrenheit below 70°, which is the temperature at which the capacity of the battery is taken. Unfortunately, this falling off in capacity comes during the winter, at the very time when the demands on the battery, due to short days, are greatest.

Second: The layover of the car must be sufficient to allow the batteries to be charged. It is obvious that the straight storage system cannot be successfully used if the cars are operated on a schedule that does not permit the charging of the battery, unless the batteries are changed, removing the discharged set and replacing it with a fully charged set. This exchange of batteries, while it will not overcome the difficulties of the short layover and consequent lack of charging, is an expensive method of operating, especially where the terminal yards are of any size, on account of the amount of labor involved.

Third: The layover yard should be of a size and design, and the make-up of the incoming and outgoing trains such, that it will not be necessary to move the car and interrupt the charging, but to obtain these conditions in practice is almost impossible, unless great expense for extra yard room and equipment is incurred. If the yard is congested, or the make-up of the train requires considerable shifting of the cars, the operation of the straight storage system is interfered with, resulting in expensive and unsatisfactory lighting service, or the yard operation is interfered with to the detriment of other branches of the service.

When carbon filament lamps were the only lamp to be obtained, the low efficiency of these lamps resulted in a heavy demand upon the battery, which seriously limited the application of this system.

With the advent of the metalized filament, then of the tantalum, and later of the tungsten lamp, these limits have been extended, and it is now possible to light cars on runs, which with the carbon lamp it was impossible to operate.

The higher efficiency lamps have improved the situation by decreasing the demand on the battery, and, therefore, decreasing the time necessary to recharge it, but the application of this system is still limited by the above conditions.

In order that a straight storage system of electric lighting be successful it is necessary that the terminal yards be provided with an edequate system of wiring, so that the batteries may be placed on charge, without it being necessary to place the cars on certain tracks. In other words, it should be possible to place the battery on charge wherever the car may stand in the yard.

Ample generating capacity should be installed, so that the placing of cars on charge need not be delayed due to lack of power. To provide these terminal facilities requires a considerable investment per car, and it is common experience on many roads, although the management is perfectly willing to furnish money to equip the cars, they are very slow to see the necessity of providing funds for installing adequate terminal charging facilities, and as a result of the inadequate facilities that are provided, the percentage of failures of light on cars operated on the straight storage system is geater than it should be.

The variation of voltage above referred to from 67.2 at beginning to 57.6 at end of discharge causes a great variation in the candle power of the lamps. The life and candle power of an incandescent lamp are functions of the voltage, but the percentage change of life and candle power is much greater than the percentage change of voltage, and the decrease of candle power, due to this variation of voltage, has been the cause of considerable complaint.

In order to obtain a reasonable candle power when the battery was nearly discharged, it has been customary to use a lamp that would give normal candle power at the average voltage, which for 32 cells of battery is about 63 volts.

The higher voltage to which the lamps are subjected with the battery fully charged, results in decreasing their life, by causing the bulbs to blacken, and the filaments to burn out, thus greatly increasing the cost of operation.

So far as the writer is aware no attempts toward regulating the voltage, and consequently the candle power of the lamps, have been made when using the straight storage system, although it is perfectly feasible to do so. The reason for this probably is—that to do so entails a loss of power, and the amount of power available is limited.

The second system mentioned, the head end, has generally been considered as applicable only to certain cars operated in what may be called "solid trains," that is, trains in which the cars are kept together to a more or less extent from one terminal to the other, although it frequently happens that cars are picked up and dropped en route.

This system was first used, we believe, in 1887, on a train known as the "Florida Special," this train running solid from Jersey City, N. J., to St. Augustine, Fla. It was later installed on the limited trains of the Pennsylvania and New York Central, and lately has been used quite extensively on trains operated on Western roads.

This head end system has been installed in a variety of ways, viz.:

Engine or turbine driven generator set in baggage car, taking steam from the locomotive, train lines and batteries on each car.

Engine or turbine driven generators set in baggage car, taking steam from the locomotive, train lines on each car and batteries on one or more cars.

Engine driven generator set in special car equipped with steam boiler, and train lines on each car.

Turbine generator set mounted on locomotive, taking steam from the locomotive, lamp and battery booster on tender, train lines and batteries on each car.

Turbine generator set mounted on locomotive, taking steam from locomotive and train lines on each car.

No matter how installed it requires that each car be equipped with train line wires and means for connecting these wires on adjacent cars.

The original installation referred to consisted of a three cylinder Brotherhood engine, direct connected to an Eichemeier dynamo, rated at 80 volts and 80 amperes at 850 R. P. M. These engines were very wasteful of steam and frequently broke down, but were kept in service over ten years, for the reason that no other apparatus that was offered seemed to meet the conditions as well. 20-K. W. De Laval turbines arranged to be operated at 75, 60 and 35 pounds pressure were then used and later a 15-K. W., and still later a 25-K. W. Curtis turbine generator were employed.

When this system is used without batteries, it follows that whenever the generator is not operating, there is no light. This would happen, should the engine crew shut off steam, at division points when changing locomotives, or when the train line wire is broken from any cause, such as a defective connector, connector working loose, or cutting a car in or out. This difficulty in the case of changing locomotives, has sometimes been overcome by connecting the train to a local circuit and transferring the load by means of a throw-over switch, before shutting down the train unit, but to do so interferes with the work of the inspectors in detaching the locomotive.

In the other cases mentioned the failure of light on some or all of the cars cannot be overcome, except by the use of storage batteries, and the practice is becoming more and more general to use batteries in connection with this system, on one or more cars, depending upon the funds available and the manner in which the train is broken up.

The difficulties of this system as generally used are as follows:

First: Steam pressure insufficient and supplied for only part of time.

Second: Steam hose bursting or leaking at coupling.

Third: Difference in voltage in the various cars, due to difference in "drop" in train line wires.

Fourth: When batteries are used, excess voltage on lamps due to difference in charge and discharge voltage of batteries.

In regard to the first, enginemen frequently do not turn back sufficient steam to operate the turbine at its rated pressure, and as a result it is not run at its best efficiency, or may even not carry its load. The enginemen frequently shut off the steam entirely when ascending to heavy grades or if train is late, or engine steaming badly.

The rubber steam hose generally used, frequently bursts, or leaks sufficiently at the coupling to materially reduce the steam pressure. Metallic hose has been used, but apparently has not given results sufficiently satisfactory to justify its general use.

In order to equalize the potential on the different cars as much as possible it is customary to run one wire direct from one terminal of the generator to the rear of the train, where it is connected by a "jumper," to a wire leading to the fore part of the train, to which are connected one terminal of the batteries and lamp mains on the various cars. The other terminal of the generator is connected to a wire which leads back from the forward part of the train and is correspondingly connected to the other terminal of the batteries and lamp mains on the various cars. This serves to equalize the potential between cars having the same relative position with respect to the two ends of the train, but the end cars have a greater potential than the center cars and in long trains this difference of potential is appreciable, and is noticeable on account of the difference in the brilliancy of the lights.

When batteries are used in connection with the head end system, another difficulty, due to difference in voltage is encountered. This is the difference between the voltage necessary to charge a set of batteries and the voltage of same set on discharge.

A cell requires a terminal voltage of 2.1 to 2.5 volts to charge it, depending upon the state of charge, and the same cell, on discharge, will give a voltage from 2.1 to 1.8 volts, depending on the state of discharge.

These figures, multiplied by the number of cells in series, commonly 32, will indicate the range of voltage that must be covered. That is, to fully charge the battery 85 volts are required and at end of discharge, the battery voltage is only 57.6 volts.

It is customary to use a lamp that will give normal candle power at the average condition of discharge, or 63 volts, and the batteries and lamps being connected in multiple, it follows that if the generator be operated at a voltage sufficient to charge the batteries this voltage will be destructive to the lamps, while if operated at normal lamp voltage, the batteries will not only not receive charge, but will actually discharge.

It is, therefore, customary to run at a compromise voltage, about 66 volts at the lamps when they are burning, and when not, to raise the voltage to a point sufficient to charge the battery. These are real difficulties and attempts have been made to overcome them in several ways, but with one exception, none of these systems ever really progressed beyond what might be called the experimental stage. This one was used in actual service and found fairly satisfactory, but for various reasons aside from the merits of the system, its use was not extended beyond the original installation.

These reasons were the great difficulty which would be encountered with any head end system while the cars were being equipped. The introduction of any car not properly equipped to be used with the head end system adopted, would interfere to a more or less degree with the operation of the system, while the operating department would find it practically impossible to arrange the runs of the cars so as to prevent the introduction of such cars in trains that were being operated in this manner. The matter would be further complicated where cars were operated in joint service, as such service would entail the adoption of the same head end system by the connecting roads, and the simultaneous equipping of cars.

Since the last of these systems has been tried, lamp voltage regulators have been brought out in connection with axle generators, that could readily be used with the head end system, and would overcome the difficulty in regard to the difference in potential between the batteries in a charged and discharged condition.

It is believed that the use of this system will not extend very much beyond the present stage, at least, on Eastern roads.

(To be continued.)

SIGNAL INSTRUCTION CARS, PENNSYLVANIA R. R.

To increase the efficiency of the men operating its trains, the Pennsylvania Railroad has determined to adopt the use of signal instruction cars on all of its divisions. The divisions on the main line between Philadelphia and Pittsburg have just been equipped. The company realizes that safety of operation depends upon its employes having a thorough knowledge of all signals, and it has been decided that explicit personal instructions shall be given frequently to enginemen, firemen, conductors and trainmen. The instructions to be given in this signal car will include not only block and interlocking signals, but all other signals used in the movement of trains.

The new signal instruction cars are 60 feet long, divided into two compartments. One room will be used for examinations, while the other will contain a table upon which is to be placed under a glass cover a large track chart of the railroad, which can be rolled back and forth by means of rollers placed at each end. This chart shows all main running tracks, switches, cross-overs, all signals, track troughs, stations and mile posts. The men will be given an opportunity to study this chart prior to passing an examination on it. Each car is provided with a set of model signals, which can be manipulated so as to show the signal indications the men receive on the road. The cars are in charge of examiners, each of whom has an assistant. They will have charge of all examinations, with the exception of those on machinery and air brakes. The cars may also be used for examination of employes on other subjects than signals, such as train rules.

WHY HE DIDN'T JUMP.

The following story is told of a well known superintendent of motive power who worked up through the operating department at the business end of the trains.

Wm. Grant (not his name) was pulling the throttle of a ten-wheeler ahead of a heavy freight. In the cab besides himself were the fireman, of course, and the head brakeman. After reaching the summit of a heavy grade the two on the left hand side of the cab became involved in a strenuous discussion as to what was the proper course of action in case of the sudden prospect of a head-on collision. To settle the dispute it was referred to the engineer. Bill's reply was convincing, "Stick to her, of course."

He had no sooner relieved himself of this opinion when all three spotted the headlight of another train ascending the grade down which the freight was thundering. The two men on the left side lost but few seconds in "unloading." Bill jammed on the air and then, remembering that he had only a partial air train, he released and reversed without shutting off. Under ordinary conditions he would never have been able to lift the links with steam against the old-fashioned slide valves, and when the lever passed center it went to the corner with considerable force.

The other train was a passenger, and its engineer had so nearly succeeded in getting her stopped that a smashed pilot, smoke box and headlight measured the damage. After the collision Bill closed his throttle and then remained on his seat apparently in deep thought. He was the only man on either engine, and a crowd of passengers rather worshipfully inclined gathered around his engine. The conductor of the freight rushed up after seeing that the wreck was protected, and, seeing Bill still on his seat, burst into a string of profanity. "Why in ———— don't you get down, look 'em over and find out if we can get out of here?" was his delicately worded question.

With a motion at the crowd Bill answered in a hoarse whisper: "Get them away from me and come up here." The conductor wonderingly climbed into the cab for an explanation and was surprised to hear the engineer whisper, "Help me put her over, Jim, my overalls are jammed in the quadrant."

TRAVELING ENGINEERS' ASSOCIATION.

The eighteenth annual convention of the Traveling Engineers' Association will be held at the Clifton hotel, Niagara Falls, Canada, commencing at 10:00 a. m. Aug. 16, 1910, and continuing four days. Following is a list of subjects to be discussed at the coming convention:

Fuel Economy, under the following heads:

(a) Value of present draft appliances. Can they be improved to effect fuel economy?

(b) Firing practices, including the prevention of black smoke.

(c) Roundhouse practices; whether it is more economical to knock or bank fires at terminals.

(d) Whether it is more economical to buy a cheap fuel of a low heat value or a higher priced fuel of a greater heat value.

(e) Devices and appliances for use on engines and tenders to prevent waste en route.

Superheat, as applied to locomotives.

How can the traveling engineer best educate the present-day fireman to become the successful engineer of the future?

Latest developments in air brake equipment and its effect on train handling.

What progress has been made in reducing the cost of locomotive lubrication, and is it advisable to place this item entirely under the control of the road foreman or traveling engineer?

New valve gears as compared with Stephenson or Link Motion, referring particularly to economy of operation and maintenance, and also necessary procedure in case of breakdowns.

A Experimental Mallet Articulated Locomotive*

By G. I. Evans.

A Mallet Articulated Locomotive was designed and constructed by the Canadian Pacific Railway during 1909, embodying some original features which, in addition to its being the first of its kind on this road, made it an experimental locomotive. The object of this paper is to describe briefly some of its details, tests made on it, and finally what it is doing in regular service.

As the locomotive was to be used in pushing service in the Rocky Mountains, it was necessary that it should traverse curves of at least 15 degrees and have comparatively high tractive power.

*From a paper read before the Canadian Railway Club.

The following table gives the general dimensions:

Type	0-6-6-0
Gauge	4 ft. 8½ ins.
Service	Pusher
Fuel	Bit. Coal
Tractive Power	57,400
Weight on drivers, working order	262,000
Weight, total in working order	262,000
Weight of engine and tender, working order	391,000
Wheel base, front engine	10 ft. 4 ins.
Wheel base, rear engine	10 ft. 4 ins.
Wheel base, total engine	35 ft. 2 ins.
Wheel base, engine and tender	60 ft. 7 ins.

Canadian Pacific Experimental Articulated Locomotive.

Weight on drivers÷tractive effort	4.57
Tractive effort × dia. drivers÷equivalent heating surface	975
Equivalent heating surface÷grate area	59
Weight on drivers÷equivalent heating surface	77
Cylinders, dia. and stroke HP	23¼ ins. × 26 ins.
Cylinders, dia. and stroke L.P	34 ins. × 26 ins.
Valves, dia. and kind H.P	11-in. Piston
Valves, dia. and kind L.P	12-in. Piston
Driving wheels, dia.	58 ins.
Driving axles, size	Main, 9½×12; others, 9×12
Boiler, kind	Radial stayed, wagon top
Pressure	200 lbs.
Firebox, length and width	120 ins. × 69⅞ ins.
Firebox, thickness of sheets	5-16 ins., ⅜ in., ½ in. and 7-16 in.
Firebox, water spaces	Sides, 4½ in.; throat, 5 in.; back, 3½ in.
Tubes, number and dia. in front section	281, 2 ins. O.D., and 12, 2¼ ins. O.D.
Tubes, length in front section	96 ins.
Tubes, number and diameter in rear section	289, 2 ins. O.D
Tubes, length in rear section	109 ins.
Heating surface, tubes	2,605 sq. ft.
Heating surface, firebox	180 sq. ft.
Heating surface, total	2,785 sq. ft.
Superheating surface	420 sq. ft.
Equivalent heating surface	3,415 sq. ft.
Grate area	58 sq. ft.
Tender tank, kind	Semi-water bottom
Tender frame sills	Centre, 13 ins.; sides, 10 ins.
Tender trucks, kind	Equalizer
Tender wheels, size	34 ins. dia.
Tender axles	5½ ins. × 10 ins.
Water capacity	5,000 Imp. Gals.
Coal	12 tons

The outline of the locomotive is shown by the line drawing, Fig. 1, and reference to it shows that there is considerable difference between this design and other locomotives recently put into service on American railways. The arrangement of cylinders, whereby the two pairs are brought together near the centre of the locomotive, permits of an extremely simple pipe arrangement, cutting out a number of packed expansion joints, everyone of which is a continual source of trouble through leakage. The removal of the cylinders from the front also permits of shortening the overall length of the locomotive, and, as locomotives of this type are very long, every foot possible must be saved to permit of their being taken into existing roundhouses.

Provision has been made for changing piston packing rings by simply removing the front cylinder heads, disconnecting the main rod from the crosshead, and pushing the piston out into the space between the two cylinders. The piston valves have also been taken care of in a similar manner, so there can be no objection to this arrangement on account of inaccessibility.

The boiler of the wagon top type, as shown by Fig. 2, is radially stayed, and has an unusually small front ring and smokebox. There are three separate compartments in the barrel, the front of which is practically a feed-water heater, and, owing to its small diameter, is full of water all the time. The injectors discharge into this compartment, which is connected to the boiler proper by to equalizing pipes 4 ins. in diameter, one of which is located on the side centre line and the other on the top.

The second or middle compartment is for the superheater, which consists of double loops of 1¼ ins. seamless steel

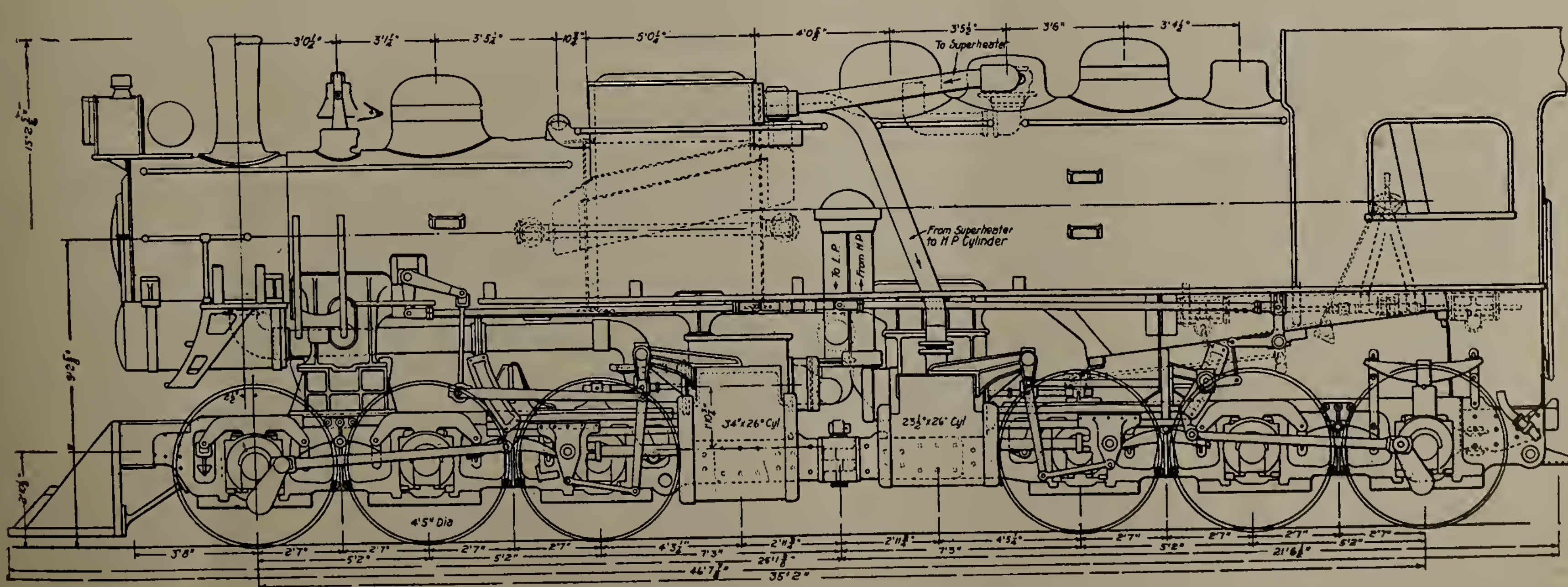


Fig. 1.—Elevation of Experimental Locomotive.

tubing dropped down into the path of the hot gases from the firebox. There are 69 of these superheater elements. One end of each connects to the saturated header, which taks steam from the boiler, and the other connects to and discharges into the superheated, which is connected direct to the H. P. cylinders. When the locomotive was first turned out the superheater was connected to the L. P. cylinders, but, from tests made subsequently, it was changed as described. The reasons for this are explained further on. Two ¾-in. blower pipes having nozzles are so located as to blow jets of steam diagonally across the superheater compartment, through the tubes, to bring down any soot which may collect.

There is no steam in the superheater pipes when the throttle is closed, but no cases of burning out have developed after about four months' service, nor is any trouble anticipated, as this condition applies, although to a lesser degree, to other types of superheaters which are giving leaving 1,555 sq. ft. in the steam generating section (tubes and firebox).

The measure of steaming capacity of this locomotive, as expressed by the formula

$$\frac{\text{T. P. (max.)}}{\text{H. S. (Total)}} \times \text{dia. drivers,} = \text{Cap.}$$

is shown in comparison with others of a similar type in the following table, and, as the Canadian Pacific locomotive has a superheater, the equivalent heating surface has been used:

Roal.	Builder.	Cap.
Can. Pac.	Can. Pac.	.975
B. & O.	A. L. Co.	.715
Gr. Nor. (road)	B. L. Co.	.813
Gr. No. (pusher)	B. L. Co.	.690
Erie	A. L. Co.	.910
D. N. W. & P.	A. L. Co.	.775
Cen. Brazil	A. L. Co.	.915

In using this factor in comparisons, it must be borne in mind that the lower its value the greater will be the capacity

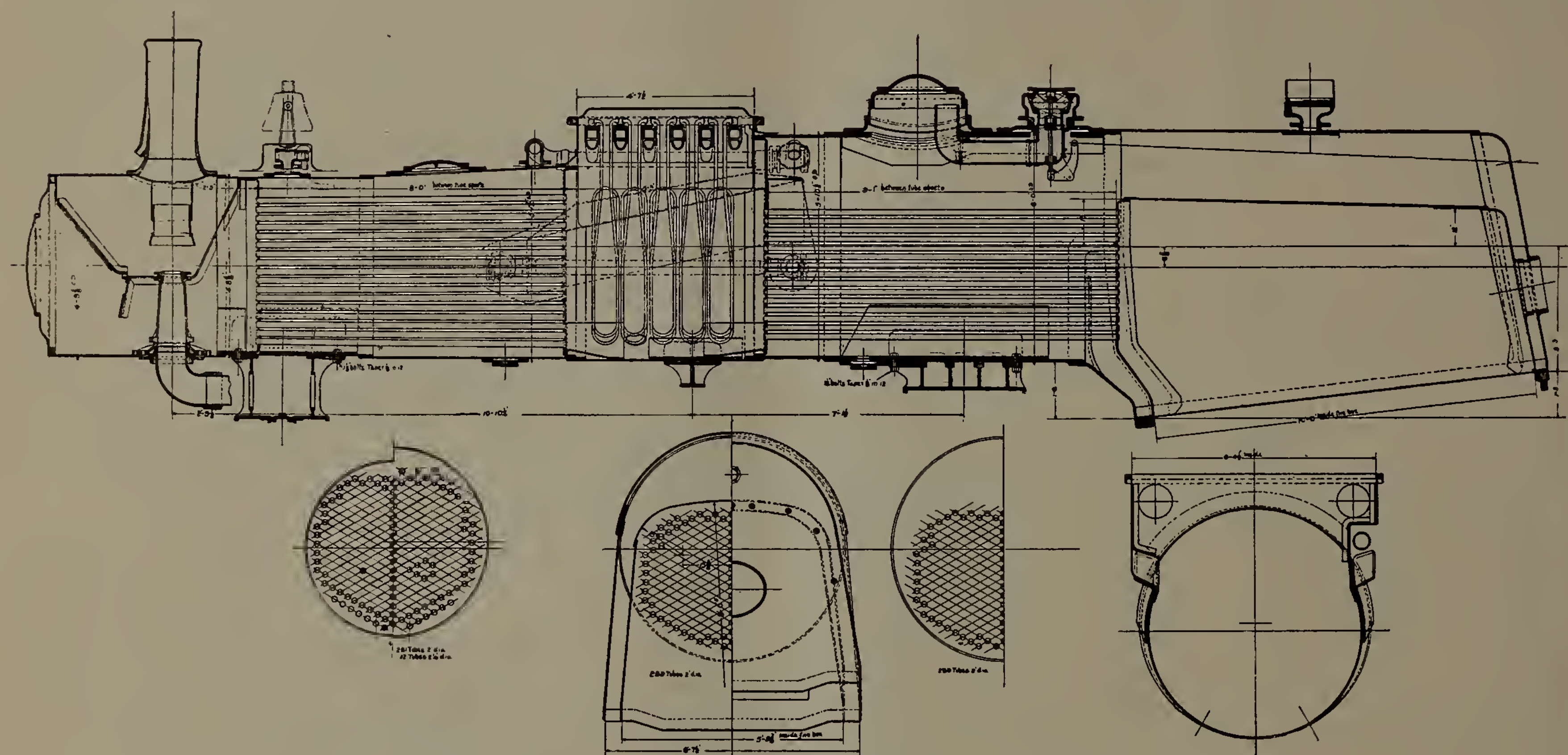


Fig. 2.—Boiler and Superheater, Experimental Locomotive.

good service. The superheater pipes are secured to the headers by union nuts, and are readily removable for repairs, one element at a time, through the opening at the top of the boiler, which is closed by a flanged steel door. If necessary, the complete superheater, header, and tubes may be lifted out bodily.

The back compartment is the boiler proper or steam generating section, and the construction is similar to ordinary boilers, except that the radii on the corners of the firebox, both inside and outside, are larger than usual. This has been done to decrease the rigidity of the sheets, which, it is believed, is largely responsible for staybolt breakage on the end rows.

There are four flue sheets in the boiler and two sets of flues. The front set is 96 ins. long and the back 109 ins., with a 63-in. superheater compartment between, and although cleaning holes have been applied underneath, it is seldom found necessary to use them, all cinders being carried through by the action of the draft.

As already stated, the front section of the boiler is really a feed-water heater, and has 281 tubes 2 ins. O.D. and 12 tubes 2¼ ins. O.D., giving 1,230 sq. ft. of heating surface, of the boiler as a steam generator, and from the above table it might seem that the Canadian Pacific locomotive would not steam satisfactorily. This, however, is not the case.

The injector check valve is located on the top centre line of the boiler, and consists of a cast-iron body, with connections for the right and left-hand injectors, and a third connection suitable for a pipe or hose coupling, which is used for filling or blowing off the boiler.

The throttle valve is located on the top of the boiler outside, and consists of an iron casting, having two 5-in. steam-pipe connections, one on either side. The joint to the boiler is made by a brass ball ring, having an opening 12¾ ins in diameter. The throttle casting extends down through this, and connects to a cast-iron dry pipe, which takes steam from a dome set further forward on the same course. The arrangement of this is shown clearly on the boiler drawing, Fig. 2.

Outside steam pipes lead from the throttle to the saturated header of the superheater, and steam, after passing through it, goes directly to the H.P. cylinders, also through outside pipes, which are heavily lagged to prevent condensation, as are also the pipes from the throttle. This portion of the piping is, of course, all high pressure, but no special importance attaches to it, as there is no movement in the pipes, the H.P. engine being attached rigidly to the boiler. There is therefore no chance of leakage if the joints are properly made.

The steam exhausts from both H.P. cylinders into a common header or receiver bolted over the ends of the steam chests, and this header connects by a 7-in. pipe to a similar one on the L.P. cylinders, which connection, however, must be flexible, as the movement of the front truck begins to affect the piping at this point, and, to minimize its effect, the connection has been placed directly over the pivot point of the front truck. The receiver pipe between the two headers extends upward about 6 ft., which was done to give sufficient volume; and this pipe, down to the point where it enters the L.P. header, is braced solidly to the boiler, and the connection which bolts to the L.P. steam chest rotates about it, due to the movement of the front engine. This rotation is about 5° on a 20° curve, which is the greatest the locomotive will be called on to traverse. The joint is packed with alternate cast-iron and babbitt packing rings, and is the only one in the pipe system in which packing is used.

The exhaust pipe connects to the cylinder and under side of the smokebox by ball joints, and both ends have a small rotary movement, but as the angular movement is only 2′ 34″ on a 20° curve, the extension between the connections is only ⅜″, which is taken up by the sliding of the pipe flanges on the flat faces on the ball rings. The flanges are held to their seats on the ball rings by 10 springs of 200 lbs. capacity each, or a total of 2,000 lbs. The extension due to the truck movement being provided for in this way, the use of the packed expansion joint is unnecessary. The arrangement of this portion of the piping, which may be called the low pressure system, is shown by Fig. 3. The dotted line shows the movements of the pipes on a 20° curve, and the diagram underneath shows the movements of the pipes as they would have been if the L.P. cylinders were at the front of the engine.

A comparison of the two arrangements shows that, with the cylinders at the front, the angular movement of the exhaust pipes would be 15° 19′ and its extension 1⅝″, which would necessitate the use of two universal ball joints with packing and a packed expansion joint instead of the two simple ball rings, which are sufficient to take up both the rotary movement and extension.

The receiver pipe movement would be the same, provided the connection to the H.P. cylinders are directly over or close to the frame connection pin. This pipe is usually given flexibility by a packed universal ball joint and a packed expansion joint.

From the above it will be seen that, with the L.P. cylinders at the front, and following the usual pipe construction, five packed joints would have been used, but with the arrangement adopted there is only one packed joint and two ball rings.

The cylinders are of the piston valve type, with inside admission on the H.P. and outside on the L.P., which permits of the most satisfactory arrangement of steam pipes. The diameters are: H.P., 24¼″×26″ stroke; L.P., 34″×26″ stroke. All four are cast separately without saddles, and are bolted together by vertical flanges in the usual manner. The H.P. have a cast-steel saddle which is common to both cylinders, and which bolts rigidly to them and to the boiler. This connection to the boiler is a very important one, the barrel being under pressure at this point, and the saddle is secured with 1¼″ bolts, having a taper of 1-16″ in 12″, driven into holes reamed from the pressure side.

The L.P. cylinders have no saddle, as there is a movement between the boiler and truck at this point. A small steadying casting has, however, been applied, which slides across the flat surface on the top of the cylinders, but no weight is transmitted to the truck by it.

The main frames are slabbed to a section 15″ deep × 3″ wide at the cylinder fits, and are braced laterally by the frame connection castings which join the two engines together. The arrangement of the cylinders and their fastening is shown by Fig. 4.

Walschaert valve motion is used. The design varies but slightly from that used on other Canadian Pacific locomotives, except in the radius bar lifting link on the L.P. engine, which, of course, must have flexible connections to permit of movement between the boiler, to which the reversing arm is attached, and the truck. It must also be made as long as possible, as, when the locomotive is rounding a sharp curve, the boiler will swing about 9″ off the centre line of the truck at this point, and the angle taken by the lifting causes the radius bar to raise in the radius link, thus shortening the travel of the valve when the engine is in forward gear and lengthening it when in backward, the radius bar being down for forward and up for backward gear. This applies to all Mallet locomotives having the radius bar suspension arranged in this manner, but is comparatively unimportant if sufficient clearance is allowed between the radius link and block at the top.

Provision has also been made for varying the cut-off in the L.P. cylinders independently of the H.P. That is, the L.P. cut-off may be lengthened or shortened without affecting the H.P.

Reference to Fig. 1 shows that the H. P. reverse shaft has two arms on the right-hand side. One of these is 11½″ long, and is connected to the power reverse cylinder, the stroke of which is 12″, and as the H.P. radius bar lifting arm is forged to the same shaft, the lift or fall of the radius bar is always proportional to the travel of the power cylinder piston. The arm on this shaft, to which the L.P. reach rod connects, has a slotted upper end with a sliding block, to which the reach rod pin connects. This block is held in any desired position by means of a screw adjustment. The shortest length of the arm is 12½″, and with the longest power piston travel of 12″, the movement of the reach rod is $\frac{12''}{11.5''} \times 12.5''$, or 13″ nearly.

If, by means of the screw, the reach rod block is moved up to 14″ from the shaft, the movement of the reach rod becomes $\frac{12''}{11.5''} \times 14''$, or 14.6″, with a consequent increase in the rise or fall of the L.P. radius bar, which will increase the travel of the valve.

A simple form of power reverse gear is used, consisting of a 6″ steam cylinder, with its piston rod connected to the reach rod shaft as described above. Rapid movements is prevented by an oil dash pot, the piston of which is connected to the same rod as the piston of the power cylinder.

The frames on each engine are in one piece, and are slabbed for the cylinder fits and for the front bumper and back footplate, which makes a very simple arrangement, there being no frame splices to break or get loose, and at the same time gives a stronger cylinder fastening. The sections of top and bottom rails are 4½″ wide × 4½″ deep, top, and 4½″ wide by 3″ deep, bottom, on both frames, and owing to the rather unusual conditions of weight distribution, the design was gone into very carefully and the sections not only checked against the piston thrust, which is usually all that is considered, but against the weights carried by the frames.

The proportion of the boiler weight carried by the front engine is concentrated at a point midway between the first and second wheels, or 31" ahead of the middle wheel, and as this is the only point on the front truck at which the boiler is supported, the weight must be such that its moment about the centre of the truck will equal the moment of the weight of the front truck itself acting at the distance its centre of gravity is located in rear of the centre of the truck.

On most Mallet locomotives now in service the above is not the case. The actual point of support of the boiler on the frames is set forward (considering a truck with the cylinders at the front) of the virtual point sufficient far to make the moment of the truck weight considerably greater. This is done to prevent rocking in a longitudinal direction, and, of course, tends to allow the truck to drop at the front, to correct which a suspension bolt working on ball seats connects the lower rail of each back engine frame to the upper rails of the front engine, and any tension put on them by screwing up on the adjusting nuts pulls down on the rear end of the front engine frame, correcting the effect of the centre of gravity of the front system falling ahead of the centre of the truck.

On the Canadian Pacific Mallet this rocking effect is checked by the frame connection castings, which have jaws that interlock in such a manner as to make longitudinal rocking impossible.

The arrangement of these castings and their pin connection is clearly shown by Fig. 4. The construction at the joint is very substantial. A turned pin 4" dia. is used, and with this arrangement of interlocking jaws the pin is put in triple shear when pulling, but for buffing shocks, which are more severe, it is entirely relieved, and the shock is taken up by the socket joint formed by the metal around the pin on the front casting fitting into a mechanical pocket on the back casting.

As the extension of the exhaust pipe, due to the truck movement, must be taken up by the sliding of the pipe flanges of the ball rings, and as only a rotary movement has been provided for on the receiver pipe, the importance of having a solid connection for the frames of the two engines is seen.

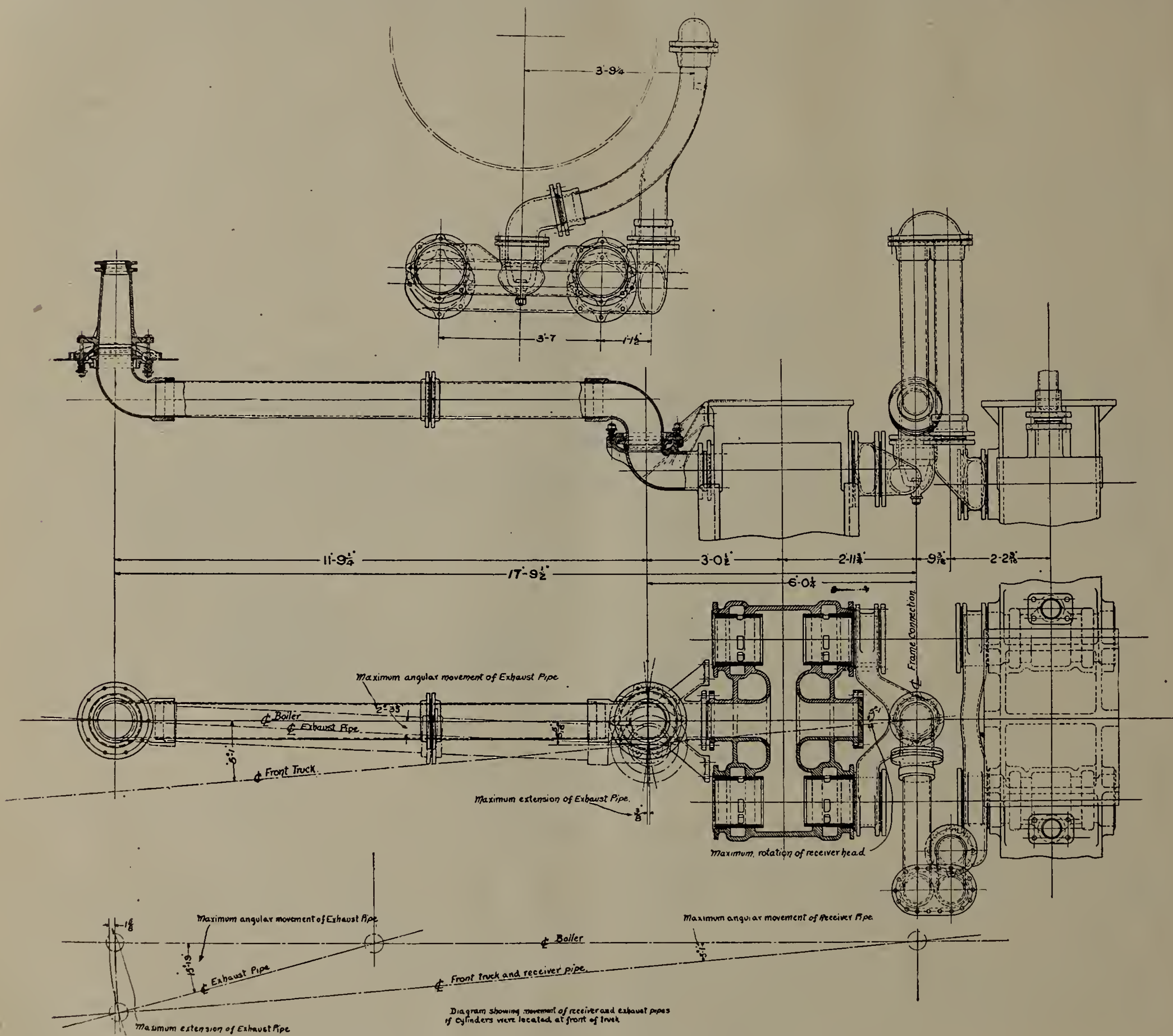


Fig. 3.—Steam, Exhaust and Receiver Pipes, Experimental Locomotive.

The spring rigging is of an ordinary type. The front engine is equalized from back to front, and has a cross equalizer at the front. The rear engine is also equalized through its whole length, but has no cross equalizers. The weights carried by the front and back engines are not equal, but are so distributed that approximately 9,000 lbs. more weight is carried by the front than by the back. As the effect of pushing or pulling a train is to reduce the weight on the front truck, and the service for which the locomotive was built calls for continued maximum tractive effort for considerable distances, it is important that the ratio of adhesive weight to tractive power be sufficiently high to ensure the engine holding the rail. As this ratio is 4.57, which is about as low as is desirable, it will be seen that any transfer of weight from the front truck would further reduce the adhesion factor and tend to make the front engine slip.

Mallet articulated locomotives are built without and with guiding trucks, and in most cases, where leading trucks are used, a truck is also placed at the rear end, back of the last pair of drivers. The theory advanced for omitting these trucks is that, in going ahead, the front engine is in itself a truck, and the front drivers are able to enter a curve against the resistance of the boiler without causing undue flange pressure or danger of derailing. On the other hand, those who advocate the use of trucks do not believe as safe an engine can be obtained without as with them. In any case,

The total area of these plates is 834 sq. in., and provision has been made for lubrication, each plate having grooves connecting with an oil box on the top casting. Under these conditions the coefficient of friction may be taken as .08, which gives 1,600 lbs. at starting as the resistance due to friction. This resistance decreases slightly, as will be explained later.

In the 8¾" space between the two friction paths on the upper casting is the roller path, which consists of two wedge-shaped blocks, having an incline of ¾" in 12. These are set with their thin ends at the centre line between the frames, and these ends have also been made flat for a distance of 2" on each side of the centre.

The roller on which the inclined blocks travel is carried by two equalizers supported on springs, which in turn are

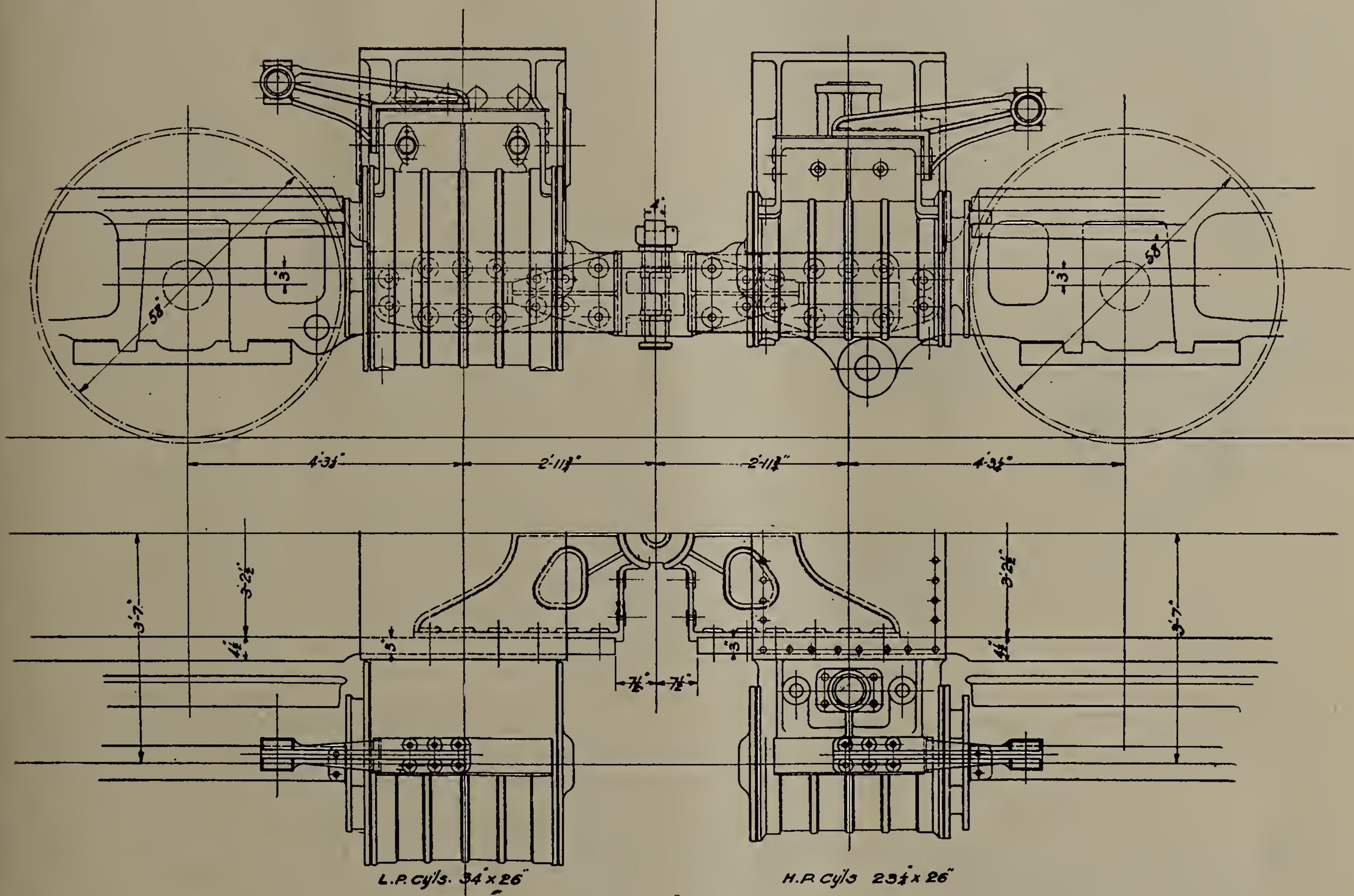


Fig. 4.—Arrangement of Cylinders and Frame Connections, Experimental Locomotive.

more advantages and better arguments can be advanced for eliminating the truck, such as the decrease in the total length of the engine, saving in weight, etc., and it can also be shown that the flange pressure is sufficiently low to ensure perfect safety.

On the Canadian Pacific locomotive trucks are not used, and the weight of the boiler, which offers the principal resistance to curving, as the truck must swing laterally underneath it, is supported partly by friction plates and partly by a spring suspended roller.

The arrangement of this device is shown by Fig. 5, and its construction and action is as follows:

There are two main castings, one of which is mounted on the frames, and the other bolted solidly to the boiler moves with it, across the frame casting. The weight of the boiler and attachments resting on the front truck at this point is 40,000 lbs., and one-half of this, or 20,000 lbs., is carried on friction plates, four of which are set on each casting, forming two approximately radial paths, with an 8¾" space between.

carried by the bottom castings, and any movement of the truck sideways, as when entering a curve, causes the inclined blocks to force the roller downward against the resistance of its supporting springs, which produces a force to pull the boiler around the curve with the truck and relieve the leading flanges of the back engine from the excessive pressure which would otherwise result. The greater the movement of the truck sideways, the greater will be the deflection of the springs, and there will be a constantly increasing rolling resistance, starting at a point which corresponds with the beginning of the incline, or 2" from the centre. The resistance at this point rises immediately to 1,250 lbs. and increases to 1,965 lbs. at 15¾", or the maximum movement sideways.

As mentioned above, the frictional resistance decreases slightly. This is due to the reduction of weight on the friction paths as the truck moves sideways, caused by the additional weight carried by the springs and, consequently, by the roller also. The decreasing frictional resistance is shown by the drop in the curve marked "frictional resistance," and begins 2" from the centre or the point where the roller picks up weight. When the locomotive is entering a curve, for the first 2" truck movement to either side the resistance is only that due to friction, or 1,600 lbs. When straightening out, as on leaving a curve, the inclined surfaces tend to slide the boiler back to its normal position on the centre of the truck against the increasing frictional resistance, thus relieving the pressure on the flanges.

The resistance may be entirely altered by changing the inclination of the wedges, or the amount of rolling or frictional resistance may be varied at will by screwing up or slacking off on the roller supporting spring nuts, which has the effect of increasing the weight on the roller and decreasing the weight on the friction plates, or vice versa.

The total resistance, however, would not be materially altered, unless the incline of the wedges were changed, which may easily be done by raising the boiler at the front, as the wedges are not cast solid with the top casting, but are held in pockets in it.

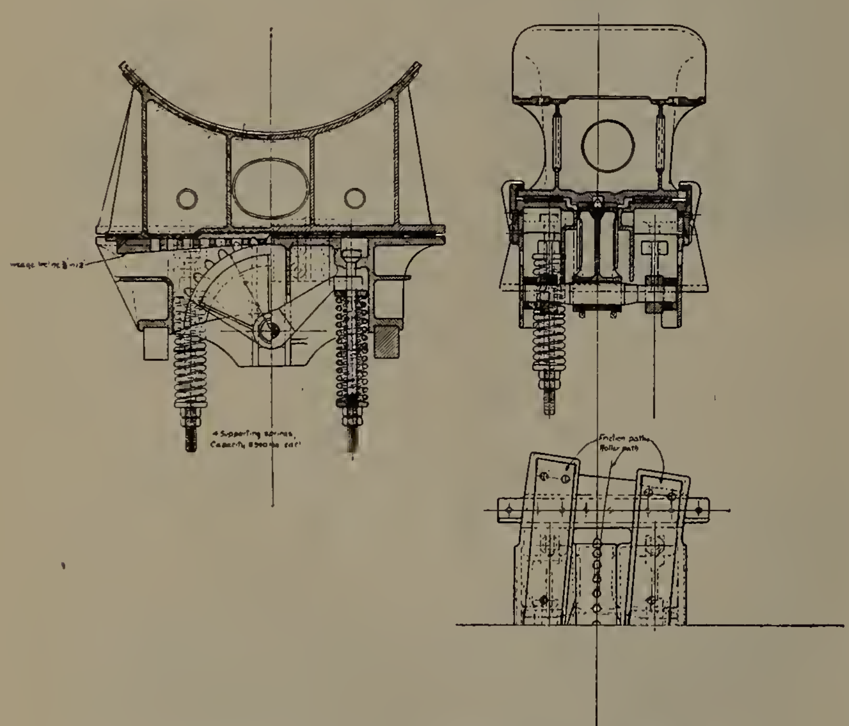


Fig. 5.—Boiler Bearing and Guiding Attachment.

TESTS.

As stated at the beginning of this paper, the locomotive was of an experimental nature, and a number of tests were made to determine if the desired results were being obtained. Thse tests were not directed towards the amount of coal and water consumed or the economy of the machine as compared with other heavy road locomotives, but were more as a check on the design in general, to show what changes would be desirable in locomotives of the same type constructed in future.

Special attention was therefore directed towards the following:

1. The receiver and exhaust pipes and their connections.
2. The boiler and machinery: whether the boiler was of sufficient capacity to supply steam to the cylinders, and what improvements could be made in the details of the latter.
3. The ability of the locomotive to curve freely, that is, traverse curves having a radius as short as any on which it would have to operate, and to do this at ordinary speeds, both heading and backing on, without danger of derailing or excessive flange wear.
4. The ability of the locomotive to develop her calculated tractive power.
5. The most satisfactory size of cylinders and arrangement of reheater or superheater, that is, what diameter of cylinder within the limits of 22" to 23¼" on the H.P. and 32½" to 34" on the L.P. would give the best results, using either reheated steam in the L.P. or superheated in the H.P.

Of these, 1, 2, and 3 could be settled by observation of the locomotive when pulling the test trains and on a 20° curve, as well as in the regular service later, while Nos. 4 and 5 necessitated the use of the dynamometer car and indicators.

The locomotive was particularly adaptable to experiment as to the size of cylinders and arrangement of reheater or superheater. The cylinders had bushings which would permit of varying their diameter and the outside arrangement of steam pipes made possible the use of a reheater for the H.P. exhause or a superheater in direct communication with the boiler at small cost.

It was apparent from the first that the receiver and exhaust pipes would do what was expected of them, and during the period of about 10 days when the locomotive was under test and 3 weeks' observation subsequently during regular service, no leakage of steam developed, nor was it even necessary to tighten up on the packing gland on the receiver pipe or the bearing plates of the sliding ball rings on the exhaust pipe. Owing to its length, the exhaust pipe has considerable capacity as a receiver, and the exhaust is very mild, but this may be considered as an advantage, as no difficulty is experienced in maintaining full steam pressure. Some leakage developed around the taper bolts which hold the H.P. cylinder saddle to the boiler, and on future locomotives other systems of fastening will be considered.

All curves were traversed freely, both heading and backing on, and, from observations made on a "Y" on which the rails were light and the curvature made 18° at one point it was proved conclusively that the artificial locomotive did less damage and curved easier than an ordinary 2-8-0 locomotive, weighing 185,000 lbs., with a rigid wheel base of 15' 10" and a total wheel base of 24' 4½", the pony truck having 5"×8" three point hangers.

The amount of flange wear after about 4,000 miles was 3-64" at the point of contact between the rail head and flange on the leading wheels, and 1-32" on other wheels, which is satisfactory service, considering the crookedness of the track on which the locomotive is operating, there being a large number of 10° curves. This amount of wear also compares very favorably with that on other locomotives in the same service.

The size of the cylinders on the locomotive, as first turned out, were 22 and 32½ × 26", or in the volumetric ratio of 2.18 to 1, and the exhaust from the high pressure cylinders passed through the reheater before entering the low pressure steam chest. Three other combinations of cylinders and position of reheater or superheater were tried, and altogether six tests were made before the final size of cylinders was determined. A large number of indicator cards was taken, and those shown in Fig. 6 are fairly representative of each test. In the table showing the summary of indicator cards the measure of steam at cut-off is expressed in terms of the following: "Steam at cut-off=(T.P. per lb. m.e.p. × cut-off % + t.p. per lb. m.e.p. × clearance %) × pressure at cut-off + 14.7."

In tests 1, 2 and 3, which were made under similar conditions, it was found that there were practically equal amounts of steam in each pair of cylinders, and that the low pressure cylinders were developing considerably greater power than the high pressure cylinders. This condition can best be accounted for by the increased volume of steam in the receiver,

Test No.	Card No	M E P	H P	Indicated Tractive Power	Steam at Cut-off Measure	Steam at Cut-off %	Work in Cylinders %	Tractive Power Total	Horse Power Total
1	5 H P	90	164	19500	37700		41		
	5 L P	60	238	28500	37600	99¼	59	48000	804
	6 H P	86	157	18650	33800		43		
	6 L P	52	207	24700	32320	96	57	43350	728
4	44 H P.	98 5	117	21300	41000		45		
	44 L. P	50	142	26000	38750	95	55	47300	518
	46 H P	91 5	109	19800	40950		44		
	46 L. P	48 5	139	25200	38600	94	56	45000	496
5	2 H P.	111 5	124	24200	42500		48		
	2 L. P.	50 5	134	26300	37300	87½	52	50500	516
	3 H P.	117 5	116	25550	44250		47½		
	3 L. P.	54 5	128	28200	39100	88	52½	53750	488
6	9 H. P.	100	194	24300	48000		46		
	9 L. P.	55	229	28600	40100	83¾	54	52900	846
	10 H. P.	99 5	193	24150	47400		45		
	10 L. P.	57	236	29600	40750	86	55	53750	858

For "Steam at Cut-off %" the largest measure in each pair of cards is taken as 100%

Test No. 1	Cylrs. 22" & 32½" x 26"	Ratio 2.18, Reheater connected to L. P
" " 2	" 22" & 32½" x 26"	" 2.18, " " " "
" " 3	" 22" & 32½" x 26"	" 2.18, " " " "
" " 4	" 22" & 34" x 26"	" 2.38, " " " "
" " 5	" 22" & 34" x 26"	" 2.38, Superheater " " H.P.
" " 6	" 23¼" & 34 x 26"	" 2.14, " " " "

Summary of Tests, Experimental Locomotive.

due to its being reheated and consequently expanded, causing excessive back pressure on the high pressure pistons, as indicated by the drop in pressure between the back pressure line on the high pressure cards and the admission line on the low pressure cards. To more nearly equalize the power, it was decided to increase the diameter of the low pressure cylinders to 34", making the ratio of 2.38, which would have the effect of emptying the receiver more rapidly, with a consequent decrease in the back pressure and rise in the M.E.P. on the H.P. pistons without materially changing the amount of work done by the L.P.

The reheater was left connected to the receiver, the lack of condensation at the cylinder cocks being very noticeable, which was a desirable feature.

The maximum temperature obtained in the L.P. steam chest, using reheated steam, was 440°, which, with a pressure of 75 lbs., would give 120° superheat.

The result of this arrangement is shown by Test No. 4, and made considerable improvement in the distribution of power, although the equalization could still be improved.

At the conclusion of this test the reheater pipes were changed to connect to the H.P. steam chest and the receiver pipe, as shown by Fig. 3 was applied. Superheated steam would thus be used in the H. P. cylinders and the exhaust would pass direct to the L.P. steam chest.

The amount of steam shown by the L.P. indicator cards in Test No. 5 now averaged about 87% of that shown by the H.P. cards, and the total amount of power as calculated from the series of indicator cards was approximately equal between the two engines.

It was next decided to try and increase the total power of the locomotive, which could still be done, as the factor of adhesion could be reduced without going below safe limits.

The most satisfactory ratio, as indicated by the previous tests, would have been 2.38, as shown by Test No. 5, but as the bushing had been removed from the L.P. cylinder its diameter could not be further increased, and the H.P. only were changed, their diameter being increased to 23¼", or a ratio of 2.14. Although the L.P. cylinder diameters could not be increased, their cut-off could be lengthened by means of the adjusting arm, previously described, without changing the cut-off in the H.P., which would have a similar effect in reducing the back pressure on the H.P. pistons.

The results obtained with this arrangement are shown by Test No. 6, and, everything considered, it was the most satisfactory which had been tried. The power had been increased, and the amounts developed by each engine were reasonably well balanced.

The decrease in the measure of steam in the L.P. cylinders, due to the position of the superheater, is well illustrated in this test of comparing it with No. 1, in which the amounts were very nearly equal.

As the tests just described indicated that the best results would be obtained with cylinders 23¼" × 26" on the high pressure engine and 34" × 26" on the low, and with the high pressure cylinders taking steam from the superheater, the locomotive was therefore put into regular service in the Rocky Mountains, pushing on the gade eastward from Field to Stephen. The maximum grade is 2.2% and there are two spiral tunnels of 2,890 ft. and 3,200 ft. long, having a radius of 573′ 0″.

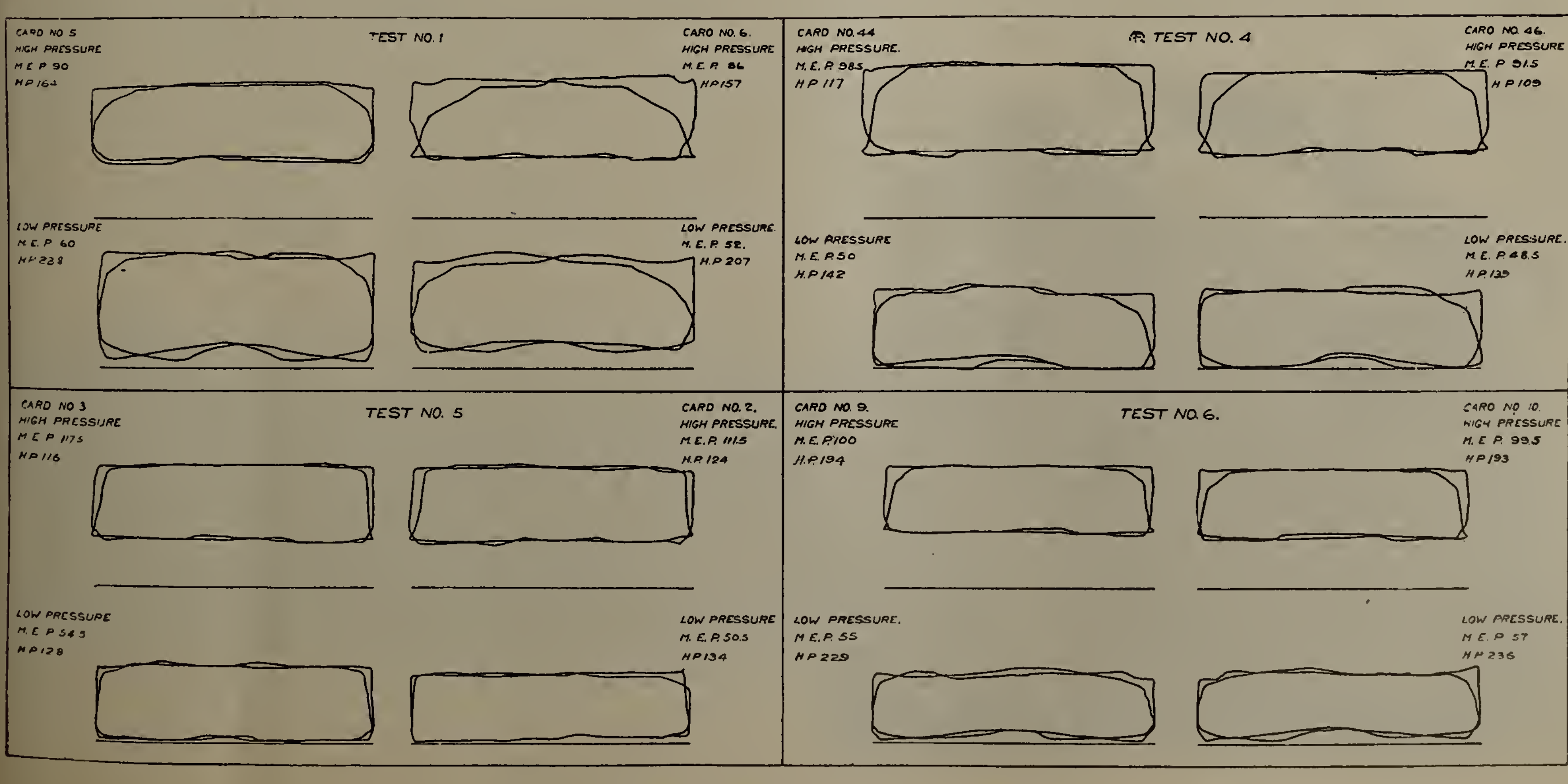


Fig. 6.—Indicator Cards, Experimental Locomotive.

Fig. 1.—New Tank Car Compared with Conventional Design of Same Capacity.

The full rating of the regular locomotives in summer is 424 tons, and on the same basis the Mallet locomotive should handle 660 tons, which it does without trouble, and has also taken up 700 tons, which may be considered the maximum tonnage for this grade.

Dominion coal was used on the tests made at Montreal. This is a friable, rather fine coal, and an average of the analysis of 25 samples gives the fixed carbon as 55.71%, and the heat value 13729 B.T.U's.

That used in regular service is known as Canmore coal, and is mined in the Rocky Mountains. It is much finer than the Dominion coal and very dusty, and must be thoroughly wet down before firing, otherwise a considerable percentage goes up the stack in the form of cinders. It is rather higher in fixed carbon than the former, but the heat value is about the same.

The locomotive steamed as successfully with the Canmore coal as it did with Dominion coal, although adjustments were necessary in the smokebox diaphragm and draft pipes, the diameter of the exhaust nozzle with both coals being 4¾".

The maximum temperature shown in the receiver pipe in service was 350°, and the average was about 345°. As the pressures ranged from 60 lbs. to 75 lbs., this would give from 38° to 25° superheat in the receiver.

The amount of condensation in the L.P. cylinders is very small, and the cylinder cocks are closed after a few revolutions, which, of course, tends to decrease the water consumption.

As the locomotive has not been in service sufficiently long, no figures are available as to cost of maintenance, but it is to be expected that, as there is practically double the amount of machinery, this will be somewhat higher than on the consolidation locomotives in the same service. The operating costs will be slightly higher when considered on a locomotive mile basis. The same crews do the work for the same wages, but more lubricant, waste, and sand must of necessity be used, and the cost of wiping and cleaning will also be higher. On a ton mile basis, which is the fairest comparison for operating cost, it will be lower, due to the greater tonnage hauled, which, it is considered, together with the saving in fuel, will show considerable economy in favor of the Mallet locomotive.

Fig. 2.—Body Bolster and Draft Gear Housing, New Tank Car.

Interesting Design for Tank Cars

The accompanying illustrations show in detail design of a tank car recently built by the Chicago Steel Car Co., Chicago. The car has proved a success in service and its manufacture in large orders is assured. Mr. H. C. Priebe of the mechanical department is directly responsible for the details.

It will be noted that there is an absence of any underframing and that the car consists simply of the tank with its interior stiffening and the trucks with, of course, the addition of the bolsters, draft, rigging, etc. The design of the car is made possible by the construction of the body bolster which is clearly shown in Figure 2. Figure 1 shows the completed car compared with a tank car of the conventional design. It will be noted that the new design lowers the center of gravity considerably—eighteen inches, in fact. This is a feature very much to be desired, of course, provided nothing essential is sacrificed to that end.

The tank stiffening, which renders a center sill unnecessary, is produced in any one of three ways. Figure 3 may be called design "A." This method does away with a structural longitudinal sill entirely. The bottom tank plate is increased in thickness to ⅝ of an inch. The plates of the end bulkheads are bent downwards and rivetted to the bottom plate in such a manner as to form a tensional resistance member. This design may be preferred in the tanks constructed for

Fig. 3.—Tank Without Structural Stiffening, Design "A."

the purpose of carrying heavy oils when interior structural members might cause congestion.

Figure 4 illustrates a tank fitted with a center sill which extends into the end bulkheads and which is securely rivetted top and bottom at the ends. For want of a better name this construction might be called design "B." The construction in this case does not call for tank metal of heavier stock than in the ordinary design.

Figure 5 illustrates a tank which for all practical purposes is so constructed as to include what would be the center sill better to allow for easier repair in the case of accident by making the draft gear housing detachable. In extent of bearing this bolster conforms to M. C. B. standard requirements with a liberal percentage to spare.

In selecting between the methods of construction it is probable that design "C" would produce the best result. It is hardly probable that any serious objection to an interior structural sill can be made, in which case design "A" would find little favor. Design "B" is simply a modification of the other two.

Fig. 4.—New Tank Car, Design "B."

of the completed car and the result is a lowering of the center of gravity to an extent only limited by the clearance of the wheel flanges, while still preserving all the essentials of the conventional style steel underframe cars. In design "C" the channel shapes comprising the longitudinal sill are split and sawed at the bulkheads, the top sections extending to the ends of the tank where they are securely anchored.

Returning to the body bolster shown in Figure 2, it will be seen that its construction remains the same in all three tank designs. While the draft gear housing could easily be made in one piece with the bolster proper, it was thought

In the general drawing, Figure 6, all the details common to the three designs are shown. The running board and other attachments are bolted to an extension of the body bolster. Some of the dimensions shown on this drawing bring out the advantages of the general construction, and it is expected that the essential feature of a low center of gravity will find favor among those who have been troubled in the past by derailments which have been credited to the unsteadiness of loaded tank cars.

An additional advantage in this tank car is the fact that it can be made from 2,500 to 4,000 lbs. lighter than the

Fig. 5.—Tank Equipped with Center Sill and Lateral Bracing, Design "C."

standard tank car of the same capacity. This is an advantage which will appeal to transportation officials, who are accustomed to figure haulage cost at about two mills per ton mile.

It has been suggested that an application of the principals involved in the above could be made to the construction of locomotive tenders. The design would seem to be particularly adapted to tenders of the Vanderbilt type. Whether or not difficulties would arise to prevent such an adaptation is yet to be demonstrated.

Stress Thrown Upon Bolts by The Wrench

By W. N. Allman, Mechanical Dept., B. & O. R. R.

It is quite impossible to calculate accurately the stress that a bolt is subjected to by screwing a nut upon the end of it; it is, however, possible to obtain a rough computation or an approximate stress when the bolt is screwed up solidly against some resisting structure.

For example, suppose that a given bolt or stud is provided with a nut which is to be screwed up tightly against some resisting structure so as to throw a tensile stress in the bolt. Let the nut be turned by means of a wrench whose effective length be "l" inch. When the nut has been advanced and brought apparently well up into place, let us suppose a force "P," representing the force of the workman applied at the end of the wrench, be applied, and it is found that in the most effective manner, will just move it. The work done by the man at the wrench, per revolution of the nut under these conditions is found by multiplying the force, "P," by the circumference of the circle described by the end of the wrench at the point at which the force is applied. For one turn of the wrench a force "P" at the handle would pass over a distance equal to "$2\pi l$," at the same time the axial load "T" would be moved a distance "p" along the axis.

Let us assume that the screw runs absolutely without friction, either in the nut or against the surface where the nut bears against the seat. Then the work performed by the workman is all expended in stretching the screw, or deforming the structure to which it is attached.

Under the assumed condition of perfection the equation for the equality of the work at the handle and at the screw is

$$P2\pi l = Tp$$

$$\text{or } T = \frac{P2\pi l}{p}$$

where

P = force applied at the end of wrench
π = Pi, = 3.1416
l = length of wrench in inches
T = Axial load, or tension in bolt
p = distance nut travels on screw in one turn of the wrench

From the above we could calculate the tension, "T" on the bolt if the screw were absolutely frictionless in all respects, friction, however, is always present and it is necessary to make some allowances for the fact that in the real screw the friction is very far from being negligible. Hence the ratio of useful work "Tp" to the work applied "$P2\pi l$" is not unity as above relations assume. Then by introducing the efficiency in the above formula we have,

$$\frac{T\,p}{P\,2\,\pi\,l} = \frac{l}{l + n\,d}$$

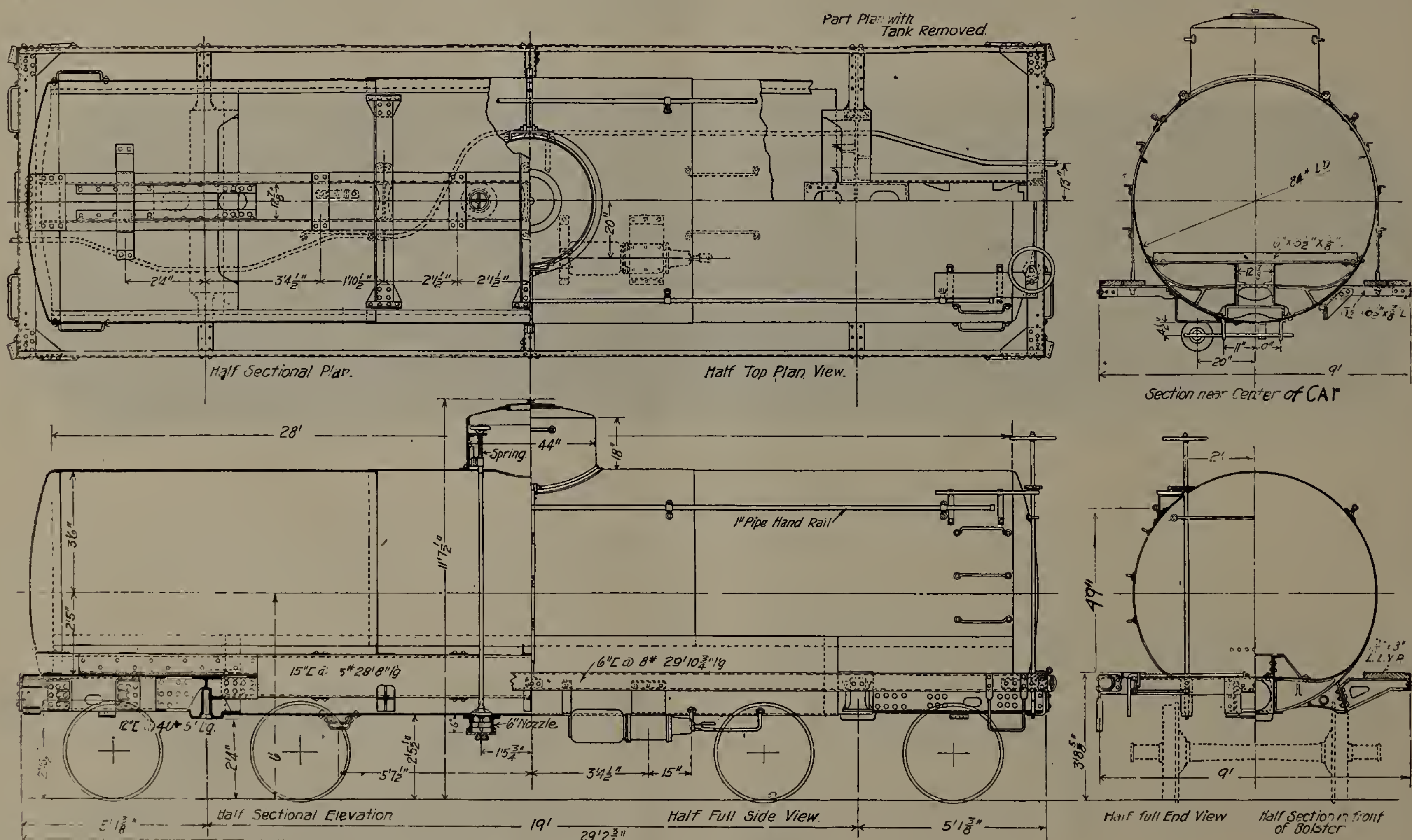
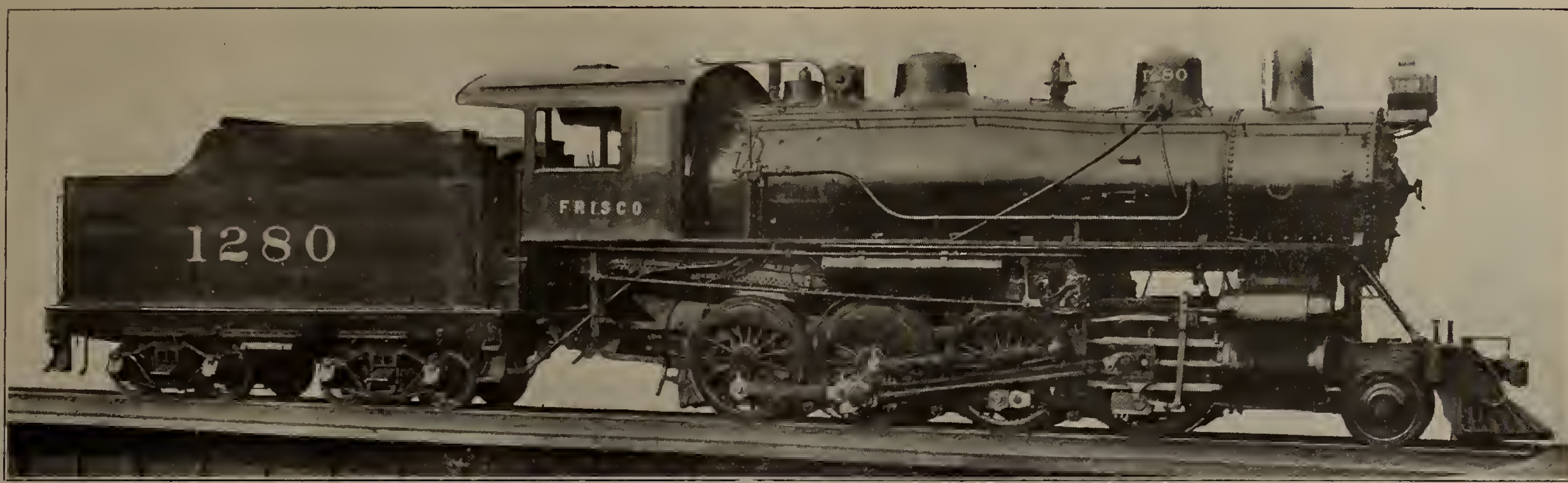


Fig. 6.—Elevation, Plan and Details of New Tank Car.

The actual tension that the given screw would produce in the bolt would be smaller than the value here calculated, and the friction (which will be known by the letter "E") by which the foregoing result must be multiplied in order to obtain the true result, is called the efficiency of the screw.

The efficiency of screws has been studied both experimentally and theoretically; but the experimental data on this subject is far less numerous than one might suppose, considering the elementary character and the fundamental importance of the screw in nearly every branch of applied mechanics.

In the transactions of the American Society of Mechanical Engineers, Volume 12, 1891, pages 781 to 789, there is a paper on screws by Mr. James McBride followed by a discussion by Messrs. Wilfred Lewis and Arthur A. Falkenau



Consolidation Locomotive, St. Louis & San Francisco R. R.

to which we desire to direct the reader's attention. In this discussion Mr. Lewis gives a formula for the efficiency of a screw of the ordinary kind which has proven to be quite correct of a screw of the ordinary kind which has proven to be quite correct for all ordinary purposes, this formula is written as follows:

$$E = \frac{i}{1 + n\ d}$$

where

E = the efficiency
n = the number of threads per inch
d = the external diameter of the screw

If we multiply the value of "T" as found above by this "factor of efficiency" the value of "T" as corrected for friction becomes,

$$T = \frac{P\ 2\ \pi\ l}{(I + n\ d)\ p'}$$

As an example of the application of this formula, let us consider a case in which a workman turns up a nut on a ¾ in. bolt by means of a wrench whose effective length is 30 inches, the maximum effort exerted at the end of the wrench being say 100 pounds. A standard ¾-in. bolt has 10 threads per inch, then the formula becomes

$$T = \frac{100 \times 2 \times 3.1416 \times 30}{(I + 10 \times \frac{3}{4})\ \frac{1}{10}} = \frac{18849.6}{.85} = 22{,}176 \text{ lbs.}$$

That is the actual tension in the bolt is over 22,000 pounds, according to the formula.

In setting up a nut on a bolt, it very often happens that a workman will take a wrench and slip a piece of pipe over the end of it to obtain a greater leverage, and then apply the force at the end of the pipe, which sets up an enormous stress in the bolt, and without proper caution strains it to its elastic limit. Under such circumstances as this there is little use in trying to compute the tensile stress upon the bolt. It rarely happens, however, that a large bolt is actually pulled apart by the wrench, a small one may be and often is; but the tensile strength of a bolt say 1½ or 2 inches in diameter is so great that even the most violent mishanding usually fails to cause direct and immediate separation, but repeated application of excessive stress may cause the bolt to fail after a short time, however, by "fatigue" of the material.

In tightening up the nuts on studs of cylinder heads on a steam cylinder in order to make the heads absolutely steam tight it requires some initial tension in the bolt, then if the studs stretch enough to relieve the initial pressure between the two surfaces then their stress is due to steam pressure only.

It is to be noted that for cases of mere fastening the safe tension is high, as just before the joint opens the tension is about equal to the load and yet the fastening is secure. On the other hand bolts or studs fastening joints subjected to internal fluid pressure must be stressed initially to a greater amount than the working pressure which is to come on the bolt. This initial stress is a matter of judgment on the part of the workman, the designer in order to be on the safe side should provide ample size bolts so that the bolts will not be broken off by a careless workman accidentally putting a greater force than necessary on the wrench handle.

New Locomotives For The St. Louis & San Francisco R. R.

The Baldwin Locomotive Works have recently completed 35 locomotives for the St. Louis and San Francisco R. R. These engines are divided into two classes, 20 being of the Pacific type for passenger service, and 15 of the consolidation type for heavy freight service. The two designs will be considered separately.

Pacific Locomotive, St. Louis & San Francisco R. R.

Pacific Type Locomotives.

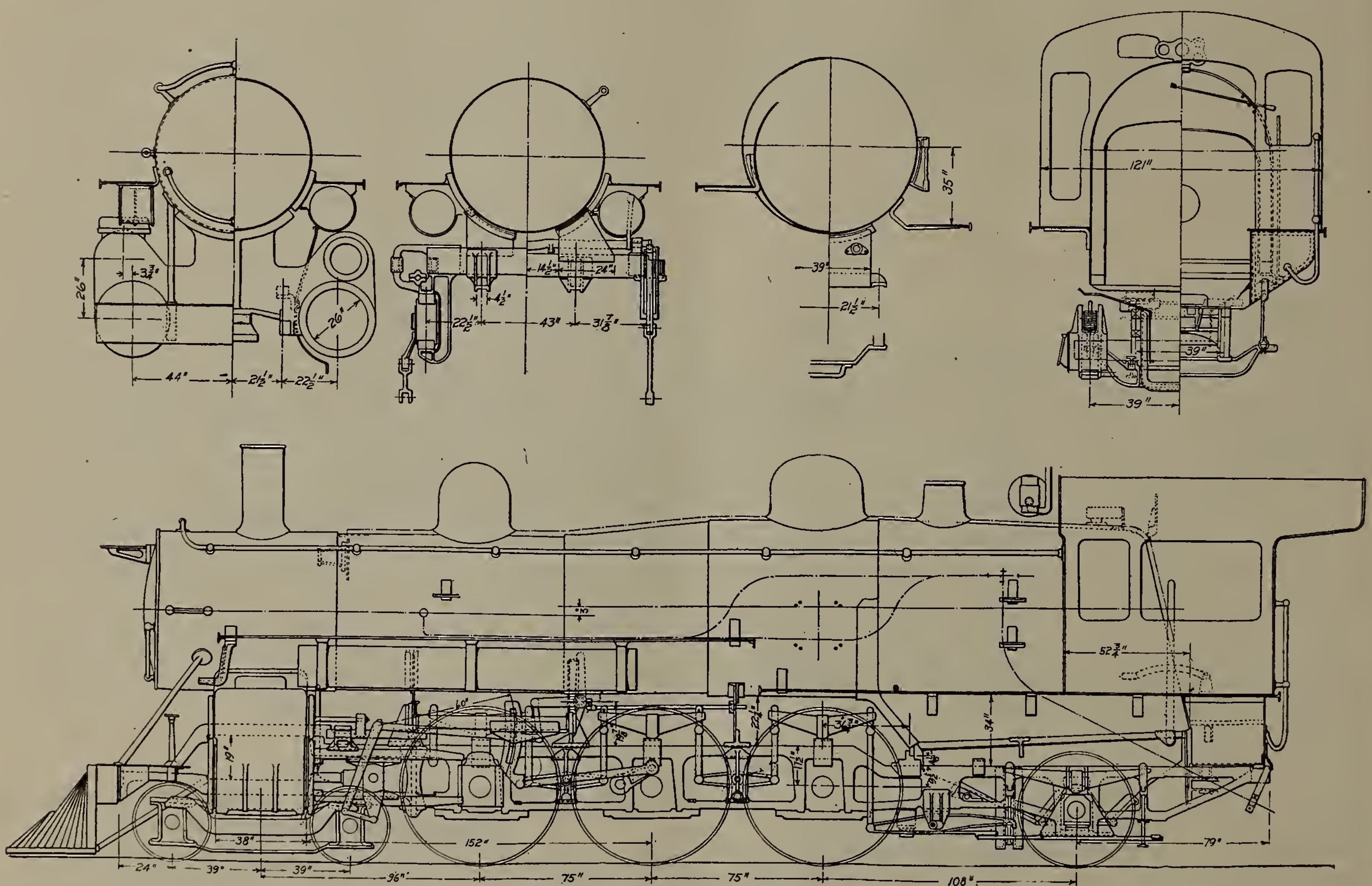
These engines use superheated steam at a pressure of 160 pounds, and the maximum tractive force developed is 37,300 pounds. The locomotives are designed to traverse 16 degree curves.

The boiler used in this design is of the extended wagon-top form, and is arranged to accommodate a fire tube superheater of the Emerson type. The firebox has a sloping throat and back head, and is radially stayed. Two "T" bars, hung on expansion links, support the front end of the crown, and 300 flexible staybolts are disposed in the breakage zones in the sides, back and throat. The barrel is composed of three rings, with butt-jointed diamond seams on the top center line. The superheater elements are placed in 24 tubes 5 inches in diameter, arranged in four vertical rows of 6 tubes each. The headers are straight and stand in a vertical position. The saturated steam section divides at the top of each while the rear bracket is formed in one piece with the cast steel guide bearer. The cross-head is provided with a lug, to which the valve road is secured.

The main frames are of cast steel, 4½ inches wide, while the rear sections are of the same material, and measure 4 inches in width. The front rails are of forged iron. Cast steel is used for the equalizing beams and beam fulcrums. The rear truck is of the Hodges pattern, with outside journals. The truck is equalized with the drivers; the springs are mounted over the truck boxes, and the side swing is taken by the spring hangers, which are jointed for the purpose.

Consolidation Type Locomotives.

These engines follow Rock Island standards in many respects, and use saturated steam at a pressure of 185 pounds. The tractive force exerted is 39,600 pounds. This design illustrates an increasing tendency to use fairly large wheels on



Details of Pacific Locomotive, St. Louis & San Francisco R. R.

header, and extends downward on either side of the superheated steam section which is centrally located. A plug is placed in the front wall of the header opposite each pipe. The superheated sections of the two headers are connected, at the bottom, by a horizontal equalizing pipe. Application has been made for a patent covering this design of superheater. The arrangement of the front end is in accordance with the Master Mechanics' standard. The adjustable diaphragm plate is located in front of the nozzle, and a petticoat pipe is placed under the stack. A single nozzle is used.

The steam distribution is controlled by inside admission piston valves, 13 inches in diameter. The steam lap is 1 inch, and the exhaust clearance ⅛ inch; the valves are set with a maximum travel of 5¾ inches and a constant lead of ¼ inch. Walschaert motion is used, and a simple design of gear has been worked out. The links are carried by longitudinal bearers, outside the leading drivers. Each combining lever is pinned to a long cross-head supported in suitable brackets. The front bracket is bolted to the top guide-bar, eight-coupled locomotives, as the drivers are 63 inches in diameter. Flanged tires are used throughout.

As to the Pacific type locomotives, the boilers are of the extended wagon-top type, with wide firebox. The water spaces measure five inches in width all around, and the side water legs incline slightly outward as they rise. The front end of the crown is supported on three rows of expansion links. The arrangement of flexible stay bolts is similar to that used in the Pacific type. The longitudinal seams in the barrel are sextuple riveted, and welded at the ends. The dome ring has a welded seam on the top center line.

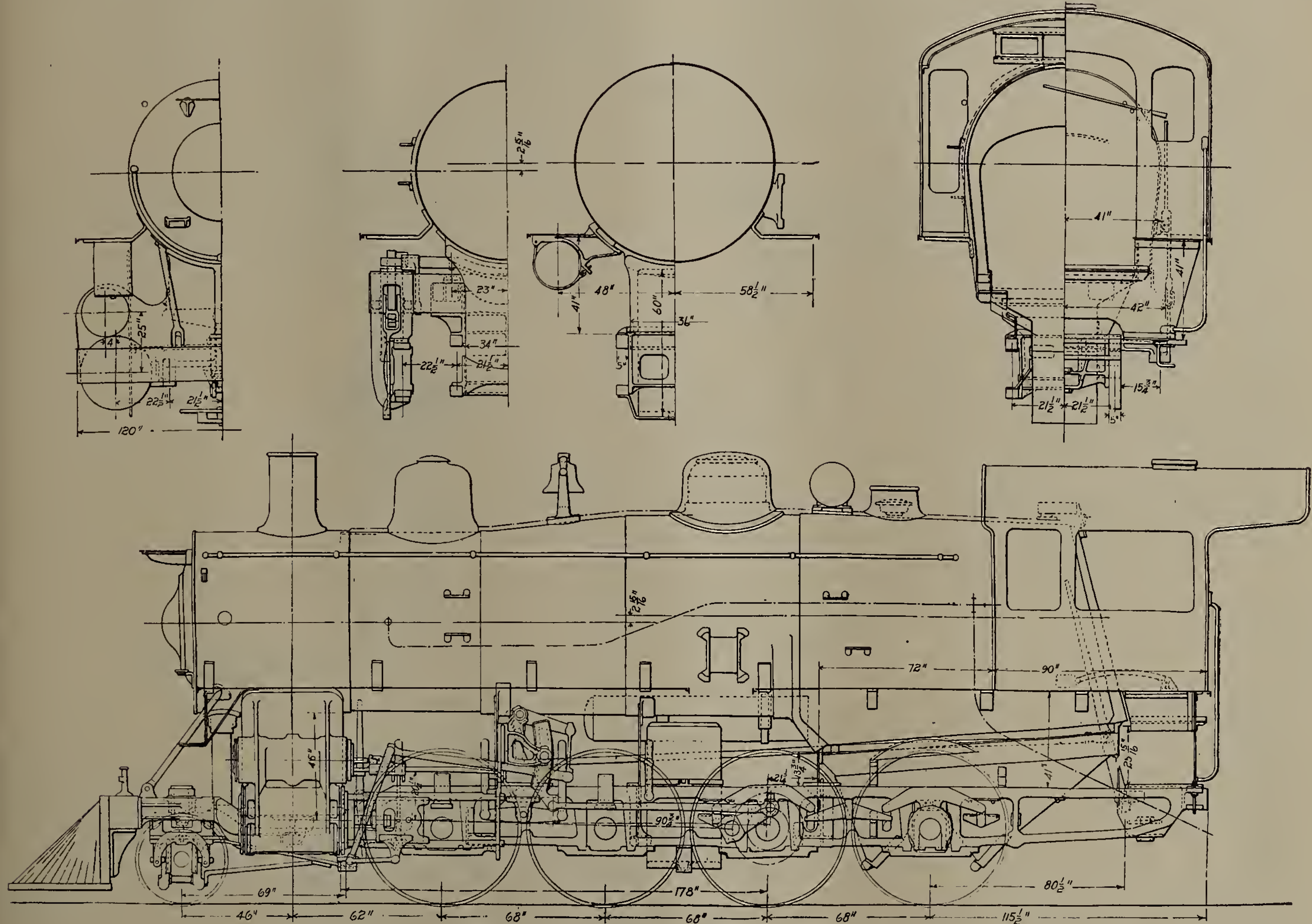
The steam distribution is controlled by inside admission piston valves, 12 inches in diameter. These are set with a travel of 6 inches and a constant lead of 3-16 inches. The steam lap is 1 inch, and the exhaust 0 inches. The cylinder walls are sufficiently thick to be subsequently rebored and bushed down to the original diameter, if desired.

The link and reverse shaft bearings are bolted to the guide yoke. This arrangement provides ample room for a long eccentric rod, as well as for a convenient length of radius road. The latter is extended beyond the link, and is suspended from its rear end. The upper end of the combining lever is coupled to a cross-head, to which the valve road is attached.

The frames are of cast steel 5 inches in width, and each frame is in one piece with a single front rail which passes under the cylinder saddle. Immediately in front of the cylinders the frames are bolted to a steel deck casing. The transverse frame braces include three substantial steel castings. One is bolted to the lower rails, immediately back of the first driving pedestals and under the guide yoke; another is placed between the second and main driving axles, and is bolted to both the upper and lower frame rails; while the third is located under the front end of the firebox. The

Pacific Type.

Gauge	4 ft. 8½ in.
Cylinder	26x28 in.
Valve	Balanced Piston.
Boiler—	
Type	Wagon Top.
Material	Steel.
Diameter	68 in.
Thickness of sheets	11-16 and ¾ in.
Working Pressure	160 lbs.
Fuel	Soft Coal.
Staying	Radial.
Fire Box—	
Material	Steel.
Length	108 in.



Details of Consolidation Locomotive, St. Louis & San Francisco

first and second pairs of driving wheels are equalized with the engine truck; the two remaining pairs are equalized through beams placed over the boxes, and connected by an inverted leaf spring.

The absence of any inside valve motion allows room between the frames for a large air drum, which is supported in a vertical position ahead of the main driving axle. A second drum is hung under the running board, on the right-hand side.

The tenders of both classes have steel frames composed of 13 inch channels. The trucks are of the arch-bar type with cast steel bolsters. In the case of the passenger locomotives, the engine and tender truck wheels are steel-tired, whil the consolidation engines have solid forged and rolled steel truck wheels throughout. All these wheels were supplied by the Standard Steel Works Co.

The principal dimensions of both classes of engines are given in the accompanying tables:

Width	68 in.
Depth, front	72¾ in.
Depth, back	65 in.
Thickness of sheets, sides	5-16 in.
Thickness of sheets, back	⅜ in.
Thickness of sheets, crown	7-16 in.
Thickness of sheets, tube	⅝ in.
Water Space—	
Front	4½ in.
Sides	4½ in.
Back	4½ in.
Tubes—	
Material	Iron.
Wire Gauge	5 in., No. 9; 2¼ in., No. 11
Number	5 in., 24; 2¼ in., 174
Diameter	5 in. and 2¼ in.
Length	20 ft.

Heating Surface—
Fire Box ... 185 sq. ft.
Tubes ... 2,667 sq. ft.
Total ... 2,852 sq. ft.
Grate Area ... 51 sq. ft.

Driving Wheels—
Diameter, outside ... 69 in.
Diameter, center ... 62 in.
Journals, main ... 10½x12 in.
Journals, others ... 9x12 in.

Engine Truck Wheels—
Diameter, front ... 33 in.
Journals ... 6½x10 in.
Diameter, back ... 50 in.
Journals ... 8x14 in.

Wheel Base—
Driving ... 12 ft. 6 in.
Rigid ... 12 ft. 6 in.
Total Engine ... 32 ft. 9 in.
Total Engine and Tender ... 64 ft. 9 in.

Weight—
On Driving Wheels ... 134,900 lbs.
On Truck, front ... 47,550 lbs.
On Truck, back ... 38,200 lbs.
On Trailing Wheels ...
Total Engine ... 220,650 lbs.
Total Engine and Tender, about ... 370,000 lbs.

Tender—
Wheels, Number ... 8
Wheels, Diameter ... 33 in.
Journals ... 5½x10 in.
Tank Capacity ... 7,500 gals.
Fuel Capacity ... 14 tons.
Service ... Passenger.

Engine equipped with Emerson superheater, superheating surface, 590 sq. ft.

Consolidation Type.

Gauge ... 4 ft. 8½ in.
Cylinder ... 23x30 in.
Valve ... Balanced Piston.

Boiler—
Type ... Wagon Top.
Material ... Steel.
Diameter ... 74 in.
Thickness of sheets ... ¾ and 3-16 in.
Working Pressure ... 185 lbs.
Fuel ... Soft Coal.
Staying ... Radial.

Fire Box—
Material ... Steel.
Length ... 120 in.
Width ... 60 in.
Depth, front ... 69¾ in.
Depth, back ... 56¼ in.
Thickness of sheets, sides ... ⅜ in.
Thickness of sheets, back ... ⅜ in.
Thickness of sheets, crown ... ⅜ in.
Thickness of sheets, tube ... ⅝ in.

Water Space—
Front ... 5 in.
Sides ... 5 in.
Back ... 5 in.

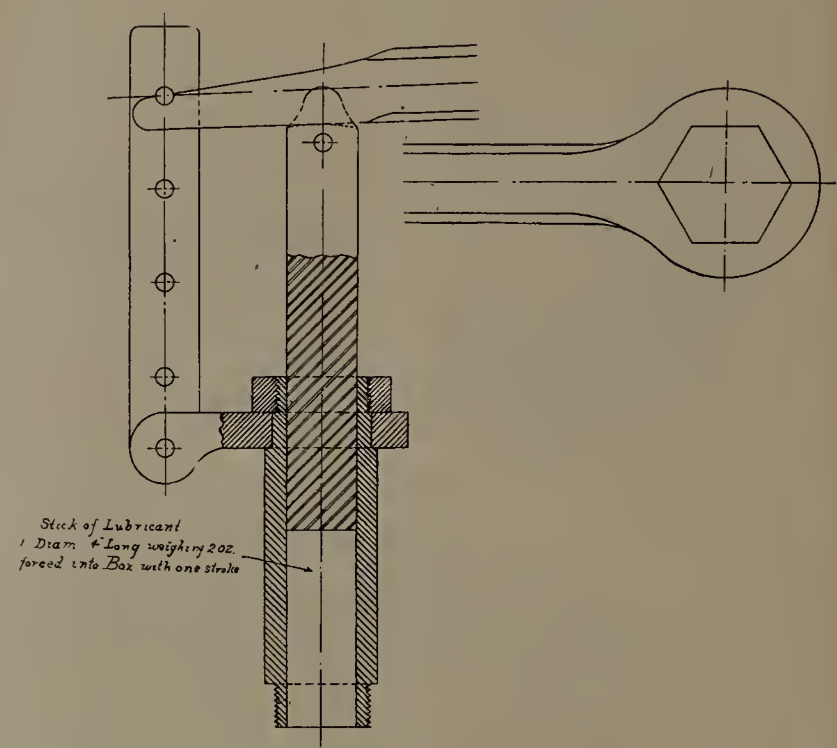
Tubes—
Material ... Steel.
Wire Gauge ... No. 11
Number ... 340
Diameter ... 2 in.
Length ... 15 ft. 6 in.

Heating Surface—
Fire Box ... 176 sq. ft.
Combustion Chamber ...
Tubes ... 2,745 sq. ft.
Firebrick Tubes ...
Total ... 2,921 sq. ft.
Grate Area ... 50 sq. ft.

Driving Wheels—
Diameter, outside ... 63 in.
Diameter, center ... 56 in.
Journals, main ... 10x12 in.
Journals, others ... 9x12 in.

Engine Truck Wheels—
Diameter, front ... 36 in.
Journals ... 6x12 in.
Diameter, back ...
Journals ...

Trailing Wheels—
Diameter ...
Journals ...



Grease Box Filler.

Wheel Base—
Driving ... 17 ft.
Rigid ... 17 ft.
Total Engine ... 26 ft.
Total Engine and Tender ... 58 ft. 1½ in.

Weight—
On Driving Wheels ... 187,350 lbs.
On Truck, front ... 20,200 lbs.
On Truck, back ...
On Trailing Wheels ...
Total Engine ... 207,550 lbs.
Total Engine and Tender, about ... 360,000 lbs.

Tender—
Wheels, Number ... 8
Wheels, Diameter ... 33 in.
Journals ... 5½x10 in.
Tank Capacity ... 7,600 gals.
Fuel Capacity ... 12 tons.
Service ... Freight.

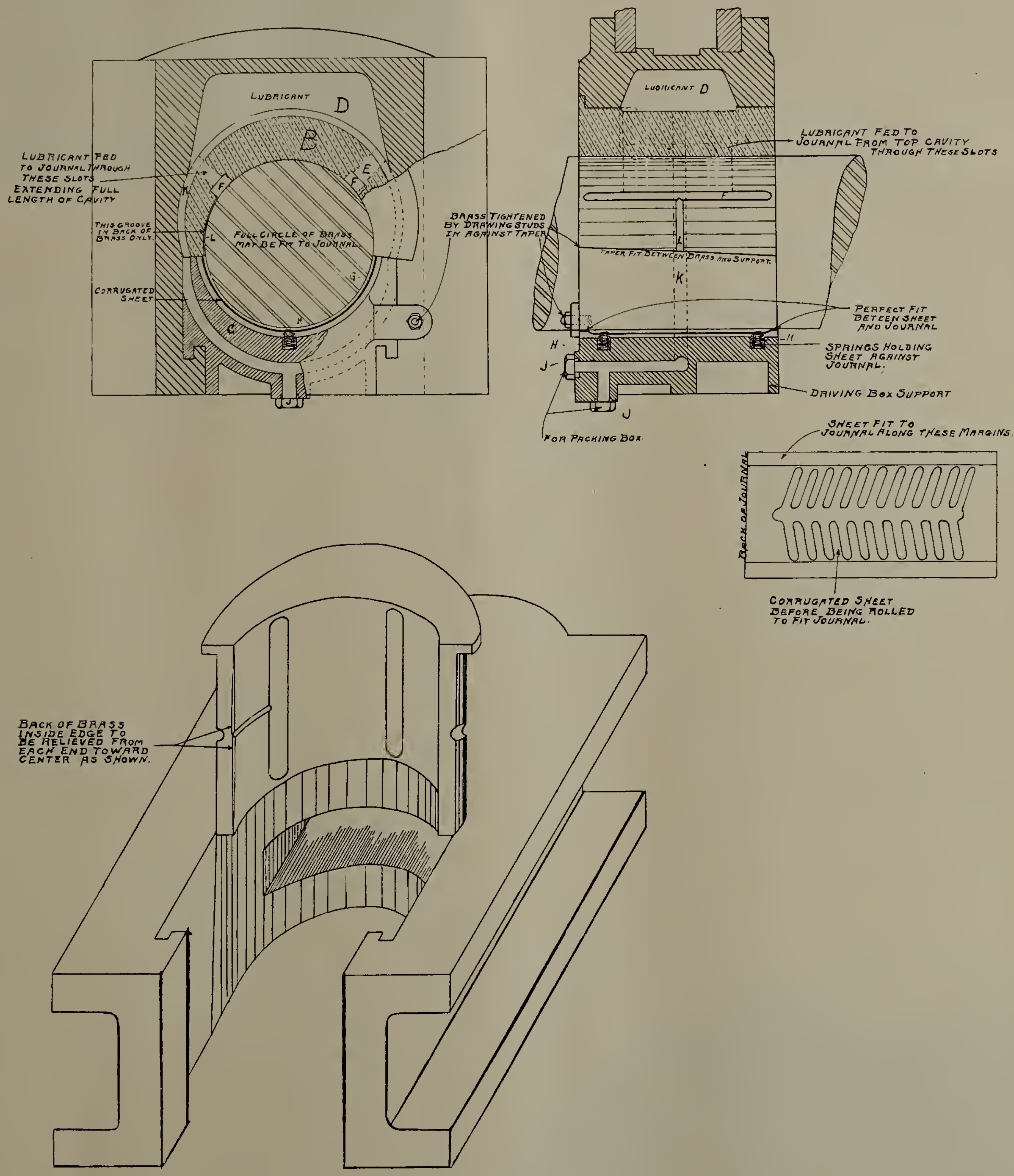
An Improved Journal Box

The accompanying drawing shows a new design of journal box for locomotive driving journals which has been in service on engines of the western division of the Wabash Railroad for the past year. This journal box was designed and patented by Asst. Master Mechanic L. K. Smith of Moberly, Mo. This journal box is past the experimental stage and has proved satisfactory and economical since its application. Its main features are: A removable brass, full bearing to center of axle, method of lubrication, and the box held rigid or solid at the bottom.

The brass can be removed and a new brass applied by one man and in one hour's time, without dismantling any part of the engine, thereby eliminating the present practice of placing the engine over a drop pit to remove the wheels, boxes, etc. This feature will be readily appreciated by all railroad officials, as it prevents removing engines from service to renew driving

eliminate machine work on boxes as engines come to the shop for general overhauling and also prolong the life of the box.

On the drawing, figure "A" represents the driving box, "B" the brass, and "C" the cellar or wedge for holding in place the brass. The design of the driving box is a radical departure from the ordinary box now in use. The upper part above the brass is cored out for receiving and holding the proper amount of grease for running the brass from shopping to shopping. This cavity is marked "D." The lubricant, or grease, is fed to



New Locomotive Driving Box.

brasses. The brass is removable and does not require the use of the hydraulic press to apply the brass to the box. The brass is turned to a neat fit, and has bearing to the center of the journal, which will, in a great measure, prevent the pounding of journal bearings.

The brass is held securely in place by the cellar or wedge. The top edge of the wedge and the lower edge of the brass, being tapered, hold the brass in place under all conditions. The wedge is held in place by the two studs shown on the drawing. The shoe and wedge faces will remain parallel, on account of the mechanical construction of the cellar and box. This will

the journal through the outlets "E" and into cavities "F," covering the entire width of journal.

A corrugated sheet "G" is placed under the journal and held in position by the two small coil springs marked "H." This sheet stands away from the journal about ⅛ inch, except at each end where it has a tight fit, thereby preventing the grease from working out. This cavity is filled with grease.

The packing of driving box with grease is very simple, and does not require a competent mechanic. Either of the plugs "J," one under the cellar and one on side of cellar, is removed and the device, especially designed for packing the box with grease, is applied, the operator filling the pump with grease cartridges 1 inch in diameter and about 4 inches long, each cartridge weighing 2 ounces. This is forced into the box until the cavities are filled. The grease, after entering the cellar, is forced up through the cavities "K" in cellar and brass, to the main cavity "D." The grease is fed to the journal automatically by expansion, when the engine is in motion, and the revolving journal carrying it to the corrugated sheet under the journal, filling the corrugations, which are so constructed that the overflow of grease is carried back into grooves "F" through groove "L" at the back of the brass only, thereby permitting no waste, whatever, of the grease. Another drawing shows the simple device used for packing grease cups and journal boxes.

Recomended Changes in Rules of Interchange*

Preface, 3rd Paragraph. All inspection of freight cars foi interchange will be made in accordance with the following rules and the M. C. B. Rules for Loading.

Rule 7. Change first paragraph to read: "Shelled out: wheels with defective treads on account of cracks or shelling out spots 2 inches for cars of 80,000 capacity or over and 2½ inches or over for cars of less than 80,000 capacity, or so numerous as to endanger the safety of the wheel."

To make the wording of this rule consistent with Rule 19 and gauge dimensions.

Rule 9. Change to read: "Worn through chill; when the worn spot is two inches or over in length for cars of 80,000 capacity of over, 2½ inches or over in length for cars of less than 80,000 capacity. Care must be taken to distinguish this defect from flat spots caused by sliding wheels."

To make wording consistent with gauge dimensions.

Rule 10. Change to read: "Worn flange, cast iron or steels wheels; Wheels under cars of less than 80,000 pounds capacity, with flanges having flat vertical surfaces extending 1 inch or more from tread, or flange 15-16 inch thick or less, gauged at a point ⅜ inch above tread. Wheels under cars of 80,000 pounds capacity or over, with flanges having flat vertical surfaces extending ⅞ inch or more from tread, or flange 1 inch thick or less, gauged at a point ⅜ inch above tread. (See figs. 4 and 4a).

Worn flange, steel and steel tired wheels; flange having flat vertical surfaces extending 1 inch or more from tread, or flange 15-16 inch thick or less, (see figs. 4 and 4a)."

The above changes are suggested so that the wording of the rule will be consistent with gauge dimensions, and also more clearly define the rule as it relates to cast iron or steel wheels.

Rule 11. Change last line of this rule to read: "standards of 1907 and 1909. (See Fig. 2-a)."

Standard for wheel tread adopted in 1909 has been added.

Page 9, Figure 2-a.

Maximum flange thickness gauge shown in this figure and M. C. B. circular dated January 1, 1910, relating to same, should be changed in accordance with the following sketch for the reason that gauge cannot be laid out as per circular. The dimensions given on sketch are based on the standard flange dimensions.

Page 10, Figure 4-a.

Change notes under this figure to read: "For cast wheel under cars of less than 80,000 pounds capacity, and all steel or steel tired wheels with flanges 15-16 inch thick or less; cast wheels under cars of 80,000 pounds capacity or over, with flanges 1 inch thick or less.

Reworded to make note clear to inspectors.

*Adopted by the Central Railway Club, March 11th, 1910.

Page 11, Figure 4-a.

Change note under this figure to read: "For cast wheels under cars of less than 80,000 pounds capacity, and all steel or steel tired wheels 1 inch or more from tread; for cast wheels under cars of 80,000 pounds capacity or over, ⅞ inch or more from tread.

Rule 18. Chipped flange: If chip is on throat or on the opposite side of throat of flange and exceeds 1½ inches in length and ½ inch in width, or if it extends ⅛ inch past center of flange.

Rule 19. Flat sliding: If the spot caused by sliding is 2 inches or over in length on cars of 80,000 lbs. capacity or over, and 2½ inches or over, on cars of less than 80,000 lbs. capacity.

(Care should be taken to distinguish this defect from worn through chill.)

Rule 19a. Cars equipped with steel or steel tired wheels with slide spots 2 inches or over in length, delivering company shall be responsible for same, a defect card to be furnished for the labor of turning.

The delivering company shall also furnish a defect card at the time to be forwarded to the car owner covering loss of service metal.

Rule 20. Broken flange, except as in rule 14; chipped flange if the chip is on throat side of flange, and exceeds 1½ inches in length and ½ inch in width, or if it extends ⅛ inch past center of flange if not caused by defective casting; broken rim, if not caused by defective casting, if thread measured from the flange at a point ⅝ inch above tread is 3¾ inches in width (see Fig. 5) or any breakage caused by unfair usage, derailment or accident.

Rule 22. Axles broken or having seamy journals, fillets in back shoulder worn out, or collars broken off or worn to ¼ inch or less under fair usage. Pitted journals: if journals can be trued up, a labor charge only to be made. If journal cannot be trued up owner to be responsible for same.

Rule 33. Cars equipped with air-brake hose other than 1⅜ inch, M. C. B. standard, and so branded, after Sept. 1st, 1909, except cars offered in interchange, where delivering company is responsible.

Note: Cars equipped with 1¼ inch M. C. B. standard hose and so branded, applied prior to Sept. 1st, 1909, will be accepted in interchange.

Note: A fac-simile of the badge plate to be incorporated in the rules for the guidance of the inspectors, and the figures designating the size of the hose on the badge plate be increased to ¼ inch or 5-16 inch.

Rule 38. Locks: Side and end doors and fittings, roof doors, grain doors, water troughs and attachments, and all inside and concealed parts of cars, missing or damaged under fair usage and failure or loss, under fair usage of any parts of the body of car, except as provided for in rules 42 and 87. All cars not originally equipped with retaining valves.

Rule 42. Material missing from body of car offered in interchange, except locks, grain doors, water troughs and attachments, and all inside and concealed parts of car.

Rule 43. M. C. B. couplers not equipped with steel or wrought iron knuckles. The manufacturer's name to be stamped plainly on each knuckle.

Rule 45. Cars equipped with M. C. B. couplers having pocket rear-end attachments and so stenciled, if found with stem or spindle attachment in place of pocket, or any car having tandem attachment, found with pocket for single spring.

Rule 49 to 59 inclusive. It is recommended that the combination of damage be eliminated, and that a new rule be incorporated making the combination to read one end sill

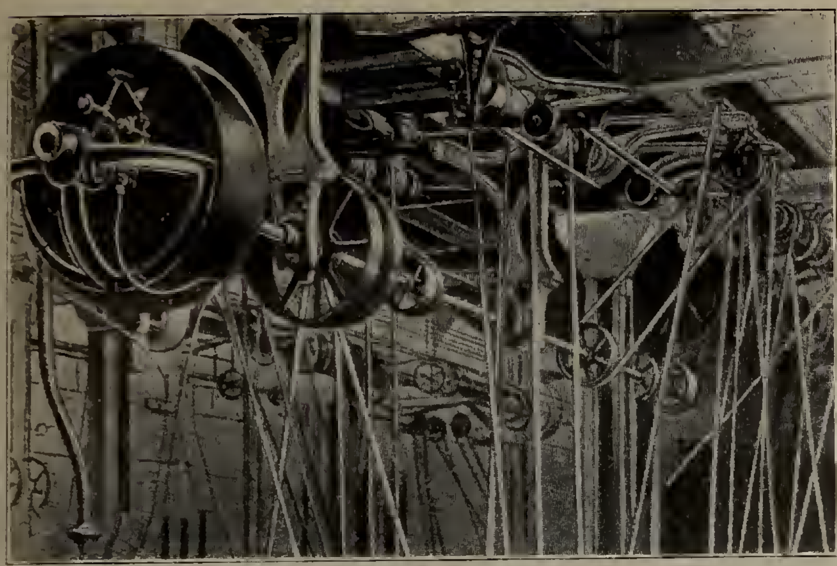


Fig. 1.—One Method of Arranging for Group Drive.

and two longitudinal sills. Also to incorporate in this rule, or a new rule to take the place of 55 to read: damaged longitudinal sills, if necessitating the replacement or splicing of more than three sills.

Rule 56. Change this rule to eliminate the combination on the end of car, and make it read: Damage to end of car or any portion of same broken outwardly, will be considered owners' defects.

Rule 65. Change to read so as to provide that "splice 9B be the only splice shown in the rules for good cars."

Rule 71. In replacing air-brake hose on foreign cars for which bills are made, new 1⅜ inch M. C. B. standard air hose, so branded, must be used.

Rule 89. Change the price for removing wheels to $2.00 per pair or any style of truck instead of the present rates.

Rule 113. Your committee request that proper consideration should be given the portion of this rule referring to the application of metal center sills. That "when cars are equipped with metal center sills less than 12 inches, $80.00 shall be added to the bodies, and cars equipped with metal center sills 12 inches or over, $120.00 shall be added to the value of the body for cost of such sill." Inasmuch as they do not consider the increase of $40.00 on the value of body sufficient, and that some should be increased in value.

Also add to this rule, when cars are equipped with metal draft gear continuous from end to end of car in combination with metal needle beams, $40.00 shall be added to the value of car bodies for the cost of such metal draft gear.

Your committee respectfully recommends any cars exceeding the inside dimensions of those given by the American Railway Association shall have the dimensions, both inside and outside over-all, stenciled on the side of car for the guidance of the inspectors giving the necessary information.

T. J. O'Donnell, Arb. Niag. Frnt. Insp, Ass'n.
B. H. Hawkins, M. M., D. L. & W. R. R.
R. S. Miller, M. C. B., N. Y. C. & St. L.
I. S. Dowling, M. C. B., L. S. & M. S. Ry.
M. Meehan, F. C. R., Erie R. R.
W. Shone, G. F., N. Y. C. & H. R.
J. S. Lentz, M. C. B., L. V. R. R.
C. Montgomery, M. M., P. M. Ry.
W. H. Williams, M. M., B. R. & P.
W. H. Sitterley, G. Insp., P. R. R.
C. E. Spoor, M. C. B., B. & S. Ry.

Committee.

Mechanical Features of Electric Driving in Machine Shops*

It is with the mechanical features of motor driving that this paper is to deal, and chiefly with what has been done in the electrical equipment of the most commonly used machine tools in the plant of the General Electric Company, at Schenectady, with a few sketches of some large work that has been erected outside.

Some ten or twelve years ago it was decided to erect a large and up-to-date electrically driven machine shop, and plans were started some time ahead of the completion of the building. At first the plan was to have every machine tool individually driven, but the time was so short that we abandoned this idea and concluded to arrange the machines in groups, driven by a motor direct-coupled to the end of a section of lineshaft. This arrangement was used only to take care of small and medium-sized machines, of which few, if any, were at that time equipped with individual motors.

Considerable difficulty was experienced in arranging the lineshafts and countershafts in this system, owing to their being traversed by small side-bay electric cranes. Figure 1 gives a general idea of this method of group-driving. However crude it may appear in the light of present practice, it was considered in its time thoroughly up-to-date.

One of the mechanical difficulties encountered in attaching individual motors to small machines was the unwieldy size of some of the earlier motors of small capacity. Sometimes the motor would be as large or larger than the machine and this feature was largely responsible for the prevalence of group-driving of small machines, even where the individual drive would have been preferred. Recent improvement in motor design has led to a great reduction in the size of motors for a given capacity, so that the 25-h.p. motor of today is not nearly so large as the 10-h.p. motor of earlier years. It is therefore much easier now to make the motor an integral part of the machine; and even where only fractional parts of a horsepower are required, for light operations, suitable motors of very small weight are now available which are well adapted in size to the smallest tools.

Small Machine Tools

Figures 2, 3 and 4 show good examples of individual motor drives, in which the motors are inconspicuous and form in-

*From a paper to be read before the American Society of Mechanical Engineers.

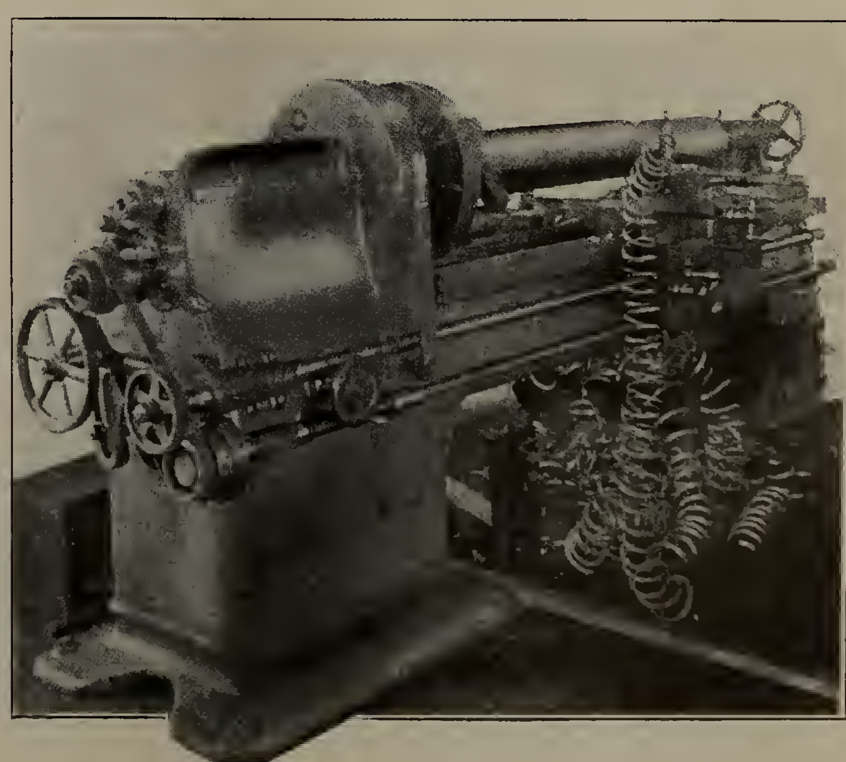
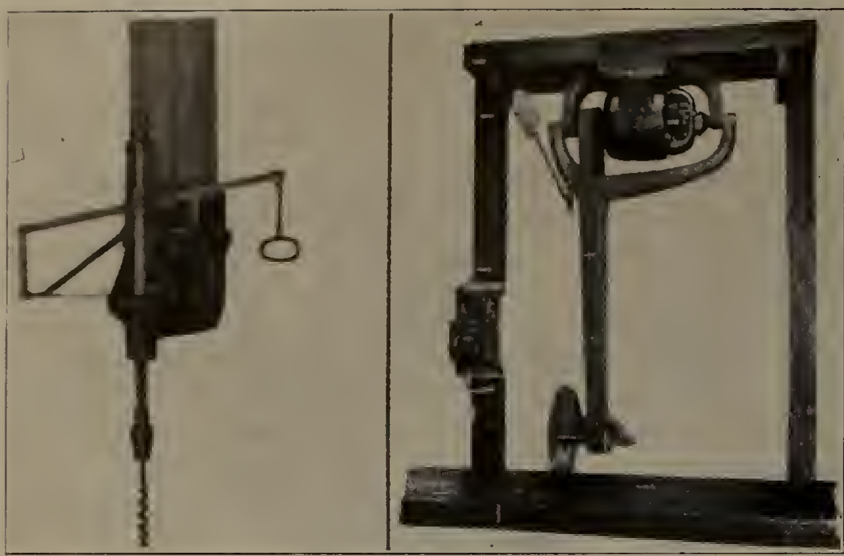


Fig. 2.—Lathe with Induction Motor Concealed in Leg.



Figs. 3 and 4.

tegral parts of the machine tools. Figure 2 shows a lathe driven by an induction motor concealed in the cabinet leg. Figure 3 illustrates a wood-boring machine driven by an induction motor through a single pair of bevel gears. The inverted motor is bolted to a plate, which is in turn bolted to the bottom of a post and to the frame of the tool. At first, the plate was arranged to swivel on the tool post, in order to provide means for moving the tool longitudinally over the work; but later, this adjustment was abandoned, as it proved to be easier to move the work horizontally with reference to the tool. This tool is a good example of the compactness of the electric motor, and its easy adaptability to wood-working machinery. Figure 4 shows the application of a direct-current motor to a 24-in. swing saw.

Large Machine Tools.

The large lathes, vertical boring mills, planers, milling machines, etc., were supplied each with its own individual motor, which was a marked improvement over the original belt-and-countershaft methods of driving. Since starting this work, the company has changed over several thousand machine tools to motor drives. Most of the difficulties in changing from belt to motor driving were in making suitable connections between the motor and the tool to be driven. We do not pretend that in every case we have adopted the best arrangement, as in many cases the machine tool is not of sufficient value to warrant an expensive mechanical connection.

Take, for example, a medium-sized lathe of relatively moderate value. If an expensive transmission device was required in order to apply a motor to the lathe, the total cost of the lathe, as changed, might easily be more than the price of a new lathe especially designed for motor driving. In such cases it is found expedient to erect the countershaft and cone about four feet above the headstock, on suitable brackets, fasten the motor in a convenient place on the machine, and contine the use of cones and belts.

In all cases where old machine tools are converted to electric driving, it is desirable to mount the motor on some part of the machine if possible, rather than on the floor near the machine. In the former case, the machine tool constitutes an independent self-contained unit which can be moved by the crane as a whole and located wherever desired. Cleanliness is promoted, by leaving a clear floor space to sweep, and the motor is less liable to accumulations of dirt caused by sweeping. There is also a tendency for the motor and the machine tool to become shifted out of alignment, if they are separately mounted on the floor.

For lathes of more importance, and where the value of the tool warrants, we make an all-gear drive, with reversing gears, which are used principally for screw cutting. Figure 5 shows a lathe equipped with reversing gears. More recently we have produced motors which can be very quickly reversed, obviating the necessity of reversing-gears.

When the original change was made from belt to motor drive there was one particular triple-geared lathe, 72-in. swing, to which we applied a two-to-one variable speed motor. The only change necessary in this case was to substitute two gears for the lathe cone, mounted on a quill, and made to engage with a pair of rocking gears on the motor. This gave a speed variation of four to one at the motor, and with the triple gears of the lathe, we had an exceedingly fine speed range. The motor is placed in a most advantageous position, in the headstock underneath the spindle. During about ten years' service it has never been removed.

In a shafting department like that of the General Electric Company, where the range of size does not vary over three or four inches on the standard work, no very great speed changes are necessary, and a two-to-one motor usually has range enough to meet all requirements. What is particularly needed is ample power, strength of parts, and simplicity of construction, especially in lathes used for roughing, which are usually handled by unskilled labor.

For finishing shafts, however, where greater accuracy is required, an all-gear drive with steel gears is not satisfactory, because the chattering set up by the action of the gear teeth is very apt to be transmitted to the finished work, leaving parallel ridges. This difficulty was overcome in some special lathes which we had built for the purpose, in which the driving gear on the main spindle was left loose and acted on the driving plate, keyed to the spindle, through four rubber buffers. This device is shown in Fig. 6.

More recently, trouble from this same cause was experienced in one of our tool departments, and was corrected by the use of a pinion made of muslin. This pinion has several features which specially adapt it to motor-driven machine tools. It is practically noiseless and very durable, does not shrink, and is sufficiently flexible and elastic to absorb vibrations which might be transmitted to the finished work.

Another application to motor driving in connection with lathes, and one that has been much appreciated, is the use of an auxiliary motor to operate lathe carriages having a long travel, of about 35 ft. The motor is bolted to one side of the carriage, and carries a pinion which meshes with the hand-wheel gear. A two-way switch is provided for operating the motor in either direction. The use of a motor not only saves the operator a difficult task, but it has also proved a great economy of time. It formerly required 30 to 35 minutes to shift the carriage through its full travel, and the hand wheels were placed so low that a man had to stoop to use

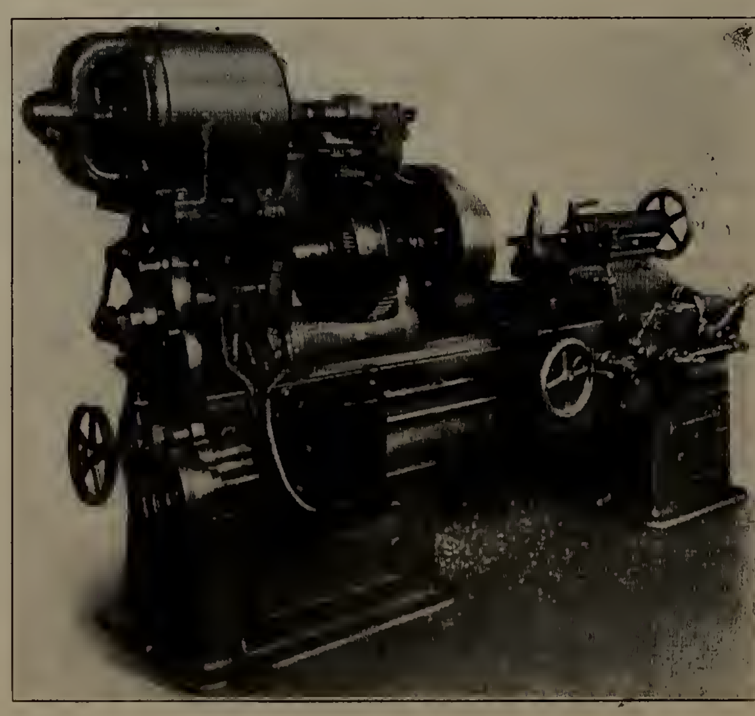


Fig. 5.—24-In. Lathe with Reversing Gear Motor.

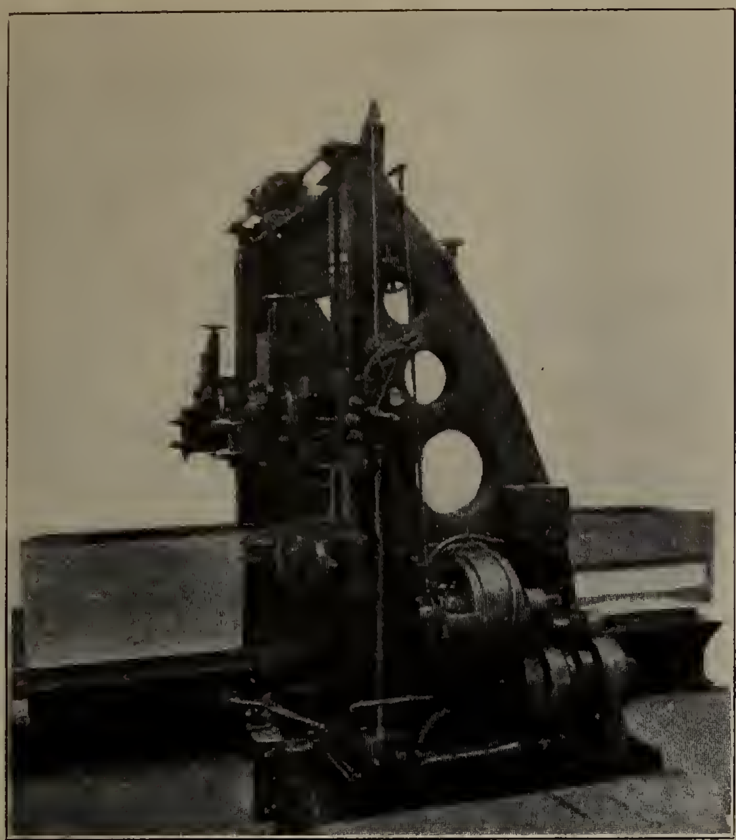


Fig. 7.—Planer with Motor and Compressed Air Clutch.

them. The motor will move the carriage from one end of the lathe to the other in a minute and a half, and it can be stopped at any point within a 1-16 in. of the cut.

The best location for a motor on a lathe, and on most machine tools, is as low down on the machine as possible. The amplitude of the vibrations set up will be smaller, the closer the motor is to the floor, and the liability of chattering will therefore be reduced. The location of the motor in the cabinet leg, or in the headstock of a lathe, as shown in Fig. 2, is ideal, but there are, of course, many cases where the motor must be mounted over the headstock because no other place is available. The necessity of having the motor out of the way of the work is obvious, as turnings of chips, if allowed to get into the motor, would at once give rise to electrical troubles, especially in direct-current machines.

Controllers.

The location and arrangement of controllers for lathes depend upon the class of work to be performed. Where the lathe is started, stopped and varied in speed by the controller, the latter should be mounted on the front of the lathe, and the handle extended by means of a shaft to the lathe carriage, where it will be constantly under the hand of the operator. Ease of control unquestionably results in the rapid and economical production of work. Where the work varies considerably in diameter, frequent changes of speed will be required, and where the most efficient cutting speed can be obtained by simply turning a conveniently located handle, the work will be turned out at a maximum speed. If frequent shifting of belts is required, a great deal of the work will be done at less than maximum speed, owing to the extra exertion involved.

For lathes with constant-speed motors, operated with clutches and shifting levers, or machines on which continuous automatic operations are carried on, such as screw machines, the motor can be kept running for long periods without attention from the operator. In such cases the controller may be mounted at any convenient place on the machine, or near by on the floor, by means of a bracket.

Planers.

Figure 7 illustrates the application of motors to driving planers at the Schenectady shops. The first step was simply

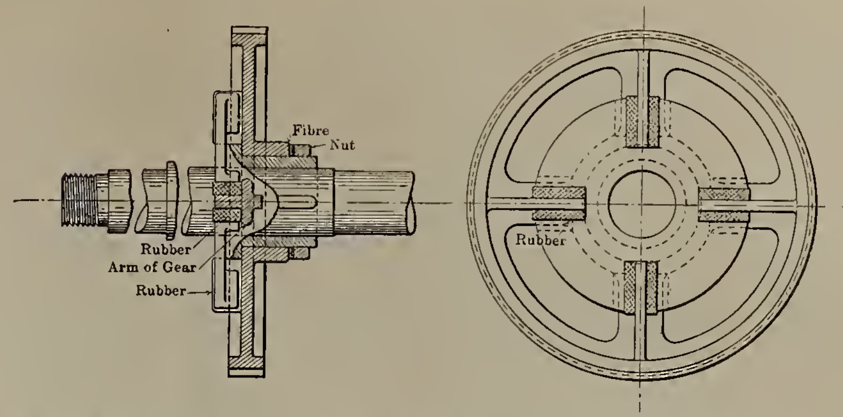


Fig. 6.—Device to Obviate Chatter Marks on Finished Work.

to discard the lineshaft and drive the countershaft from a motor placed on the floor. When this planer was operated by belts it was next to impossible to reverse it in a shorter space than about thirty inches, and even then with a great deal of wear and tear on the belts. Early in 1900 the company produced their first magnetic clutches for driving planers. The first of these clutches was applied to a Bement-Miles planer, 10 ft. wide by 20 ft. long. With this clutch we are able to reverse the planer practically to a line, and to reduce the space required for reversing to about 12 inches. Some trouble was experienced, however, with these first magnetic clutches, owing to the design of the magnets, and pneumatic clutches of a peculiar design were subsequently adopted and have been entirely satisfactory. Figure 7 shows the arrangement of the motor and pneumatic clutch, as applied to the planer.

Our second lot of magnetic clutches was redesigned to eliminate the difficulties experienced with the first lot, and the new ones were applied to a number of portable slotters. These machines mave been in continuous operation practically night and day up to the present time. The clutches have operated with entire success, and I believe the magnetic clutch will eventually be found an important and efficient feature of transmission gears for planers and slotters.

Vertical Boring Mills.

In our original scheme for attaching motors direct to boring mills, an all-gear drive, with variable-speed motors, was selected, and with very slight changes, has been employed up to the present time. A solid foundation is laid, extending under the entire machine, a depression in the back between the side frames forming a bed for the motor, which is securely fixed in position. This common foundation makes the motor and the machine a single compact unit, and no additional floor space is required for the motor. No work put upon the table can interfere with the motor, the gears entirely out of sight, and the controller is placed at the right-hand side of the machine, where the operator usually stands.

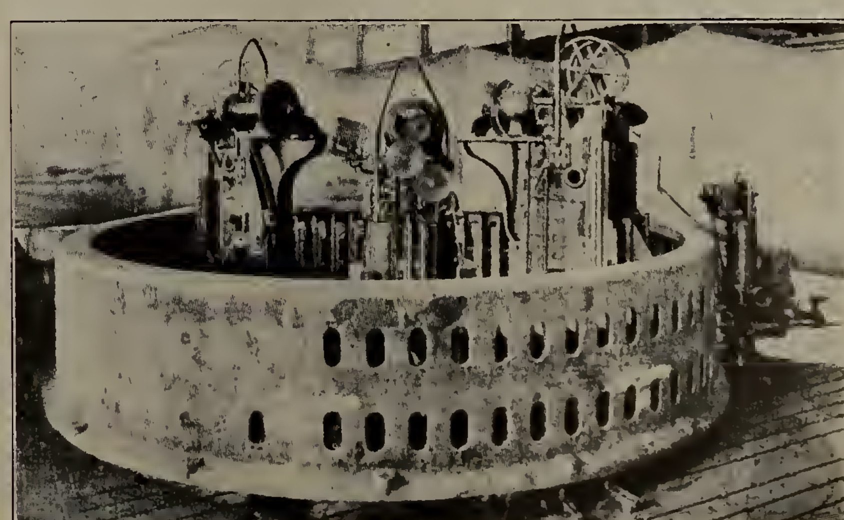


Fig. 8.—Application of Motor to Portable Tools on Iron Floor Plate.

On boring mills from 20 ft. to 25 ft. in diameter, with the usual slow intermediate and direct-gear drive that comes with the mill, a variable-speed motor of two-to-one ratio gives a very satisfactory speed range.

Portable Tools.

Various machine tools of the portable type are used in ordinary large machine shops, and are placed in various positions on iron floor plates. The efficiency of these machines, such as rotary planers, slotters, etc., used in erecting departments, has been greatly increased by the use of electric motors. A group of these tools working on a large casting is shown in Fig. 8. The use of portable tools was almost impossibie before the advent of the electric motor, but now the machine tools used in erecting shops, and in isolated places away from the source of power, when equipped with electric motors are ready to run at a moment's notice. On up-to-date rotary planers the motor is placed on the carriage; the under-side of the bases is planed, and means are provided for transfering the planers by electric cranes.

Under the old arrangement, if machinery stood idle for days and weeks, the countershafts and loose pulleys were so neglected that they would squeak; some one would then throw off the belts to stop the noise, and two hours' work was frequently necessary before they could be started for a hurried job. The same thing is true of some boiler makers' and blacksmiths' machines, such as rolls, shears, cutting-off machines, etc.

Belting.

Twenty-five or thirty years ago, in the days of the old jobbing shop, the buildings were not so high-studded, and the lineshafts and countershafts were usually within reach of a twelve-foot or fifteen-foot ladder at the most. Cone belts running to machine tools were very easily manipulated, and an expert lathe hand would never think of using a pole for shifting his belt from one step of the cone to another. But in these days of sanitary buildings, with ceilings from twenty to twenty-five feet high, it becomes an exceedingly difficult problem to arrange countershafts within reasonable heights, to say nothing of the necessary length of the vertical belts, the dust set in motion, and the difficulty of painting and whitewashing ceilings for the sake of cleanliness.

Another condition of lineshaft driving which has not been much spoken of, of late, is the difficulty of keeping the shaft in alignment, where the hangers are suspended from the roof trusses. The writer has seen such shafts five or six inches out of alignment, due to a heavy fall of snow on the roof, or to the settling of foundations. Another trouble is due to state laws and shop rulings, where a few trained men are employed as belt-lacers, and it is against the rules for men who are not belt-lacers to do the work. This is the cause of numerous delays, with consequent loss of production.

The only advantages that may be claimed for belts is that they take up the vibration of the gears, and thus prevent chatter marks on fine work; and that they will slip under over-load and be thrown off the pulley, stalling the machine, instead of breaking the tool or spoiling the work. It has already been explained how the effect of vibration has been remedied by means of rubber buffers or muslin pinions, and there are exceedingly few cases where belt-slip is not a detriment rather than an advantage. The use of high-speed tools calls for a considerable increase in the power necessary to drive the machines, as these tools take a heavier cut at a higher speed than those of carbon steel. These conditions make belt-slip very objectionable, and one of the chief advantages of motor driving is that it increases the power of machine tools beyond the capacity of belts to reasonable length. Modern practice is in the direction of eliminating the belt almost entirely, although there are a few machine tools, such as the older types of automatic-screw machines, grinding machines and some wood-working machines, on which they are necessarily retained.

The great majority of metal-working machines are best adapted to motor driving through all-gear connections, although a few machines, such as small grinders, buffing wheels, polishing wheels, etc., are best connected direct to the motor shaft.

Linking Up The Southwest

By E. H. Clough, Union Bldg., San Diego, Cal.

If expectation shall be fulfilled in accordance with the confident prediction of expert authority in such matters, the completion of the San Diego & Arizona Ry., linking San Diego in southern California with Yuma on the Colorado river, will provide the most direct transcontinental railroad route to the Pacific coast with a terminus at the first port of call in the United States north of the Panama canal. As a development enterprise this "cut off" will give access to the vast arid region now in process of reclamation east and west of the Colorado river south of the Grand Canyon in Arizona and along the Mexican border in southeastern California generally designated as the Imperial valley region.

The survey of the San Diego & Arizona Ry. provides primarily for a line 150 miles long extending from the shores of San Diego Bay to the interior of the Imperial valley. Beyond that point the road will be extended to Yuma, where junction will be made with the Southern Pacific, as soon as traffic is established to the initial point in the valley which it is believed will be reached some time in 1911.

The road is financed by John D. Spreckels, a Californian millionaire who has extensive commercial interests in San Diego and whose faith in the future of this section has been unswerving and unvarying. The road has already been built across the international boundary line southward along the coast to Tia Juana, a distance of sixteen miles. Thence it extends southeasterly ten miles, at which point it is seven miles south of the boundary in Mexican territory. Entering Matanuco Canyon the road runs northeasterly 32 miles to a point near the east end of the Tecata Valley, where it recrosses the international line 50 miles from San Diego. Thence the road parallels the international boundary in California until it reaches the Jucumba Valley 95 miles east of San Diego. Here the survey is north for about twelve miles, down the Carriso Canyon, and thence easterly to Imperial valley through a tunnel on the eastern slope of the Carriso bridge. The distance from the tunnel entrance to the Imperial valley is 45 miles. The Southern Pacific crosses two surveys through the Imperial valley and at one of these joints a junction will probably be made. One of these crossings is near El Centro and the other close to Calexico.

Considerable money has been added to the construction cost in the effort to eliminate heavy grades and sharp curves, as for example in the crossing of the Sweetwater valley and the Otay valley, where the maximum grade for 24 miles out of San Diego has been reduced to 4 per cent. To maintain this grade it was necessary to make a fill of 91,000 yards in the Otay valley and another of 105,000 yards in the Sweetwater valley. Heavy mountain work will make this section of the road one of the most expensive in the country. The tunnels are not numerous, but some of them are very long and the bridges, which are many, will add to the cost of avoiding curvatures.

The track of this railroad is laid as far as the first crossing of the Tia Juana river, 17 miles from San Diego. The steel of the rails is 75 pounds, laid on 7x9x8 split redwood ties connected with the continuous rail joint, resting on the plates. In track construction and rolling stock all is of the latest modern type.

One stretch of tunnel work in the mountains extends 50,000 feet. The first bridge beyond National City, a few miles south of San Diego, is 150 feet long. Between San Diego and the international line are seven bridges from 160 to 800 feet long. On the Mexican side the longest bridge is at the first crossing on the Tia Juana river, now building. This bridge is to be 1,050 feet with a ballasted deck structure on creosoted piling. At the second crossing there will be a steel viaduct with concrete piers 510 feet long and 60 feet above the river bed at the highest point. A mile east of this viaduct is to be constructed another of the same material 180 feet long, and in that vicinity are to be bored two tunnels, one of which is to be 200 feet long and the other 325 feet.

The surveys for this road have cost $200,000, and more than $1,000,000 was expended in purchasing the right of way. It is estimated that the total cost of the road will be $7,500,000. The length of the road from San Diego to Yuma will be 220 miles. This will bring San Diego and the southwestern Pacific Coast of the United States within 1,730 miles of Kansas City, the pivotal railroad point of the Southwest. The distance at present from Kansas City to Los Angeles is 1,758 miles. Thus shippers to and from the Orient and South America will save about 156 miles over the present routing to the point on the Pacific Coast nearest the "great circle" over which the commerce of the Panama Canal must pass; and at least twelve hours will be saved from Yuma to San Diego owing to the low percentage of the grade. When the San Diego & Arizona Ry. is completed, Chicago will be 350 miles nearer the Pacific Coast by this route than at present by the lines with terminals at San Francisco. The distance to San Diego will be 400 miles shorter than between Chicago and Portland or Seattle.

It is expected that when the road is finished tourist traffic now centering in Los Angeles as the objective point in Southern California, will make its first stop at San Diego. The road will be completed in 1913, and in 1915 San Diego will hold an exposition in commemoration of the completion of the Panama Canal, international in its scope so far as the countries of Mexico, Central America, South America and Western Asia are included, but specifically for the purpose of exploiting the achievement and possibilities of the great and growing Southwest. On this basis of direct ship and railroad commerce incited by the new developments brought about by the opening and operation of the Panama Canal, there is bright prospect that the port of San Diego, on the only practicable landlocked harbor, except that of San Francisco, between Alaska and Chili, will rise to prominence as one of the great seaports and most important shipping points on the Pacific Coast.

Personals

The following have been appointed general foremen of the Atchison, Topeka & Santa Fe Ry., Western Lines: W. C. Barlow, Clovis, N. M.; Geo. D. Siemantle, Raton, N. M.

W. D. Stewart has been appointed division foreman of the Atchison, Topeka & Santa Fe, Western Lines, at Las Vegas, N. M.

The following have been appointed foremen of the Atchison, Topeka & Santa Fe, Western Lines: R. E. Andrews, Vaughn, N. M.; P. H. Purcell, Raton, N. M.; C. H. Stewart, Belen, N. M.

W. E. Woodhouse, a master mechanic of the Canadian Pacific Ry., has been appointed a shop superintendent of the Canadian Pacific Ry., Western Division, with office at Calgary, Alb., as heretofore.

D. T. Main succeeds R. A. Pyne as a district master mechanic of the Canadian Pacific Ry., with office at Nelson, B. C.

Wm. Hanson succeeds Wm. Jappert as the general car inspector of the Chicago, Burlington & Quincy R. R., with office at Lincoln, Neb.

J. F. DeVoy, mechanical engineer of the Chicago, Milwaukee & St. Paul Ry., has been promoted to the position of assistant superintendent of motive power, with office at Milwaukee as heretofore.


W. D. Stewart.


J. F. DeVoy


J. J. Connors

Chas. H. Bilty succeeds J. F. De Voy as mechanical engineer of the Chicago, Milwaukee & St. Paul Ry., with office at Milwaukee, Wis.

J. J. Connors, a master mechanic of the Chicago, Milwaukee & St. Paul Ry., has been promoted to the position of assistant superintendent of motive power, with office at Dubuque, Ia.

Walter Liddell has been appointed a master mechanic of the Chicago, Milwaukee & St. Paul Ry., with office at Dubuque, Ia.

P. J. Colligan and H. Clewer have been appointed master mechanics of the Chicago, Rock Island & Gulf Ry., with offices at Dalhart, Tex., and Ft. Worth, Tex., respectively.

C. L. Adams succeeds J. W. Howell as the master mechanic of the Kansas City, Mexico & Orient Ry. of Texas, with office at Sweetwater, Tex.

A. Worley succeeds Jas. Hodge as the master mechanic of the Macomb & Western Illinois R. R., with office at Macomb, Ill.

W. H. Schmieding has been appointed the superintendent of car service of the Mexican International R. R. (National Rys. of Mexico), with office at Mexico, D. F.

W. M. Netherland, general storekeeper of the Southern Ry., has been appointed assistant general manager, with office at Washington, D. C.

J. W. Gerber has been appointed general storekeeper of the Southern Ry., with office at Washington, D. C.

A. B. Clinger has been appointed superintendent of motive power of the Toledo & Western R. R., succeeding I. P. Schofield. His office is at Sylvania, O.

The Value of a Patent

The following, taken from the American Vehicle, describes a situation often met with by manufacturers. Is there not room for improvement in our patent laws?

A Cleveland concern which had discovered an infringement of its patent on a certain article, wrote to its patent attorney for light. That the attorney is an honest man is evident from his letter, which here follows:

"I have given very careful consideration to your letter of ———, and would say that patents are worth only what you can make out of them. They do not afford any protection whatever against infringement unless enforced. It looks to me as though you could enforce your patent against ———, as they appear to have copied your structure almost exactly. It would probably cost you several thousand dollars to secure judgment against them if they accepted the suit, and in the end the chances are that you would have an injunction against their manufacture of this construction, and be awarded nominal damages.

"The ——— company probably knows that it would not be worth your while to go to the expense of putting them out of the field. On the other hand, if you brought suit they would probably discontinue the manufacture of ——— rather than stand the expense of defending the suit. They probably bank on your not suing them.

" * * * My advice at this time would be to file a bill of complaint against the ——— company if it would be worth from $3,000 to $5,000 to secure an injunction against their continued manufacture of the machine.

"All of which brings me back to an answer to your last question, 'What is a patent good for, anyway?' It is, as a practical matter, good for nothing in the way of protection, unless enforced."

Among The Manufacturers

NEW LITERATURE.

The Wm. H. Wood Loco, Fire Box and Tube Plate Co. of Media, Pa., has issued a booklet descriptive of the Wood corrugated firebox and containing a large number of letters showing "What others say about us."

* * *

"Highway Bridges" is number 8 in a series of "Designing Data" booklets published by the North Western Expanded Metal Co., of Chicago, and contains valuable information on this subject. No. 1 in this series contains a goodly amount of information relating to building construction.

* * *

"A mixture taken hot from the crucible, poured into the mould of publicity and cast once in a while by the Chicago Bearing Metal Co., of Chicago," is the way this company speaks of its original little organ—"The Graphose Age."

* * *

The Independent Pneumatic Tool Co. of Chicago has sent out an illustrated circular of the many varieties of pneumatic tools made by this company.

* * *

Bulletin No. 388 of the National Brake & Electric Co. of Milwaukee takes up very fully the various types of national motormen's valves.

* * *

The firm of Joseph T. Ryerson & Son of Chicago has issued a bulletin on the Ryerson portable cylinder boring bar which give a very complete description of them.

* * *

The American Blower Co. of Detroit, Mich., has issued a very comprehensive bulletin on the "A. B. C." heater for use in connection with fans for heating and ventilating.

* * *

In a neatly gotten up booklet entitled "The Pennsylvania Railroad and the Farmer," this road tells of the work being done by its "farmer specials" and why co-operation between the farmer and the railroad is beneficial to both parties. It is well worth reading.

* * *

Fairbanks, Morse & Co. of Chicago, Ill., has just issued a motor car catalog, which is a very artistic production as well as being of practical interest. The cars shown represent the progress in the manufacture of gasoline cars for track use during their fifteen years' experience in this business, embracing different types for every requirement and department of railroad work, from the small car light enough for one man to handle, to a large car seating 35 people, for passenger service.

* * *

The Draper Mfg. So. of Port Huron, Mich., has issued a complete catalogue of valve facing tools, check and globe valves, brass and iron balls, flue welders and other articles made by the company.

* * *

The Acme Machinery Co. of Cleveland, Ohio, has issued a very comprehensive catalogue of bolt, nut and forging machines which is abundantly supplied with good half-tone reproductions.

* * *

The Walter A. Zelnicker Supply Co. of St. Louis has issued bulletin 102 showing a large number of offerings of rails and equipment.

* * *

"Hydraulic Valves and Fittings" is the title of a 120-page illustrated catalogue just issued by the Watson-Stillman Co., 50 Church St., New York. Its pages list many types and combinations of hydraulic valves and fittings and any engineer will find this book handy when figuring on new hydraulic installations.

* * *

The Safety Car Heating and Lighting Co. of New York has issued a new section of a loose-leaf catalog which gives a complete description of the Thermo Jet System of car lighting.

* * *

H. B. Fuller, 186 W. 3rd St., St. Paul. has issued a descriptive booklet of all-steel adjustable scaffolding and step-ladders.

* * *

An attractive leaflet on the Imperial car window screen has been issued by the General Railway Supply Co. of Chicago.

* * *

Among the specialties manufactured by David Lupton's Sons Co. of Philadelphia are the Pond operating device for shop and power house windows, rolled steel skylights, metal fire doors, fire-proof windows and windows of a special design. These are shown fully in a recent booklet of this company.

* * *

The Dunlap Engineering Co. of Columbus, Ohio, which recently succeeded the Columbus Pneumatic Tool Co., has issued a catalogue on "Pneumatic Tools," containing a full line of air drills and hammers.

* * *

Joseph T. Ryerson & Son of Chicago has issued two booklets on the subject of "Tool Steel" and "Glyco," this being a babbitt metal. Both of these booklets contain much information on their respective subjects.

* * *

The McRoy Clay Works of Chicago have prepared a booklet on the subject of "Underground Transmission Railway Signaling," bringing out the advantages of underground conduits for signal wires.

* * *

"Leach" sanders are fully described and illustrated in a pamphlet of the American Locomotive Sander Co. of Philadelphia. This is one of a number of different sanders manufactured by this concern.

* * *

The McConway & Torley Co. of Pittsburg, Pa., has issued an attractive leaflet descriptive of the Janney X coupler.

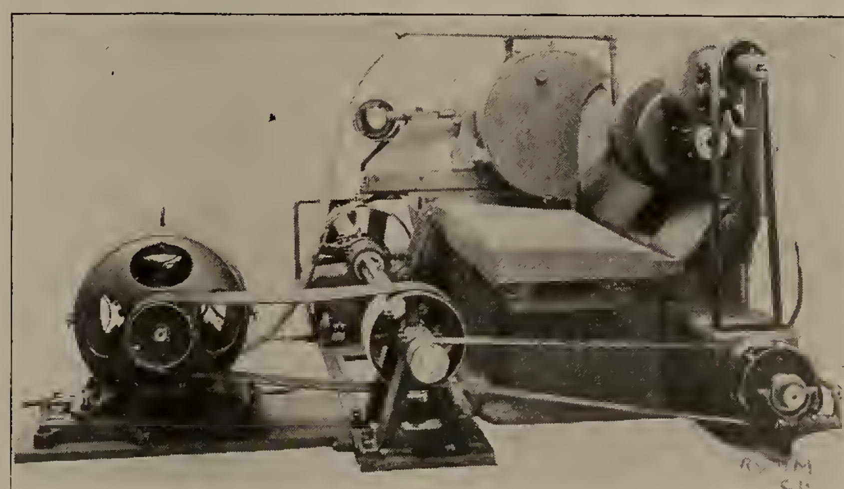
SELF-CONTAINED GRINDING MACHINE.

The accompanying illustrations show a new grinding machine designed on original lines and built by the Landis Tool Co. of Waynesboro, Pa. Throughout, the machine is of the high power and heavy duty construction, and while intended for finishing all classes of work within its range, it is especially adapted for grinding chilled rolls. The regular practice in this work for grinding the body is to support the roll by its journals on bearings mounted on the table of the machine. Previous to this operation the journals or necks are themselves ground, which is done with the roll carried on centers in the same manner as for plain grinding. The grinding wheels are 24 inches in diameter and the guard is made to take them with faces up to 4 inches wide. The wheel can be used at full size in diameter for grinding 16-inch rolls—the full swing of the machine. To compensate for any slight error in the alignment of the headstock and roll axles and to avoid any tendency of the drive to influence the roll from its true axial position, with the bearings, an equalizing fixture is attached to the face of the headstock which drives the roll with equal force from opposite points across the center. Another feature contributing greatly to the making of accurate work is, the stationary work table which is supported its entire length by the main column of the machine.

The bearings for supporting the rolls when grinding the bodies and the equalizing driving fixture are not shown, but become regular parts of the equipment when the grinder is furnished for roll work. This machine is also adapted for railway shop work for grinding locomotive pistons, piston valves, valve stems, crank, link, and knuckle pins, axles, etc. It is provided with a gap so that pistons can be ground with their heads in place and also for the swing of valve yokes when grinding the stems. The gap can be located along the table to suit the work when the machine is built. The machine is of the self-contained type and is designed to be driven either by a motor or from the line shaft.

With any form of drive the power is applied to the main shaft at the rear of the machine from which it is distributed and transmitted to all of the different working parts. The grinding wheel is driven from the large pulley located at about the center of the machine, which is mounted in a carriage rolling on the track shown extending from the base of the machine and travels with the wheel carriage as it is traversed. This pulley is driven by step grooves on the main shaft engaging rollers in its sleeve or hub which makes practically a frictionless drive as it is traversed or slides over the shaft. The grinding wheel belt is 6 inches wide and passes over intermediate pulleys so arranged as to automatically take up any change in its length and at the same time keep it under a uniform tension. The belt has almost 200 degrees contact on both the driving and driven pulleys, and its length can change about 8 inches by stretching before it becomes necessary to remove a section.

The grinding wheel head is massive and rigid—a feature so essential to rapid and perfect grinding. The spindle is of very large dimensions and is made of hardened steel; the bearings are of phosphor bronze, are self-aligning, are adjusted in tapers for taking up wear and have self-oilers. A very important feature of this wheel head is that the bearings are protected by special covers and are positively dirt proof. The grinding wheel has provision for balancing, this being done by two weights mounted to be adjusted in a circular or annular groove in the side of the wheel collar or center; this is another very important feature.



Landis Heavy Duty Grinding Machine.

The headstock is very powerfully geared and has ample power for driving the largest piece of work or roll that can be placed in the machine. It is arranged to give five changes of speed to the work, these being made mechanically by the movement of a single lever and by shifting a back gear in the gear box at the end of the machine another range of five speeds is obtained, making a total of ten work speeds. These speeds are indicated on a dial, and the changes can be made quickly and with ease. All parts of the clutch mechanism are made of hardened tool steel and all gears are finished by planing.

RYERSON HIGH SPEED FRICTION SAW.

Cutting steel shapes by high speed friction disks is generally acknowledged to be the most rapid and efficient method known. It is the method used to the exclusion of all others in the largest steel mills and the principal structural and car shops throughout the country where a large tonnage of steel is turned out.

Until recently high speed friction saws were large, heavy and expensive machines, requiring high power motors, massive

New Universal Shear, Covington Machine Co.

foundations and a large amount of supplementary equipment—pumps, controllers, etc., entailing an expense of seldom less than five thousand dollars. This made them entirely too costly and troublesome to install in the average sized structural or car shop, and, as a result, such shops have heretofore had to depend on the so-called beam shears, made in Germany, and on the slow speed saws.

Prompted by the suggestions of a number of railway mechanical men, Jos. Ryerson & Son of Chicago has succeeded in designing a saw which seems to fill all requirements in the cutting of steel sections, bars, rails, etc.

The Ryerson high speed friction saw has a capacity to cut continuously, 15-inch 80-pound beams without turning the beam, and other sections of smaller or equivalent cross sectional area. A 15-inch beam may be cut in from 28 to 38 seconds and smaller sections in proportionate time. The machine is entirely self contained and has no bolts, gears or other driving mechanism that consume power or are apt to get out of order. All parts of the machine are designed as simple, as they can be made without sacrificing strength and efficiency. The machine complete occupies floor space approximately seven feet long by four feet wide. No foundation other than a good floor is necessary.

A specially designed motor is sold with the saw. It is wound for an intermittent rating of 52 H. P. All bearings are wide and made extra heavy to withstand the thrust of the saw operation. All banding and insulation is special, and on direct current motors the commutator is lengthened. Each motor carries the standard guarantee of the electric company as well as our own. These special motors are designed for 110, 220, 440 and 500 volts direct current, and alternating current of 60 cycle, 2 and 3 phase, in standard voltages.

The saw discs are made from ordinary flanged steel, and two are furnished with each machine. Additional blades can be made in any shop, or will be furnished at reasonable prices. The only sharpening necessary is to occasionally renick the blades on the edge, which operation can be done in about fifteen minutes with a special chisel which is furnished with each machine.

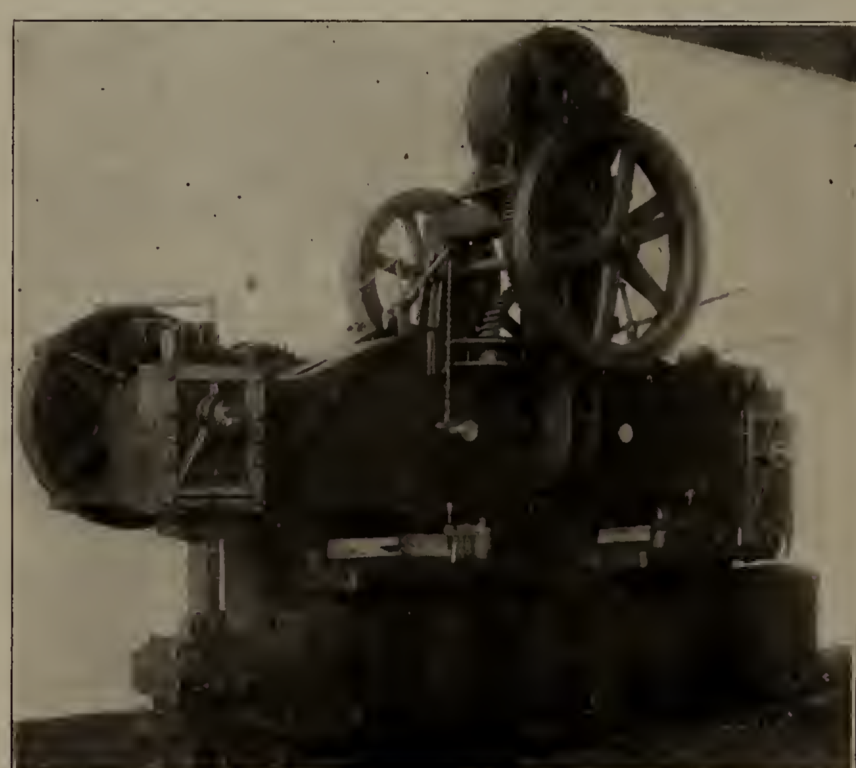
UNIVERSAL SHEAR FOR CHANNELS, ANGLES AND PLATES.

The need in ship yards and railroad shops for a machine to cut square or mitred the various channels and angles required for ship building purposes has been met by the machine shown in the accompanying illustration. While especially built for the marine department of the Maryland Steel Co., Sparrows Point, Maryland, this machine is intended for any class of iron workers. It is provided with a coping attachment at one end of the machine; a plate shear at the other, and two angle shears, operating at an angle of 45 degrees, in the center of the frame. The latter have a capacity for cutting up to 15 in. x ¾ in. channels, and 6 in. x 6 in. x 1 in. or 8 in. x 8 in. x ¾ in. angles. The plate shear has a capacity for 1-in. material. Each shear is controlled by its own clutch, and the machine may be operated by different groups of men all working at the same time, and without interfering with each other.

The frame, plungers, pendulums, clutches, and all parts subject to shock are made of semi-steel castings. Hammered steel shafts, containing .4 to .5 carbon are used for the shafts, and the question of lubrication has been given especial consideration. The gears are provided with long sleeve hubs, and the covers which protect the gears are bored to receive them. The gears in turn support the shafts, which have bearing surfaces throughout their length.

A patent stop motion is used, which automatically throws out the clutch on each shear when it reaches its highest point. For the coping attachment, which may also be used for punching, the stop mechanism is adjustable so that the

Ryerson High-Speed Saw.



New Universal Shear, Covington Machine Co.

plunger may be stopped in any point of its down stroke. The machine weighs about 23 tons. It is driven by 25 H. P. electric motor, and is manufactured by the Covington Machine Co., Covington, Virginia.

IMPROVED LIFTING JACKS.

Fairbanks, Morse & Co., of Chicago, as selling agents for the Duff Mfg. Co., are handling two jacks having a number of interesting features, one being a forged steel hydraulic jack and the other a ball-bearing screw jack. The Duff-Bethlehem hydraulic jack is forged entirely out of steel, each part being a steel forging, so that practically every joint is eliminated and the entire jack contains but two small packings, which are insignificant in number. This construction makes the ram of the jack a one-piece forging and with the pump chamber forged integrally therewith, eliminating all packings and joints in the ram. The cylinder of this jack is also a one-piece forging having the base forged integrally therewith eliminating the use of packing and joint at the bottom of the cylinder, which construction absolutely prevents leakage, and permits much greater pressure and affords a hydraulic jack that weighs from 30 per cent to 80 per cent less than other jacks of equal size and capacity.

The construction of the valves in the Duff-Bethlehem jack represent considerable of an improvement and they are also given an improved location in the jack which permits each and every jack to operate at any angle, that is, vertically or horizontally, with its full range of lift.

On account of the forged steel construction of the jacks all sizes are capable of withstanding an enormous overload and contain a greater factor of safety than any other jack. The valves of the Duff-Bethlehem jacks are absolutely positive and can be attended to without removing the packing and the packing without removing the valves. Both the cylinder and the ram of these jacks have a solid bottom, thus no packings are required at those points, and the only packings in the jacks is the one on the outside of the ram and the other the small packing on the pump piston. The axis of the pump stroke coincides with that of the pump well, which insures uniform wearing of the pump packing. It can be readily seen in this construction of "one-piece forgings" that the most troublesome packings and joints have been entirely eliminated in the Duff-Bethlehem jacks and jacks cannot "creep" under a load.

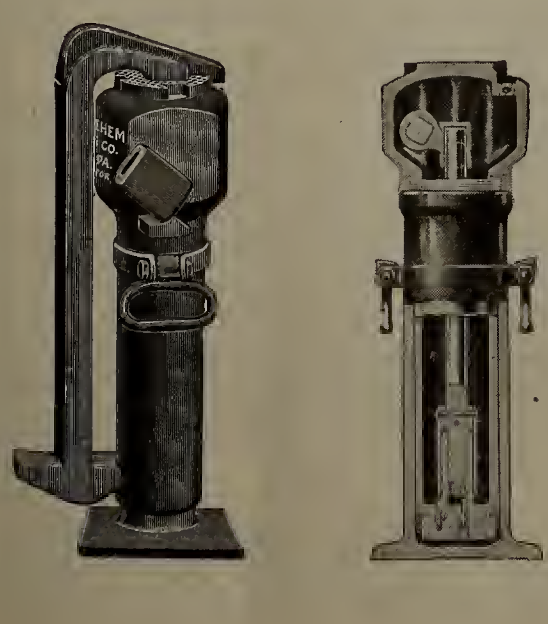
The Duff ball-bearing screw jack contains an improved ball bearing, in that the balls are much larger in size, therefore much stronger and capable of greater strains as well as operating much more easily under a load. Special tool steel plates are provided to take care of these balls in the main bearing so that practically no wear whatever occurs during the constant operation of the jack in the most severe service. Another point which is an improved feature is the fact that this jack contains an additional bearing on the bevel pinion to take the thrust at that point. The Duff jack is the only ball bearing jack containing a bearing at this point, as other jacks of this character are made with plain surfaces rubbing together, causing considerable friction and rendering the jack much harder in operation. In both bearings in the Duff jacks the balls are separated by a bronze cage, eliminating all friction between the balls.

HEAVY 12-INCH AND 10½-INCH UNIVERSAL WOOD WORKER.

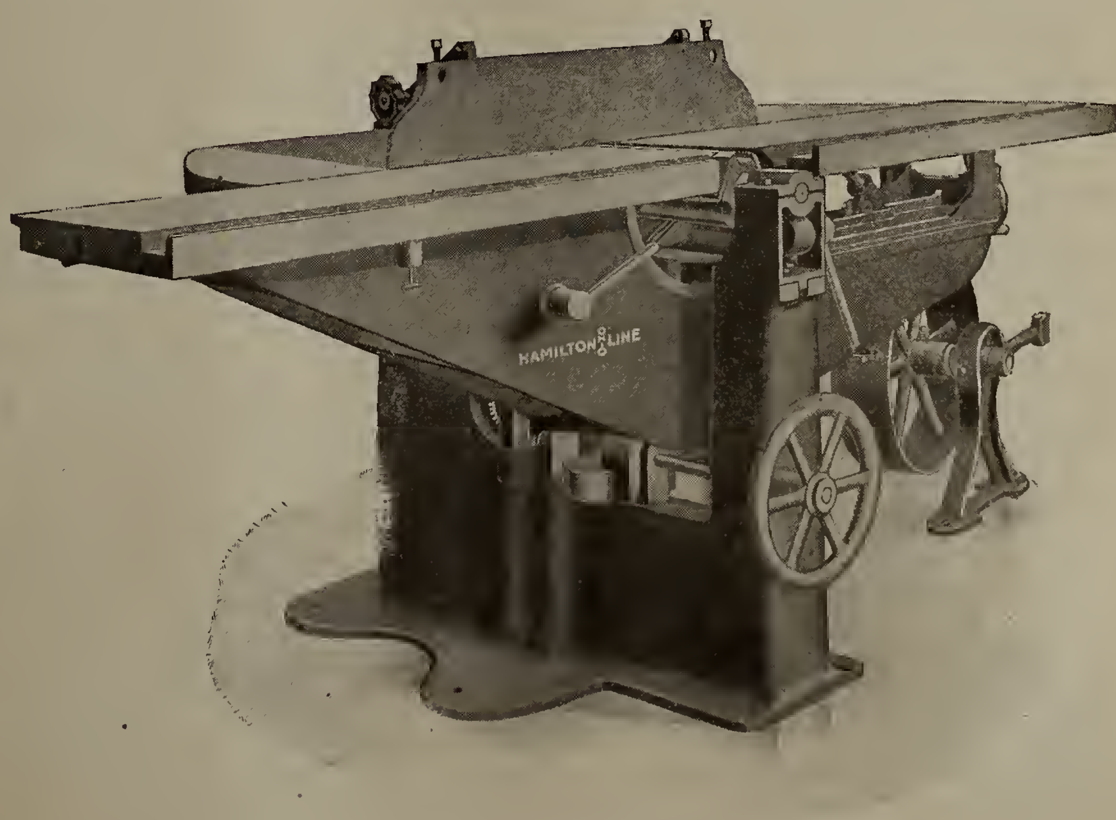
The accompanying illustration shows a machine built in the most substantial manner for extra large and heavy work, of heavy, massive design well calculated to withstand all strain to which it may be subjected in the many different operations performed upon it.

It is constructed by the Bentel & Margedant Co., of Hamilton, Ohio, with three table tops independently and collectively adjustable. The frame is of the solid cored pattern cast in one piece with the heavy outside bearing column which supports the mandrel outside the head. The two front tables are carried on a heavy bracket which is adjustable up and down on the front face of the frame without disturbing the adjustment of the two tables relative to each other. The front or forward table has an independent adjustment up and down and to and from the cutterhead through the agency of the four incline slides mounted on the bracket.

The third table or back top is of very great importance for handling large heavy work. It has an independent adjustment up and down through the handwheel and screws provided for that purpose. For cross gaining or other work



Duff Ball Bearing Screw Jacks.



Hamilton 10-inch and 12-inch Solid Wood Worker No. 12.

of like character the three tables can be brought to a uniform level, giving a table support of large dimensions for resting the material. The front tables are provided with wide grooves for the reception of slide boards, gauges, etc.

When so ordered this machine will be provided with an additional cutterhead, mandrel and housing set vertically at right angles to, and in the rear of the horizontal cutterhead, a rear view of same being shown in the small cut herewith. This head is used when planing and squaring material on two sides in one operation. When so arranged an additional fence is provided which can be set for any amount of cut on the side head. The other fence illustrated is used when the horizontal head is used only. Either the single or double machine can be fitted, upon order, with a universally adjustable boring and routing table as also separately illustrated in the small cut. The machine either single or double is also built 10½ inches wide as well as 12 inches. The machines weigh about 1900 and 2000 lbs.

The construction of the 10½-inch machine corresponds in all details with the 12-inch machine, differing from the latter only in the width of the front tables. The boring and routing table is also provided on order for the reverse side. One head for each mandrel, saw frame, gaining frame, rabbeting iron and wrenches are provided. The countershaft for either machine has tight and loose pulleys 12" diameter by 6¼" face, and should make 750 revolutions per minute.

INDUSTRIAL NOTES.

J. M. Odenheimer has been appointed manager of railroad sales of the Pennsylvania Flexible Metallic Tubing Co., of Philadelphia. Mr. Odenheimer's office is in the Rockefeller Building, Cleveland, Ohio.

On the first of May, The Cleveland Twist Drill Company, will move its Chicago Branch to No. 9 North Jefferson St. In its new location greatly improved facilities for the prompt handling of its steadily increasing business are afforded.

Charles Conlisk, well known to many of the "old-time" supply men, died at his home at Stevens Point, Wisconsin, April 16. Mr. Conlisk was connected with William Sellers & Co., Inc., for a number of years, and retired some two years ago.

W. F. La Bonta, formerly purchasing agent of the Chesapeake & Ohio, has accepted a position as representative of the Union Spring & Manufacturing Co., Pittsburgh, Pa. Mr. La Bonta's headquarters will be in the American National Bank building, Richmond, Va.

The Isthmian Canal Commission will receive bids until May 11 for locomotive cranes, inspection car, copper ladder rungs, wattmeters, chain blocks, lights, axes, adzes, machettes, scrubbing brushes, locks, hinges, gongs, vacuum gages, foot valves, cocks, iron and vitrified pipe fittings, brass chain, screws, rivets, nails, hasps and staples, copper gaskets, grommets, small shop tools, saws, twist drills, corundum wheels, manila rope, rubber belting, insulating paper, chalk line, lumber, etc. (Circular 577.)

Tom Brown, formerly master mechanic of the Juniata shops of the Pennsylvania Railroad at Altoona, and later connected with the Westinghouse interests, the American Car & Foundry Co. and E. Keeler & Co., has been appointed a special representative of the Westinghouse Air Brake Co., and is giving considerable attention to the draft gear question. Mr. Brown's headquarters are at 165 Broadway, New York City.

C. A. Nathan, chairman of the executive committee of the railway supply men exhibiting at the International Railway General Foreman's convention at Cincinnati, May 3-7, advises that about 150 companies are to be represented and that arrangements are completed for displaying the exhibits in the corridor of the Grand Hotel adjacent to the convention hall. S. P. Egan is chairman of the entertainment committee, and his plans include a varied program.

R. B. Darby, formerly assistant engineer of motive power of the Lake Shore & Michigan Southern at Cleveland, Ohio, has accepted a position as mechanical engineer of the Pilliod Ca., New York. Following his graduation from Purdue University in 1901, he entered the engineering department of the New York Central & Hudson River, at West Albany, N. Y. In March, 1903, he went to the Gould Coupler Co., New York, and in the latter part of April of the same year he became mechanical engineer of the New York, Chicago & St. Louis, which position he resigned to become chief draftsman of the Pittsburgh & Lake Erie on August 1, 1904. On February 15, 1905, he entered the services of the Lake Shore & Michigan Southern, becoming chief draftsman on April 1, 1906, and in June, 1908, he was made assistant engineer of motive power, which position he has just resigned to become mechanical engineer of the Pilliod Co.

Le Grand Parish, since 1906 superintendent of motive power of the Lake Shore & Michigan Southern, with office at Cleveland, has resigned to accept the presidency of the American Arch Co., which hereafter will conduct the business of the American Locomotive Equipment Co. of Chicago and the brick arch department of the Franklin Railway Supply Co. Mr. Parish was born at Friendship, N. Y., in 1866. His railroad career has been one of unusual activity and brilliancy. He commenced with the Lake Shore and Michigan Southern in 1889, since which time he has been chief clerk of the car department, general foreman, master car builder, assistant superintendent of motive power, and superintendent of motive power. His remarkable rise can be attributed largely to his unusual ability as an organizer. For a number of years Mr. Parish has taken an active part in the affairs of the Master Car Builders' and the Master Mechanics' Associations. At present he is second vice-president of the former and he also, at one time, served a term as president of the Western Railway Club. The officers of the American Arch Company are, J. S. Coffin, chairman; Le Grand Parish, president; Charles B. Moore, vice-president; Samuel G. Allen, secretary and treasurer. The principal office of the company will be at 30 Church street, New York, with branch offices at Chicago, St. Paul, Omaha, Denver, Los Angeles and at San Francisco.

H. S. Covey, secretary of the Cleveland Pneumatic Tool Co., Cleveland, Ohio, was recently elected a director of the company. E. S. Cook was elected vice-president.

The Chicago Bearing Metal Co., Chicago, has moved its office to rooms 520 and 521 in the new McCormick building, Michigan avenue and Van Buren street.

The Standard Steel Car Co., Pittsburgh, Pa., is building two new steel buildings at its plant at Ellwood City, Pa. They are to be respectively 80x340 ft. and 50x300 ft.

The Ostermann Manufacturing Co., West Pullman, Ill., announces that the name of the company has been changed to the West Pullman Car Works. The company will continue to build and repair wood and steel freight car equipment.

The Chicago office of the coupler department of the National Malleable Castings Co., Cleveland, Ohio, has been moved from the Old Colony building to 311 Railway Exchange.

L. C. Ullrich has resigned as assistant to the general manager of the Southern Railway to accept a position in the sales department of the Scullin-Gallagher Iron & Steel Co., St. Louis, Mo. Mr. Ullrich was born at St. Louis, Mo., on December 30, 1878, and entered railway service with the Denver & Rio Grande at St. Louis as a clerk in the general agent's office in March, 1894. In 1898 he was appointed chief clerk, which position he held until 1901. During the following year he was secretary to the general manager of the Mobile & Ohio at St. Louis, after which he became secretary to the vice-president and general manager of the Southern Railway, and later chief clerk to the same officer, which position he has just resigned to enter the sales department of the Scullin-Gallagher Iron & Steel Co. Mr. Ullrich will have headquarters at No. 1 Wall street, New York.

The American Car Screen Co., Pittsburg, has recently completed equipping with the Scott adjustable car window screen four new dining cars, seven composite cars, and two cafe-observation cars at the Pullman shops. The Scott screen is securing wide recognition as an improvement for the protection of first class passengers.

The Ingersoll-Rand Co., New York, has received an order from the Pittsburgh Contracting Co. for an equipment of air compressors and rock drills for use on section 53 of the Catskill aqueduct, New York.

C. H. Rhodes, for several years in the purchasing department of the American Steel & Wire Co., Chicago, at Pittsburgh, Pa., has been appointed purchasing agent for the company, with office in Chicago.

The Pennsylvania Equipment Co., West End Trust building, Philadelphia, Pa., wants a standard gage locomotive crane, 15 tons capacity, delivered at Buffalo, N. Y.

Capt. W. D. Davis, Q. M., U. S. A., Ft. Leavenworth, Kansas, is asking for bids until May 2 on rails, angle bars, ties, etc., and on a track scale.

S. M. Wight, signal inspector, Lake Shore & Michigan Southern, at Cleveland, Ohio, has resigned to take a position with the General Railway Signal Co., Rochester, N. Y.

Frederick Mortimer Robinson, for the past six years sales agent of the Pressed Steel Car Company, Pittsburgh, Pa., died on April 2. Mr. Robinson was 33 years of age, and had formerly been connected with the Chesapeake & Ohio Railroad. He was a Knight Templar and a member of the Acca Temple of Shriners, at Richmond, Va., a member of the Commonwealth Club of Richmond, the Cleveland Coal Club, the Union Club of Pittsburg, the Railway Club of Pittsburg, and the Virginia Historical Society of Richmond, Va.

S. R. Fuller, Jr., formerly of the Gould Coupler Co., New York, has accepted a position as sales agent for the Scullin-Gallagher Iron & Steel Co., St. Louis, Mo. Mr. Fuller will have headquarters at No. 1 Wall street, New York.

The Acme Railway Equipment Co., Philadelphia, Pa., has recently furnished its Acme uncoupling device for use on the following equipment: 2,150 cars for the Lehigh Valley; 5,000 miscellaneous cars for the New York, New Haven & Hartford; 2,000 box cars for the Boston & Maine, and 200 ore cars for the Minneapolis, St. Louis & Sault Ste. Marie.

The Stevens Point Foundry & Machine Co., Stevens Point, Wis., has been awarded the contract for furnishing all castings to be used on the Chicago division of the Soo line during the ensuing year.

Frank L. Norton, formerly manager of eastern sales of the Scullin-Gallagher Iron & Steel Co., St. Louis, Mo., has been elected vice-president in charge of sales, with office, as heretofore, at No. 1 Wall street, New York.

The Kerr Turbine Co. of Wellsville, N. Y., has arranged for representation in two more American and three foreign cities as follows: San Francisco and Oakland, Cal., United Iron Works; London, Eng., Economical Gas Alliance Construction Co., Ltd.; Mexico City, J. H. Bloomberg; Sidney, N. S. W., A. F. Partridge. With the above the Kerr Turbine Co. now has active representatives in twenty-six cities. The use in Europe of American turbine units of the small sizes built by this firm would hardly seem to warrant representation on the other side, but numerous Kerr turbines have been sold in England alone, one customer there having bought seven on repeat orders.

Mr. C. P. Williams has been appointed eastern representative of the Chicago Railway Equipment Company, succeeding Mr. E. G. Buchanan, who has resigned.

B. K. Hough has been appointed Boston sales manager for the Wisconsin Engine Co. His office is located in the Oliver Bldg. Boston.

Frank McMurdie, superintendent of the American Blower Company's Detroit plants since about 1895, has resigned, his resignation taking effect March 31st. After a short pleasure trip, he will take the general superintendency of the Clarage Foundry & Mfg. Co., of Kalamasoo. Mr. McMurdie was one of the oldest employes of the American Blower Co., having entered its employ in 1883.

During the past several months the Northern Engineering Works, Deroit, Mich., has been placing orders for new tool and machinery, consisting largely of lathes, gear cutters and milling machines, which machinery is now being installed.

The Blue Island Rolling Mill & Car Co., Chicago, has increased its capital stock from $500,000 to $750,000. The new plant which the company is building at Blue Island, Ill., nearing completion and it is hoped that it will be ready for operation by June 1.

The Pressed Steel Car Co., has been granted an order by the United States Circuit Court at New York, suspending the injunction and order for accounting granted in the suit against it of the Simplex Railway Appliance Co. This order is granted pending the determination of an appeal by the Pressed Steel Car Co., and is on a provision that the company shall file a bond with the court in the sum of $20,000 to cover costs and damages which might accure to the Simplex Railway Appliance Co. in case the appeal goes against the Pressed Steel Car Co.

Mr. A. E. Rosenthal, heretofore general sales manager of the Davenport Locomotive Works, has resigned to become western representative of the Lima Locomotive & Machine Co. His office will be at 1601-03 in the new Steger building in Chicago, after May 1.

Work of rebuilding the Denver plant of the Griffin Wheel Co., Chicago, which was burned March 8, is progressing rapidly and it is expected that a portion of the plant will resume operation May 15.

The General Railway Supply Co., 531 Marquette building, Chicago, which has been handling the sale of the Schroyer friction curtain rollers and fixtures, has discontinued the sale of these appliances.

George W. Fleming, of the Pittsburgh Gage & Supply Co., Pittsburgh, Pa., has been appointed eastern sales manager, with office at 91 Liberty street, New York.

The stockholders of the American Brake Shoe & Foundry Company have authorized an increase of the common and preferred stock by $2,000,000 each, bringing each class up to $5,000,000. They have also authorized the payment of $1,000,000 in common stock for the acquisition of the International Brake Shoe Company, which has $300,000 capital stock and which operates plants in Canada.

Railway Mechanical Patents Issued During April

Bolster for cars or other vehicles, 953,048—William H. Miner, Chicago, Ill.

Antifriction center bearing for railway cars, 953,054—John F. O'Conner, Chicago, Ill.

Friction spring draft rigging,. 953,055—John F. O'Connor, Chicago, Ill.

Box car, 953,115—William P. Bettendorf, Davenport, Iowa.

Flooring for railway cars, 953,116—William P. Bettendorf, Davenport, Iowa.

Ash pan for locomotives, 953,137—John H. Hackley, Cherryvale, Kan.

Brake beam, 953,148—Ernest A. Le Beau, Chicago, Ill.

Brake lever fulcrum, 953,163—Charles H. Williams, Jr., Chicago, Ill.

Railway car, 953,176—John O. Neikirk, Morgan Park, Ill.

Dump car, 953,182—Frederick Seaberg, Chicago, Ill.

Car replacer, 953,221—George W. McMunn, Pittsburg, Pa.

Grain car door, 953,244—Orblin Van Camp, St. Thomas, N. D.

Headlight, 953,288—Ephraim B. Poole, Delmar, Ala.

Brake beam finger guard, 953,314—Carl E. Bauer, Hammond, Ind.

Locomotive spark arrester, 953,320—Harry A. Dailey, Wheeling, W. Va.

Railway car, 953,347—Spencer Otis, Chicago, Ill.

Brake valve, 953,349—William K. Rankin, Philadelphia, Pa.

Air deflector for cars, 953,350—Paul J. Schraeder, Chicago, Ill.

Air brake coupling, 953,458—Mark A. Brown, Chattanooga, Tenn.

Railway car brake, 953,510—Louis Boirault, Paris, France.

Car truck, 953,555—John B. Seely, Hammonton, N. J.

Sliding door ash pan, 953,573—Hiram Alaman and William M. Lindley, Terre Haute, Ind.

Car underframe, 953,582—Anton Becker, Columbus, Ohio.

Car truck, 953,681—John C. Barber, Chicago, Ill.

Brake beam, 953,695—Charles F. Huntoon, Chicago, Ill.

Brake beam, 953,772—Charles H. Williams, Jr., Chicago, Ill.

Railway car, 953,781—Richard J. Edwards, Galena Ill.

Brake beam, 953,784—Philip B. Harrison, Chicago, Ill.

Dump car, 953,865—Robert L. Sites, Knoxville Tenn.

Grain door, 953,869—Hans Thompson, Minneapolis, Minn.

Car underframe, 954,026—Charles F. Frede, St. Louis, Mo.

Draft gear, 954,058—Arthur L. Stanford, Chicago, Ill.

Draft gear, 954,071—Olof Anderson, Chicago, Ill.

Metallic car sash, 954,094—Elmer E. Greene, Altoona, Pa.

Railway car, 954,166—John Bryan, Yellow Springs, Ohio.

Car roof, 954,194—William K. Lavis, La Grange, Ill.

Car door burglar alarm, 954,231—George A. Ulrich, Guadalajara, Mexico.

Locomotive ash pan, 954,274—Joseps B. Ennis, Paterson, N. J.

Cardoor, 954,326—Frank A. McComber, Marshalltown, Ia.

Electric locomotive, 954,475—Frank L. Sessions, Columbus, Ohio.

Car ventilator, 954,509—Robert E. Frame, St. Louis, Mo.

Automatic train stop, 954,517—Samuel D. Jarvis, Latham, Ill.

Dumping car, 954,560—Carl P. Astrom, Hasbrouck Heights, N. J.

Ladle car, 954,561—Carl P. Astrom, Hasbrouck Heights, N. J.

Car door operating mechanism, 954,698—Charles J. Rehlin, Pittsburg, Pa.

Vehicle brake, 954,711—William J. Wilde, Hazleton, Pa.

Car construction, 954,908—Harry H. Adams, New York, N. Y.

Seal lock, 954,910—George H. Barker, Yonkers, N. Y.

Exhaust controlling device for locomotives, 954,998—John A. Richardson, Wausau, Wis.

Automatic train pipe coupling, 955,045—Oliver C. Blair, Houston, Tex.

Automatic train stop, 955,059—Sidney M. Duncan, Eastend, Tenn.

Dumping ash pan, 955,072—Thomas J. Hudson, Sutton, W. Va.

Car window, 955,123—Lars J. Berg, Pullman, Ill.

Electric signaling device for motor cars, 955,192—Joseph J. Palous, Berlin, Germany.

Means for locking drop doors of dump cars, 955,225—Ralph G. Taylor, Davenport, Iowa.

Convertible stock car, 955,238.—Albert Westphal, Baltimore, Md.

Brake beam, 955,239 and 955,240—Charles H. Williams, Jr., Chicago, Ill.

Car replacer, 955,375—Franz J. Woods, Des Moines, Ia.

Car door, 955,381—Henry A. Christy, Kenilworth, Ill.

Double safety car wheel and propelling parts co-operating therewith, 955,382—Le Vert Clark, Detroit, Mich.

Portable car truck, 955,398—William H. Harris, Gladstone, N. Mex.

Mechanism for operating carbrakes, 955,450—William D. Brewster, Syracuse, N. Y.

Dumping railway car, 955,452—John V. Ericson, Chicago, Ill.

Safety brake for cars, 955,536—William E. Nolan, Sullivan, Ind.

Flush car door supporting and operating means, 955,537—David F. Noll, Altoona, Pa.

Var ventilator, 955,543—Edward Posson, Chicago, Ill.

Car roof framework, 955,544—Edward Posson, Chicago, Ill.

Air brake controlling means for locomotives, 955,611—Samuel N. Stevens, Fitchburg, Mass.

Brake beam, 955,620—Sylvester U. Walck, Lehighton, Pa.

Air brake system, 955,625—Andrew J. Wisner, Philadelphia, Pa.

Car seal, 955,638—Samuel F. Estell, Florence, Cal.

Extension car step, 955,658—Edgar S. Mitchell and George A. Campbell, Homer, La.

Life guard for railway cars, 955,678—George A. Parmenter, Cambridge, Mass.

Mailbag catching and delivering apparatus. 955,697—George W. Saylor, Philadelphia, Pa.

Apparatus for cooling journal boxes on railway trains, 955,743—Walter P. Andrews, Jefferson, Tex.

Car door, 955,755—Alva B. Bulloch, Irondale. Ala.

Car door, 955,757—Charles Buss, Glenwillard, Pa.

The New York Central & Hudson River is soliciting bids for two-story, 400 by 400 brick and steel warehouse to be erected at Buffalo, at estimated cost of $200,000, and also for car shops and power plant to be built at Oswego at a cost of $80,000.

The Erie R. R. has had plans prepared for remodeling its 3-story brick passenger station and office building at Buffalo, N. Y.

The Chicago Great Western has an inquiry in the market for 5,000 tons of bridge work.

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ANNOUNCEMENT.

This issue of the Railway Master Mechanic contains what is probably the most complete set of photographs of mechanical officials ever collected. It is probably the last time they will appear in connection with any special issue of this paper for some years. From time to time, as changes and promotions are noted in our columns, the photographs will appear individually and the reproductions are filed for that purposes. It is expected that the June issue of the Railway Master Mechanic will be kept by many as a souvenir on the strength of the album feature, but in order that it may be a source of interest for years to come the publishers have decided to bind up a large number of books in cloth and board covers, each of which will contain a copy of the June and July issues. The book will be made as durable as possible with the idea that it will be one of frequent reference value, as, aside from the indexed photographs, the convention report contained in the July issue will lend its interest. It was originally the intention to publish in this issue the photographs of our friends among the supply men, but on account of lack of space this feature had to be postponed to the July issue. As the July number is to be bound with the issue for June, the books will contain both series of photographs.

SUPERHEATER TESTS ON THE SANTA FE.

On another page of this issue we are publishing, in part, the results of a very exhaustive series of service tests on superheating conducted on the New Mexico division of the Atchison, Topeka & Santa Fe Ry. between La Junta, Col., and Raton, N. Mex. The superheaters used are the designs of Mr. W. F. Buck, superintendent of motive power, and Mr. H. W. Jacobs, assistant superintendent of motive power. These tests are unusual in character in that they are practically the first to demonstrate the results of a moderate superheat as applied to locomotives, both compound and simple, of several classes in actual service. While the theoretical results of laboratory tests are valuable in that they indicate what may be expected in service, still there is no question as to the greater comparative value of results as recorded from tests in actual service.

To Prof. H. B. MacFarland, engineer of tests, is due the credit of exploiting, for the benefit of the mechanical world at large, the work of Mr. Buck and Mr. Jacobs in the successful application of superheaters of original design to the motive power of the Santa Fe. The results are carefully complied in a volume from which we have freely quoted. The impression has gone abroad that the Atchison, Topeka & Santa Fe Ry., long foremost in the use of compound locomotives, has been supplanting the principal with the superheater. Incidentally the publication of the results of these tests shows that, other than in the case of one class of power, superheated have been applied to the engines as an adjunct rather than as a substitute for compounding. The difficulty of carrying on a series of tests of this kind under service conditions is well known, and it is to be hoped that all who are interested may profit to the fullest extent by these tests, the thoroughness and completeness of which cannot be questioned by any one who examines the recorded results as published. We agree with Prof. MacFarland in his statement that the data is more complete than any that has been heretofore presented to the public on the subject.

While the tests covered the performance of two classes of power, we are able to extract, in this issue, only from the report of the tests on engines of the "Santa Fe" type, numbers 901 and 923. In a future issue we hope to publish, in brief, the report of test runs of the Mikado type simple engine, number 898, equipped with the Jacob's superheater.

At the Chicago shops of the Chicago & Northwestern Ry. the iron moulds for the casting of bearings are water-jacketed and a good circulation of water is maintained so that bearings can be removed at once after casting. Considerable time is saved on this work and it has been entirely satisfactory.

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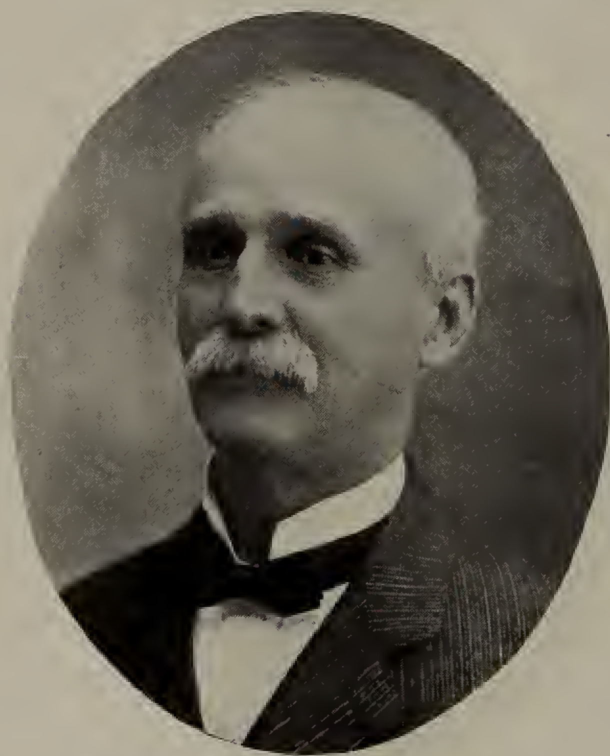

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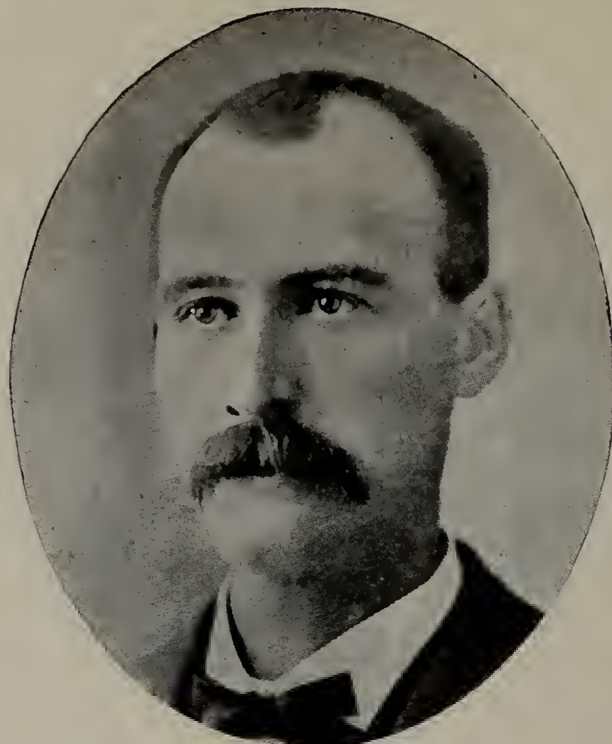

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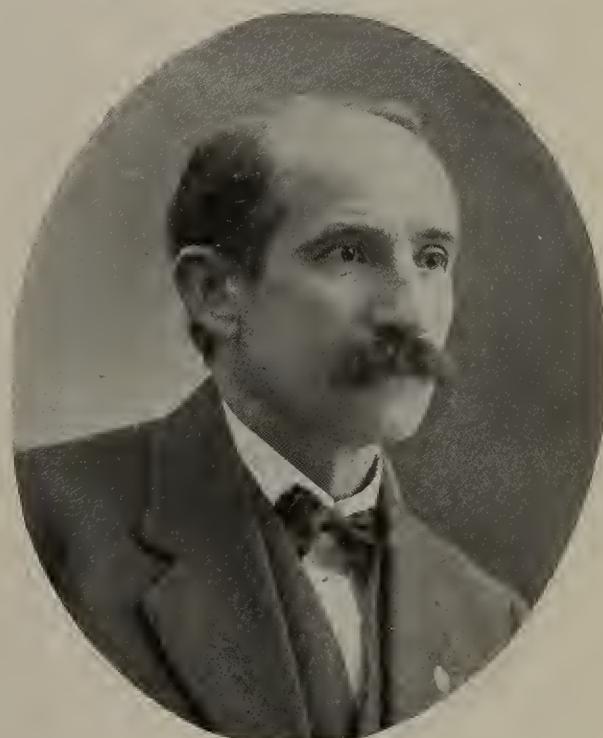
M. M., Huntington & Broad Top Mt. R. R.

M. J. POWERS,
M. M., Denver & Rio Grande R. R.



C. W. TESSIER,
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S. M. P., E., J. & E. Ry.

C. D. VANAMAN,
M. M., Florida East Coast Ry.

W. C. ARP,
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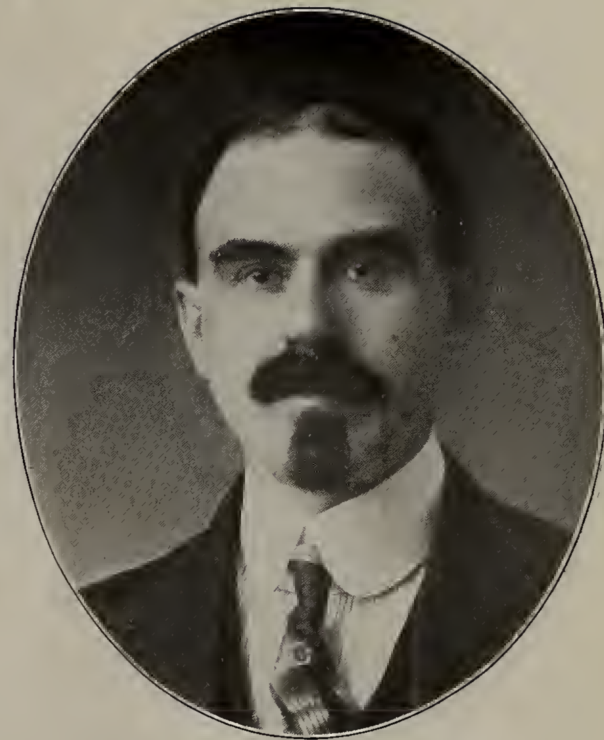
Gen. Fore. Car. Dept., C., M. & St. P. Ry.


E. W. PRATT,
A. S. M. P., C. & N. W. Ry.


C. H. EMERSON,
M. C. B., Elgin, Joliet & Eastern Ry.


GRANT HALL,
S. M. P., Canadian Pacific Ry.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S. M. P., Grand Rapids & Indiana Ry.

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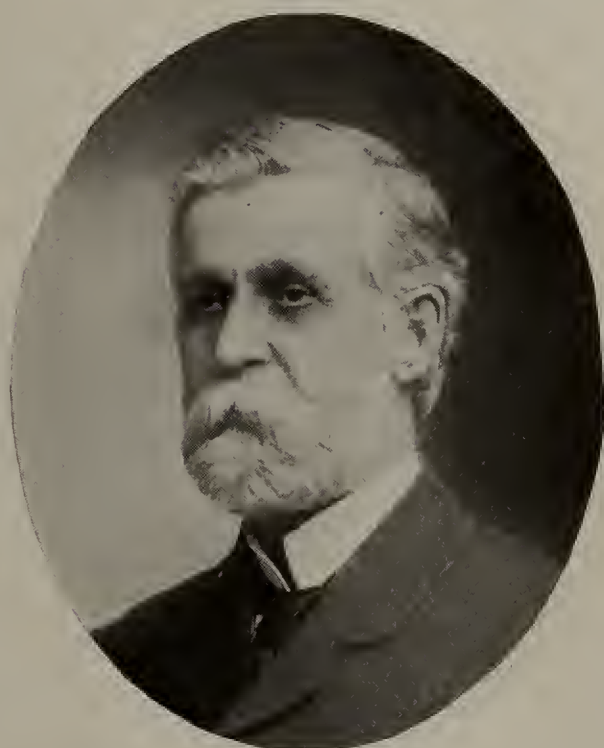
L. B. RHODES,
S. M. P., Virginian Ry.

C. H. WIGGIN,
S. M. P., Boston & Maine R. R.



G. W. KENNEY,
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M. C. B., Grand Trunk Ry.

J. H. MURPHY,
M. M., C., N. O. & T. P. Ry.

H. E. PASSMORE.
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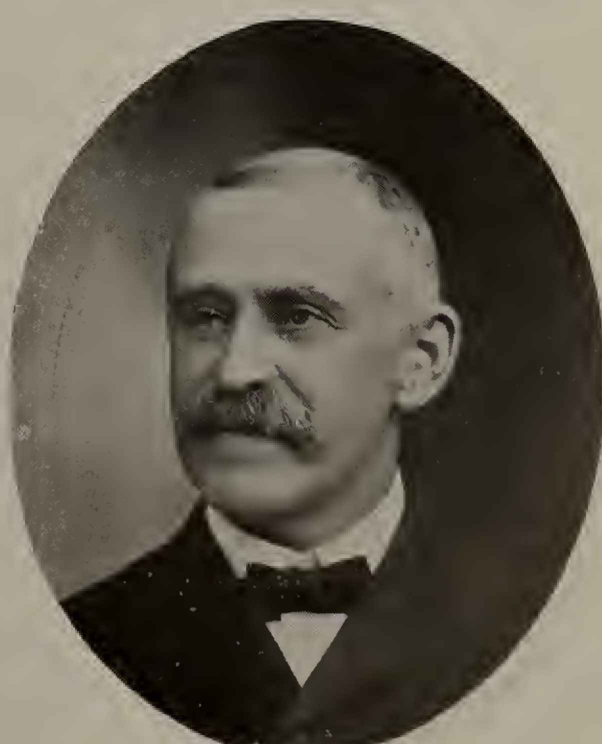

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M. M., L. & N. R. R.

GEO. W. STUBBS,
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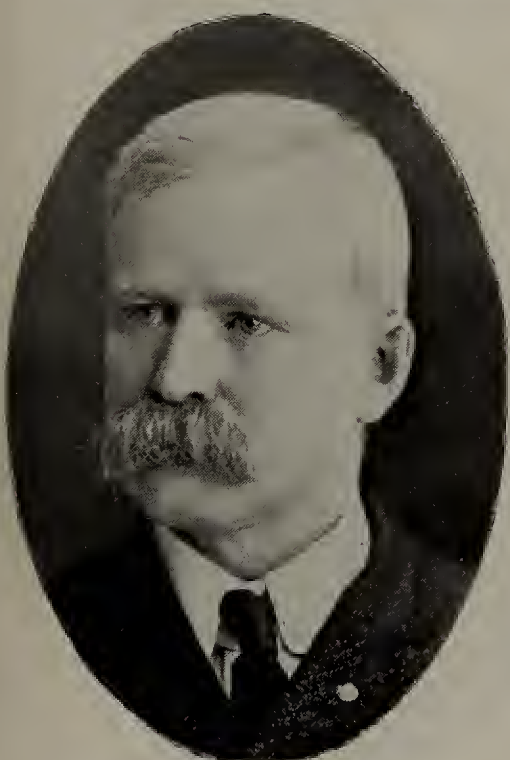

M. E. WELLS,
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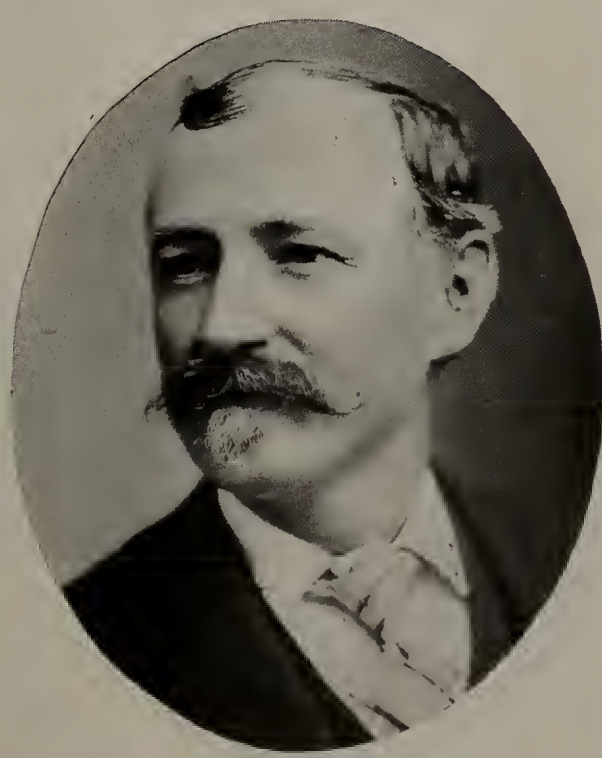
H. D. JOHNSON,
Gen. Supt., Chicago & South Bend Ry.

G. H. GILMAN,
M. C. B., Northern Pacific Ry.



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J. J. MONAHAN,
M. M., Louisville & Nashville R. R.

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JOHN F. NEWHOUSE,
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STEWART J. DILLAN,
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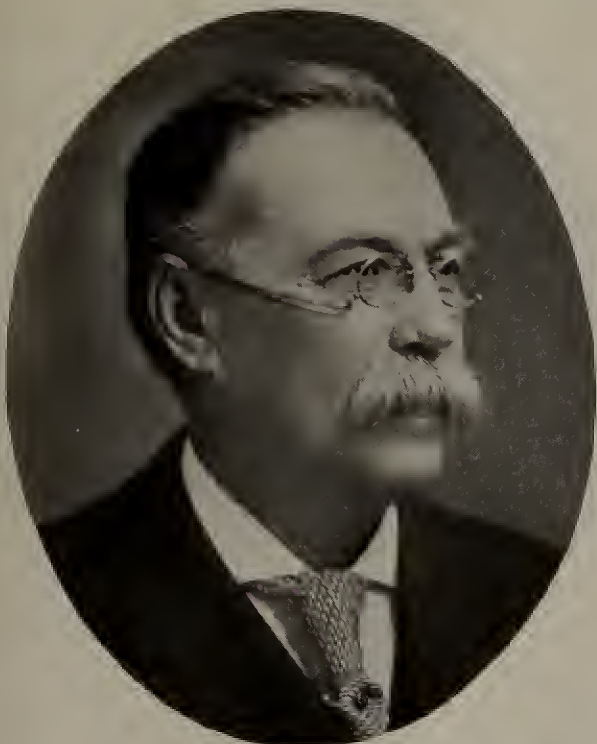

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CHAS. N. SWANSON,
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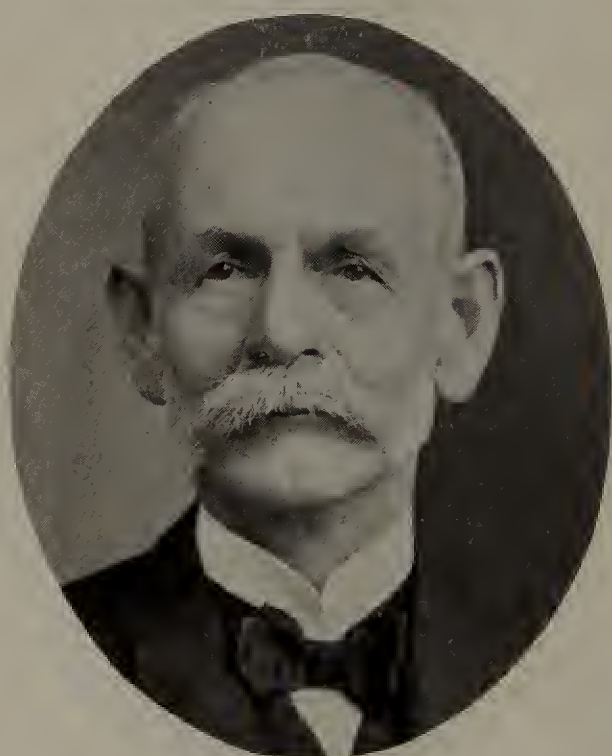
J. S. PEARCE,
M. M., Norfolk & Western Ry.


J. W. MARDEN,
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M. M., Lehigh & New England R. R.


JNO. L. DRISCOLE,
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M. C. B., Buff. & Sus. Ry.

E. O. ROLLINGS,
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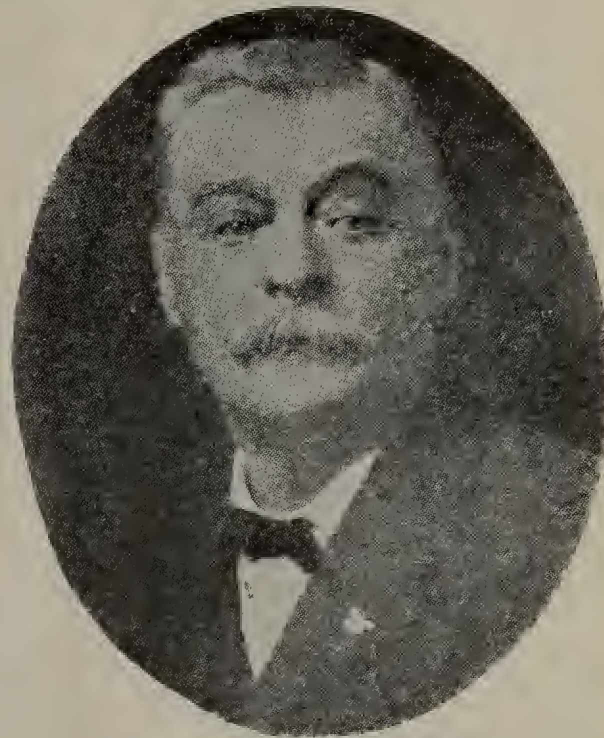

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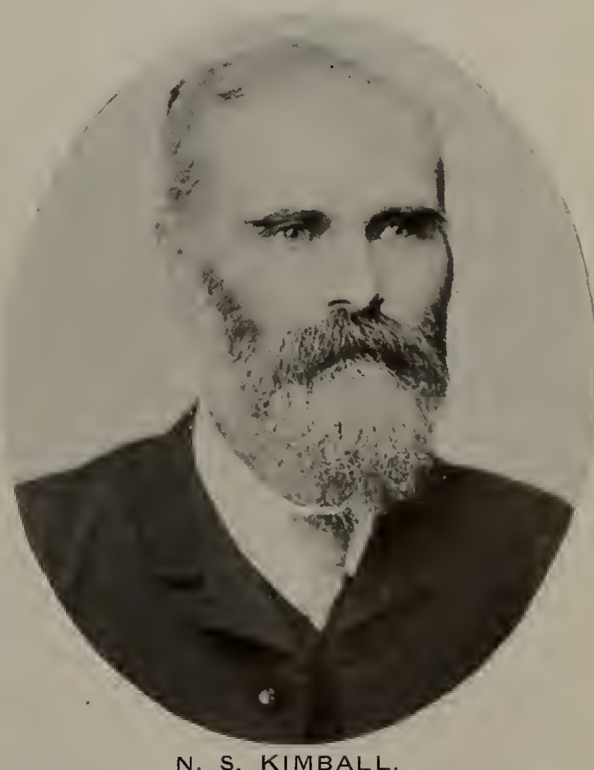
M. M., El Paso & Southwestern Sys.

C. MONTGOMERY,
M. M., Pere Marquette R. R.

H. H. HALE,
M. M., C. H. & D. Ry.

G. W. RINK,
Mech. Engr., Central R. R. of N. J.

Geo. N. RILEY,
S. M. P., McKeesport Connecting R. R.



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H. T. PEYTON,
M. M., A. T. & S. F. Ry.

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M. E., Colo. & Southern Ry.

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Gen. Fore., C. N. O. & T. P. Ry.

GEO. ROMMEL,
M. M., Phil. & Reading Ry.

C. E. GOSSETT,
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M. M., Chi. Gt. Western R. R.

C. J. McMASTER,
Gen. Foreman, Rutland R. R.

C. D. SCHAFF,
M. M., New York Cent. Lines.

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M. M., N. O., T. & M. Ry.


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ROBT. TAWSE,
S. M. P., D. T. & I. Ry.


W. J. MILLER,
M. M., St. L. S. W. Ry.

Superheater Tests, Atchison, Topeka & Santa Fe Ry.*

INTRODUCTION.

At the present time, superheated steam is receiving a great deal of attention on the part of locomotive builders and officials of modern railways. The subject is one of great importance to all motive power officials. The time is ripe for an aggressive railroad to determine whether or not superheated steam shall be used on different classes of power. The matters of fuel economy, of reduced cost of repairs and maintenance, of increased speed and hauling capacity, of decreased time on road, of simplicity in mechanical construction, of low cost in equipment and of adaptability of a type of superheater to all classes of power—all come up for consideration in final decision.

Many types of superheaters have been tried, some have been greatly complicated, some have proven highly economical, some have had their efficiency destroyed on account of mechanical and lubricating defects, some have proven to be merely steam dryers, yet even in this capacity have proven very satisfactory, giving such gains in fuel economy and increased serviceability of engines as to warrant most careful investigation and test of superheaters with a moderate degree of superheat for different classes of power and for different kinds of service.

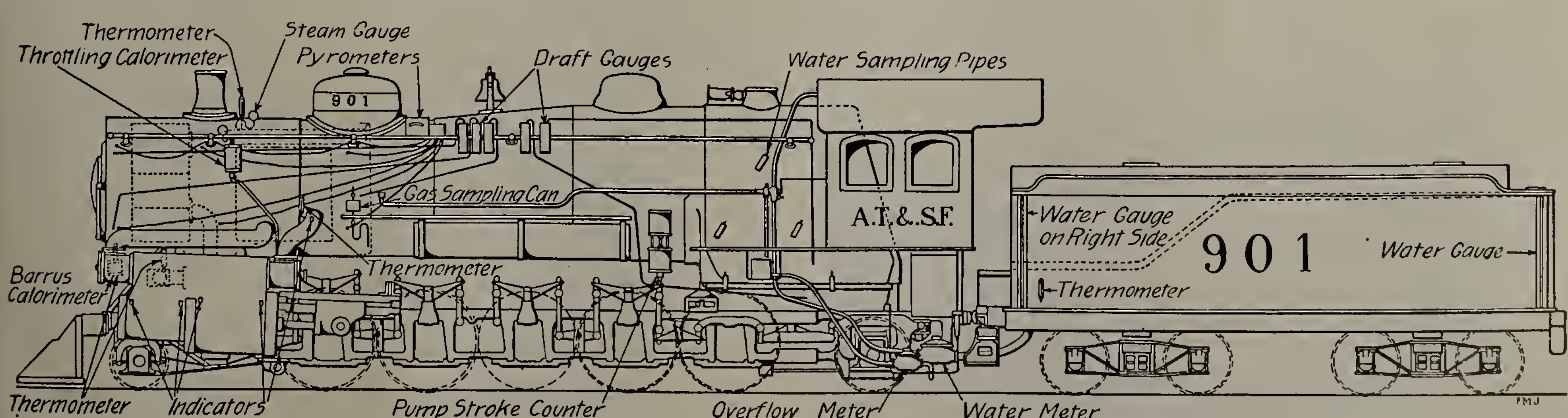
A critical knowledge of the art of superheating, records of performance of the different types of locomotives with superheaters in service in this and in foreign countries, consideration for maximum efficiency with minmum cost were factors in deciding that the type of superheater to give ultimate satisfaction would be a smokebox, tubular superheater, so proportioned as to deliver steam to the cylinder at a temperature not to exceed 450 degrees. Such a superheater, giving not over 100 degrees of superheat, may be known as one giving a moderate degree of superheat.

The design of a superheater, involving all the above points, as well as being adaptable to simple and compound engines, was worked out by Mr. H. W. Jacobs, assistant superintendent of motive power. The first superheater was applied to a simple engine in freight service. The results obtained warranted the installation of other superheaters and the further application to a compound engine to give superheat to both high and low pressure cylinders. The compound engine is the prevailing class of power on the system therefore, in order to get the maximum benefit from the Jacobs superheater, it was necessary to prove its value in this connection.

Santa Fe Type Locomotive Fitted with Jacobs Superheater and Reheater.

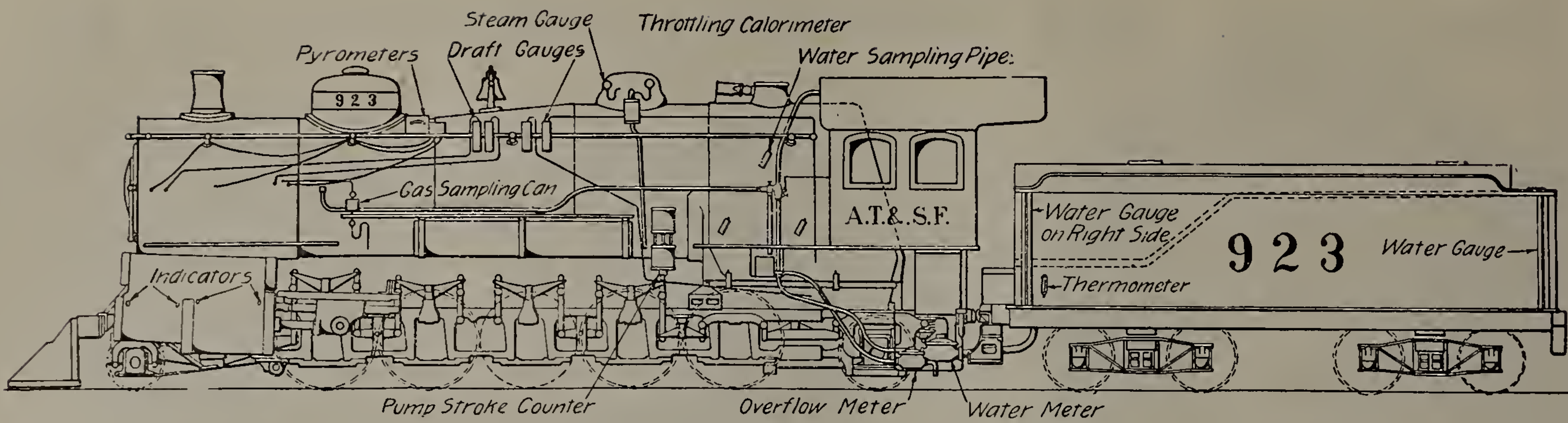
A series of tests was arranged to determine the benefit to be obtained from superheated steam in actual service under conditions met on the road; comparative results were to be determined by testing a similar engine without superheater equipment over the same territory. While fuel economy was to be considered the important point to be determined, yet, at the same time, it was decided to make a thorough test, obtaining data to show the complete performance of the locomotives. With this end in view, the engines were equipped with special apparatus for test record. There was no desire to obtain results under uniformity of laboratory conditions, such as are impossible in ordinary practice, but to record variable conditions as they occur

*A report compiled by H. B. MacFarland, engineer of tests with an introduction by W. F. Buck, superintendent of motive power.



ENGINE 901

Equipped with Jacobs High and Low Pressure Smokebox Superheater, showing location of Test Apparatus.



ENGINE 923

Showing Location of Test Apparatus.

in actual mountain service with heavy tonnage trains, with normal side track delays and with regular engine crews.

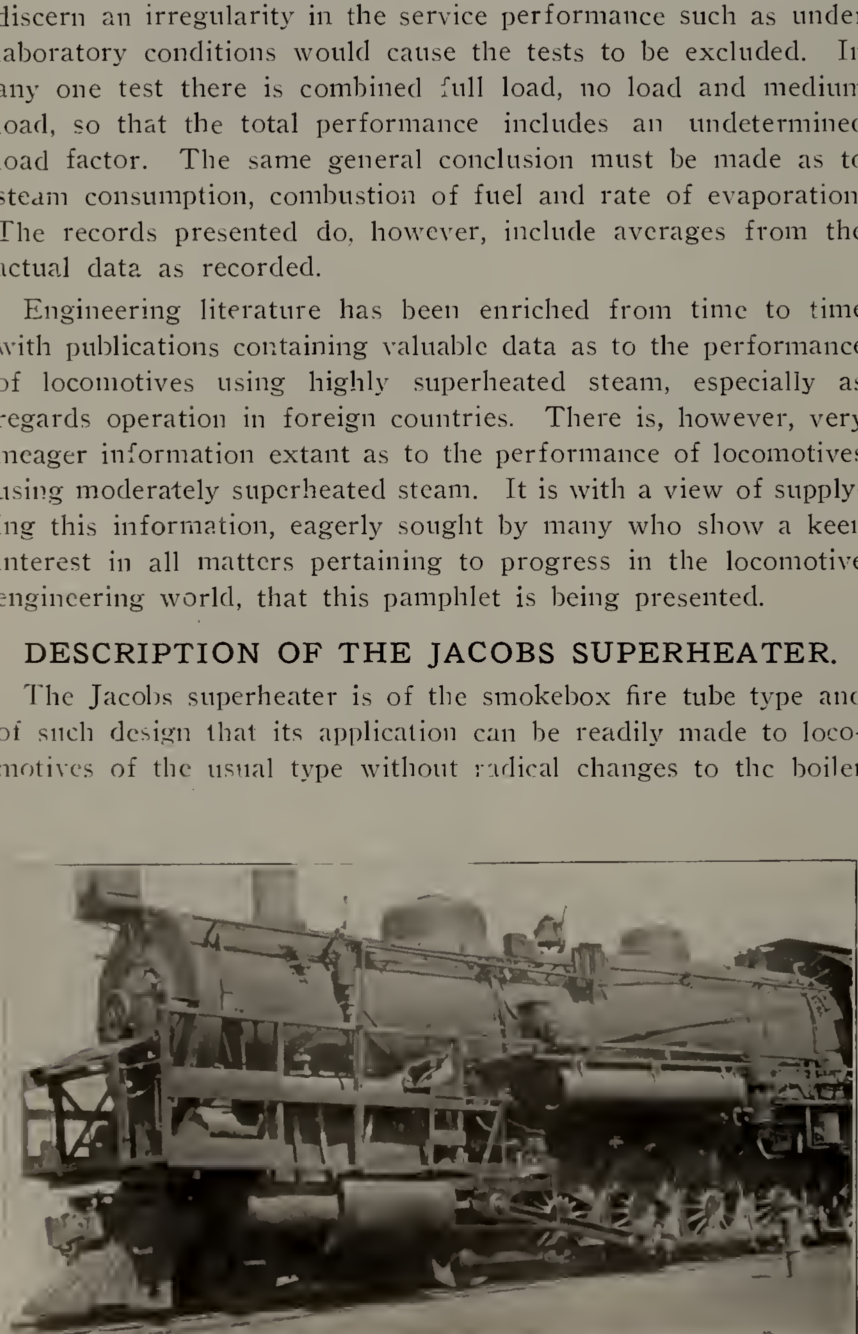
The results obtained from these tests were so satisfactory as to warrant the equipping of fifty new Atlantic type and thirty new Pacific type of passenger engines with this type of superheater. Later results of service performance and careful tests on our four new Mallet engines warrant the equipping of forty new Mallet freight engines with the Buck-Jacobs type superheater. Moreover, there are many installations of superheaters being made on locomotives as they go through the shops for general overhauling.

In presenting the results of the series of tests, no apology is necessary to the engineering profession whose critical eye may discern an irregularity in the service performance such as under laboratory conditions would cause the tests to be excluded. In any one test there is combined full load, no load and medium load, so that the total performance includes an undetermined load factor. The same general conclusion must be made as to steam consumption, combustion of fuel and rate of evaporation. The records presented do, however, include averages from the actual data as recorded.

Engineering literature has been enriched from time to time with publications containing valuable data as to the performance of locomotives using highly superheated steam, especially as regards operation in foreign countries. There is, however, very meager information extant as to the performance of locomotives using moderately superheated steam. It is with a view of supplying this information, eagerly sought by many who show a keen interest in all matters pertaining to progress in the locomotive engineering world, that this pamphlet is being presented.

DESCRIPTION OF THE JACOBS SUPERHEATER.

The Jacobs superheater is of the smokebox fire tube type and of such design that its application can be readily made to locomotives of the usual type without radical changes to the boiler



Showing Arrangement of Head-End Test Apparatus.

or front end. The principal features in its operation is the utilization of waste heat in the combustion gases without a sacrifice of effective heating surface in the boiler.

In its present form and construction, the Jacobs superheater consists of two steel drums, fitted with a series of horizontal fire tubes between the heads and with steam pipe connections. In the early stages of the development of the superheater, considerable experimental work was carried on to determine the diameter of fire tube giving the most satisfactory results. These researches brought out very strongly, the superiority of the two and one-quarter-inch tube. The shells of the two drums are of five-eighths-inch boiler plate. The heads are flanged similar to standard practice common to front flue sheets on all locomotives.

The illustrations afford some conception of the general design and location of the superheaters. The rear drum is made oval in cross section to provide room for passage of the dry pipe extension to the front drum and is placed directly before the front flue sheet of the boiler. The forward drum of the superheater is circular in cross-section and placed just ahead of the exhaust pots. For facilitating repair work on boiler tubes, the rear drum is placed about 24 inches ahead of the front flue sheet and a manhole, provided in the bottom of the smokebox, gives access to a boilermaker. A 20-inch return flue in the front drum and a six-inch central flue in the rear drum are lined up so that leaky or defective flues may be cut out of the boiler and removed through the front end without the necessity of taking out the superheaters.

The rear superheater drum, situated as it is, almost immediately in front of the front flue sheet, is exposed to high gas temperatures, subjecting the tubes to severe stresses through expansion and contraction. Under ordinary boiler construction this would result in a constant source of trouble through leaking. Under the method of construction followed with the Jacobs superheater, however, trouble from this source is reduced to a minimum. The tubes in the rear drum of the superheater are inserted without copper ferrules, then rolled and expanded, after which they are welded at both ends by either the autogenous or electric method, thus insuring perfect and permanent joints. It has not been found necessary to weld the tubes in the front drum, as the temperatures of the surrounding gases are considerably lower than those surrounding the rear drum and the stresses are correspondingly less severe. These tubes are merely rolled, expanded and beaded, similar to common practice with boiler flues.

The two drums are as light as consistent with safety and are of very compact construction, their design being such that they afford maximum volume and superheating surface per unit of weight. There are no heavy headers or castings to cause a slow absorption of heat and at the same time a restriction of available area for superheating. The contraction permits a maximum degree of superheat within a short period after locomotive begins working steam.

The drums are securely held in place by "Z" shaped drum brackets. A reference to the drawings shows their construction and how contraction and expansion, both vertically and horizontally, is cared for by slotting these brackets on one end and by placing them along the bottom and sides of the drum. All parts of the superheaters are readily accessible; the drums may be removed by removing nuts from the retaining bolts and studs. The manner of construction of these superheaters is so thorough that they rarely require attention between periods of general shopping.

The general construction of all superheaters is such that steam passes through the dry pipe extension to the rear head of the front superheater. A reference to the drawings of different types of superheaters with their explanatory notes gives in detail the path of steam in passing through the various types of superheaters. In both drums baffle plates of thin steel direct the circulation of the steam over all the tubes. These plates prevent the steam from flowing in a direct line from entrance to exit and bring the steam in direct contact with all the tubes in the drums, besides increasing its velocity of flow over the tubes.

One of the peculiar properties of steam is that upon coming in contact with any hot surface, it forms a thin non-conducting film thereupon which tends to repel rather than to absorb heat. It follows, therefore, that if this film can be removed through a sort of scrubbing action due to high velocity of steam, and, if this action can be constantly accelerated, that the body of steam affected will be greater, the temperature head between the fire side and steam side of the flues will be reduced and the efficiency of the drums for superheating purposes increased. The baffle plates are intended to direct the steam in such manner as to effect the greatest possible transmission of heat through the tubes from the gases to the steam, giving thereby reduced temperature of smokebox gases and increased superheat in steam.

In all types of the Jacobs superheaters the flue gases pass from the boiler flues through the tubes of the rear superheater. This is accomplished by deflector plates placed around the back end of the rear drum and front end of the forward drum of the superheater except for a space of eighteen inches at the bottom. These plates extend from the outer shell of the superheater drums to the smokebox shell. Upon leaving the rear drum the gases in the central and top flues are deflected around the petticoat pipe and elbow which serves to connect the large cylindrical return flue in the forward drum to the petticoat pipe. The exhaust nozzle extends through this elbow and the exhaust steam travels up and out of the stack through the petticoat pipe without circulating through the smokebox or coming in contact with the superheater drums. This arrangement of drafting prevents any direct draft from the boiler flues to the stack.

After the gases pass through the rear drum and are partially deflected as above described, they travel forward through the tubes of the front drum and are drawn back through the central return flue in the front drum to the petticoat pipe, and out the stack. This is a radical departure in drafting locomotives, as it does away with the diaphragm and netting, the draft being very direct and also pulling on the fire much more evenly, thus obtaining more complete combustion and more efficient evaporation.

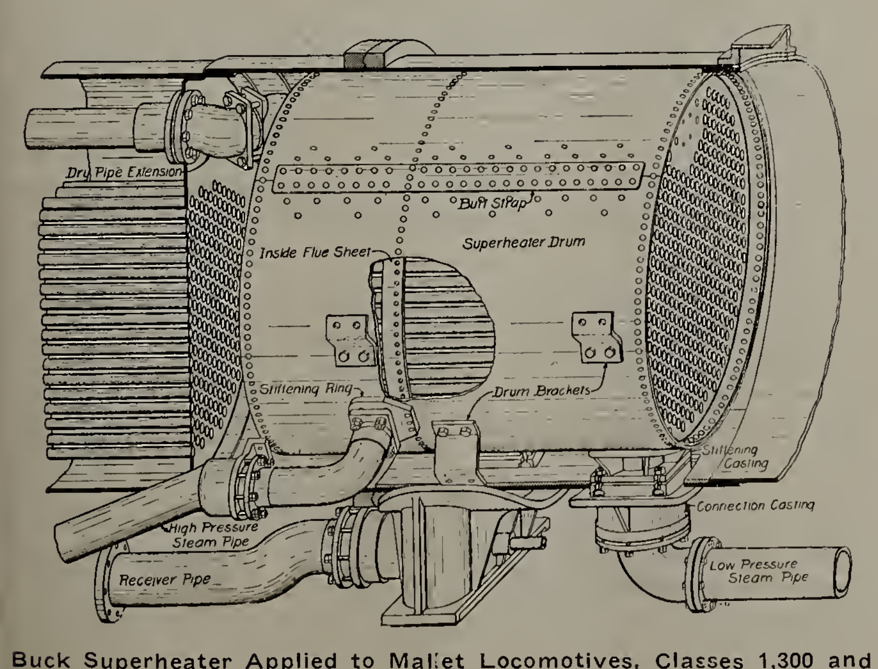
DESCRIPTION OF THE BUCK-JACOBS SUPERHEATER.

In addition to the Jacobs type of fire tube smokebox single expansion and high and low pressure superheaters, a later design known as the Buck type has been applied to four new Santa Fe Mallet locomotives, 1300 and 1700 classes. This type consists of one steel shell for high and low pressure superheaters with a dividing partition or third head which serves to separate the high pressure section of the superheater from the low pressure section. The high pressure section in this superheater is the rear section and is about one-half the length of the forward or low pressure section. With this design it is desired to take advantage of the initial high temperatures of the gases with a narrow high pressure superheater and by increasing the length of the low pressure superheater to obtain relative high results from this section.

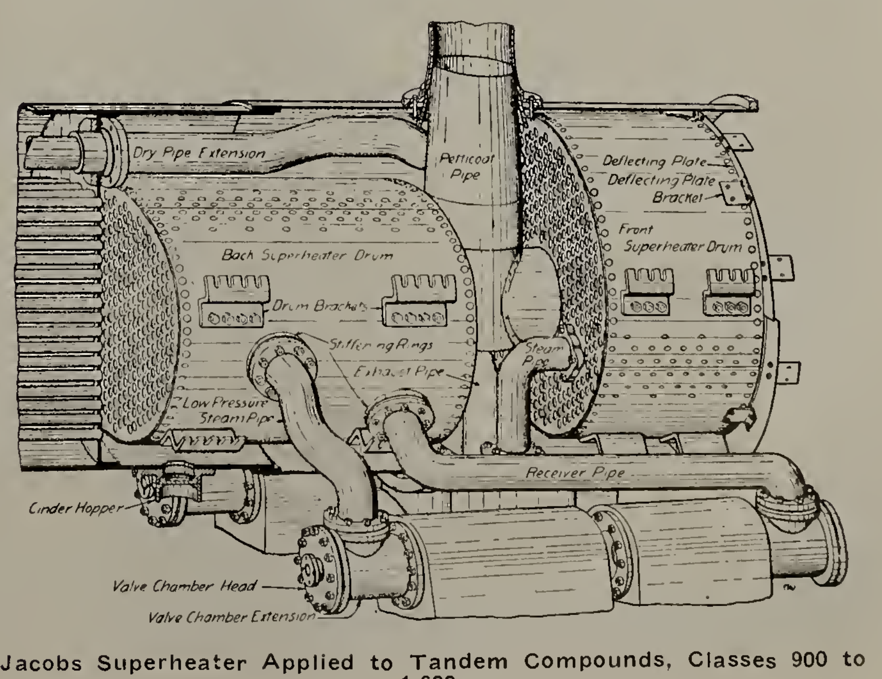
Since the application of the Buck superheater several improvements in design have been adopted. The new superheater, known as the Buck-Jacobs type with outside steam pipe connections, applied to the new Mallet engines now being constructed at Baldwin Locomotive Works at Philadelphia, will not be a separate drum, as in the 1300 and 1700 classes. Its three heads will be riveted to the boiler shell and all of the steam pipes will be outside pipes, readily accessible and easy of application. By this method it is intended to make the superheater as much a part of the boiler as is the feed water heater. Such a construction offers only a minimum obstruction to the gases, cinders and sparks. This design will increase the available tube superheating surface and will also increase the steam temperatures. The forty new coal burning Mallets, lately ordered, will be so equipped, as well as twenty new Atlantic and twelve new Pacific type engines.

The design is such that the question of "moderate superheating" for both high and low pressure cylinders in Mallet locomotives is greatly simplified. The double superheater is placed just ahead of the end of the boiler flues, and behind the feed water heater, with manholes on the top of the boiler and sufficient space at each end to permit a boilermaker to enter and work on or remove leaky or defective flues.

In this type of superheater, the waste combustion gases pass through the superheater tubes uninterrupted and then through the feed water heater tubes to the stack.



Buck Superheater Applied to Mallet Locomotives, Classes 1,300 and 1,700.



Jacobs Superheater Applied to Tandem Compounds, Classes 900 to 1,600.

COMPARATIVE ROAD TESTS OF SANTA FE TYPE TANDEM COMPOUND LOCOMOTIVES.

Present developments in the use of superheated steam in locomotive performance have led to a great number of tests of such locomotives to determine the lines along which future construction should proceed. Many of these tests have been made with highly superheated steam; others with low degree of superheat. The tests herein recorded relate to the performance of freight locomotives equipped with superheaters designed to give moderate superheat.

Experience with the Baldwin superheater, as installed on different freight locomotives on the system indicates that economical results may be obtained with a properly designed superheater giving such a moderate degree of superheat as is necessary to reduce cylinder condensation. While considerable virtue has been attributed to superheaters with a low degree of superheat, yet its value has not been so pronounced as to warrant the equipping of all locomotives on the system with this kind of superheater. Experience obtained with superheaters, however, indicates that some type of smokebox superheater will give better results, all things considered, than a superheater which requires the deformation of the boiler and a consequent reduction of efficient heating surface in the boiler flues.

In November, 1908, engine 888 was equipped with a smokebox superheater of the Jacobs type. This engine was assigned a portion of the time in helper service and a portion of the time in regular freight service until December, 1909, when she went into shop for a general overhauling. The performance of this engine during this period of time was superior to other engines of her class, and results indicate the superior qualities of the Jacobs moderate degree superheater over the Baldwin low degree superheater as applied to other engines of similar class.

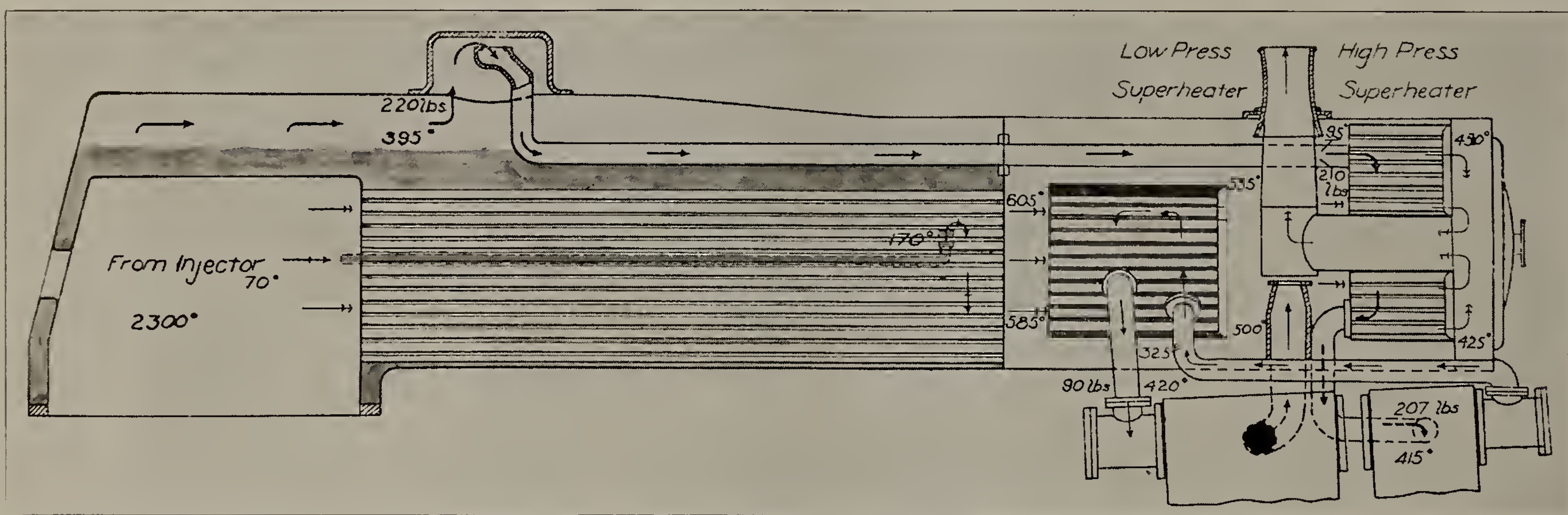
In June, 1909, engine 901 was turned out of Topeka shops equipped with a Jacobs high and low pressure superheater. Engine 901 is a tandem compound locomotive of the 2-10-2 type, also known as the Santa Fe type locomotive and is used for heavy mountain service. Locomotives of this class have a total weight on drivers of 234,580 pounds and a total engine weight of 287,240 pounds. Their tractive force is 62,800 pounds. The weight of tenders when loaded is 165,800 pounds.

From the very start this locomotive with superheater showed her superiority over other locomotives of her class. The engine started quicker, hauled a greater tonnage and used less fuel. The superior advantages of moderately superheated steam on this class of power were apparent to all observers. A special point noticeable is that when the cylinder cocks are opened no water drips from them, while on the other locomotives of similar type there is a continual stream of water running from the cylinders through the high and low pressure cylinder cocks.

It has been generally conceded that superheated steam is of value in passenger locomotives where high speeds are attained, but the economy of using superheated steam with freight locomotives where low speeds are attained has not heretofore been definitely settled. In order to determine the value of superheated steam in freight service, arrangements were made to make a thorough test of engine 901 operating under ordinary conditions of road service and to make a similar test of another engine of same class not equipped with superheater to get comparative results to determine the efficiency of superheated steam for compound freight locomotives. The installation of superheaters on all classes of locomotives and for all conditions of service is such a big problem on a great system that much importance was given to the tests in order to secure accurate data relative to all conditions of engine performance.

Engines.

The engines of the class under test were designed by the Baldwin Locomotive Works at Philadelphia, and are known as the Santa Fe type, with the general classification of 2-10-2, but are known on the system as the 900 and 1600 classes, as the total of 160 engines of this class are identified by numbers under these series.



Temperature and Pressure Diagram of Engine 906, Results Obtained by Actual Test. Jacobs Superheater.

At the time of their introduction, eight years ago, and until the advent of heavy Mallet articulated compounds into this country, they were the largest locomotives in the world. On account of their single rigid wheel base they are not applicable to the very shortest curves, but on track where they can be used give extremely satisfactory service in point of tonnage pulled and economical operation.

They are outside cylinder tandem compounds, and operate with a boiler pressure of 220 pounds. The cylinders consist of three principal castings—the saddle, to the sides of which the low pressure cylinders are bolted; the low pressure cylinders, to the front of which the high pressure cylinders are bolted, and the high pressure cylinders. Both piston valves on either side of the engine are attached to one stem and are designed to give the same cut-off in both high and low pressure cylinders. The high pressure valve has inside admission, the low pressure outside admission.

The engines are all built with fifty-seven-inch drivers and are used in both miscellaneous pusher and heavy freight service on the heavy grades found in that portion of the southwest through which the Santa Fe runs. In this territory it is necessary to cross five ranges of mountains on which the maximum grades vary from 2 to 3.5 per cent. On all of these mountain ranges the Santa Fe type is the prevailing class of freight power. Due to the weight of the heavy reciprocating parts of these engines, they have a limiting speed of twenty-five miles per hour. Greater speeds, however, may be attained but at an increased expense of engine maintenance.

Of these engines, seventy are used as coal burners and ninety as oil burners. In starting heavy tonnage trains on 3 and 3.5 per cent grades they will exert a draw-bar pull of 75,000 pounds and can maintain a 45,000 pound draw-bar pull at ten miles per hour on a 3 per cent grade. These engines were designed for heavy freight service on single track where traffic is heavy and where the main idea is to pull tonnage and make speed. This consideration for speed reduces their rating somewhat from the theoretical rating of that possible in a slow drag train.

The actual rating of these engines on through freight trains is shown by the following table:

Grade, feet per mile	Grade, per cent	Tonnage rating
184.8	3.5	540
158.4	3.0	600
132.0	2.5	650
105.6	2.0	950
79.2	1.5	1150
52.8	1.0	1350
26.4	0.5	3300

No changes were made in the construction of engine 901 at the time of the application of the Jacobs superheater except those necessary in the design of steam pipes and the moving of the front flue sheet back forty-two inches. While the shortening of the flues reduced the flue heating surface considerably yet this change did not prove at all serious in affecting the steaming qualities of the boiler. No changes were made in the valve setting, as shown by the tables on the following pages, giving data and valve setting for engines under test.

The construction of the Jacobs smokebox superheater entirely changes the front end drafting. In non-superheating locomotives, the sparks and cinders drawn through the boiler flues are caught, broken up and for the most part extinguished before leaving the stack, by striking the front end netting and baffle plate. The petticoat pipe regulates the gas current and tends to aid in distributing the draft more evenly through all the flues. Any adjustment of this pipe, either up or down, is apparent in a coal burning engine by the change in the fire box. Such a change in an oil burner engine is shown by a changed steaming efficiency or variation in boiler pressure.

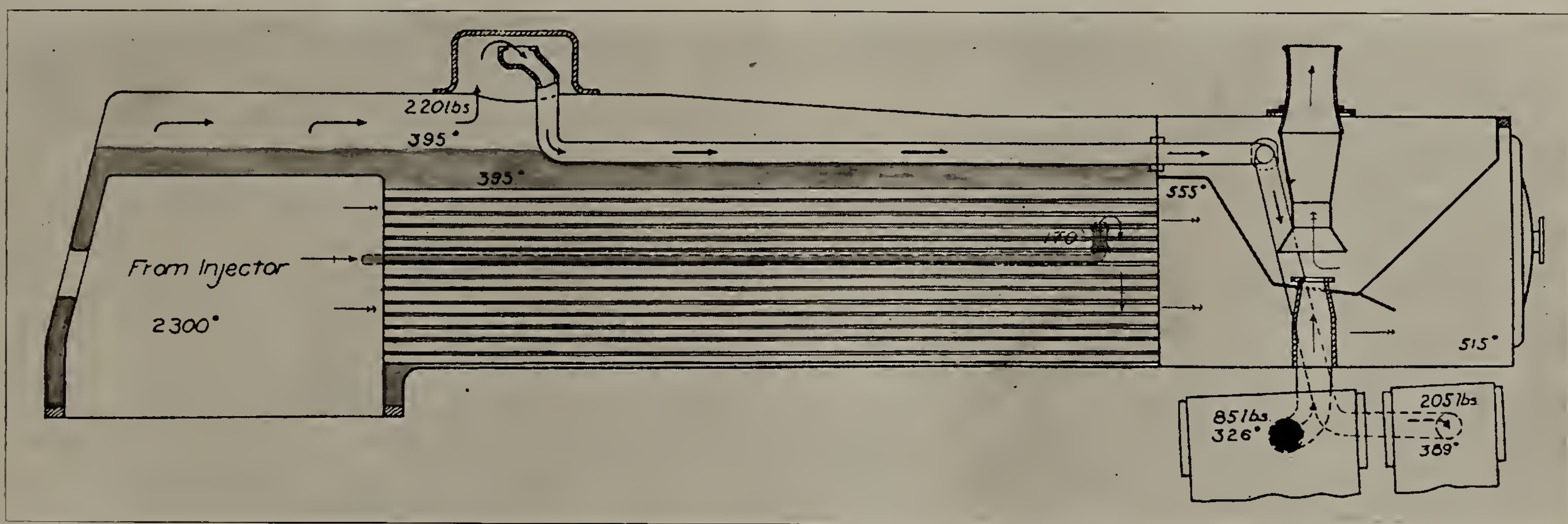
There is no netting or baffle plate in the locomotive equipped with a Jacobs smokebox superheater. The petticoat pipe is only a return flue or concentration tube for the gases. Cinders and sparks strike against the two drums, are whirled around the front of the front drum and by the time they leave the stack are extinguished. Further, there are not so many cinders drawn through the flues as in other locomotives. The sharp high peaks of draft noticed in most fireboxes are not present. The draft is more constant, and neither as many or as large cinders are lifted high enough to be drawn through the flues.

Engine 901 required a slightly smaller nozzle than the 923. Engine 901 had a five and five-eighths inch diameter nozzle and engine 923 a five and three-fourths inch, or one-eighth inch diameter in favor of engine 923. The back pressure in any locomotive cylinder depends both on the speed and on the exhaust nozzle diameter; the larger the exhaust nozzle, the smaller the smokebox and fire box drafts. It is therefore important in applying front end superheaters to make their construction such that they are self-cleaning with nozzle large enough so that the cylinder back pressure is not greater than in other locomotives.

The indicator cards taken on both engines show that the nozzle can be varied one-fourth inch in diameter and not affect the back pressure to any constant amount. In the case of engines 901 and 923, it is impossible to tell from the cards which had the larger nozzle, while in the general average the 901 shows a slightly smaller back pressure than the 923.

It can, therefore, be said that when properly adjusted the Jacobs smokebox superheater for engines in freight service assures no live cinders from the stack, and is self-cleaning with exhaust nozzle and cylinder back pressure similar to any non-superheater engine.

Engines 901 and 923 were equipped with four three-inch arch tubes placed in the fire box in such a manner as to allow the ready application of arch brick equipment. Locomotives of this type are subjected to very high temperatures in the fire box, and when they are not most carefully drafted draw harder on the lower and central flues, thereby putting undue internal strains on the top ones. The gases are also drawn directly into the flues many times before combustion is complete, and so escape from the stack at a high temperature. The brick arches that are applied change the drafting in the fire box. The arch becomes white hot, thereby increases the box temperature and improves the combustion of the gases. The drafts in the lower flues are reduced and the middle and upper flues give more effective service.



Temperature and Pressure Diagram Engine 923. No Superheater. Results by Actual Test.

The comparative performance of engines 901 and 923 with and without arch shows a decided saving for the arch in pounds of coal per thousand gross ton miles; this saving amounted to 29.6 pounds, or 12.8 per cent for engine 901, and 62.2 pounds, or 19.6 per cent for engine 923. Unfortunately, however, only one run per engine without the arch was made and with such a limited comparison there is too great a possibility of variation to draw broad final conclusions as to efficiency of arch brick equipment. Evaporative efficiency appears to be greater without the arch for engine 901, but on this run the boiler was not worked to its maximum capacity and some such a result might be expected. Neither engine steamed as freely or carried as constant boiler pressure without the arches as with them, and generally the arches seemed to make maximum working condition more simple.

The application of a superheater between the high and low pressure cylinders of a tandem compound locomotive affords an opportunity for studying the effects of a large receiver volume on the distribution of indicated horsepower between the high and low pressure cylinders for various engine speeds.

On the non-superheater locomotive, the receiver volume between the high and low pressure cylinders is very small, only amounting to six cubic feet, and furthermore the cylinder receivers on each side of the locomotive are entirely separate. The high pressure exhaust line follows closely the low pressure admission line and with equal ratios of cut-off, the ratio of indicated horsepower in the two cylinders is nearly unity, averaging 1 to 1:21 for the entire runs. Any increase in speed tends to bring the ratio closer to unity so that both high and low pressure cylinders develop nearly the same amount of power.

Due to small receiver volume, the receiver pressure fluctuates greatly and records with distinctness the characteristic events of the stroke. On the superheater locomotive the receiver between the high and low pressure cylinders has a capacity of 34.5 cubic feet. Both high and low pressure cylinders exhaust into the one receiver at different quarters of the stroke, and thereby maintain a comparatively high receiver pressure. With the aid of the starting valve the pressure is raised to a maximum in one stroke. As soon as this pressure is attained, the back pressure line of the high pressure cylinders becomes a straight line parallel to the atmospheric line. While its height depends entirely on how hard the engine is working, yet it is never slanted downward nor does it follow the low pressure admission line as in the other locomotive.

Both high pressure cylinders exhaust at different times into a common receiver. Due to the large volume of this receiver, the admission line on the low pressure is maintained more nearly horizontal than on the engine without large receiver volume. The receiver is a superheater and also serves to re-evaporate water condensed in the high pressure cylinders, thereby greatly increasing the volume of the exhaust steam from the cylinders as well as making a further increase in volume by superheating. Accordingly there is always a tendency for an increase in the back pressure in the high pressure cylinders. These conditions cause an increase of pressure in the high pressure cylinder, reduce the mean effective pressure in the high and increase it in the low pressure cylinders. thereby increasing the horsepower ratio between the two cylinders from 1 to 1.98 for the average of the entire runs. The lower the speed the more even the division of power. The higher the speed the greater the ratio in favor of the low pressure cylinder.

This distribution of power made engine 901 slightly more powerful at slow and average speeds than engine 923. At high speeds, however, the difference in power was less perceptible. The gain in horsepower in the low pressure cylinder more than offset the loss in the high pressure cylinder, both at high and low speeds. The influence of a large receiver on starting is a most important one. If the starting valve is not sufficiently large or there is not a by-pass allowing steam at boiler pressure to enter the receiver through a quick opening valve the engine will be so slow in starting that the insufficient engine momentum acquired will be inadequate to start a heavy train. On this engine the simpling or starting valve was large enough so that the large volume receiver was quickly filled with steam at a good pressure. The first low pressure cards taken at starting showed from one-fifth to one-fourth more horsepower than cards immediately following. This condition for starting made the engine exceptionally powerful, so that when necessary to stop for switching or for section men on steep grades or on bad curves, there was no great difficulty in starting the train. Other engines of her class under such conditions of stopping usually have to back up and run for the grades.

The indicator cards for engine 923 are typical cards for engines of this design though the lead on cards at slow speed does not seem in all cases to be sufficient. The indicator cards of engine 901 are such as should be expected at slow speeds. At high speeds, however, there was considerable negative work in the high pressure cylinders, part of which was due to lack of lead and excessive compression and part to the way in which both high pressure cylinders exhausted at different times into the one receiver.

Territory.

The tests were made on the first district of the New Mexico division, between La Junta, Colo., and Raton, N. M., a distance of 105 miles. On account of the mountain grades, however, the tonnage rating is different for this class of power between La Junta and Trinidad from that over Raton mountain between Trinidad and Raton. It is customary to use helper engines on Raton mountain and on account of not being able to distinguish properly data concerning performance of engine under test when in service on the mountain with train and helper, results relative to performance between Trinidad and Raton were omitted.

The distance from Raton to the top of the mountain is but six miles and the time for making the trip is so short that error in performance due to impossibility in getting similar initial and final conditions is so great as to allow nearly any deduction in regard to economy of engines. The distance from Trinidad to La Junta, however, is so great that slight irregularities in initial and final conditions bear such a small percentage to results as not to be misleading in making deductions in results obtained.

The distance from La Junta to Trinidad is 81.5 miles and in this distance there are fifty miles of an almost constant grade of 59.7 feet per mile, the remaining 31.5 miles having the same average ruling grade but all rolling. From Timpas to Simpson, a distance of 32.3 miles there is an opportunity to make, as nearly as possible, a capacity test of the locomotives, as in this territory there is an almost constant uphill grade. There are, however, a few momentum grades but they are not such as to relieve the engine of draw bar pull.

Arrangements for Test.

Careful arrangements were made to obtain full data as to actual performance of engine relative to coal and water consumption, equality of steam, boiler pressure, height of water in gauge glass, throttle and reverse lever positions, the drafts in the firebox and front end, degrees of superheat to cylinders, indicated horsepower, dynamometer horse power, draw bar pull, speed, and tonnage hauled. The diagrammatic arrangement of the apparatus as installed on the different locomotives is shown by the drawings.

The road tests could not, of course, be made under laboratory conditions as such are impossible to attain in ordinary practice. They were made in actual mountain service with heavy tonnage trains. The engineer was instructed to make no difference in the general operation of the engine on account of tests. The regular engine crews, who had for a considerable time been assigned to the different engines were used, so that the results of tests might be more nearly in conformity to actual operations. The conditions of road service do not permit of a constant position of either reverse lever or throttle over the track, but requires continual changing in position in order to maintain regular speed and prevent excessive draw bar pulls with long trains and consequent break-in-twos. As a consequence the records show considerable irregularity in performance on account of curves and grades. The average results, however, show considerable regularity in that there is such a correspondence in results recorded and grade conditions as to identify the operation of the engine on any particular portion of the trip. The special importance, then, to be laid on the records is that they contain in detail, the history of all changes made and that readings were taken frequently enough to obtain this data.

Testing Apparatus.

All the coal used for the various trips came from Willow mine number five located at Hebron, New Mexico. One car load of coal was sacked at a time, each sack containing 200 pounds. Enough coal for each run was taken from the car of sacked coal and placed on the tender at terminals. Before beginning a test run, the condition of the fire was noted and care was taken that it was clean and even; at the end of the run the same condition was approached as nearly as possible.

The sacks were emptied to the fireman as needed, so that no more than 500 pounds of coal was open at any one time. The time of emptying each sack was noted, a careful record was kept of the number of shovels of coal used by the fireman, as well as the time of firing. An exact record was kept of the number of shovels of coal fired.

Samples of coal from different sacks was taken during each test run, and from the accumulation of samples of fifty pounds a sample for each test was obtained by the standard method of quartering. The average samples thus obtained were analyzed and efficiencies for the runs were based upon the results of this analysis.

Three-inch Empire hot water meters were placed in each branch pipe; by-pass pipes for use when the engine was not under test were arranged to protect the meters. The meters were constantly checked by comparison with readings of gauge glasses on right front and left back corner of engine tank. Before the series of tests the engine tender was leveled and calibrated by weighing in water fifty gallons at a time. By leveling the tank and filling it with water and noting simultaneous readings of meter and tank gauges, the meters were calibrated and correction factors determined. The overflow of water from the injectors was discharged into calibrated cans, each of nine gallons capacity. As soon as the cans were nearly filled the amount was noted and cans were then empited. A one and one-half inch Empire hot water meter was placed in discharge from one of the overflow cans in order to check the method of measuring the overflow. The total amount of water overflowing from the injectors varied considerably on different runs and on different engines, depending very much upon the condition of the injectors. The amount of overflow was deducted from that shown by the injector meters, in determining the amount carried to boilers. No credit, however, was allowed for the heat in the water lost.

The quality of the steam was determined at the dome for engine 923 and in the dry pipe extension for engine 901. The calorimeter was of the Peabody throttling type and of latest design for this work. The calorimeter itself was carefully lagged. The calorimeter for finding the quality of steam leaving the high pressure cylinders was of the separating type, a Barrus universal steam calorimeter of the 1895 type.

Crosby steam gauges were used in the cab and on the calorimeter. These gauges were tested constantly by means of the Crosby dead weight steam gauge tester. Pressure in the superheater and receiver of the engines were obtained by special piping to the steam indicators. A Short & Mason compensated barometer was used for taking atmospheric pressures. These pressures varied constantly during the trip on account of changes in elevation.

"U" tubed draft gauges containing water were used in obtaining the drafts in the smoke box, between superheaters, in the firebox and in the ashpan. These gauges were bolted on the hand rail, and pipe connections were made to the gauge board from the various points where drafts were desired.

Thermal couples were used for measuring the smoke box temperatures. The Hoskins pyrometer was used for this purpose. The apparatus consisted of an eight-point switch with proper connections to front end. All the readings were taken from one instrument fastened on the hand rail. The couples themselves were of one-sixteenth inch material, and were very sensative to changes in temperature, so that differences in temperature in gases at top or bottom of smokestack were shown almost immediately. The pyrometer itself was so substantial in construction that after several months of service it showed upon test to be registering accurately.

An angle thermometer reading up to 212 degrees was used in obtaining temperatures of feed water. This thermometer was placed in the front of the engine tender close to suction pipe. Thermometers reading up to 600 degrees Fahrenheit were used in determining the superheat of steam to cylinders. These thermometers were tested from time to time against standard thermometers and proper corrections made.

Power Measurements.

The latest type of Crosby continuous outside spring indicators were used. The springs were tested before each series of runs. The indicators themselves were carefully tested for parallelism at various times throughout the tests, and were constantly tested for free, easy pencil movement, since in a series of road tests there is more or less dust or sand to interfere with operation of indicators.

While thirty-six cards may readily be taken at one time with the continuous indicator, yet it was found, after numerous trials, that three showed very accurately the information desired. Three were taken at each reading, and in working up the data the middle card was used as a sample; the other two cards indicating that the conditions just before and after taking the card differed not greatly from that at the time of taking the card. Cards were taken from all four cylinders simultaneously and connections were made to the dynamometer car so that an offset was made on the chart registering the beginning and end of each period of taking cards. This method of registering indicated accurately the location on road where cards were taken. The indicator reducing motion was of the slotted lever type, which took its motion from the engine cross-head and in turn drove a small cross-head. The second cross-head had a light tube or motion rod. On this tube were adjustable fingers to which the indicator drum cords were attached.

To determine accurately the work done by the engine and the resistance of the different trains, a dynamometer car was used. This car is known as the Westinghouse Air Brake Car number five, and was obtained from the Westinghouse company for making this series of tests. The dynamometer itself is of the diaphragm type and is capable of recording very high drawbar pulls and buffs.

The record of performance as shown on the twelve-inch roll attached to the chronograph shows very distinctly the variations in drawbar pulls at quarter second intervals. Time measurements of one-half seconds are shown by offsets in line on left side of the paper. Distance measurements in revolutions of the wheels are shown on the right side of the paper by offsets in pen line. The diameter of the wheel is such that the number of revolutions of the axle in six seconds gives the speed in miles per hour. The paper also records a base line upon which distance signals are recorded by an offset in the line, made by breaking the circuit on the part of the observer. Mile posts, time and stations are written on the chart. A separate base line is used for recording of time during which indicator cards were taken. All data regarding dynamometer horsepower, drawbar pulls and speeds were obtained from the charts in the dynamometer car.

Tonnage Measurements.

The tonnage haul was taken from the conductor's wheel report. These reports show weight in cars as per waybills, and also light weight of cars. The light weights of cars were invariably checked by noting the actual light weight stenciled on cars in train and comparing them with the wheel report. In all cases the tonnage refers to the number of tons in the train and does not include tonnage of tender and engine.

Observations.

The determining of points at which readings should be taken is of great importance in road tests where results serve to indicate average performance. Even on up grades, such as in a territory between La Junta and Simpson, there are a great many momentum grades. On this account it is a difficult problem to choose points at which observations should be taken that will indicate, with any degree of fairness, the real performance of the engine.

In order to assure uniformity of readings, certain mile posts were chosen and the different observations were made at these mile posts. By such an arrangement the readings made served for an average performance obtained during the trip. The indi-

Description. Dimensions, and Proportions

ENGINE NUMBER	901	923
BOILER:		
Type--wagon top, radial stay, wide firebox.		
Outside diameter, first ring, inches	81.05	81.05
Capacity, with water surface at level of second gauge cock:		
Water space, cubic feet	483.0	562.8
Steam space, cubic feet	84.2	94.6
FLUES:		
Number	391	391
Outside diameter, inches	2.25	2.25
Thickness, inches	0.125	0.125
Length between sheets, inches	197	239
Total fire area, square feet	3360	4077
Arch—Diameter, inches	3	3
Thickness, inches	0.128	0.128
Length, inches	104.5	104.5
Fire area, square feet	12.8	12.8
FIREBOX:		
Length inside, inches	104.25	104.25
Width inside, inches	78	78
Depth front end, inches	74.5	74.5
Depth back end, inches	72.5	72.5
Fire area, square feet	209	209
Total heating surface, based on inside of firebox and inside of flues, square feet	3582	4299
Grates, rocking finger--area, square feet	58.5	58.5
Ratio heating surface to grate area	61.24	73.84
Ratio fire area through flues to grate area	0.147	0.147
Ratio firebox heating surface to grate area	3.57	3.57
Ratio flue surface to firebox heating surface	16.08	19.61

Comparison of Heating Surfaces.

ENGINE NUMBER	901	923
DRIVERS:		
Number of pairs	5	5
Diameter, inches	57	55.375
Circumference, inches	179.07	174
CYLINDERS:		
Arrangement--outside, tandem compound		
High pressure, right, diameter, inches	19,125	19
High pressure, left, diameter, inches	19	19
Low pressure, right, diameter, inches	32	32
Low pressure, left, diameter, inches	32	32.5
Stroke of piston, all cylinders, inches	32	32
PISTON RODS:		
High pressure, right, diameter, inches	3.5	3.25
High pressure, left, diameter, inches	3.5	3.25
Low pressure, right, diameter, inches	4.5	4.5
Low pressure, left, diameter, inches	4.5	4.5
VALVES:		
Type and design--piston valve, Baldwin locomotive works design		
Type of link motion--Stephenson, open rods		
Greatest valve travel, inches	5.25	5.25
Outside lap of valves, high pressure, inches	0.875	0.875
Outside lap of valves, low pressure, inches	0.750	0.750
Inside lap of valves, high pressure, inches negative	0.250	0.250
Inside lap of valves, low pressure, inches negative	0.375	0.375
RECEIVER VOLUME:		
High pressure superheater, cubic feet	33.7	
Low pressure superheater or receiver, cubic feet	34.5	6.0

Comparison of Drivers, Cylinders, Rods and Valves.

cator cards were taken on an average of thirty times per run. The pyrometer, calorimeter, drafts, temperatures, height of water and boiler pressures were taken on an average of forty times per trip, throttle and reverse lever positions were noted for each change. Water meters were read at every mile post where indicator cards and calorimeter readings were taken, and also at the top and bottom of grades as well as at the time of stopping and starting of engine. The dynamometer readings were taken continuously from the start to the end of each trip, excepting on the trips from Trinidad to La Junta. On these runs the dynamometer records were cut out at Thatcher. The number of shovels of coal was recorded as fired; the number of sacks of coal, as emptied.

TEST RUNS.

The test runs herein outlined were made with the idea of comparing the actual performance of the same type of tandem compound locomotives with and without Jacobs superheaters. For this comparison, engine 901, equipped with high and low pressure Jacobs superheaters and recently out of Topeka shop from a general overhauling, and engine 923, also from a general overhauling at La Junta shops, were selected. Previous to being equipped with superheaters, engine 901 had no record as to superior qualities of performance. Engine 923, on the other hand, had the reputation among shop men and road men as being the best runner and steamer on the division. This engine was in first-class mechanical condition; her boiler and flues were in fine shape.

Several preliminary runs were made to determine the best drafting conditions and make such adjustments in test apparatus as to record specific data needed. The test runs were then made under the normal conditions prevailing and with such tonnage as available and under such condition of service, either through or local freight, as consistent with operative conditions.

Run No. 7, Engine 901.—This run was made from Trinidad to La Junta on August 4th. There were 2875 tons in the train consisting of sixty-five cars. The total time on the road was five hours and forty-two minutes. The total delayed time was one hour and thirty-eight minutes, leaving an actual running time of four hours and four minutes. Ten thousand one hundred pounds of coal were used during this trip with an average coal consumption of 43.1 pounds of coal per thousand gross ton miles. The ashes removed at the end of the run amounted to 1,364 pounds; the ashes in the coal as fired as shown by analysis amounted to 1,044 pounds. Seventy-four thousand one hundred and seventy-seven pounds of water were supplied to the boiler. The equivalent evaporation was 8.82 pounds of water per pound of coal, but by crediting the heat imparted by the waste gases to the superheateers, this was increased to 9.5 pounds of water per pound of coal. The theoretical evaporation for the coal used on the trip was 13.77 pounds of water per pound of coal so that the boiler efficiency was 69 per cent for the run. The maximum temperature of steam to high pressure cylinder was 418 degrees, that to low pressure cylinder was 488 degrees. The maximum superheat in high pressure cylinders was 39 degrees, in low pressure cylinders 105 degrees. During the trip six stops were made in loading and unloading local freight and during a considerable portion of the delayed time the engine was used for switching purposes incidental to loading freight.

Run No. 9, Engine 901.—The run was made from Trinidad to La Junta on August 7th. There were 3,009 tons in the train of eighty-one cars. The total time on the road was seven hours and twenty-eight minutes; the total delayed time was three hours, so that the actual running time was four hours and twenty-eight minutes. The causes for such unusual delays as occurred on this trip were due mostly to a broken knuckle and hot-boxes on cars in train. During periods of delay 1,200 pounds of coal were consumed. The total coal consumed for the run amounted to 9,300 pounds or 37.9 pounds per thousand gross ton miles. The total ash removed was 1,346 pounds, while that in the coal was fired, as shown by analysis, was 1,201 pounds. Sixty-nine thousand eight hundred and thirteen pounds of water were evaporated, which gives an equivalent evaporation from and at 212 degrees of 8.93 pounds of water per pound of coal fired. Giving credit to heat taken up in superheating steam, the equivalent evaporation is increased to 9.62 pounds of water per pound of coal. The theoretical evaporation of coal used during this trip was 13.63 pounds, so that the boiler efficiency for the trip was 70.6 per cent.

Run No. 10, Engine 901.—The run was made on August 8th, from La Junta to Trinidad, with a train of 1,337 tons in forty-nine cars. The total time on road was six hours and seven minutes, the delayed time was one hour and fifty-two minutes, so that the actual running time was four hours and fifteen minutes. The coal consumed on the run was 21,833 pounds; this performance showed a consumption of 200.3 pounds of coal per thousand gross ton miles. For a distance of 32.3 miles from Timpas to Simpson, the coal consumed was 238.7 pounds per thousand gross ton miles. One hundred fifty-six thousand four hundred and twenty-one pounds of water were delivered to the boiler, so that the equivalent evaporation of water per pound of coal was 8.23. This figure was increased to 8.79 by crediting the amount of heat yielded by the waste flue gases in superheating steam. The theoretical evaporation of the coal used on this trip was 13.7 pounds of water per pound of coal, so that the boiler efficiency for the trip was 64.3 per cent. The maximum temperatures of steam to high pressure cylinders was 428 degrees, that to low pressure cylinders was 453 degrees. The maximum superheat to high pressure cylinders was fifty degrees, that to the low pressure cylinders 140 degrees. The average number degrees superheat to the high pressure cylinders was 24.4 degrees, that to the low pressure cylinders was 102.2 degrees.

The highest continuous drawbar pull exerted during this run was 39,050 pounds at a speed of ten miles per hour. At 12.8 miles per hour, the engine exerted a drawbar pull of 38,550 pounds at the back of the tender; at twenty miles per hour, a drawbar pull of 30,950 pounds was exerted.

Run No. 12, Engine 901.—The run was made from La Junta to Trinidad on August 11 with 1,328 tons contained in forty-six cars. The total time on road was seven hours and two minutes; the total delayed time was one hour and forty-four minutes, so that the actual running time was five hours and eighteen minutes. All data recorded relative to the performance of the engine on this trip is shown graphically on one of the charts herewith. This chart has been so arranged that it is easy to identify the characteristic performance of the engine on the different grades and under different operating conditions. Maximum and minimum conditions recorded show up very fully on this graph. A total of 22,048 pounds of coal were fired on the trip and 158,355 pounds of water were supplied to the boiler, so that the equivalent evaporation from and at 212 degrees was 8.22 pounds of water per pound of coal. Giving credit for heat regained from waste gases in superheating steam, the equivalent evaporation is raised to 8.81 pounds of water per pound of coal, so that the boiler efficiency attained for the run is 65.8 per cent. The fuel consumed for the total run averaged 203.8 pounds of coal per thousand gross ton miles. On the heavy stretch from Timpas to Simpson, the fuel consumed averaged 250.0 pounds of coal per thousand gross ton miles. The boiler efficiency for this portion of the trip was 64.8 per cent. The maximum temperature attained in the high pressure steam was 422 degrees and in the low pressure steam 432 degrees. The maximum superheat in the high pressure steam was 35 degrees and in the low pressure 105 degrees. Engine gave a drawbar pull of 39,740 pounds at a speed of 12.7 miles per hour. At a speed of sixteen miles per hour, a drawbar pull of 32,490 pounds was developed, while at a

Engine 923

Cylinders .... 19"x32"x32"
Steam ports .... 1 5/8" H. P.
Exhaust ports .... 6 1/2"
Bridge .... 3 3/4"
Eccentric throw .... 6"

Outside lap .... H.P. 7/8", L.P. 3/4"
Inside lap ....H.P. 1/4" neg., L.P. 3/8" neg.
Valve travel ...... 5 1/2" front, 5 5/8" back
Saddle pin .... set back 3/4"
Lead full gear .... line and line

Motion	Side	Cut Off Front End	Cut Off Back End	Difference Cut Off	Exhaust Open Front	Exhaust Open Back	Difference Exhaust	Exhaust Close Front	Exhaust Close Back	Difference Exhaust Close	Lead Front	Lead Back	Maximum Port Opening
Forward	Right	11 7/8	12	1/8	20 3/8	20 7/16	1/16	6 9/16	6 1/2	1/16	11/32	11/32	7/16
		18 1/4	18 1/4	0	24 5/8	24 5/8	0	3 13/16	3 13/16	0	5/16	5/16	5/8
	Left	12 1/8	11 7/8	1/4	20 1/4	20 1/16	3/16	6 1/2	6 3/8	1/8	21/64	11/32	15/32
		18 1/4	18 1/8	1/8	24 3/4	24 5/8	1/8	3 3/4	3 5/8	1/8	19/64	5/16	21/32
Back Up	Right	11 1/4	11 1/4	0	20 1/8	20	1/8	6 3/4	6 1/2	1/4	21/64	11/32	7/16
		18	18	0	24 5/8	24 1/2	1/8	3 7/8	3 3/4	1/8	19/64	5/16	5/8
	Left	11	11 1/8	1/8	19 3/4	19 7/8	1/8	7	6 3/4	1/4	21/64	11/32	7/16
		17 3/4	18	1/4	24 1/2	24 7/8	3/8	3 7/8	4	1/8	19/64	5/16	5/8

Dimensions of Valve Setting.

Engine 901

Cylinders .... 19"x32"x32"
Steam ports .... 1 5/8" H. P.
Exhaust ports .... 6"
Bridge .... 3 3/4"
Eccentric throw .... 6"

Outside lap .... H.P. 7/8", L.P. 3/4"
Inside lap ....H.P. 1/4" neg., L.P. 3/8" neg.
Valve travel ...... 5 5/8" front, 5" back
Saddle pin .... set back 3/4"
Lead full gear .... line and line

Motion	Side	Cut Off Front End	Cut Off Back End	Difference Cut Off	Exhaust Open Front	Exhaust Open Back	Difference Exhaust	Exhaust Close Front	Exhaust Close Back	Difference Exhaust Close	Lead Front	Lead Back	Maximum Port Opening
Forward	Right	12 3/4	12 7/8	1/8	20 1/8	21	1/8	6	6	0	5/16	5/16	15/32
		19 3/4	19 1/4	1/2	25	25	0	3 7/16	3 3/8	1/16	1/4	1/4	2 1/8
	Left	13	13 1/8	1/8	21 3/8	21 1/8	1/4	5 7/8	5 3/4	1/8	5/16	21/64	15/32
		19 1/2	19 1/2	0	25 3/8	25 5/8	1/4	3 5/16	3 1/4	1/16	1/4	1/4	21/32
Back Up	Right	13 1/2	13 3/8	1/8	21 3/16	21 5/16	1/8	5 3/8	5 1/8	1/4	9/32	9/32	15/32
		20	20	0	26	25 7/8	1/8	3	2 7/8	1/8	1/4	1/4	21/32
	Left	13 1/2	13 5/8	1/8	21 1/2	21 1/4	1/4	5 5/8	5 3/8	1/4	9/32	19/64	15/32
		20	19 7/8	1/8	26	25 7/8	1/8	3 1/8	3	1/8	1/4	1/4	21/32

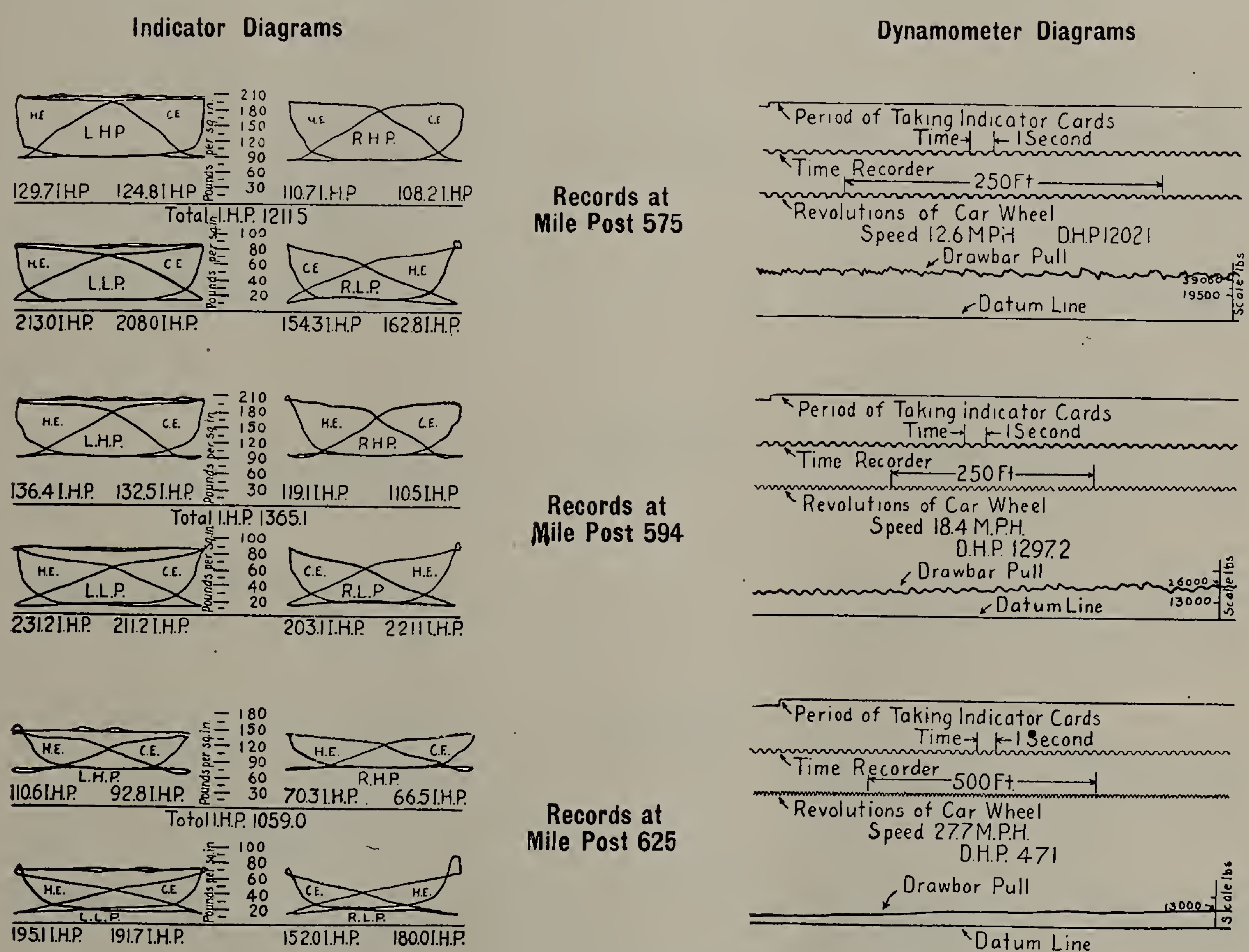
Dimensions of Valve Setting.

speed of twenty-six miles per hour a drawbar pull of 19,530 pounds was exerted. At milepost 617, the engine showed 1937 indicated horsepower at twenty-six miles per hour and developed 1,354 drawbar horsepower. This power was developed under accelerating conditions.

Run No. 13, Engine 901.—This run was made on August 13th, with 3,166 tons contained in 59 cars. The total time on road was five hours and forty-five minutes, delayed time one hour and forty minutes, so that the actual running time was four hours and five minutes. On this run 8,300 pounds of coal were fired so that the average consumption of coal was 32.2 pounds per thousand gross ton miles, which was the best record obtained on down-grade runs. The water supplied to the boiler amounted to 61,801 pounds. The evaporation at the dome, from and at 212 degrees, was 8.62 pounds of water per pound of coal. This evaporation was further increased, on account of heat absorbed from waste gases in superheating steam, to 9.15 pounds of water per pound of coal. The heat value of the coal used was considerably less than on previous trips. The coal itself had a theoretical evaporative value of 13.25 pounds of water per pound of coal, so that the efficiency of the boiler was 69 per cent. The maximum temperature of steam to high pressure cylinders was 408 degrees, that to low pressure cylinders was 439 degrees. The maximum superheat in high pressure steam was thirty-two degrees and that in low pressure steam was 110 degrees.

Run No. 14, Engine 901.—The run from La Junta to Trinidad was made on August 14th with 1,351 tons in fifty-seven cars. All of the previous runs of this engine were made with arch brick equipment. The principal object of this run was to determine the bearing that the arch brick equipment had on general performance and to determine the relative economy of this equipment. The coal consumption for this run was 25,511 pounds, so that the average consumption was 231.7 pounds of coal per thousand gross ton miles. The water supplied to the boiler amounted to 185,980 pounds. The evaporation from and at 212 degrees was 8.37 pounds of water per pound of coal, but this was increased to 8.89 pounds upon crediting to the boiler the amount of heat absorbed in superheating steam from the waste gases. The maximum temperature of the steam to high pressure cylinders was 405 degrees, that to the low pressure cylinders 438 degrees. All data obtained on test run is graphically shown on one of the charts, so that the maximum and minimum conditions are readily identified with the prevailing grade over which run was made. At a speed of twenty-six miles per hour the engine exerted a drawbar pull of 40,430 pounds. At a speed of 16.7 miles per hour, a drawbar pull of 28,860 pounds was recorded.

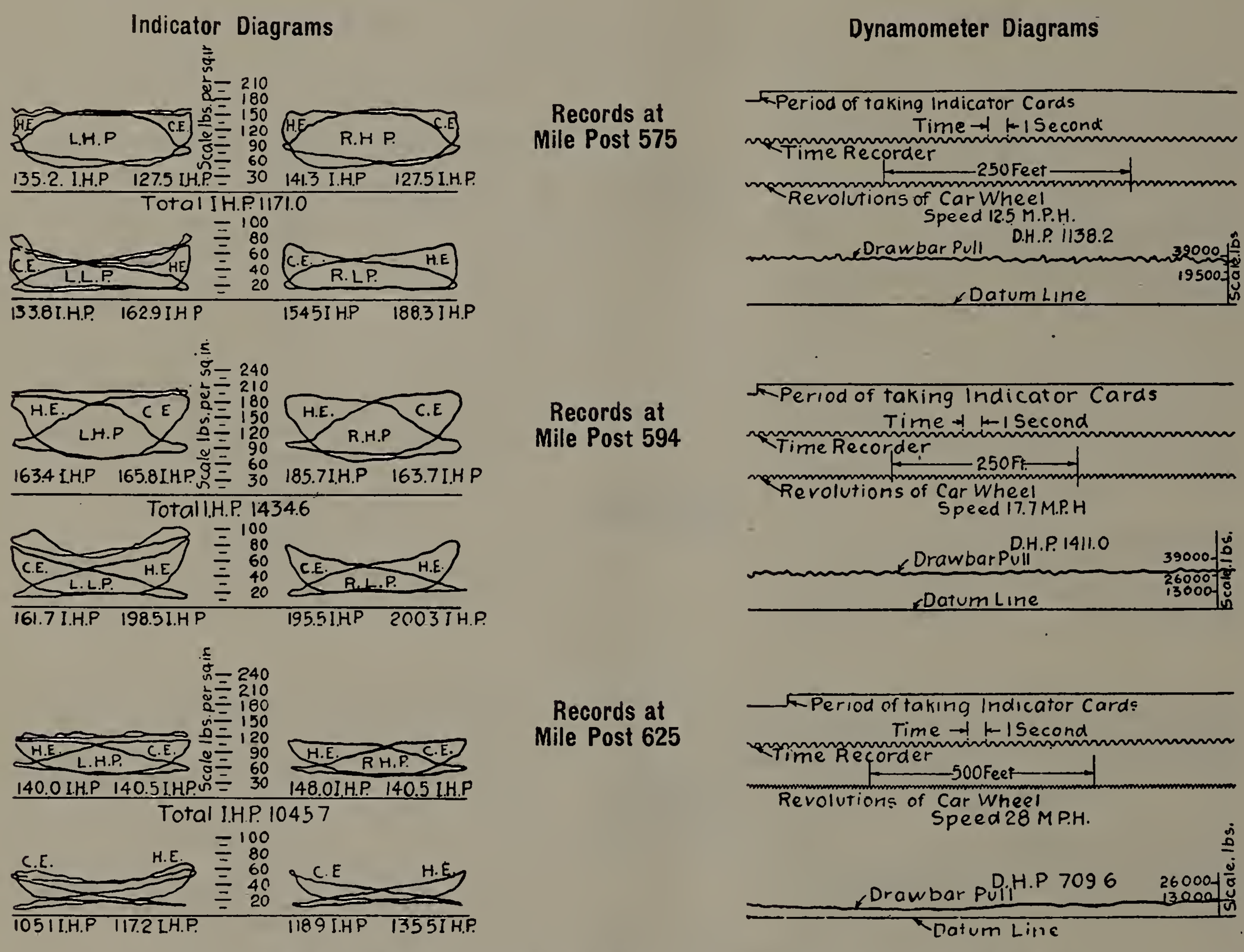
Run No. 2, Engine 923.—The run was made on August 22nd, from Trinidad to La Junta with 3,171 tons in sixty-two cars. The total time on road was seven hours and forty-two minutes, the delay was three hours, so that the actual running time was four hours and forty-two minutes. Two delays occurred during the trip on account of breaking of train equipment, one of one hour on account of a broken knuckle and one of twenty minutes on account of a drawbar pulled out. During these periods six hundred pounds of coal were fired. The total coal consumption for the run was 11,370 pounds. The average coal consumption per thousand ton miles was 44.1 pounds. The total water supplied to the boiler was 74,340 pounds. The evaporation from and at 212 degrees was 7.25 pounds of water per pound of coal. The theoretical evaporation of the coal used for the trip was 14.1 pounds of water per pound of coal so that the boiler effi-



Typical Diagrams Taken During Tests of Engine No. 923.

ciency was 51.4 per cent. The ash in the coal as fired amounted to 1,413 pounds, while there were removed from the ashpan 1,979 pounds of ash.

Run No. 3, Engine 923.—The run was made on August 24th from La Junta to Trinidad with 1,126 tons in fifty cars. The total time on road was eight hours and fifty-five minutes, the delayed time was two hours and thirty-eight minutes, so that the actual running time for the trip was six hours and seventeen minutes. On this run, as on run number two, the engine did not have arch brick equipment. One object of the run was to determine the value and efficiency of the arch brick equipment so far as fuel consumption was concerned. The results of the run on this account are more properly compared with those obtained on run number fourteen of engine 901. The total coal consumed for the trip amounted to 26,988 pounds. The average fuel consumption per thousand ton miles was 317.2 pounds of coal, which was greatly in excess of figures obtained on any other run. The total water supplied to the boiler was 172,907 pounds. The equivalent evaporation from and at 212 degrees was 7.33 pounds of water per pound of coal. The boiler efficiency for the run was 52.2 per cent. At a speed of 12.4 miles per hour a drawbar pull of 33,350 pounds was exerted. At sixteen miles per hour, the drawbar pull was 27,990 pounds; at 19.3 miles per hour, the drawbar pull was 21,080 pounds. On the territory from Timpas to Simpson 3.11 pounds of coal were burned for each million foot pounds at the drawbar, and 74,730 heat units in the coal were consumed per dynamometer horsepower per hour. These figures are considerably higher than results obtained on any other test runs. A graphical representation of data obtained during test is shown on the chart for this run, so that a glance is sufficient to show the characteristic performance of engine for this trip.



Typical Diagrams, Taken During Tests of Engine No. 923. Equipped with Superheaters.

Run No. 4, Engine 923.—The run was made August 25th from Trinidad to La Junta with 3,062 tons in fifty-one cars. This was the first trip by engine with arch brick equipment. The run was made in four hours and forty minutes, delayed time fifty-two minutes, so that the actual running time for the trip was three hours and forty-eight minutes. This is the shortest time made on any of the test runs. The total coal consumed for the trip was 9,390 pounds, giving an average of 37.6 pounds of coal per thousand ton miles. During the trip 64,989 pounds of water were delivered to the boiler. The equivalent evaporation was 7.74 pounds of water per pound of coal. The theoretical evaporation of the coal burned for this trip as determined by analysis was 14.0 pounds of water per pound of coal, so that the efficiency of the boiler was 55.3 per cent. The ash in the coal as fired was 1,160 pounds, that removed from ashpan at the end of trip was 1,287 pounds. These figures show a close comparison with theoretical ash and actual ash.

Run No. 5, Engine 923.—The run was made on August 27th, with 1,265 tons in 69 cars. The total time on road was six hours and fourteen minutes. The delayed time twenty-nine minutes, so that the actual running time was five hours and forty-five minutes. This was the first run made on up grade with engine equipped with arch brick. The total fuel consumed for the trip was 24,618 pounds of coal, or an average of 238.8 pounds of coal per thousand ton miles. This was the very best record obtained during the test with this engine on up-grade runs. On the heavy grade from Timpas to Simpson the average fuel consumption per thousand ton miles was 292.9 pounds of coal. During the trip 169,713 pounds of water were supplied to the boiler. The evaporation from and at 212 degrees was 7.82 pounds of water per pound of coal. The boiler efficiency was 52.2 per cent. On the portion of the run from Timpas to Simpson, the boiler

Road Test of Santa Fe Type Tandem Compound Freight Locomotive No. 901 Equipped with Jacobs Smokebox, High and Low Pressure Superheaters.

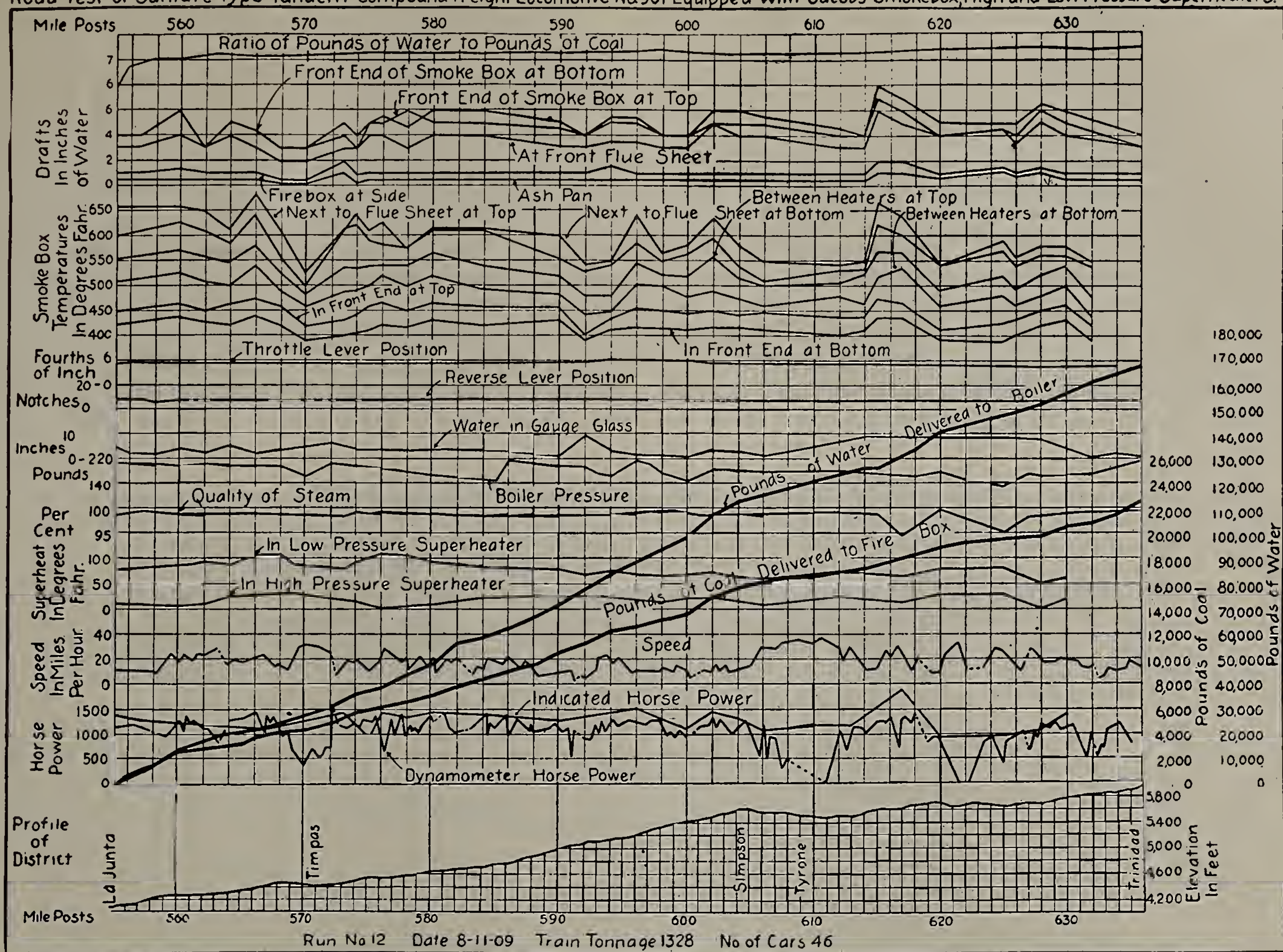


Chart for Run No. 12, Engine No. 901.

Road Test of Santa Fe Type Tandem Compound Freight Locomotive No. 901 Equipped With Jacobs Smokebox, High and Low Pressure Superheaters.

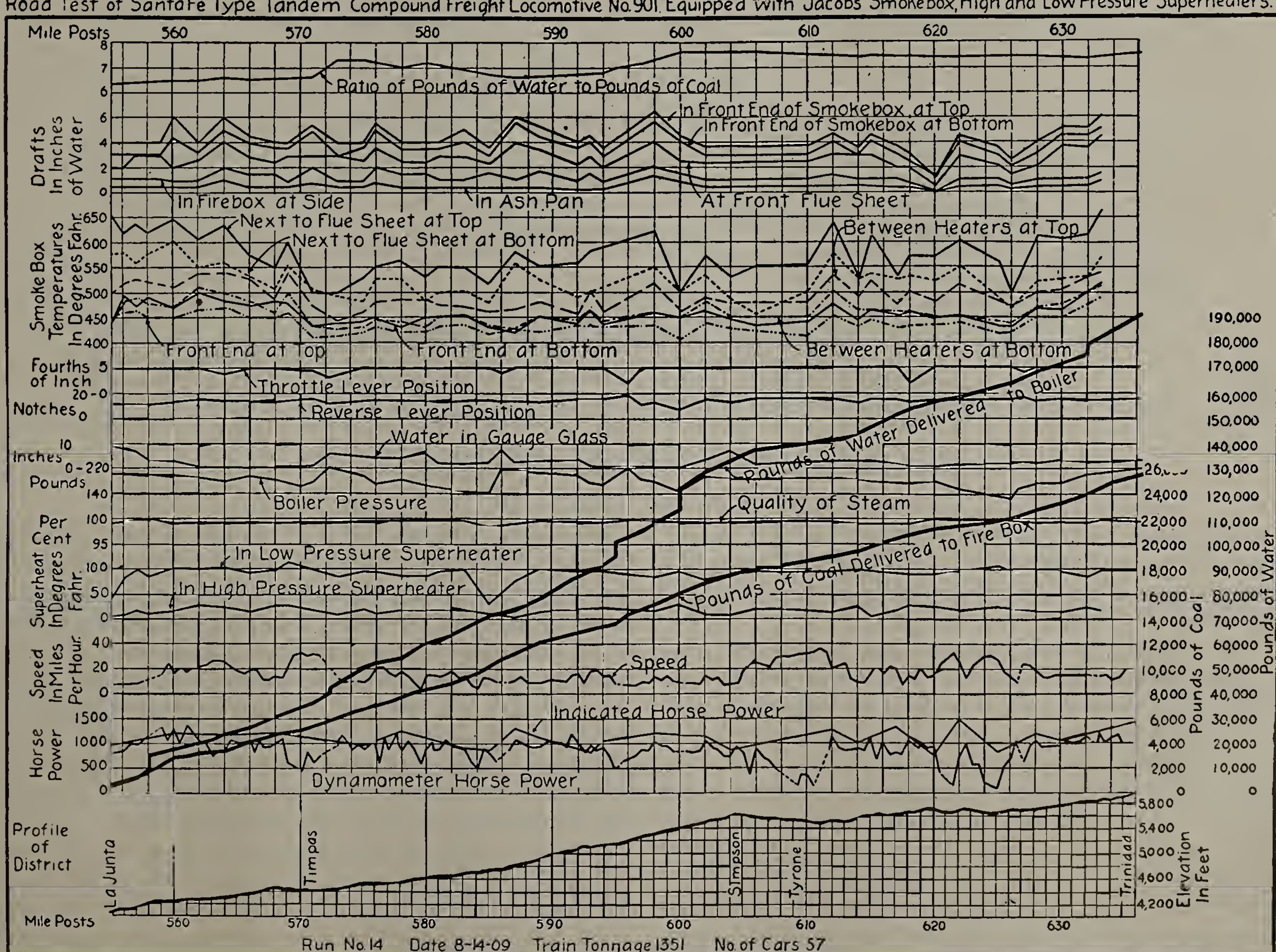


Chart for Run No. 14, Enginee No. 901.

efficiency was 56.3 per cent. The engine gave a drawbar pull of 34,220 pounds at a speed of 11.8 miles per hour, 27,650 pounds at a speed of 15.6 miles per hour, and 24,540 pounds drawbar pull at a speed of 19.6 miles per hour.

Run No. 6, Engine 923.—This run from Trinidad to La Junta was made on August 28 with 3,101 tons in a train of sixty-five cars. The total time on road was seven hours and thirty-four minutes, total delayed time three hours and six minutes, so that the actual running time was four hours and twenty-nine minutes. The total fuel consumption for the trip was 11,635 pounds of coal, the average coal consumption for the run was 46.1 pounds per thousand ton miles. The water supplied to the boiler for the trip was 80,763 pounds. The evaporation was 6.94 pounds of water per pound of coal. The equivalent evaporation from and at 212 degrees was 7.87 pounds of water per pound of coal. This evaporation was considerably better than was made by Timpas to Simpson, 81,785 pounds. The equivalent evaporation for the trip was 7.89 pounds of water per pound of coal; from Timpas to Simpson the equivalent evaporation was 7.87 per cent. The boiler efficiency for the trip was 56.1 per cent, and for that part of the run between Timpas and Simpson the boiler efficiency was 57.4 per cent. At a speed of 17.3 miles per hour a draw bar pull of 27,990 pounds was exerted; at twenty-six miles per hour a drawbar pull of 14,690 pounds was exerted. A maximum of 1,460 indicated horsepower was developed on this run at mile post 593; at the same time a drawbar horsepower of 1,202 was developed, so that 82.3 per cent of the power developed in the cylinders was exerted in pulling the train. The resistance of engine and tender to motion, together with frictional resistance, amounted to 258 horsepower or 17.7 per cent. The speed at this time was 18.9 miles per hour. These results were obtained on a slight momentum grade; soon after this

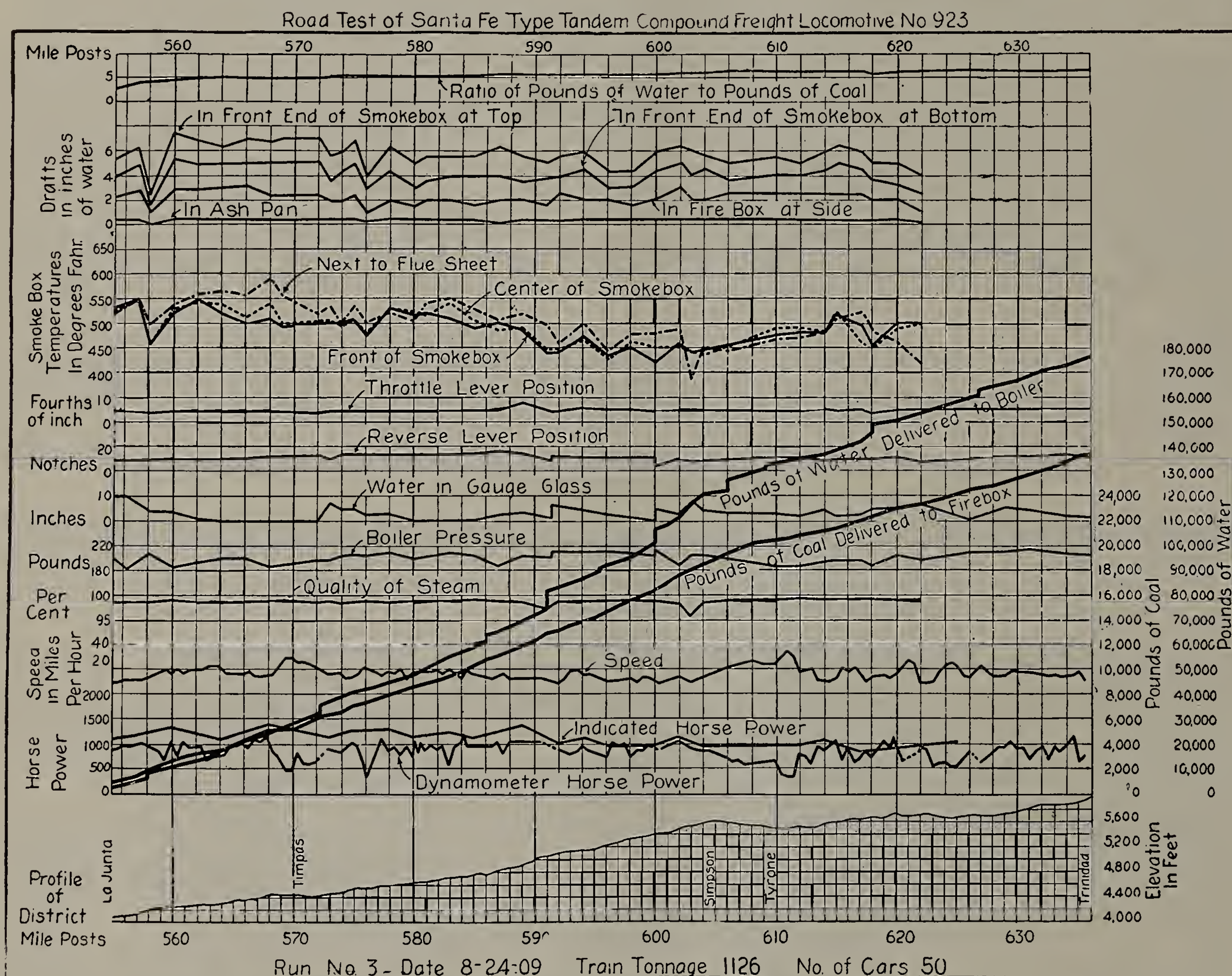


Chart for Run No. 3, Engine 923.

engine on any other down grade run. The theoretical evaporation of the coal used for the trip was 13.8 pounds of water per pound of coal, so that the boiler efficiency for this trip was 57 per cent.

Run No. 7, Engine 923.—The run was made August 29th from La Junta to Trinidad with 1,176 tons in a train of sixty-four cars. The total time for the trip was six hours and fifteen minutes, the delayed time thirty-two minutes, so that the actual running time was five hours and forty-three minuutes. The total coal consumed for the trip was 25,981 pounds, of which 11,968 pounds were used from Timpas to Simpson. The average fuel consumption per thousand ton miles for the entire trip was 271.2 pounds of coal, and for the run from Timpas to Simpson was 315.1 pounds of coal per thousand ton miles. The total water supplied to the boiler for the trip was 179,175 pounds, from reading was taken the speed and power dropped off. The record of performance as obtained is shown in graphical form on the chart for this test. A study of this chart in comparison with other charts obtained shows a great difference in relation between indicated and dynamometer horsepower. Nearly all of the runs were characterized by results that indicated horsepower was at times less than the drawbar horsepower. Such results would be impossible to obtain, except on a road test of this character. These results do not indicate, however, that the apparatus was recording improperly, but they bring out facts that are characteristic of every day performance.

A careful study of the dynamometer chart in connection with the profile of the grade and curvature of the track, reveals the fact that the power developed in the cylinders of the engine is often less than the drawbar horsepower. Just as the engine is on the point of tipping over the grade the whole weight of engine and tender, instead of being moved up the grade by the power developed in the cylinders, is thrown forward and tends to exert an increasing drawbar pull. This sometimes will amount to several thousand pounds and the drawbar pull will increase throughout a considerable portion of the train and the train will accordingly be accelerated unless the engineer is thoroughly familiar with the handling of heavy trains under such conditions. In order to prevent this increase in drawbar pull, as well as to permit increase in acceleration until the train is sufficiently over the crest so that there is no liability of pulling drawbars on account of undue stresses, the engineer shuts off throttle for a short period of time, maintaining normal speed. If at the time an engineer shuts off his throttle indicator cards are taken, they will show power in the cylinders less than that at the drawbar.

A brief summary of the runs leads to the following conclusions:

1. There is a marked decrease in coal consumption for a superheater engine. The decrease averages 20.8 per cent per thousand ton miles for up grade runs, 11.5 per cent for down grade runs and 19.6 per cent for constant hard working of engine on heavy grades.

2. There is a reduction of total water for up grade and down grade runs, also for heavy grade work with superheater engine.

3. Superheater engine uses 10 per cent less water per hour, developing more drawbar horsepower on heavy working.

4. Superheater engine shows for heavy working, a decrease of 16.3 per cent in coal per indicated horsepower hour.

5. Superheater engine shows for heavy working, a decrease of 12.9 per cent in dry steam per indicated horsepower hour.

6. There is a reduction in coal of 14.1 per cent per drawbar horsepower hour in favor of superheater engine.

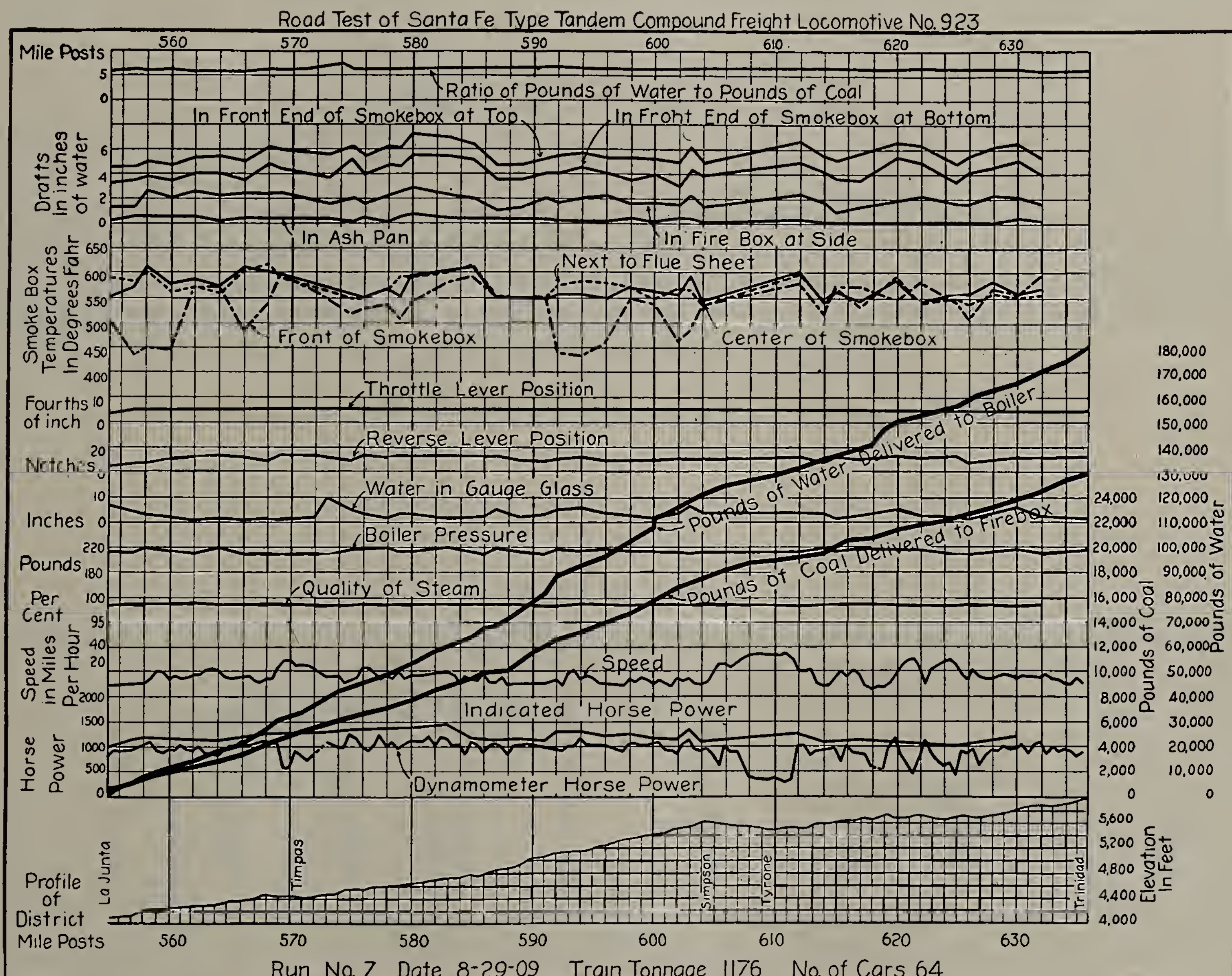


Chart for Run No. 7, Engine 923.

On the one side of the crest, the weight of the engine and tender is being moved up the grade and is offering resistance to motion of train; on the other side of the crest the weight of engine and tender, due to the fact that they are running down hill, tends to accelerate motion of train. Due to this fact the determination of points on a territory is an important one in order that characteristic performances and efficiencies that seem reasonable may be obtained.

CONCLUSIONS.

The object of the test runs is brought out most forcefully in the tables of average results. No effort was spared to obtain concrete information relative to every detail of operations of the engines on all the runs. The complete computations of average results of runs are so arranged that information concerning distinct parts of engine operation is drawn together as compactly as possible.

7. Superheater engine shows a decrease in heat units per drawbar horsepower of 17.3 per cent.

8. There is a marked increase in evaporation of superheater engine. It gave an average of 11.6 per cent more dry steam per pound of coal than non-superheater engine.

9. Superheater engine with 16.6 per cent less heating surface gives equivalent evaporation of 10.6 per cent more water per square foot heating surface than non-superheater engine.

10. Superheater engine shows a boiler efficiency 7.6 per cent greater than non-superheater engine; with credit for heat to superheater from waste gases the boiler efficiency is 15.8 per cent greater.

11. Boiler capacity is increased because of heat recovered in superheated steam by 7.1 per cent. Boiler requirements are further decreased on account of lower water rate of engine, due

La Junta to Trinidad

Engine Number	Run Number	Date 1909	Duration of Test: Total Time on Road	Duration of Test: Total Delays	Duration of Test: Running Time	Speed—Miles per Hour	Train Tonnage	Number of Cars	1000 Gross Ton Miles	Pounds of Coal per 1000 Ton Miles
			Hrs. Min.	Hrs. Min.	Hrs. Min.					
901	10	8- 8	6-07	1-52	4-15	19.17	1337	49	108.8	200.3
901	12	8-11	7-02	1-44	5-18	15.37	1328	46	108.2	203.8
923	5	8-27	6-14	0-29	5-45	14.20	1265	69	103.1	238.8
923	7	8-29	6-15	0-32	5-43	14.25	1176	64	95.7	271.2
901	Ave.	-----	6-34	1-48	4-46	17.07	1333	48	108.5	202.1
923	Ave.	-----	6-14	0-31	5-43	14.23	1220	67	99.4	255.0
WITHOUT ARCH BRICK EQUIPMENT										
901	14	8-14	9-08	2-39	6-29	12.57	1351	57	110.2	231.7
923	3	8-24	8-55	2-38	6-17	12.97	1126	50	91.6	317.2

Engine 901 with Jacobs superheater shows a saving of 52.9 pounds coal per 1000 gross ton miles over engine 923, or a reduction of 20.8% in fuel.

Engine 901, with Jacobs superheater and without arch brick equipment, shows a sav- of 85.5 pounds of coal per 1000 gross ton miles, or a reduction of 27.0% in fuel.

Summary of General Performance, Both Engines.

La Junta to Trinidad

Engine Number	Run Number	Indicated Horse Power: High Pressure Cylinders	Indicated Horse Power: Low Pressure Cylinders	Indicated Horse Power: All Cylinders	Draw Bar Pull, Pounds	Draw Bar Horse Power	Machine Friction Horse Power	Machine Efficiency Per Cent	Locomotive Efficiency Per Cent	Boiler Horse Power	Boiler Efficiency Per Cent
901	10	454	901	1355	23,991	1039	316	76.7	3.9	1316	64.3
901	12	475	835	1310	25,183	1070	240	81.7	5.0	1070	65.8
901	14	320	801	1121	24,942	894	227	79.8	4.5	1018	67.7
923	3	489	585	1074	21,381	869	205	80.9	3.8	917	52.2
923	5	579	678	1257	26,094	1074	185	85.7	4.7	972	52.2
923	7	558	662	1220	25,028	968	252	79.3	4.1	1045	56.1
901	Ave.	416	846	1262	24,705	1001	261	79.3	4.5	1135	65.9
923	Ave.	542	643	1185	24,168	970	214	81.9	4.2	978	53.5

Engine 901 shows 126 less horse power in high pressure cylinders, 203 more horse power in low pressure cylinders and a total of 77 more horse power developed. Average draw bar pull about the same for both engines. Engine 901 shows 31 more draw bar horse power developed and had 47 more horse power consumed in friction. Machine efficiency 2.6% lower but locomotive efficiency 0.3% higher. Boiler horse power 157 units greater and boiler efficiency 12.4% higher.

Summary of Horsepower, Friction and Efficiency.

Timpas to Simpson

Engine Number	Run Number	Date 1909	Duration of Test: Total Time on Road	Total Delays	Running Time	Speed--Miles per Hour	Train Tonnage	Number of Cars	1000 Gross Ton Miles	Pounds of Coal per 1000 Ton Miles
			Hrs. Min.	Hrs. Min.	Hrs. Min.					
901	10	8-. 8	2-13	0-09	2-04	15.61	1337	49	43.18	238.7
901	12	8-11	3-08	0-36	2-32	12.77	1328	46	42.89	250.0
923	5	8-27	2-57	0-28	2-29	13.03	1265	69	40.86	292.9
923	7	8-29	2-48	0-20	2-28	13.09	1176	64	37.98	315.1
901	Ave.	-----	2-41	0-23	2-18	14.05	1332	48	43.04	244.4
923	Ave.	-----	2-53	0-24	2-29	13.03	1221	67	39.42	304.0
WITHOUT ARCH BRICK EQUIPMENT										
901	14	8-14	4-36	1-24	3-12	10.09	1351	57	43.64	280.1
923	3	8-24	4-39	2-05	2-34	12.57	1265	49	40.86	313.2

Engine 901 shows an average saving of 59.6 pounds of coal per 1000 gross ton miles or a decrease of 19.6% in fuel consumption over engine without superheater. Without arch brick equipment, engine 901 shows a saving of 33.1 pounds of coal per 1000 ton miles, or a decrease of 10.6% in fuel.

Summary of General Performance.

Timpas to Simpson

Engine Number	Run Number	Indicated Horse Power: High Pressure Cylinders	Low Pressure Cylinders	All Cylinders	Draw Bar Pull, Pounds	Draw Bar Horse Power	Machine Friction Horse Power	Machine Efficiency Per Cent	Locomotive Efficiency Per Cent	Boiler Horse Power	Boiler Efficiency Per Cent
901	10	485	931	1416	28,500	1162	254	82.1	4.5	1221	62.2
901	12	503	874	1377	29,293	1161	216	84.3	5.4	1047	64.8
901	14	308	706	1014	29,788	907	107	89.5	4.7	999	68.7
923	3	504	614	1117	24,488	940	177	84.1	3.4	1165	55.2
923	5	598	700	1298	31,036	1180	118	90.9	4.6	1092	56.3
923	7	575	699	1274	29,662	1069	205	83.9	4.2	1106	57.4
901	Ave.	432	837	1269	29,194	1077	192	85.3	4.9	1089	65.2
923	Ave.	559	671	1229	28,395	1063	166	86.3	4.1	1121	56.3

Engine 901 shows 127 less horse power in high pressure cylinders, 166 more horse power in low pressure cylinders and a total of 40 more horse powerd eveloped. Average draw bar pull shows 2.8% more. Engine 901 shows 14 more draw bar horse power developed and had 26 more horse power consumed in friction. Machine efficiency 1.0% lower, but locomotive efficiency 0.8% higher. Boiler horse power 32 units less and boiler efficiency 8.9% higher.

Summary of Horsepower, Friction and Efficiency.

to superheated steam. The resulting effect of superheating as shown by the tests is to increase the effective boiler capacity without increasing its actual capacity.

12. No difficulty was experienced in working water in steam to high pressure cylinders, as the moisture was evaporated in the superheater under all conditions. On this account the superheater engine is not liable to knock out cylinder head, or in case of compound engines to loosen the intermediate joint between high and low pressure cylinders.

13. Steam from low pressure superheater was superheated 90 to 125 degrees and supplied to cylinders at not over 450 degrees.

14. Superheat was sufficient to prevent entirely the dripping of water from cylinder cocks.

15. There was great uniformity of superheat under varying loads and rates of fuel consumption.

16. The tests show that for operation under local condition with usual side track delays that a superheater engine gives greater economy than a non-superheater engine.

17. The efficiency of the low pressure superheater is greater than that of the high pressure superheater. On this account superheating low pressure steam is more desirable than superheating high pressure steam.

18. The brick arch in the firebox gave an increase in economy of operation by decreasing the coal per thousand ton miles and by increasing the evaporation per pound of coal.

19. Superheater engine developed 20 per cent more drawbar horsepower per square foot of heating surface than non-superheater engine.

20. Superheater engine gave for best performance 10 per cent more horsepower for same cylinder volumes than non-superheater engine.

Electric Car Lighting

By J. R. Sloan

(Continued from Page 163, May Issue)

The third system of electric lighting steam passenger equipment cars mentioned—the axle generator system—consists essentially of a generator driven in some manner from the car axle, a set of batteries and the necessary mechanism for the regulation of the axle generator. Within the last few years there has been added to these a lamp voltage regulator.

Cars equipped with axle generators are subject in a much less degree to the limitations in regard to service, that obtain with the two previous mentioned systems.

Each car is an independent unit, carrying its own source of power, and, therefore, requires ordinarily a very much shorter layover, much less yard wiring at terminals, interferes less with the work of the yard master, and the engine crew en route are powerless to interfere with its operation.

The system, however, is not without its drawbacks, viz.:

First: Difficulty in transmitting power from the car axle to the armature shaft, where the drive is between very short centers and is exposed to all conditions of weather, snow, ice, etc., flooded from track tanks, and bombarded with ballast.

Second: The great range of speed through which the generator must adjust itself automatically and the use of the regulating mechanism that is thereby entailed.

The first axle generators were known as the constant current type, i. e., the generator for a given setting delivered of the same number of amperes, at all times, regardless of the ncessities of the case, although by changing the setting the number of amperes delivered could be varied.

The batteries and lamps were connected in multiple across the battery and to compensate for the difference between the charging voltage of the battery and the lamp voltage, or average voltage of the battery on discharge, a fixed resistance was introduced in the lamp circuit as the generator "cut in," to protect the lamps.

In consequence of the constant current feature it was necessary to adjust the output of the generator to the conditions of the run, so that taking the run as a whole the battery would receive the proper amount of charging.

If the car was changed to a different run, the setting also had to be changed.

One of the great objections to this type of generator was the poor voltage regulation on the lamps. For instance, if the battery were in a discharged condition, it would require less than normal voltage, for which the lamp resistance was calculated, to produce the predetermined current and consequently the lamps would burn below candle power, while if the batteries were fully charged, the reverse would be the case.

In order to guard against failure of lights it was common practice to set the output of the generator at a value in excess of the actual requirements of the run, with the consequence that the batteries were overcharged and the resulting evolution of gas, blew out the active material and decreased the life of the battery.

Later, this constant current system was modified by introducing a differential winding in the regulating solenoid, which carried the lamp current, causing the generator to pick up more or less of the lamp load, in addition to the battery load, depending on the effective number of turns in this differential solenoid winding.

This was an improvement, but overcome the over-charging of the battery only in part, and to a less degree the poor regulation of the lamp voltage.

Since these early machines, great improvements have been made, and what is now demanded by the railroad companies is a generator and regulating apparatus that will accomplish the following:

First: Charge the battery at its normal rate until a certain predetermined terminal charging voltage is attained. When this voltage is attained the charging current is to be tapered off, until it falls to practically zero value, or the charging current is practically discontinued and the battery floats, neither charging nor discharging.

Second: The lamp load should be picked up entirely independently of the battery load.

Third: The lamp voltage should be maintained practically constant, regardless as to whether the generator is operating and supplying current to the lamps, or whether the battery is discharging and supplying this current. By "practically constant" is meant that a variation of 1.5 per cent above or below normal lamp voltage, or a total variation of 3 per cent, is permissible.

Fourth: That the "cutting in" speed should not exceed 20 miles per hour, and that from this speed to 80 miles per hour the apparatus will perform as above.

One other point which has been the cause of much trouble with axle generators in the past, is the construction of the various coils and the quality of the material. It has been common practice to use ordinary cotton covered wire for these coils, painted with shellac. In service these coils become oil soaked and would then "ground" or would become overheated, and the insulation would be burned out, so that a fifth requirement could be added, as follows:

Fifth: That all coils should be constructed so as to be heat, oil and moisture proof.

It is believed that if sufficiently rigid specifications be drawn covering the above points, and also covering heating, voltage, and insulation tests, and workmanship and material, that axle generators could be obtained that would give satisfactory service in operation, and it is further believed that generators now on the market would fulfill such specifications.

One of the greatest troubles with the operation of axle generators is the drive. Axles are either hammered or rough turned, and in both cases are tapered, the smaller diameter being at the center of the axle, and as the pulley is generally placed to one side of the center of the axle, this makes it difficult to properly secure the pulley.

The common means of transmitting the power is by belt, generally so-called "rubber" belt. With this type of belt it is extremely difficult to join the two ends of the belt so that the joint will have a tensile strength approximating the tensile strength of the belt itself. In other words, the joint is the weakest spot in the belt, and the belt is lost by this joint failing. It is an extremely rare case to have a belt actually worn out in service.

Experiments are being made using the Morse chain, and also a standard automobile chain. The objection to these chains is their comparatively great first cost, to which must be added the cost of the two sprockets, as they wear out about as fast as the chain. Greater mileage, however, has been attained by the use of chains than with belts, and the experience to date indicates that there is a possibility that this form of drive may ultimately be successful. Assuming that if one chain gave the same mileage as four belts and that the costs for material were the same, the chain would then have the advantage of the labor in applying these belts, as well as the avoidance of the possible failures that might have resulted, due to the loss of the belts. The chain would also be unaffected by accululation of ice and snow, which seriously interferes with the belt. The chain also does away with the necessity of a tension device as it can be run slack. Such a device is necessary when using belts in order to get tension to give the belt sufficient adhesion to drive the load, but no way has been devised as yet to tell when the proper tension is applied, and it is believed that in a majority of cases this tension is too great, resulting in a greater strain than necessary on the belt and fastening, and resulting in decreasing the mileage of the belt, and increasing the wear on the bearings.

When electric train lighting was inaugurated in this country, the carbon filament lamp used required 4.5 watts per candle power, this was later decreased to 3.5, and then to 3.1 watts per candle power.

The Gem or metalized filament was then brought out in which the energy was cut to 2.5 watts per candle power, followed by the tantalum lamp, which reduced the energy consumption to 2 watts per candle power.

The latest lamp to be used in this service is the tungsten, which is burned at an efficiency of 1.25 watts per candle power.

The writer has no information relative to the number or candle power of the lamps installed on the cars of the Florida Special above mentioned, but as late as 1897, the standard equipment of a 12-section drawing room state room sleeper was 35—12 candle power lamps, and 6—12 candle power portable berth lamps, these were only used when called for by the passenger, or a total of 492 candle power. Today, the same car would be equipped with two berth lamps of 8 candle power in each upper and lower berth, and 44—12 candle power lamps for the rest of the car, making a total candle power for the car of 976 candle power, or an increase of almost 100 per cent.

It should also be noted that the light from the tungsten lamp used at present is much whiter and brighter than that from the carbon filament lamps used in 1897, so that the apparent increase in illumination is even greater than would appear from the figures.

In 1897, all lamps were used slear, generally in combination gas and electric fixtures of such a design that it was impossible to use a shade that would protect the eyes from the glare of the lamp.

Later frosted and opal dipped lamps were used, but it is becoming the practice to use a clear lamp in a fixture designed so that the shade screens the lamp bulb from the eyes.

In the past very little attention was given to equipping the car with lamps and fixtures which would give the best results, from the illuminating standpoint; that is, taking into account not only the light produced, but also its effect on the eye. Some work has been done lately along these lines but much remains to be done.

In the opinion of the writer the day will soon arrive when all steam equipment operated in passenger service will be electrically lighted, and that the great majority of the lighting will be done by axle generators, although the "Head End" and "Straight Storage Systems" will still be used when the conditions are such as to make them applicable.

The International Railway General Foremen's Association.

The sixth annual convention of the International Railway General Foreman's Association was held at Cincinnati, May 3d, 4th, 5th and 6th. In making his address President T. H. Ogden, general foreman of the Dodge City shops of the Atchison, Topeka & Santa Fe, said in part as follows:

"A few years ago railway mileage was counted by the hundreds and heads of departments were personally acquainted with the most of the men under them, while today the railway mileage is counted by the tens of thousands and the heads of the departments are far removed from the men in the ranks and only know them by the reports showing the results of their work and the cost of doing it. We have become mere cogs in the great wheel of progress, known only by the work we perform and the results we obtain.

"A vital matter is the question of harmony and co-operation which should exist between the general foreman and the foremen and men under him, as well as with the master mechanic and the higher officials of the mechanical department and the members of other departments with whom we come directly in contact. We should not lose sight of the fact that in harmony and co-operation in our shop organization lies our strength upon which depends our efficiency and success. We must not allow a feeling of distrust to be created among our foremen or workmen. Keep close together, as in addition to harmony and co-operation, we should practice team work with our men and with the enginemen and with the other officials.

"It has been stated to me since our last meeting that many many foremen show indifference to the work reported by the enginemen; we must not overlook the fact that by maintaining harmony with the enginemen we gain their confidence and support, which is essential to our success and will be recognized by our superiors as ability to assume positions of leadership and responsibility. So let us in our various positions strive to create a harmonious feeling and to keep out the feeling of distrust among our shop force and all with whom we are associated in the performance of our duties. If we can accomplish this our work will be easy and our efforts to install new ideas in the shop work will meet with approval and success and we will have the support of all in the systematic and economical operation of our departments."

Mr. L. H. Bryan, secretary of the association, in presenting the secretary and treasurer's report stated that the total membership, inclusive of active, honorary and associate members, now numbers 297, and that the net cash balance in the treasury at the time of reporting was $258.56, with indications that the amount would be augmented to nearly $1,000 after the affairs of the session just closed were settled. In business session it was decided hereafter to hold three-day sessions instead of five and the by-laws were amended to that effect. By unanimous choice, Chicago was selected as the place for holding the next convention.

In outlining the work of the next convention much favor was expressed for a change in the nature of the subjects to be treated. The consensus of opinion was that less attention should be given technical matters, such as design and construction of motive power and apparatus, and more to the methods of handling men, work and materials, since it is the province of the foreman to produce results from these elements on an economical basis rather than to consider the merits of such designs as are evolved by the mechanical engineer's department. The executive committee in outlining next year's work will be governed by this consideration.

The following are the subjects presented for consideration at the several sessions:

The Foreman and His Men, by Mr. W. L. Kellogg, superintendent of motive power and cars, Cincinnati, Hamilton & Dayton Ry.

Self-Cleaning Ash Pans, by Mr. C. T. Walters, general foreman, Great Northern Ry., St. Paul, Minn.

Commercial Gas as Fuel, by Mr. Wm. G. Reyer, general foreman, Nashville, Chattanooga & St. Louis R. R., Nashville, Tenn., and Mr. H. D. Kelley, general foreman, Chicago & Northwestern Ry., Chicago, Ill.

Advisability of Installing a Hot Water Washout and Filling System, by Mr. C. H. Voger, general foreman, Cleveland, Cincinnati, Chicago & St. Louis R. R., Bellefontaine, O., and Mr. C. L. Dickert, general foreman, Central of Georgia R. R., Macon, Ga.

Oxy-Acetylene Welding, by Mr. J. M. Davis, general foreman, Colorado & Southern R. R., Denver, Colo., and Mr. W. T. Lauer, general foreman, Erie R. R., Huntington, Ind.

Superheaters, by Mr. A. L. Ball, general foreman, Chicago, Indianapolis & Southern R. R., Kankakee, Ill.

The Wide Firebox, by Mr. C. Bowersox, general foreman, Toledo, St. Louis & Western R. R., Frankfort, Ind.; Mr. C. H. Voger, general foreman, Cleveland, Cincinnati, Chicago & St. Louis R. R., Bellefontaine, O., and Mr. H. O. Olson, machine shop foreman, Duluth & Iron Range R. R., Two Harbors, Minn.

Location of the Point of Water Delivery to Locomotives, by Mr. H. M. Brown, assistant master mechanic, Chesapeake & Ohio R. R., Hinton, W. Va.; Mr. A. F. Bradford, general foreman, Cleveland, Cincinnati, Chicago & St. Louis R. R., and Mr. C. W. Seddon, superintendent of motive power and cars, Duluth, Missabe & Northern Ry., Proctor, Minn.

In addition to the foregoing an address was delivered before the association by Prof. Hermann Schneider of the University of Cincinnati, who remarked at some length on the selection and training of apprentices.

In the election of officers for the ensuing year the following were chosen: President, Mr. C. H. Voger, general foreman, Cleveland, Cincinnati, Chicago & St. Louis R. R., Bellefontaine, O.; first vice-president, Mr. T. F. Griffin, general foreman, Cleveland, Cincinnati, Chicago & St. Louis R. R., Indianapolis, Ind., and secretary-treasurer, Mr. L. H. Bryan, general foreman, Duluth & Iron Range R. R., Two Harbors, Minn.

The following firms were exhibitors at the convention: Armstrong Bros. Tool Co., Chicago, Ill.; Ashton Valve Co., Boston, Mass.; Celfor Tool Co., Buchannan, Mich.; Chicago Pneumatic Tool Co., Chicago, Ill.; Crane Company, Chicago, Ill.; Crucible Steel Company of America, Pittsburg, Pa.; Curtain Supply Co., Chicago, Ill.; Dearborn Drug & Chemical Works, Chicago, Ill.; Detroit Lubricator Co., Detroit, Mich.; Joseph Dixon Crucible Co., Jersey City, N. J.; Fairbanks, Morse & Co., Chicago, Ill.; J. A. Fay & Egan Co., Cincinnati, O.; Franklin Railway Supply Co., New York City; Garlock Packing Co., Palmyra, N. Y.; Gold Car Heating & Lighting Co., New York City; Goldschmidt Thermit Co., New York City; Green, Tweed & Co., New York City; Hunt-Spiller Mfg. Co., Boston, Mass.; Jenkins Bros., New York City; H. W. Johns-Manville Co., New York City; the E. A. Kinsey Co., Cincinnati, O.; Nathan Mfg. Co., New York City; Otley Mfg. Co., Chicago, Ill.; Storrs Mica Co., Owego, N. Y.; Strong, Carlisle & Hammond Co., Cleveland, O.; Talmage Mfg. Co., Cleveland, O.; West Disinfecting Co., Cincinnati, O.; Westinghouse Air Brake Co., Pittsburg, Pa.

In the Aurora Shops of the Chicago, Burlington & Quincy R. R.

It quite often happens that bearings become loosened from the iron shell which supports them, thus causing an undue amount of play and friction. In order to obviate this, the castings are made with grooves and projections to hold the bearing metal, but it is difficult to make these grooves of such a form that they will be efficient in holding the metal and at the same time allow the pattern to be drawn easily. In figure 1 is shown a device in use on a moulding machine at the Aurora, Ill., shops of the C., B. & Q. R. R., which accomplishes both results very handily. After the mould has been made, a slide beneath the moulding machine is pulled forward and this actuates a lever which in turn draws back the portion of the pattern which forms the lip shown in the cross-section view. It will be noted that the projections which form the lips in the casting are made in lefts and rights and are made to work simultaneously by means

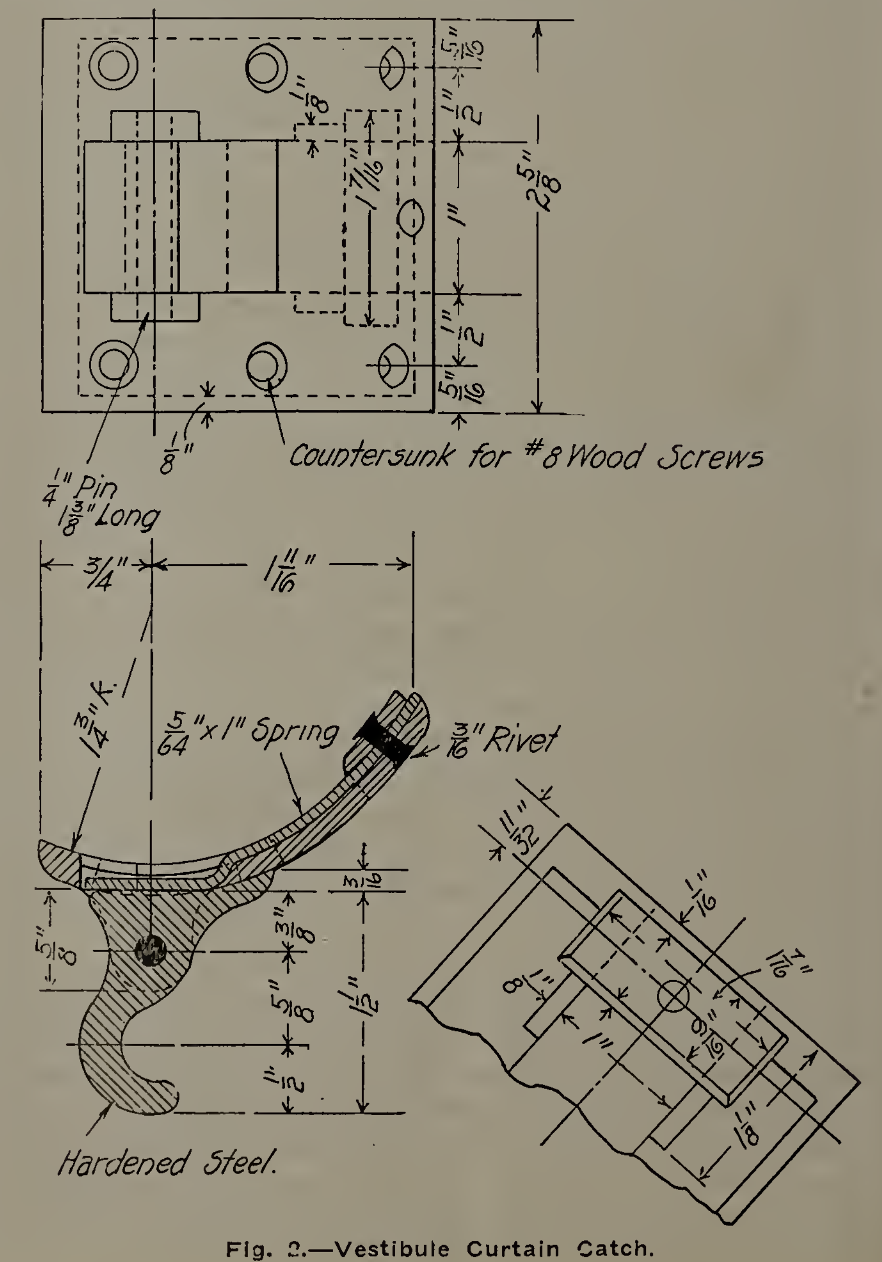


Fig. 2.—Vestibule Curtain Catch.

of meshing teeth. When the slide is pushed to the extent of motion, it is seen from the drawing that the above-mentioned parts are locked in place. This device was patented in 1902 by F. J. Lass, now mechanical engineer on the National Railways of Mexico, who was at that time at Aurora.

The car shops of the Chicago, Burlington & Quincy R. R. are well equipped for handling all the work pertaining to this department and it is worthy of note that all the smaller parts, such as brass lamp brackets, locks, door knobs, etc., are made at Aurora. Considerable time is saved in the turning up of door knobs by using a cutter made of a block of tool steel and having a cutting edge with a contour similar to that of the door knob. This is attached to the cross plate of a small turret lathe and the knob, having been drilled and tapped, is placed in the lathe and is made ready for the polishing room at one cut, whereas ordinarily a round-nosed, straight and facing tools are used, making three distinct cuts.

A vestibule curtain catch for Pullman posts which has a decided advantage over the ordinary catch is shown in figure 2. The body is of brass, while the hook is make of soft steel, case-hardened. The distinctive feature, however, is the spring fastened along the back of the body which allows the hook to release when a great strain is put upon it, thus preventing the tearing of the curtains, which is the result with the ordinary catch. The spring is made of German spring steel. This device has been patented by Andrew Lian, foreman of the brass finishing shop, and over 500 of them are in use on the Burlington at present, while the Great Northern and Northern Pacific railways are also contemplating the use of them.

The use of compressed air is very fully developed at the Aurora shops; one noteworthy example of its use is for moving the heavy heads on the large car wheel lathes. An air cylinder about 4x12 ins. is attached to one end of the machine and connection is made between the head and the piston rod of the air cylinder. An air pipe is connected to each end of the cylinder and a three-way cock, located close to the operator, enables him to handle the heavy head quickly and easily. Quite a number of telescopic air jacks having two pistons, one inside of the other, are used about the plant, and they are of especial value in the round house pits, where the jack is mounted on a small truck and is run from one pit to another.

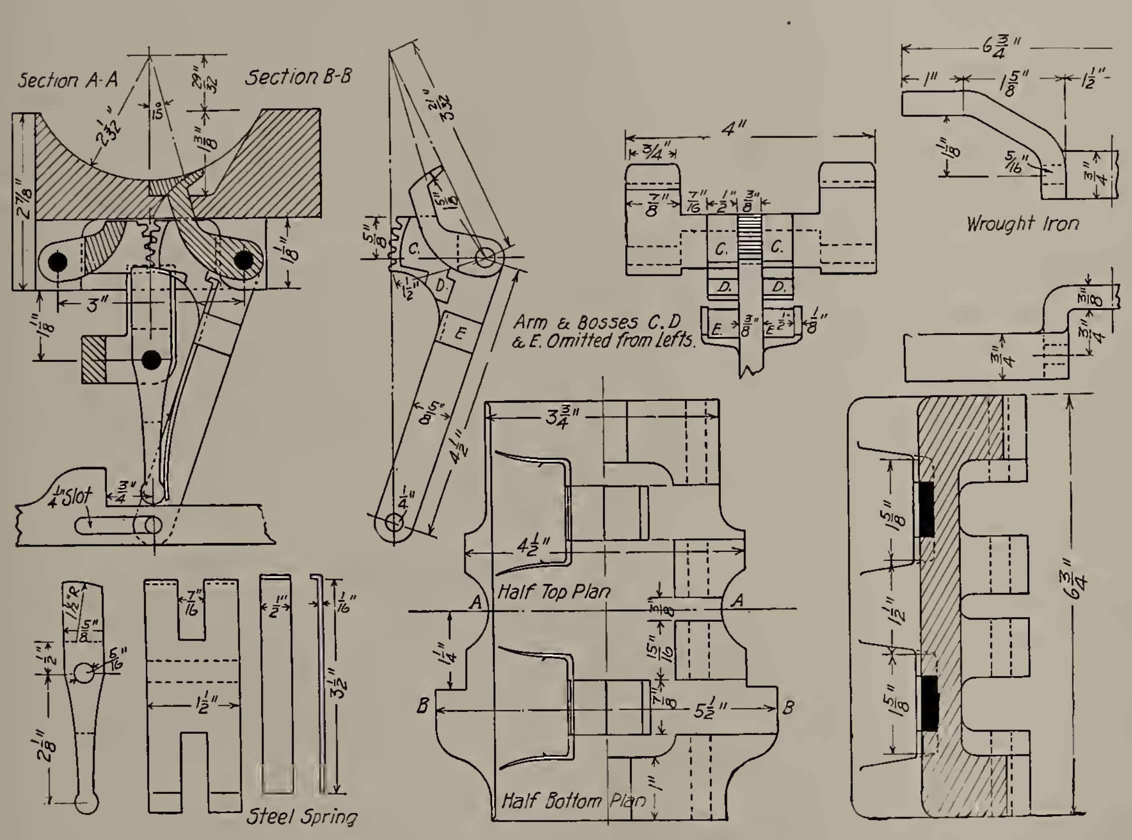
Figure 3 shows a very simple and cheaply made air hoist for ash pans which has a single piston with a travel of 18 ins.

In the wood-working shop a very good idea of emergency air control of the power has been carried out by connecting up an air cylinder and piston to the main power clutch and locating a number of control valves for the same about the shop so that in case of an emergency the power can be shut off instantly.

The Weathering of Coal.

The Engineering Experiment Station of the University of Illinois has just issued Bulletin 38, which contains the results of experiments conducted to determine the change in weight, the change in colorific value and the amount of disintegration that are liable to occur in the grades of coal found in Illinois and neighboring states under different conditions of storage, such as in the open air in piles; in covered bins, and under water. These experiments were conducted by S. W. Parr, Professor of Applied Chemistry, and W. F. Wheeler, first assistant, Department of Chemistry. This Bulletin reports a continuation of the experiments of the weathering of coal published under the same title in 1907 in Bulletin No. 17 The experiments described in the present bulletin deal with car-load lots of coal under conditions comparable with actual experience in the storage of coal. Car-load lots of both nut and screenings were exposed in covered bins, in open bins and under water, for a period of one year. The initial values were determined for the freshly-mined coal, and analyses were made approximately ater two days, ten days, two months, six months and one year.

Coal of the type found in Illinois and neighboring states is not affected seriously during storage when only the changes in weight and losses in heating power are considered. The changes in weight may be either gains or losses of probably never over 2 per cent. in a period of one year. The heating value decreases most rapidly during the first week after mining and continues to decrease more and more slowly for an indefinite time. In the coals that have been tested, 1 per cent. is about the average loss for the first week and 3 to 3½ per cent. would cover the losses for a year, although in



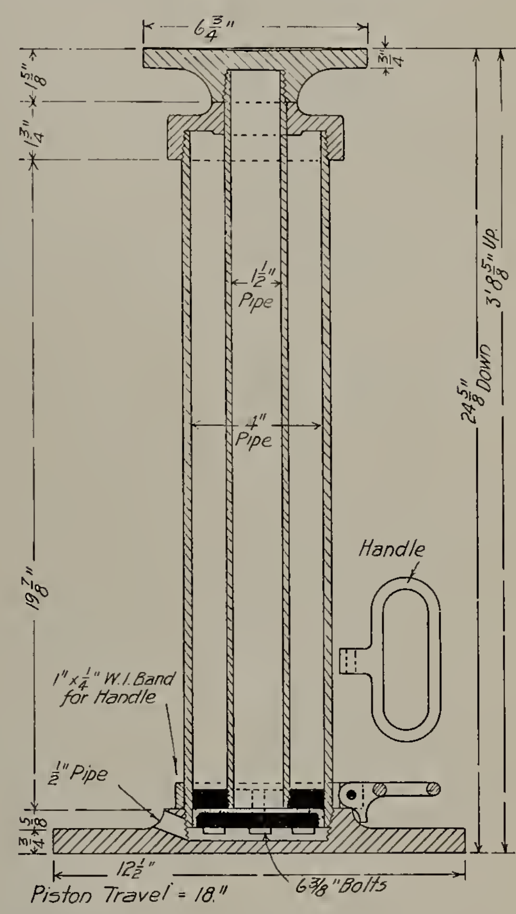


Fig. 1.—Machine Patterns for Shell Brasses. Fig. 3.—Air Hoist.

some instances the loss was found to be as high as 5 per cent. in a year.

The losses due to disintegration of the coal and to spontaneous ignition seem to be of far greater importance than any changes in weight and heating value, although they cannot be expressed in figures for comparison. The storage of coal of a size larger than is to be used would overcome part of this objection to storage, as the coal could be crushed to the most advantageous size just before firing. The larger sizes of coal are also much less liable to take fire spontaneously. Storage under water will prevent disintegration of the coal to a very large extent, and it will absolutely prevent any fire losses. Aside from these advantages in favor of storing coal under water, there seems to be very little to be said in favor of any particular method of storing coal.

Efficiency Tests, Pennsylvania R. R.

Some 300,000 efficiency tests were held last year by the Pennsylvania Railroad and practically a perfect record was made by the employes. The average number of tests made each day was 820 and of the total for the year 99.75 per cent were perfect. In the twenty-five one hundredths of one per cent of failures are included the cases where enginemen passed signals by a few feet before stopping their trains, and similar cases, which, though violations, were not such as would make possible an accident to a train. These tests are conducted by officials who, at unusual times and places, set signals at caution or danger, display fusees, or place torpedoes on the track. The tests made in 1909 were divided into four classes, in which the following records were made by the men: Bloock signal rules, 47,384, of which 99.6 per cent showed perfect observance on the part of the employes; rules governing flagmen, and the use of fusees, torpedoes, and other signals, 45,887 tests, with 99.6 per cent perfect; trains ahead of schedule time, 92,379 tests, with 99.8 per cent perfect; and signalmen relieving each other, 99.9 per cent perfect out of 112,901 tests. Eight of the twenty-six divisions of the Pennsylvania Railroad showed perfect records in all signal tests made during the year. On the Sunbury and Shamokin divisions a total of 12,539 block signal rule tests were made and in only nine cases was the observance imperfect. Twelve divisions had over 99 per cent of efficiency tests perfect, 19 divisions had perfect records in trains checked for running ahead of schedule time, and 9 divisions had perfect records in signalmen relieving each other on time.

The Shifting of Wheels.

The general soundness with which railway wheel sets are made is strikingly illustrated by the English Board of Trade inspector's report on the accident which occurred at Stoats Nest on the London, Brighton and South Coast Railway at the end of January, seeing that only two previous derailments due to a similar cause are on record, says the Mechanical World. In the case of the train in question the inspector states that there was no defect in the running of the particular carriage concerned when it left Brighton as part of the train, and the actual spot where the shifting of the wheel outwardly on its axle took place cannot be definitely determined. It is, however, probable that when running through one of the trailing connections of three cross-over roads, the wheel rubbed against one of the check rails, and that the looseness of the grip between the wheel and the axle allowed this rubbing to cause the wheel to shift on its axle, this being the primary cause of the accident. The two former derailments from a similar cause occurred at Maidenhead and Exeter respectively on the Great Western Railway a number of years ago, and since then the company has applied a pressure of 50 tons to all wheels passing through the shops. Similar precautions are now being taken by the London, Brighton and South Coast Railway, together with other tests to ensure that the present rolling stock is thoroughly sound from the wheel-set point of view. The inspector suggests that other railway companies should follow this example, and it is stated that they have agreed to do so. The Stoats Nest accident, in which the wheel was found to have shifted 1 in. outwards, involved the loss of several lives, and it is unfortunate that it has been impossible to ascertain definitely how the movement took place.

Soldering Flux for Metals.

Double chloride of zinc and ammonium is recommended as preferable to salammoniac for use in soldering metals, according to De Voldere in the "Chemiker Zeitung." The preparation takes the form of a vitreous, translucent, brittle mass, and, being hygroscopic, must be kept in a closed tin. Though it becomes coated with a thin whitish film in time, the original appearance is restored by remelting. For soldering it is applied either by rubbing it on the surface of the metal, which is heated to the melting point of the solder, or else the melted preparation is brushed on. The flux is easily prepared from zinc chloride and ammonia, the pure chloride being preferable. Of this salt, 883 parts are dissolved in distilled water in an enamelled pan, and sufficient ammonia solution to correspond to 117 parts of gaseous ammonia is added by degrees and stirred in by means of a strip of zinc or glass rod, to keep down the temperature and prevent spurting. A gelatinous, milky mass is produced, and this must be heated gently on a sand bath to expel the water contained in it. When the appearance changes to that of a thick oil the temperature is raised to boiling point, and maintained thereat until a sample dropped on a glass plate sets quickly and remains transparent. The mass is then poured out into a zinc tray about 1½ to 2 in. deep, and left to cool in a perfectly dry place.

Personals

D. R. Macbain, assistant superintendent of motive power, New York Central & Hudson River, has been appointed superintendent of motive power of the Lake Shore & Michigan Southern Ry., to succeed Le Grande Parish, whose resignation to accept the presidency of the American Arch Co. was noted last month.

R. B. Kendig, mechanical engineer of the Lake Shore & Michigan Southern, has been appointed general mechanical engineer of the New York Central lines to succeed F. M. Whyte, who has resigned to become general manager of the New York Air Brake Co.

A. R. Ayers, assistant master mechanic of the Lake Shore & Michigan Southern, has been appointed mechanical engineer to succeed R. B. Kendig.

T. H. Goodnow, master car builder of the Lake Shore & Michigan Southern, has been appointed assistant master mechanic to succeed A. R. Ayers, at Elkhart, Ind.

J. W. Singer, superviser of materials of the Lake Shore & Michigan Southern, has been appointed master car builder to succeed T. H. Goodnow, with office at Englewood, Ill.

J. T. Carroll, master mechanic of the Lake Erie & Western, has resigned to become a superintendent of motive power of the Baltimore & Ohio R. R., with office at Pittsburg, Pa.

F. H. Reagan, assistant superintendent of Collinwood shops, has been appointed master mechanic of the Lake Erie & Western to succeed J. T. Carroll at Tipton, Ind.

C. M. Large, master carpenter of the Pennsylvania Lines West of Pittsburgh, died at Jamestown, Pa., April 29.

John I. Kinsey, who was for forty years master mechanic of the Lehigh Valley R. R. shop at Easton, Pa., died at that place

April 28, aged 83 years. Mr. Kinsey retired from active work twelve years ago.

T. J. Hamilton has been made district master mechanic of the Chicago, Milwaukee & Puget Sound, in charge of line from Harlowton, Mont., to Avery, Idaho. A. V. Manchester has jurisdiction east of Harlowton, and Frank Rush has jurisdiction west of Avery.

R. Wilson has been made general foreman of the locomotive department of the Chicago Great Western at Oelwein, Iowa, vice A. E. Thomas, resigned. M. Rogge succeeds Mr. Wilson as erecting shop foreman.

W. J. Rusling, assistant master mechanic of the Pennsylvania railroad at Harrisburg, Pa., has been appointed foreman of the Enola, Pa., shops, vice H. T. Coates, Jr., promoted; H. G. Huber, assistant master mechanic at Phillipston, succeeds Mr. Rusling.

E. H. Spenger has been made assistant superintendent of motive power of the Butte, Anaconda & Pacific, with office at Anaconda, Mont.

W. F. Kaderly, a master mechanic of the Southern Ry., has been appointed superintendent of motive power of the Georgia Southern & Florida, with office at Macon, Ga. He succeeds L. B. Rhodes, master mechanic, who has resigned.

A. J. Asaacks has been appointed a master mechanic of the Chicago Great Western Ry., with office at Des Moines, Ia., vice T. H. Yorke, resigned.

J. W. Johnson has been appointed a master mechanic of the Chicago Great Western, with office at Clarien, Ia.

H. W. Bleeze succeeds Frank Singer as master mechanic of the Colorado Springs & Cripple Creek District Ry., with office at Colorado Springs, Colo.

E. C. Hanse succeeds M. W. Cahill as master mechanic of the Louisville & Wadley R. R., with office at Wadley, Ga.

C. M. Hoffman has been appointed an assistant superintendent in charge of motive power of the Oregon Short Line, vice A. H. Gairns. His office is at Pocatello, Idaho.

L. B. Rhodes has been appointed superintendent of motive power of the Virginia Ry., with office at Norfolk, Va.

New Books

THE CORROSION AND PRESERVATION OF IRON AND STEEL. By A. S. Cushman and H. A. Gardner; 373 pages, cloth, 6x9; published by the McGraw-Hill Book Co., New York. Price $4.00

The object of the authors in writing this book was an elucidation of the electrolytic theory of corrosion, this theory being considered accepted, at least provisionally, by all authorities on the subject of metal rusting. In the words of the authors, "so diverse a subject as the corrosion and preservation of iron would be encyclopedic if the attempt were made to take up every phase in detail. The protection of boiler tubes presents a very different problem from the protection of bridge structures and yet the same main principals can be applied to the consideration of each case." It is this point that the authors have had in mind, and while a number of specific cases of corrosion are presented and discussed, the object has been to treat the subject in a general way. For this reason no separate chapters are included on special phases of the problem. On this account these readers who propose to use the words for reference purpose in special cases of inquiry will depend upon the index of the volume rather than upon chapter headings for guidence. In the very complete presentation and development of the electro-chemical explanation of corrosion, it is the intention that technologists will find in this volume a working theory both suggestive and practically useful. The book is appended with a very complete bibliography on the subject in hand and, as above hinted, the index renders the information convenient for reference use. Illustrations are used frequently enough to render clear the descriptive matter. The readers of the Railway Master Mechanic will be particularly interested in the chapter on "Paints for Various Purposes." This section of the book includes hints on the very descouraging problem of the paint preservation of iron and steel equipment.

THE VALVE SETTERS GUIDE. By James Kennedy; 58 pages, cloth, 5½x7; published by the Angus Sinclair Co., New York. Price 50 cents.

A practical man's instruction book for the setting of four common locomotive valve gears. It deals with the Stephenson, Walschaerts, Baker-Pilliod and Joy systems, and the matter is a compilation of articles on the subject by the author published in Railway and Locomotive Engineering. Each style of valve motion is described fully and briefly with the assistance of illustrations and the method of procedure in the correction of faults in setting or in assembling is explained. The book should be very useful in the instruction of apprentices or for the assistance of practical men in gaining familiarity with any of the gears mentioned.

Among the Manufacturers

NEW LITERATURE.

The Vanadium Metals Co., of Pittsburg, Pa., has issued a circular illustrating the difference between the vanadium bronze bell and the standard bell.

* * *

Bulletin M of the Rockwell Furnace Co., of New York, is descriptive of the tilting crucible furnace for oil or gas fuel made by this company.

* * *

The Electric Controller & Mfg. Co., of Cleveland, Ohio, has issued a leaflet descriptive of E. C. & M. lifting magnets.

* * *

Edgar Allen & Co., of Chicago, has issued a catalogue giving prices and descriptions of various grades of tool steel and drill chucks.

* * *

"Ventilation for Comfort and Health" is the title of a handsome booklet published by the American Blower Co., of Detroit, Mich., which shows many different applications of the "Sirocco" electric fan and air purifier in the home and office.

* * *

The Boston Gear Works, of Norfolk Downs, Mass., has issued its catalogue for 1910, which contains prices and descriptions of many different styles of spur and bevel gears, internal gears, worms, racks, ratchets, sprockets and chains.

* * *

Where electric railways operate cars in trains, the straight air system of braking has not been found entirely satisfactory. Bulletin 389 of the National Brake & Electric Co., of Milwaukee, Wis., takes up three different types of emergency and release valves for use with the straight air system which gives it many of the advantages of automatic air.

* * *

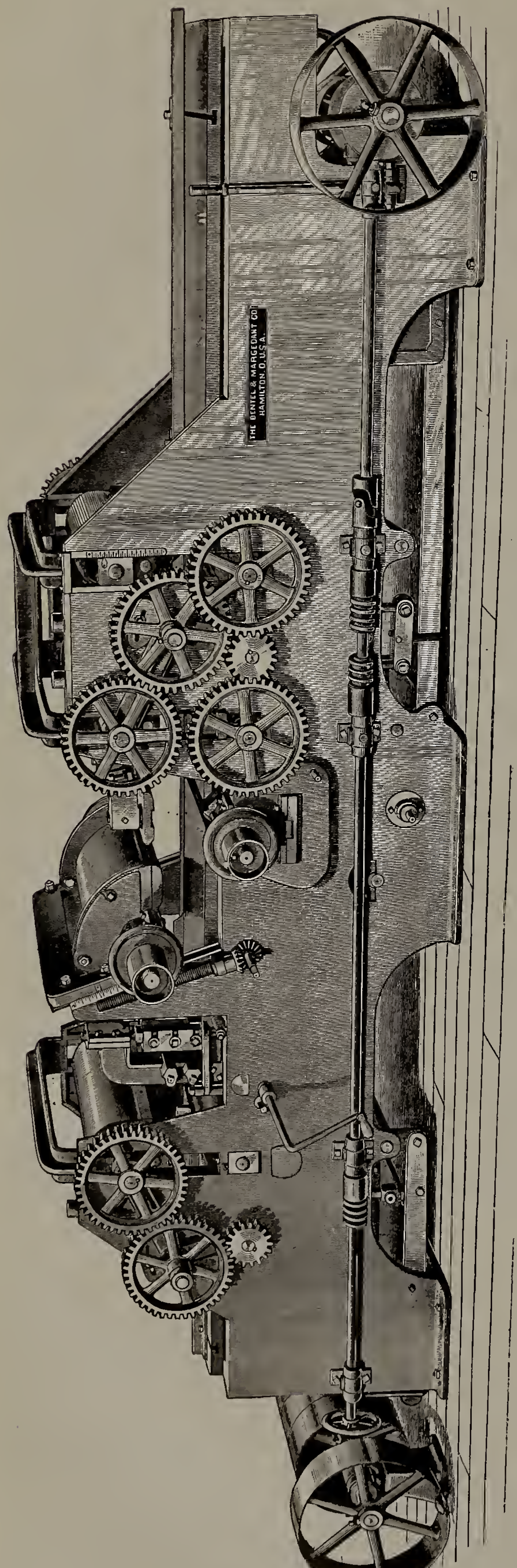
The American Wire Rope News for May contains some interesting photographs and data concerning the use of the wire rope of the American Steel & Wire Co.

* * *

In a leaflet recently issued by the J. D. Smith Foundry Supply Co., of Cleveland, there is described a rather extraordinary battery of rolling drawer core ovens recently installed by this company for a firm in Ohio.

* * *

The "Water Works Material" catalogue for 1910 of the Kennedy Valve Mfg. Co., of Elmira, N. Y., describes in detail



Heavy Car Sill Planer, Matcher and Timber Dresser.

water valves, hydrants and other accessories of a water works installation.

* * *

The annual catalogue of the Landis Machine Co., of Waynesboro, Pa., is a neatly arranged booklet of the dies, die heads, bolt cutters and other similar machines manufactured by this concern.

* * *

Catalogue 13 of the Galion Iron Works, of Galion, Ohio, contains a complete line of general contractor's machinery and supplies; also much of interest to highway officials.

* * *

The Turner-Fricke Mfg. Co., of Pittsburg, Pa., has issued a catalogue of gas and gasoline engines which contains many photographic reproductions of the engines. Both the photographs and reading matter are clear and concise.

HEAVY FOUR-SIDE CAR SILL PLANER.

An exceptionally heavy car sill planer, matcher and timber dresser, manufactured by the Bentel & Margedant Co., Hamilton, Ohio, is shown in the accompanying illustration. The machine is one of the most modern as well as one of the largest of its kind. The parts are heavy and stiffly constructed with a view to adapting it fully to the work it is intended to perform.

The feed rolls, six in number, are of large diameter with large heavy journals and are driven by a train of large expansion gears. They rise and lower in massive housings by means of screws and a system of levers. All rolls are raised and lowered by power simultaneously, the operator standing at the feeding end and simply throwing in a lever. The lower head is placed in front so as to operate on the material first, thus affording a smooth surface for the material to slide upon, and a place to gauge and measure from. The head is carried in a heavy housing which is made to slide entirely out of the machine for ease and facility in sharpening the knives.

The upper head comes next to the lower. It is mounted rigidly in a massive housing raising and lowering through two heavy screws. The heavy bonnet chipbreaker carries an adjustable shoe on the bottom which can be set close to the knives, and it swings entirely out of the way for sharpening and adjusting the knives. The side heads are carried in housings of an entirely new construction. The lower end of the mandrel runs in a step-box which allows the end of the mandrel to rest in oil, thus keeping it cool. The heads are carried between two boxes, the upper one being removable to get at the heads. The tables are cast solid and provided with gauges and fences.

The feed has three changes of speed varying from 30 feet up to 65 feet per minute. It can be given faster or slower feed by changing the size of the pulleys. The whole length of the machine, including countershaft, is 17 feet, and whole width 5 feet 4 inches. Jointer heads 12 inches long or high are furnished for the side mandrels. The machine will plane two sides 24 inches by 12 inches or four sides 20 inches by 12 inches.

A NEW DESIGN IN LOCOMOTIVE VALVE GEARS.

Since 1842, when the Stephensons placed on their locomotives the first reversible valve gear (the unpatented product of the mind of one of their factory draughtsmen) there have been invented upwards of fifty reversible motions, each calculated to improve the functions of steam admission and exhaust, together with the complications resultant upon the necessity for variations in cut-off, lap, lead and quick port opening. It seems remarkable, considering the prolificness of valve gear inventors, therefore, that only the designs of William Williams (the shifting link) and Egade Walschaerts should have survived through the decades marked by so many radical improvements in the general design of the railway locomotive. And it bespeaks much for the rare attainments of these two inventors, and the magnitude of the problem with which they coped.

William Williams was a Welshman in the employ of the Stephensons and it was through his neglect to have his valve gear patented that the name of his employers was perpetuated by the device.

Working independently of any knowledge of what Mr. Williams had done, Egade Walschaerts, a young Belgian, succeeded in perfecting the valve gear that bears his name. He applied it to a locomotive on the Belgian States Railways in 1848 and it rapidly became popular among the mechanical men of European railways. Meanwhile the Stephenson shifting link gear had secured a sure footing in the practice of American mechanical engineers, and in spite of the fact that the use of the Walschaerts gear has been almost universal in European countries for many years, it is only recently that this gear has found favor upon American railways. It must be remembered that a good reason has existed for this variance of opinion in the fact that until recently European locomotives have been inside connected. While the recent increase in the number and size of the parts of American locomotives has compelled the use of a valve gear which has its moving parts outside of the frames. In the main, however, the same features of the Walschaerts valve gear that caused its acceptance for general application in Europe are responsible for its adoption so many years later in this country.

This historical data is too well known to require detailed explanation here, yet it seems necessary to recall the principle points of valve gear evolvement before attempting the intelligent study of the important features of a new design.

The name of Pilliod has become, in recent years, familiar to most of the railway mechanical men of this country. Charles J. Pilliod has been for many years an indefatigable worker along these lines and his work, together with that of his brother, Henry J. Pilliod, deserves much credit. Until recently, however, they have not been able to satisfy their own minds with specifications for a locomotive valve gear.

A design, which differs from anything heretofore successfully produced, both in principle and effect, has been perfected by these men and is presented herewith in the accompanying photographic reproduction and drawings.

It is a matter of record that the conventional designs of locomotive valve gears are, more or less, only aproximately correct in the functions of valve movement. The designs herewith are, however, presented with the, thus far, undisputed statement that the Pilliod locomotive valve gear is absolutely correct in all its functions, both in the forward and backward motions. The photographs were taken from a working model from which the diagrams warranting this statement were made.

Some of the features claimed for the Pilliod gear are as follows: A uniform cut-off, uniform release, a possible 25 per cent cut-off with a 75 per cent release and a late release in the working notches of the quadrant.

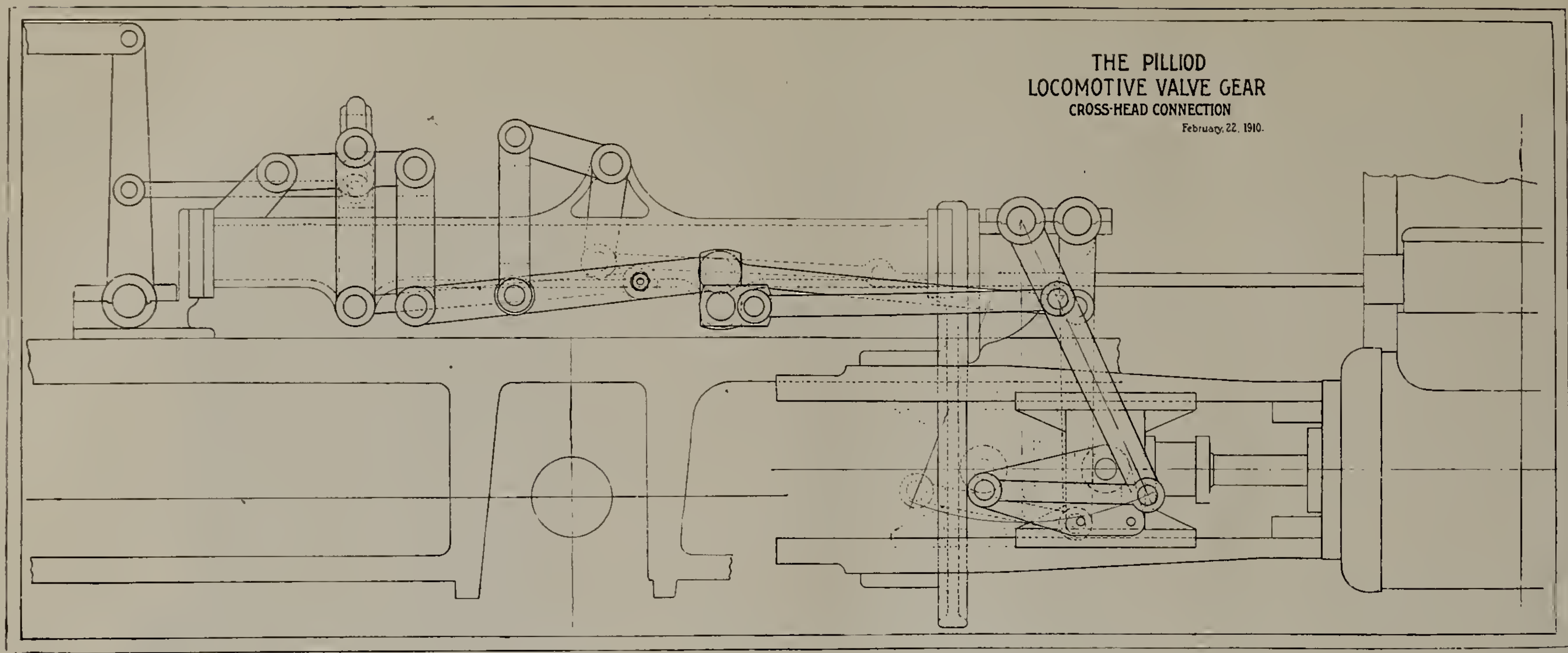
In the design of any valve motion the first consideration must be the action of the parts furnishing the power. The troubles of the valve gear designer lie principally in the difficulty of the conversion of the circular motion of the connecting rod, at the one end, into the reciprocal motion at the other, and in the elimination of the objectionable effects of the resultant angularities.

To explain the effect of this angularity of the driving parts let the crank circle be divided into 28 equal parts, or the half circle into 14 equal parts, the latter representing one piston stroke of the engine, as shown in one of the diagrams. The front and back centers of the crank mark two points, each of which marks the beginning of the piston stroke in either forward or backward motion. Experimentation shows, as is well known, that the piston travels fastest while the crank is traveling through the first half of the piston stroke, or through 90 degrees of the crank circle. For purpose of clearness the piston stroke may be divided into 4 equal parts, 25 per cent, 50 per cent and 75 per cent. By drawing radii equal to the length of the main rod from each of the points above mentioned, it will be seen that for 25 per cent of the piston travel from the front end, the crank has traveled 4½ parts of the crank circle; for 50 per cent, 6¾ parts, and for 75 per cent, 9 parts. On the back end the results are 25 per cent, 5 parts; for 50 per cent, 7¼ parts, and for 75 per cent, 9½ parts. These are the conditions of angularity that must be met in the proper distribution of steam through the valve gear.

In the motion ellipse the upper half corresponds to the travel of the valve for the front end of the cylinder and the lower half corresponds to the travel of the valve for the back end of the cylinder. The ellipses reproduced show the two extremes of service conditions, full gear and 25 per cent travel and are the same in both forward and backward motions. It follows that with the two extreme positions in harmony the intermediate positions will show corresponding harmonization. In these ellipses are shown the corresponding movements of the valve for each movement or position of the crank. A study of the diagrams clearly shows conformity to the angularity of the crank motion, at the same time showing equal port opening at each cut-off in either forward or backward motion.

It is to be hoped that the diagrams here presented will be carefully worked out by those interested that they may prove

Model of Pilliod Crosshead Connected Locomotive Valve Gear.



Elevation of Pilliod Locomotive Valve Gear.

to their own satisfaction the accuracy of the foregoing statements.

An interesting feature of the Pilliod valve gear is the fact that, without change in essential detail, the imparting motion may be taken from a single crosshead connection or from a return crank as in the conventional designs. This will be of particular interest to those who have experienced more or less trouble with the operation of locomotives on sharp curves where the attending distortion of the main frames results in appreciable error in the operation of the valve gear. All parts of either design of gear are interchangeable, as they are also for either inside or outside admission valves.

The absence of large or flat wearing parts in a valve gear is appreciated by those charged with the upkeep, and in this gear, as in several others, all wear is taken by pin connections which may be case hardened and, when necessary, replaced at a minimum of expense. The absence of any great weight in the moving parts also tends to reduce the effects of wear and at the same time this feature adds to the ease with which the locomotive is controlled from the cab.

In the case of a gear which necessitates the use of a link, errors due to lost motion are often uncorrected for long periods owing to the difficulty of making some of the adjustments, while in the case of the gear without wearing parts, other than pins, a correction is so easily made by the adjustment of tapers, or by the insertion of new parts, that the general performance of the engine should be more or less distinctly benefited in the average.

In the statements of certain facts regarding the Pilliod valve gear it is not the intention of the manufacturers to exaggerate their claims for its advantages, but rather to submit

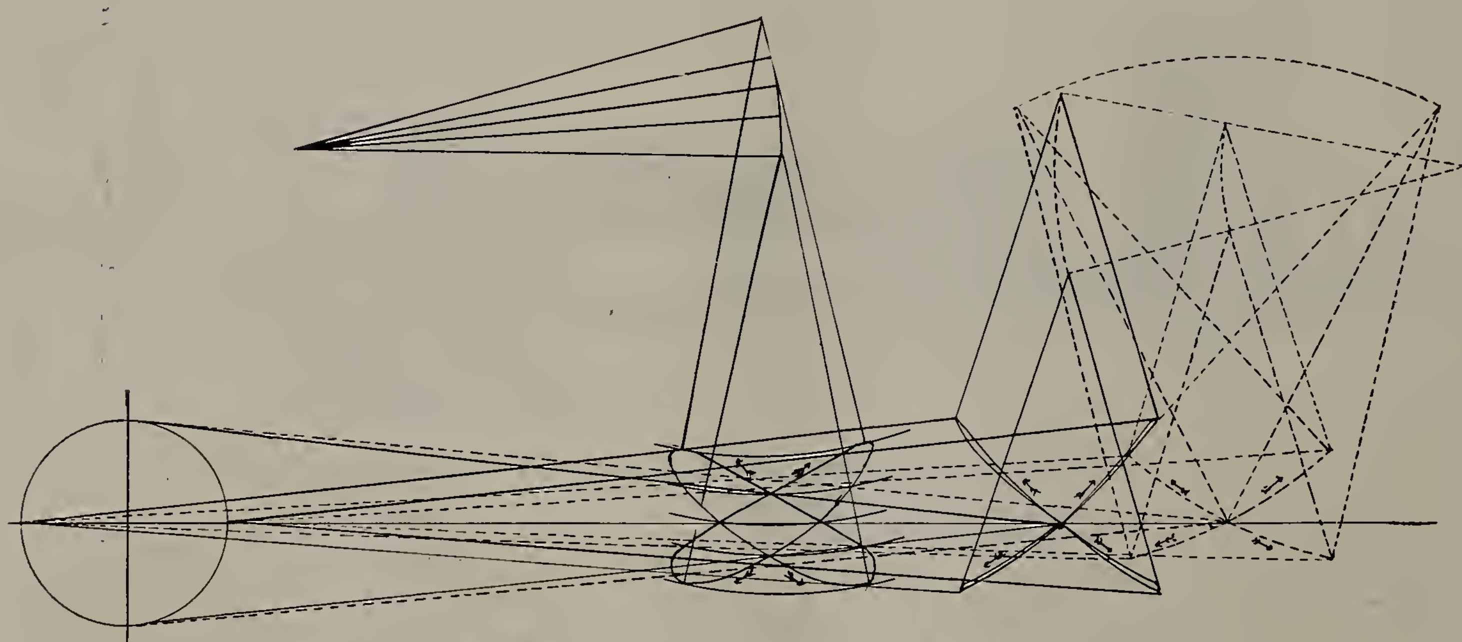


Diagram of Moving Parts, Pilliod Valve Gear.

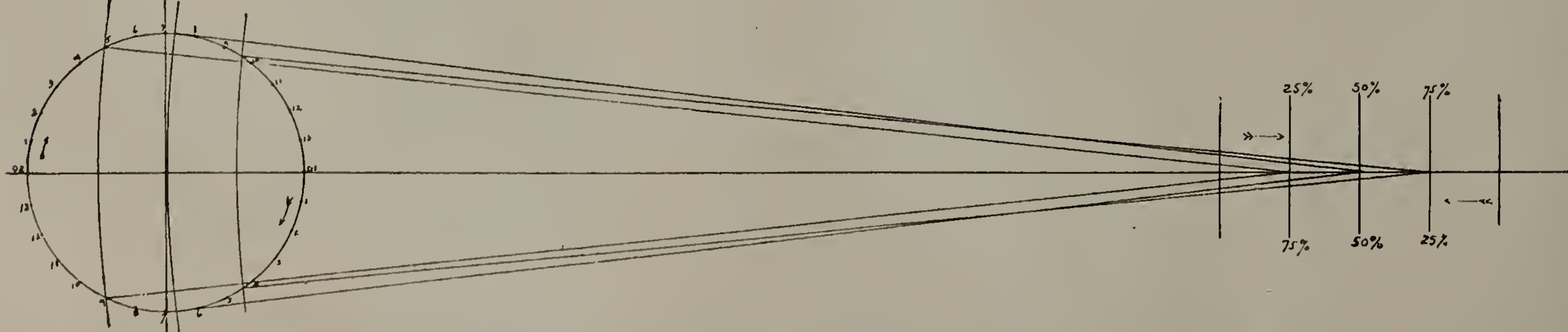
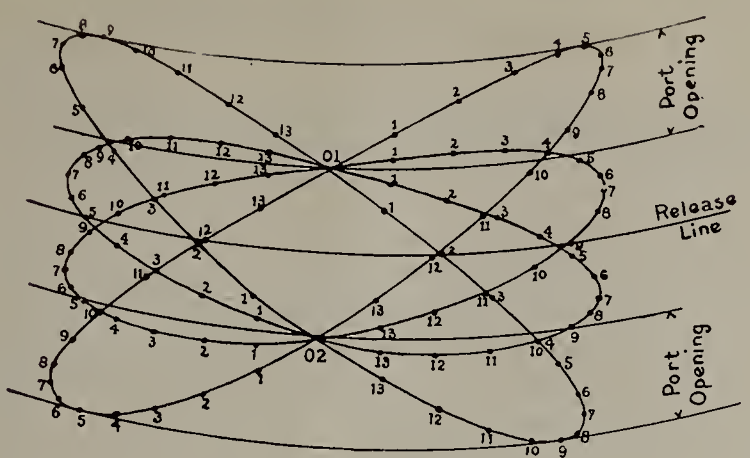


Diagram of Valve Movement, Pilliod Valve Gear.



Motion Ellipses.

for consideration facts that can be easily demonstrated. And in their assertions there is little that cannot be conclusively proven by a careful laying out of the design, while the rest is a commonsense deduction of results from the proven facts.

Industrial Notes

The Inter-Ocean Steel Co. has been running the machinery at its steel tire plant, at Chicago Heights, Ill., without any load for several days. Actual manufacturing will begin as soon as the machinery is adjusted to its bearings, which probably will be during the present week.

Mr. C. P. Hamilton has been elected a director of the General Electric Co., to succeed Mr. W. M. Crane, who has resigned.

E. S. Marshall, sales agent of the American Car & Foundry Co., St. Louis, Mo., who was formerly general master mechanic of the St. Louis Southwestern, has been placed in charge of the railway lubricating department of the Pierce Fordyce Oil Association, Dallas, Tex., successors in Texas to the Waters Pierce Oil Co.

Charles H. Ferry, formerly president of the Chicago Tire & Spring Co., Melrose Park, Ill., died suddenly in Phoenix, Ariz., May 2, at the age of 59. Mr. Ferry was born in Utica, N. Y., and after graduating from Yale he practised law in Chicago and later entered the manufacturing field.

The United Equipment Co. has been organized, with offices at 50 Church street, New York, and Great Northern building, Chicago, by Lucien C. Brown, Captain L. R. Doty and R. W. Davies, to handle steel cars, underframes and miscellaneous railway supplies. Mr. Brown and Mr. Davies were formerly with the Ralston Steel Car Co., Columbus, Ohio, and Mr. Doty was formerly with the Pittsburgh Coal Co., Pittsburg, Pa.

O. M. Stimson & Co., mechanical, consulting and inspecting engineers, has been incorporated to make investigation, inspection, specifications, drawings and reports on industrial plants, machinery and railway equipment, including cars, locomotives and materials. O. M. Stimson, who will have direct charge of the business, has had a varied experience in inspection work. After serving an apprenticeship in the engineering department of the U. S. Navy Yard, he entered the car and manufacturing business in 1886. He has served as foreman, storekeeper and mechanical engineer of the Lafayette Car Works, Lafayette, Ind., estimating engineer for the Pullman Co., manager of the Southern Car & Foundry Co., master car builder for Swift & Co., and for the past year he has been engaged in work of the character to be taken up by the new company. The company has offices at 1335 Old Colony building, Chicago.

Walter C. Kerr, president of Westinghouse, Church, Kerr & Co., New York, died on May 8 at Rochester, Minn., to which place he had gone to undergo an operation.

The Cement Products Exhibition Co., 115 Adams street, Chicago, has announced that the New York cement show will be held in the Madison Square Garden December 14-20, 1910, and the Chicago show in the Coliseum, February 17-23, 1911. A general prospectus of both these exhibitions is now being prepared which will give complete information for exhibitors, including diagrams of space available.

The Gulick-Henderson Co., inspecting engineers, New York, announces that F. B. Morse has been appointed assistant to the president, succeeding T. W. Cohill, resigned.

Mr. Herbert Green, vice-president of the Grip Nut Co., Chicago, has resigned to become vice-president of the Burton W. Mudge & Co., People's Gas building, Chicago.

C. W. Armbrust, Pres.

John F. Stevens, Vice-Pres.

EXECUTIVE OFFICIALS OF THE LOVE BRAKE SHOE CO.

The Modoc Soap Co., which will exhibit in the "Annex" on the Million Dollar Pier, is said to be the only car cleaner company to exhibit at the conventions. Henry Roever is the president.

Railway Mechanical Patents Issued During May

Steel car frame, 955,850—Andrew Christianson, Butler, Pa.
Mail delivering apparatus, 955,861—John H. Garman, Bristol, Ind.
Boiler for articulated locomotives, 955,927—Harry S. Vincent, Ridgewood, N. J.
Headlight support, 956,011—George T. Williams and Thomas L. Harris, Banks, Ala.
Grain car door, 956,078—Ella M. Greenfield, Erie, Pa.
Brake beam, 956,087—Philip B. Harrison, Chicago, Ill.
Air brake or train pipe valve, 956,153—Albert Oleson, Toledo, Ohio.
Brake lever strut or post, 956,249—Charles H. Williams, Jr., Chicago, Ill.
Safety wheel for railway cars, 956,261—James T. Andrews, Montgomery, Ala.
Car weighing apparatus, 956,323—Alonzo W. Epright, Altoona, Pa.
Automatic connector for train pipes, 956,468—Peter Beahm, Altoona, Pa.
Refrigerator car, 956,472—Gebhard C. Bohn, St. Paul, Minn.
Car vestibule door, 956,500—John S. Muckle, Philadelphia, Pa.
Brake beam, 956,616—Charles H. Williams, Jr., Chicago, Ill.
Car truck side frame and journal box, 956,633—George G. Floyd, Granite City, Ill.
Brake beam, 956,637—Philip B. Harrison, Chicago, Ill.
Car brass mold, 956,638—George L. Hoffer, Laurel, Miss.
Vehicle and locomotive sanding apparatus, 956,651—John Taylor, Liverpool, England.
Car journal box, 956,659, 956,660 and 956,661—George A. Woodman, Chicago, Ill.
Beamless brake mechanism for railway cars, 956,673—William P. Bettendorf, Davenport, Ia.
Locomotive blower and air pump exhaust pipe, 956,706—Frank L. Holcomb, Kingston, N. Y.
Back rail locomotive, 956,732—Charles A. Pratt, Chicago, Ill.
Car structure, 956,740—Abram E. Smith, Brooklyn, N. Y.
Car door, 956,758—Gustie A. Carlson, Buda, Neb.
Dump car, 956,819—John O. Neikirk, Morgan Park, Ill.
Brake for tramways and railways, 956,826—Percival J. Pringle, Sidmouth, England.
Car underframe, 956,841—Anton Becker, Columbus, Ohio.
Dump car, 956,851—Harry S. Hart, Chicago, Ill.
Car truck, 956,900—Charles H. Knobbs, Elizabeth, N. J.
Mail bag catcher and delivery apparatus, 956,935—Clayton D. Buss, Easton, Pa.
Curtain for vestibule cars, 956,966—Edward C. Holmes, Ludlow, Ky.
Car coupling, 956,976—Joseph Kelso, Pittsburg, Pa.
Trap door for vestibule cars, 956,978—William F. Kiesel, Jr., Altoona, Pa.
Body bolster, 956,997—Oswald S. Pullman, Pittsburg, Pa.
Track sander, 957,019—John H. Watters, Augusta, Ga.
Passenger car, 957,057—Herman C. Heffner, Martinsburg, W. Va.
Coupling for air brake pipes, 957,087—A. Peterson, Hannaford, N. D.
Insulator for railway trucks, 957,133—James M. Wood, Kansas City, Mo.
Locomotive ash pan, 957,142—Andrew J. Brodhead, Greenville, Pa.
Surface condenser, 957,175—Louis A. Alberger, Greenwich, Conn., assignor to Alberger Condenser Company, New York, N. Y., a corporation of New York.
Hydraulic jack, 957,177—Richard W. Baker, Roselle, N. J., assignor to The Watson-Stillman Company, a corporation of New Jersey.
Underframe for cars, 957,182—William P. Bettendorf, Davenport, Ia.
Soldering-tool, 957,180—Alexander A. Bedard, Detroit, Mich.
Journal-box, 957,186—Wendell R. Buss, Grand Rapids, and Alva J. Fairbanks, Holland, Mich.; said Fairbanks assignor to said Buss.
Machine for bending tubes, 957,199—John F. Gail, Kenosha, Wis., assignor to The Simmons Manufacturing Company, Kenosha, Wis., a corporation of Wisconsin.
Adjustable wrench, 957,214—Charles P. Johnson, Eureka, Kans.
Electropneumatic air-brake system, 957,227—George Macloskie, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York.
Pressure-equalizing mechanism for cylinders, 957,241—George W. Nistle, North Muskegon, Mich., assignor of one-third to Everett W. Brooks and one-third to Robert L. Gifford, Chicago, Ill.
Adjustable brake-head, 957,251—Lemuel Porter, Chicago, Ill.
Flexible driving connection, 957,279—Samuel M. Vauclain, Philadelphia, Pa., assignor, by mesne assignments, to Baldwin Locomotive Works, Philadelphia, Pa., a corporation of Pennsylvania.
Sliding-door-operating means, 957,284—Percy Wheeler, Oldbury, England.
Angle-cock and train-pipe connection, 957,325—Myers A. Garrett, Chicago, Ill.
Mail-handling apparatus, 957,330—William H. Hargraves and Milo M. Miller, Allentown, Pa., assignors of one-third to Charles M. W. Keck, Allentown, Pa.
Lifting-jack, 957,333—John M. Hawkins, Silvester E. Adkins and Willie C. Call, Spencer, Ind.
Electric furnace, 957,337—Hiram W. Hixon, Philadelphia, Pa.
Reversing-gear, 957,362—Dennis W. McLaughlin, Berkeley, Cal., assignor to McLaughlin Manufacturing Company, Berkeley, Cal.
Railway-car, 957,363—Robert M. Nisbett, San Francisco, Cal., assignor of one-half to William P. Crowley, San Francisco, Cal.
Smoke-exhausting device for tunnels, 957,396—Paul H. Wedmark, Lindstrom, Minn.
Brake-beam, 957,399—Charles H. Williams, Jr., Chicago, Ill., assignor to Chicago Railway Equipment Company, Chicago, Ill.
Brake-beam, 957,400—Charles H. Williams, Jr., Chicago, Ill., assignor to Chicago Railway Equipment Co., Chicago, Ill.
Car-replacer, 957,405—Edward Best, London, Ontario, Canada, and David A. Scott, Oshkosh, Wis.
Car-brake, 957,408—George M. Braham and John Lill, Hammond, Ind.
Journal-bearing, 957,435—Byron L. Morrison, Colorado Springs, Colo., assignor of one-third to Joseph W. Ady, Colorado Springs, Colo.
Track-sander, 957,482—Charles P. White, Greensboro, N. C.
Furnace-arch construction, 957,494—Colin Campbell, Rutherford, N. J.
Rotary snow-plow, 957,503—William H. Ferguson, La Grande. Ore.
Nut-lock, 957,504—Louis D. Frenot, Newark, N. J.
Car-door lock, 957,518—Patrick J. Quinn and George P. Clifford, Buffalo, N. Y., assignors of one-third to Daniel A. Driscoll, Buffalo, N. Y.
Automobile transfer turn-table, 957,536—Milo A. Baker, Los Angeles, Cal.
Oil-burner, 957,614—Valdemar F. Lässoe, Brooklyn, N. Y.
Dump-car, 957,616—Arthur Lipschutz, St. Louis, Mo., assignor by mesne assignments, to National Dump Car Co.
Passenger-car, 957,639—Harry H. Adams, Baltimore, Md.
Coupling, 957,695—Ernest Marek, Chicago, Ill.
Wrench, 957,726—Richard W. Armstrong, Parkers Landing, Pa.

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THE STOKER SITUATION.

To those who have not as yet experimented with any of the several mechanical locomotive stokers, the situation is most confusing. A stoker which has been given the most exhaustive of tryouts on one road and thrown off the engines as worse than useless, is called a great success by a representative of the mechanical department of another road. Much is claimed for each of several new designs which have seen little service as yet. In almost every case, however, the number of different opinions is limited only by the number of persons in the discussion. It seems, however, that the thinking men are agreed in the decision that the stoker which conveys its fuel is the only type which can be generally acceptable as a means of solving present difficulties. Statements to the contrary notwithstanding, the type of stoker the use of which compels the fireman, not only to shovel as much coal as would otherwise be necessary, but to handle it in an inconvenient way, which demands his whole attention while he is not busy filling a hopper several feet above the deck, and which, in short, does nothing further than poke the coal through the fire door, is doomed to the scrap heap where it can already be found in the terminal yards of several roads.

A reliable automatic stoker which is truly automatic is one of the greatest of present needs in the motive power departments and demonstrations under service conditions during the next few months of any of the several devices thus far brought out should not be regarded as final in so far as favorable results are concerned. It is a proven fact that a stoker which will be given a clean bill, making its prospects look exceedingly bright, in hot weather, will furnish a good many surprises in winter service. After all it is the men forming the crews who must be satisfied in a question of this sort, and when, in cold weather, it no longer is a particular advantage to avoid the heat of the furnace and when frozen coal, snow and ice and other features incident to winter traffic, interfere with automatic operation, the reports turned in will not be so encouraging. The coming year will undoubtedly see developments worth while in this field.

CONSOLIDATION OF THE MECHANICAL ASSOCIATIONS.

The reception of the joint committee report on the subject of consolidation of the American Railway Master Mechanic and the Master Car Builders' Associations developed nothing unexpected. The position of the members who have taken sides either pro or con has been known for some time. In the discussion which followed the admission of the report there appears to be little of conclusive nature in the arguments advanced on either side, and the decision to lay the subject on the table for another year seems to appeal to all as a wise move.

The fear that either association might lose either precedence or the advantages of any incidental individuality by combination is a groundless one in the unprejudiced mind. There are few men in the M. C. B. Association who carry the official title of Master Car Builder. Likewise the title of Master Mechanic does not mean what it did at the inception of the Master Mechanics' Association. There is only one mechanical department in which the responsibilities of motive power, machinery and rolling stock upkeep are about evenly divided. As pointed out by Mr. Wildin, the members most active in both associations are those who are equally interested in all the features of the railway mechanical department. Logically, then, any duplication of effort in two conventions bears a semblance to red tape costly in nature.

On the other hand, the argument that time can be saved by consolidation should not be taken seriously. Were it the will of the members, the three days now devoted to each convention could be taken from the same week, thus allowing a Sunday for travel at each end. This being all that could be gained in time by consolidation, there is no point made. We might go deeper and show that the time devoted to the convention sessions is not determined by the amount of business to be transacted, but on the other hand the amount of work to be done is determined by the time fixed by custom. Few would deny that a week could be spent profitably by either association in convention. Why then should the subject of time enter into the question of consolidation? One orator suggested that the interests of the supplymen should not be overlooked, that these people, who furnish the money and attend to the large amount of detail incident to the conventions would hesitate to appropriate large amounts of money necessary to the exhibit, now a custom, if the time is to be cut down and completely filled with business of the convention proper. His point is very well taken. Of direct value to the supply men is the intermission between sessions, and success in the attempt to cut down this time would result deleteriously to his interests.

By all means let us have consolidation, not for the sake of cutting down the time to be devoted to the convention, but to eliminate duplication of work, to bring the affairs more closely to a business basis, and to essentially modernize the whole proposition of the mechanical associations.

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J. M. LORENZ,
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LEWIS G. MARTIN,
Engr., Okonite Co.

W. T. DUNNING,
Sec., Chester Steel Castings Co.

J. C. WARD,
Director, Edgar Allen Co.

J. E. CHISHOLM,
Mgr. Sales, Chicago Steel Car Co.

G. S. BLANCHARD,
Mgr., Dayton Iron Wks.

FLOYD ROSE,
Floyd Rose & Co.

Representative Railway Supply Men of America.

B. E. D. STAFFORD,
G. M., Flannery Bolt Co.

TOM R. DAVIS,
Mech. Engr., Flannery Bolt Co.

G. E. HOWARD,
East. Rep., J. Rogers Flannery & Co.

W. M. WILSON,
Rep., J. Rogers Flannery Co.

B. H. GRUNDY,
Rep., J. Rogers Flannery Co.

T. J. LEAHEY,
S. E. Rep., J. Rogers Flannery Co.

J. ROGERS FLANNERY,
Pres., J. Rogers Flannery Co.

J. M. ODENHEIMER,
Mgr. Sales Ry. Dept., Pennsylvania Flex. Met. Tubing Co.

BELDEN D. JONES,
Pres., Jones Car Door Co.

Representative Railway Supply Men of America.

WM. WHITE,
Pres., National Boiler Washing Co.

GEO. C. MURRAY,
Continental Ry. Equip. Co.

EDW. E. GOLD,
Pres., Gold Car Htg. & Lighting Co.

ERNEST T. TRIGG,
John Lucas & Co.

GEO. A. POST,
Pres., Standard Coupler Co.

H. H. SESSIONS,
V. P., Standard Coupler Co.

F. S. GARRETT,
Pres., Rockwell Furnace Co.

W. S. QUIGLEY,
V. P., Rockwell Furnace Co.

L. D. ROCKWELL,
Sec., Rockwell Furnace Co.

Representative Railway Supply Men of America.

W. J. SPENCER,
Gen. Sales Mgr., Nelson Valve Co.

H. C. BAYNARD,
Asst. Gen. Mgr. Sales, Nelson Valve Co.

J. E. ROLLINS,
Mgr. Chicago Office, Nelson Valve Co.

RUSSELL BONNELL,
Mgr. N. Y. Office, Nelson Valve Co.

B. H. HILL,
Mgr. Pittsburg Office, Nelson Valve Co.

S. P. WRIGHT,
Mgr. Butte Office, Nelson Valve Co.

R. E. THOMAS,
Mgr. Philadelphia Office, Nelson Valve Co.

F. X. CLEARY,
Publicity Dept., Western Electric Co.

ED. E. SILK,
Rep., Bettendorf Axle Co.

Representative Railway Supply Men of America.

E. L. ADREON, JR.,
Pres., Adreon Mfg. Co.

WM. MILLER,
V. P., Adreon Mfg. Co.

D. R. NIEDERLANDER,
Sec. & Treas., Adreon Mfg. Co.

J. T. WILSON,
Pres. & G. M., American Balance Valve Co.

R. J. DAVIS,
Sec., American Balance Valve Co.

FRANK TRUMP,
M. E., American Balance Valve Co.

EDW. P. WELLES,
Mgr., Chas. H. Besly Co.

L. M. BOOTH,
Pres., L. M. Booth Co.

W. R. TOPPAN,
V. P. & G. M., L. M. Booth Co.

Representative Railway Supply Men of America.

S. F. BOWSER,
Pres., S. F. Bowser & Co.

C. A. DUNKLEBERG,
Sec. & Treas., S. F. Bowser & Co.

A. Z. POLHAMUS,
G. M., S. F. Bowser & Co.

S. B. BECHTEL,
S. F. Bowser & Co.

W. O. DUNTLEY,
Pres., Chicago Pneumatic Tool Co.

C. E. WALKER,
Mgr. Ry. Dept. Chicago Pneumatic Tool Co.

R. C. FRASER,
Rep., Buffalo Brake Beam Co.

J. T. TEETER,
Pres., Light Inspection Car Co.

J. M. HARTLEY,
Sec. & Treas., Light Inspection Car Co.

Representative Railway Supply Men of America.

C. H. HOWARD,
Pres., Commonwealth Steel Co.

H. M. PFLAGER,
V. P., Commonwealth Steel Co.

C. M. JENNINGS,
Pres., Excelsior Car Roofing Co.

WM. B. KLEE,
Pres. & Treas., Damascus Bronze Co.

JOHN T. BROWN,
V. P., Damascus Bronze Co.

A. P. GAHR,
Sec. & G. M., E. A. Kinsey Co.

MILTON BARTLEY,
Pres., American Nut & Bolt Fastener Co.

CHRISTOPHER MURPHY,
West Sales Agt., American Nut & Bolt Fastener Co.

SANFORD KEELER,
Gen. Agt., Nathan Mfg. Co.

Representative Railway Supply Men of America.

H. W. MALES,
Mgr. Cincinnati Office, Males Co.

A. S. MALES,
Mgr. New York Office, Males Co.

GEO. H. BRYANT,
W. Rep., Thomas Prosser & Son.

J. G. MILLER,
Rep., Pennsylvania Steel Co.

J. C. BARBER,
Pres., Standard Car Truck Co.

LEE W. BARBER,
Asst. to Pres., Standard Car Truck Co.

TOM. W. SNOW,
Pres., Otto Gas Engine Wks.

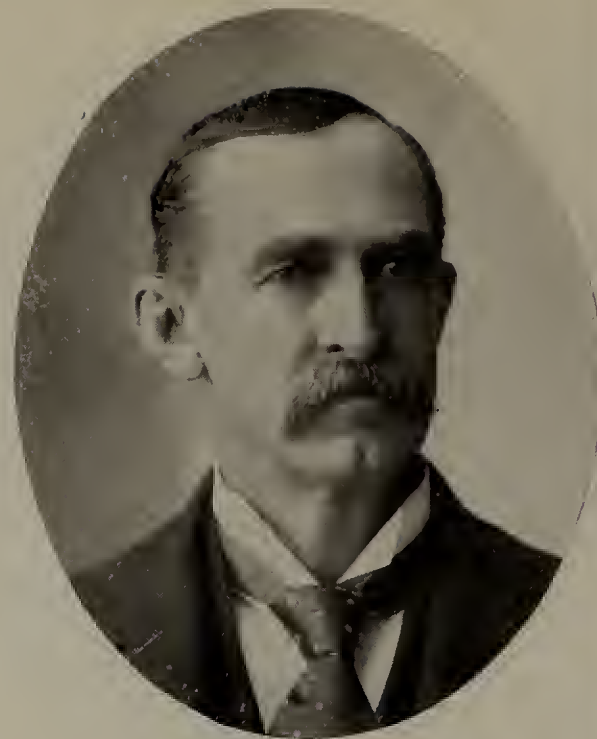
GEO. P. NICHOLS,
Geo. P. Nichols & Bro.

S. F. NICHOLS,
Geo. P. Nichols & Bro.

Representative Railway Supply Men of America.

D. C. NOBLE,
Pres., Pittsburg Steel Spring Co.

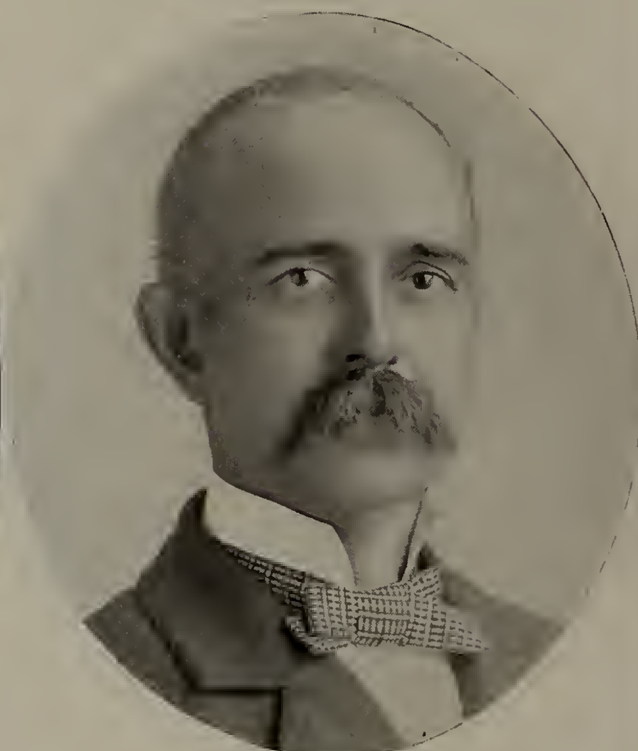
L. C. NOBLE,
V. P., Pittsburg Spring Steel Co.



THOS. W. MORAN,
Pres., Moran Flexible Joint Co.

CASS L. KENNICOTT,
V. P. & G. M., Kennicott Co.

G. L. GILLON,
Watson-Stillman Co.



F. H. STILLMAN,
Watson-Stillman Co.

PHILIP J. MITCHELL,
Phillip Justice & Co.

T. C. DUNLAP,
Pres., Dunlap Engineering Co.

J. M. GRIFFIN,
Pres., Wheel Truing Brake Shoe Co.

Representative Railway Supply Men of America.

L. A. HOERR,
Gen. Mgr., Western Ry. Equip. Co.

MARK A. ROSS,
G. M., Pyle Nat. Elect. Headlight Co.

J. W. FAESSLER,
Pres., J. Faessler Mfg. Co.

H. M. MOORE,
Treas., Cincinnati Punch & Shear Co.

J. W. DUNTLEY,
Pres., Duntley Mfg. Co.

EMERY E. DAVIS,
V. P., Davis Expansion Boring Tool Co.

F. M. HICKS,
F. M. Hicks & Co.

GEO. H. E. ROBINSON,
Mgr., Wells Light Mfg. Co.

J. HUTCHINSON,
National Indicator Co.

Representative Railway Supply Men of America.

W. H. FORSYTH,
Gen. Mgr., Curtain Supply Co.

L. T. WILMARTH,
Pres., Wilmarth & Morman Co.

F. C. SANFORD,
F. C. Sanford Mfg. Co.

J. B. BRADY,
Pres., Independent Pneumatic Tool Co.

L. S. STARRETT,
Pres., Starrett Mfg. Co.

GEO. L. WEISS,
G. M., Butler Drawbar Attachment Co.

C. M. WALSH,
Pres. & G. M., Falls Hollow Staybolt Co.

Proceedings of the 44th Annual Convention of the Master Car Builders' Association.

WEDNESDAY, JUNE 15.

The first session of the forty-fourth annual meeting of the Master Car Builders' Association was held in the Greek Temple, on Young's Million Dollar Pier, Atlantic City, N. J., on Wednesday, June 15, 1910. The president, F. H. Clark (C. B. & Q.), called the meeting to order and invited the past presidents and the present officers of the Master Mechanics and the Master Car Builders' Associations to be seated on the platform. The mayor, Franklin P. Stoy, welcomed the convention to Atlantic City. W. E. Fowler, a past president, replied to Mayor Stoy on behalf of the association.

Address of President Clark.

It gives me great pleasure, in opening the forty-fourth annual meeting of the Master Car Builders' Association to extend a word of greeting to the members and their friends here assembled. Many of you have attended our previous meetings, and your presence today indicates that you have found them either pleasant or profitable. Let us hope that we may all derive both pleasure and profit from this one. Most of our members come here because it is considered that they and the railways they represent are benefitd by their presence. I have no reason to doubt that their anticipations will be realized, but I want to suggest that they all contribute something in the way of information and encouragement to the association; that they give as well as receive. Most of the work of the association is necessarily borne by a comparatively small number of its members, but they need assistance in our annual meetings, in conferences and in committee work.

I do not intend this morning to take the time of the association to comment upon the committee reports that will be presented later for your consideration, though perhaps I might avail myself of the privilege usually accorded your president of suggesting to members of committees that their reports would be of greater value if submitted somewhat earlier to the secretary so that they will reach the members in time that they may study them. Our by-laws, as you may know, provide that reports of committees should be in the hands of the secretary by April 1, in order that he may get them out by May 1. From the fact that the reports reached the members about five weeks late, I assume that they were not all in by the first of April.

There are a number of matters concerning the work of the association of which you may not be informed, and which will not be covered by committee reports. One of the most important of these seems to be the present status of the safey appliance question as reported in full by our safety appliance committee. Congress passed a bill about two months ago, which received the signature of the President, and which provides that within six months from its passage the Interstate Commerce Commission, after hearing, shall designate the number, dimensions, location and manner of application of sill steps, hand-brakes, ladders, running boards and other parts mentioned in previous safety appliance acts. This bill provides that the rulings of the Interstate Commerce Commission shall be effective July 1, 1911, and that the commission may, upon full hearing and for good cause, extend the time after which any common carrier may be required to comply with the provisions of the act. The commission is also given authority, after hearing, to modify or change, and to prescribe the standard height of drawbars and to fix the time within which modification or change shall become effective. It was suggested about the time the bill passed that the hearing could be materially shortened and better results obtained if a conference was arranged between a committee of your association and the inspectors of the Interstate Commerce Commission, they to represent the commission; and, as the idea met with favor by Mr. Moseley, secretary of the Interstate Commerce Commission, and your executive committee, a special committee was appointed for the purpose. The American Railway Association authorized this committee to give such attention as might be necessary to the question of drawbar heights, a matter that had previously been handled by that association. A preliminary meeting on the whole subject was held on May 24, and subsequent meetings on June 6, 7 and 8, and, as a member of that committee, I would like to testify to the fairness and earnestness of purpose evidenced on both sides. I think it very likely that the final result will be a considerable expenditure of money on the part of the railways in bringing old equipment up to the desired standards, but it seems likely that at the public hearing the Interstate Commerce Commission will grant the railways reasonable time to make their existing cars comply with the rules which they will prescribe. A public hearing on height of drawbars was held by the Interstate Commerce Commission on the 7th of the month, and it is understood that an order will probably be issued prescribing 34½ inches as the maximum height and 31½ inches as the minimum height of couplers on standard gauge freight equipment, 26 inches as the maximum and 23 inches as the minimum height on narrow gauge freight equipment, except for two-foot gauge, where a maximum height of 17½ inches and a minimum height of 14½ inches is proposed. This, I believe, will clear up the misunderstanding as to the intent of the present law, which has been given an interpretation somewhat at variance with the ideas of its framers.

It is probable that the public hearing on other details will be postponed until the early Fall in order that the conference committees may be given all the time that will be necessary in which to reach their final conclusions. If in the end there are any points of difference between the officers of the commission and the representatives of the railways, they will no doubt be settled by the commission in that time.

As I have already suggested, the orders of the commission may involve the railways of the country in considerable expense, this on account of the lack of uniformity in the application of safety appliances to our cars, and this is largely due to the fact that in some cases our safety appliance rules have not, until recently, covered some types of construction with sufficient clearness. Unfortunately, also, the association has not been in a position to enforce its rules, so that some variations have been allowed to continue which should have been corrected. The whole matter is now in the hands of the Interstate Commerce Commission, and your committee may regard itself, I suppose, as an advisory committee to that body. Where questions of safety are clearly involved there cannot very well be any serious differences of opinion, but the committee will take occasion to urge upon the officers of the commission the injustice of requiring uniformity when not essential to safety.

You may remember that at the last meeting of the association there was considerable discussion on the question of abuse of the repair card, and, as the matter was one which could not under our rules be properly handled by the arbitration committee, a resolution was passed asking that any member of the association having evidence of dishonesty in the use of the repair card should submit it to the executive committee, which would undertake to investigate the matter and handle in such manner as seemed to be to the best interest of the association. I am pleased to report that but one case of this kind was reported to the association. I am not prepared to say whether this indicates an improvement in conditions, or that the members have found it possible to adjust their differences without resorting to the good offices of the executive committee, but it has a hopeful look. There have been some claims made of sharp practice during the past year that have been thoroughly investigated by the roads interested and the charges definitely disproved.

There has been a general effort on the part of the railways during the past year or two to reduce delays in the movement of cars, and so obtain more use of the equipment. The discrepancy between the average mileage of cars in motion and the average daily mileage is so great that it seems that an increase should be possible. Delays are due to various causes, most of which would not be affected by any action we might take. The matter of delays to cars in interchange is one over which we have some control, and one to which the officers of your association, and the arbitration committee in particular, have given a good deal of attention. It is to be hoped that our rules may be finally so framed that, without working an injustice to the owners the movement of cars can be somewhat expedited through interchange points. We may not be able, under the rules now proposed by the arbitration committee, to eliminate unnecessary delays altogether, but it is often better to move cautiously in matters of this kind and gradually bring about the desired result than to make radical changes which will bring about confusion and general dissatisfaction.

It is quite possible for this association to take such action as to cause railways considerable unnecessary expense, and such action has occasionally been taken. The possession of power and authority should lead to conservatism, and this association is too powerful, and has too much authority, to warrant it in taking radical action on matters having to do with rules or standards without careful consideration.

Our committee on consolidation, working jointly with a similar committee of the American Railway Master Mechanics' Association, will present a report, as instructed, on the advantages and disadvantages of consolidation, together with a proposed constitution and by-laws. This is an important matter and one which should not be settled without a full comprehension of the points at issue. The matter has been proposed before, but the subject has never been brought to the point at which it now stands. I hope that it will receive your most careful consideration and that we shall all approach the subject without prejudice.

I am sorry to say that during the year death has claimed the following members of the association: J. J. Ellis, P. H. Peck and J. F. Divine.

Owing to the fact that the Master Car Builders' Association is an unincorporated body it will probably be unable under the laws of the State of New York to receive the Tilletson legacy of $5,000, bequeathed by the widow of a former member of this association.

I wish to thank you in closing for the privilege of presiding over your meetings, and for the assistance rendered during the year in conducting the affairs of the association.

Secretary Taylor then presented his report, which showed the membership to be as follows: Active members, 377; representative members, 332; associate members, 14; life members, 19; total membership, 742. The number of cars represented compared with last year is as follows: June, 1909, 2,403,961; June, 1910, 2,298,633.

The secretary announced the deaths during the year of J. J. Ellis, P. H. Peck and J. F. Divine, active members.

The statement of receipts and expenses showed an income of $16,509.50 and expenses, amounting to $15,919.29, leaving a balance of $590.21.

During the year fourteen railways and private car lines have signified their desire to become subscribers to the rules of interchange governing freight cars. Nine railways and private car lines have advised of their acceptance of the code of rules governing the interchange of passenger equipment.

The report of the treasurer presented by the secretary, showed a balance on hand June 10, 1910, of $1,127.82.

President Clark presented a communication from the treasurer, John Kirby, carrying his resignation.

F. W. Brazier (N. Y. C. & H. R.): I do not think a communication like that from the "Grand Old Man" of the M. C. B. Association should go by unnoticed. Mr. Kirby is, without doubt, anxious to resign his position. I believe, as he has tendered his resignation, we as a body should accept it and send him a vote of thanks for the long-continued service he has rendered to this Association, and tell him that his letter was an inspiration to us all.

C. A. Seley (C. R. I. & P.): I second the motion, and amend it to the effect that the vote shall be a rising vote. I think we should emphasize in every possible way our appreciation of the service which Mr. Kirby has rendered this Association.

The motion was unanimously carried by a rising vote.

The recommendation of the executive committee that the dues for the current year remain as at present, $4 per vote, was approved.

L. E. Endsley, associate professor of Railway Mechanical Engineering of Purdue University, and E. A. Averill, managing editor of the American Engineer and Railroad Journal, were proposed as associate members.

C. A. Seley (C. R. I & P.), E. W. Pratt (C. & N. W.), and T. H. Goodnow (L. S. & M. S.) were elected members of the auditing committee.

The committee on nominations made the following nominations: For president, T. H. Curtis, superintendent of machinery (L. & N.); A. Stewart, general superintendent motive power (Southern); D. F. Crawford, general superintendent motive power (Penn. Lines).

For vice president, the new constitution requires six members to be named; three are to be elected. The nominees are: T. H. Curtis, superintendent of machinery (N. & N.); A. Stewart, general superintendent motive power (Southern); D. F. Crawford, general superintendent of motive power (Penn. Lines); C. E. Fuller, superintendent of motive power (Union Pacific); Henry Bartlett, general superintendent motive power (B. & M.), and E. D. Bronner, superintendent motive power (Michigan Central).

For treasurer: John Kirby, of Adrian, Mich.; John S. Lentz, master car builder (Lehigh); J. W. Marden, S. C. D. (B. & M.).

For executive committee: J. D. Harris, general superintendent motive power (B. & O.); C. E. Fuller, superintendent motive power (Union Pacific); H. D. Taylor, superintendent motive power (P. & R.); J. S. Walsh, superintendent motive power (C. & O.); C. A. Seley, mechanical engineer (C. R. I. & P.), and R. D. Smith, assistant superintendent motive power (B. & A.).

The report was accepted and the president announced that the tellers would be named and the ballots distributed on Friday morning; the polls will close at 11:30 on that day, which will give the tellers time to count and report before final adjournment.

The committee on the Revision of Standards and Recommended Practice then submitted its report which will appear elsewhere in the Railway Master Mechanic.

Discussion of Report on Standards and Recommended Practice.

Mr. Kleine: I might say that in the cut of the fluted roofing the dimension line which goes to the tension, should stop at the root of the tension, so as to make the distance from centre to centre of groove, 2⅝ in.

C. M. Bloxham (U. T. L.): Referring to paragraph 22. The 6½ in. coupler butt gives one-quarter inch clearance when used in 6¼ in. butt, and with the new proposed 8½ in coupler butts, gives ½ in. clearance, when used with an 8 in. spring. Why is the additional ¼ in. clearance necessary on the 8 in. spring over the 6¼ in. spring?

Mr. Kleine: I might say that the committee accepted the recommendations of the various members who are now using the 8 in. spring. They are now using the 8½ in. coupler butt with the 8 in. spring.

C. A. Seley (C. R. I. & P.): I was connected with the request of this 8½ in. coupler butt, and would say that it has reference not only to the capacity of the 8 in. spring, but to various types of friction gears. Just why the one-quarter inch was added, originally, I do not know, but the fact remains that a large number of 8½ in. butts are in use with G springs and various types of friction gear, and rather than make another size, for a variation of ¼ in., making an 8 in. butt, it was desirable to make it 8½ in.

C. A. Schroyer (C. & N. W.): Personally, I am opposed to the adoption of another standard coupler, with a different sized butt. If this is done, it necessitates the carrying of an additional coupler in stock to meet the requirements of repairs.

Mr. Kleine: The committee on standards referred this matter to the committee on couplers for their approval, because of the large number of communications received from the different roads as to the necessity for the 8½ in. butt, and the fact that when the 9⅛ in. butt is used with the 8 in. draft spring, it puts the spring out of alignment.

J. H. Manning (D. & H.): I would like to hear a discussion on the question of using a 9⅛ in. tail with the 8 in. spring, by tapering it up from the back. There are a great number of cars in service that way now, and it is apparent that the 9⅛ in. tail can be used for the friction gear as well as the 8 in. G spring. As far as the alignment is concerned, I do not think there will be any trouble with that. We will then have only two couplers.

C. A. Schroyer: If we are to adopt a roof board according to the drawings shown in the report, we will be laughed at by everybody, because there is nothing about that roof board that is correct, and, anyhow, the time for the use of the roof board is very nearly gone. We have for forty years gone on covering our cars with matched and grooved flat roof boards, and now that we are about to abandon that practice, we are presented with a proposed standard for adoption which is not right. That drawing is not right. No one works out roof boards like that.

O. C. Cromwell (B. & O.): Paragraph 30 shows the "Limit Gauges for Inspecting Secondhand Wheels for Remounting," and the committee recommends that this be advanced for adoption as a standard. This is one of the questions which can be well left to the practice of the railway companies individually, and we should be careful not to tie ourselves down to too many standards. I do not see any particular necessity for it in connection with the interchange business.

J. J. Hennessey (C. M. & St. P.): The association should be very careful not to adopt too many standards. The wooden roof is going out gradually, and at times you cannot get lumber that you can make a 5¼ in. width board, although you pay for it: by the time the wood is seasoned, you cannot make the roof board over 5 in. At other times, it is greatly to the advantage of the railway to put on 4 in. roof boards, particularly on the outside of metal roofs. Many roads find it good practice to do away with the grooves entirely on the inside metal roofs, where the boards are put on for protection to the metal. We have come to a point where the double board roof is almost a thing of the past, and I do not believe it is even wise to submit that proposed standard to letter ballot, but that the railways should be left to their own practices in this regard. It is something which has nothing to do with the interchange of cars; it does not tie up traffic, and it may, under some conditions. The 5¼ in. widths cannot always be obtained, but we are constantly asked to allow the use of 4 in. width, which works down to 3½ in., and it makes as good a roofing as the wider roofing, the only objection being that it does not fit in where a given number of 5¼ in. boards are taken out. In view of the fact that the coming roof is to be a metal roof, either inside or outside, the necessity for the adoption of a thing of this kind is passed, and I want to make a motion, in so far as the recommendations relative to the roof board are concerned, that they be eliminated.

A motion was carried that the reference to the roof boards in the report be eliminated.

Mr. Kleine: We had a request from those who use the fluted or double roof board, who wanted to have a standard as to the best method of applying it, and the committee sent out a circular; we had nine replies, eight of which favored the fluted roofing. Under these conditions, what could the committee do but present a recommendation covering a fluted roof board?

Mr. Kleine: Replying to Mr. Cromwell's remarks with reference to paragraph 30, which covers the limit gauges for inspecting secondhand wheels for mounting. It is a question that has not received sufficient consideration. We have nothing to show now what is a good secondhand wheel—we have prices given in the Interchange Rules for secondhand wheels, and we should have something to show what is good practice in the remounting secondhand wheels and placing them under foreign cars, that is, the limits in regard to flange thickness.

W. E. Fowler: That subject was discussed by the Wheel Committee, and we came to the conclusion that it was a measure of protection that this Association owed to each of its members to see that when members were called upon to pay for secondhand wheels, they should know they were getting something under their cars that was somewhat serviceable.

C. E. Fuller (U. P.): I want to strongly advocate keeping the rule in. It is one of the best rules that has been offered, and I believe we would be making a mistake to attempt to cut it out.

A motion that paragraph 30 be eliminated from the report was lost.

The report of the committee, as amended, was then accepted.

F. W. Brazier: It is apparent that if we had not changed our constitution we could proceed at this time and finish all of the business laid out for today's two programmes, and be able to adjourn at half past one; but, according to the constitution, we must give one day's notice, and I move that our meeting tomorrow morning be from ten o'clock until the time of adjournment, unless the business should warrant an afternoon session.

The motion was carried.

In the absence of A. J. Cota, chairman of the Committee on Train Brake and Signal Equipment, E. W. Pratt (C. & N. W.), presented the report, which appears elsewhere in the pages of the Railway Master Mechanic.

T. L. Burton (C. of N. J.): My understanding was that the report was to be received largely as a progressive report and brought to the attention of the Executive Committee. We have deemed that this committee, or a special one, should be appointed to draw up specifications for a recommended practice. I do not think there is anything to be acted upon as recommended practice.

J. M. Christopher (T. H. & B.): Do I understand the Committee favored the flange shoe over the plain shoe?

T. L. Burton: The committee made no recommendation as to flanged shoes. My own experience has been that a flanged shoe can be used to very good advantage when it is used on a brake-beam having an adjustable head, provided with sufficient lateral movement to permit the shoe to adjust itself to the flange under all conditions. Unless the brake is adjustable and has some lateral movement, a slight deflection of the beam under heavy load gives distressing sliding. It seems that the shoe can also be used on what is known as the beamless type of brake, such as we have on a number of the more modern steel cars. There is no question but that the use of the flange shoe on the brake referred to materially increases the efficiency of the brake.

G. W. Wildin (N. Y., N. H. & H.): This report gives two 18-in. cylinders in two cases. If I read this right, everything would be 18-in. cylinders.

The President: Mr. Pratt cleared that up by saying that was not in accordance with the views of all the members of the committee. I think Mr. Wildin is correct. The impression intended to be conveyed was that where a certain size cylinder was specified, it could be used for that weight and down. That is, those are the maximum weights specified. Mr. Pratt very wisely suggested that the committee should have the privilege of reviewing those statements.

J. F. Devoy (C. M. & St. P.): We are going absolutely wild on this brake question. I do not wish to be understood as criticising this report in the slightest manner. In my opinion it indicates and clearly states everything that is absolutely true on the question. It is of vital importance to the Chicago Milwaukee & St. Paul for the reason that we are now getting a very large number of steel cars. A leverage of 9 to 1 is an impracticable affair; aside from the fact that it does create more braking power and costs you more money, you cannot operate it on any wheel made, whether it is cast steel or forged steel, for the reason that the brake shoe will cause heating to such an extent that the wheel and the brake-shoe will absolutely fuse. So the question as to what brake or brake-shoe is best is entirely irrelevant to the matter. It is the question of the amount of pressure exerted on the wheel.

The question was also raised as to whether the report meant one or two brake cylinders. The cars that you are getting now in this country weigh 150,000 lbs. or thereabouts. One cylinder will not give the proper shoe clearance and the proper leverage to the brake beams and the levers to take care of the situation. Our cars were first specified with one cylinder, and after experimenting for eight months with 66 cars, we have come to the conclusion that nothing will handle the situation but two brake cylinders. Aside from that, we have found there is no brake arrangement designed today which will give the power. In other words, on one lot of sleeping cars we found the brake-pin shearing. On another lot of cars, by placing the required pressure on the wheels, it bent the brake levers. The whole craze today seems to brake a train in the shortest space possible. You had better go a little bit slower with your brake and your line pressures, or you will destroy the whole foundation. In other words, the state of the art today is not such as will absolutely guarantee your going ahead with the recommendations of this committee, as stated. You cannot do it. I would much rather see a brake on a passenger car that would stop it in 400 or 500 feet longer than the distance recommended. You will spend more money on your brake-shoes—four times over what the whole thing will cost. The committee should take up not only the questions involved in this test, but as to whether you have a wheel and brake-shoe which will do the business required of it.

The report of the committee was received, and the committee is continued.

The following committees were appointed: Correspondence and Resolutions: R. F. McKenna, H. E. Passmore and J. W. Fogg.

Committee on Obituaries: For P. H. Peck—J. W. Taylor. For J. F. Divine—R. E. Smith. For J. J. Ellis—William Moore.

Secretary: In accordance with Article VI, section 4 of the Constitution, the executive committee offers the following ten names as candidates for election on the committee on nominations; five of these are to be elected at the time the general election occurs on Friday: J. F. Deems, A. W. Gibbs, W. H. Lewis, Wm. Garstang, A. E. Manchester, J. F. Walsh, M. K. Barnum, R. E. Smith, E. W. Pratt, C. A. Seley.

In the absence of Professor W. F. M. Goss, Professor Schmidt, of the University of Illinois, presented the report on Brake Shoes, printed elsewhere in the "Master Mechanic."

Professor Schmidt: The committee has made a recommendation concerning a shoe gauge. The Association has a standard gauge for the head itself, with certain allowable limits of variation in the casting of that head. It seems logical, therefore, that the shoe to fit the head should be limited by gauge. The committee proposes the gauge as a means of facilitating purchase of brake shoes, and insuring facility in interchange.

The President: Professor Schmidt suggests that inasmuch as the committee is making practically two reports, one on brake shoes and one on brake beams, that it might be well to take up this question of brake shoes and dispose of it before taking up the question of brake beams. The part of the paper dealing with brake shoes is now open for discussion.

T. R. Burton (C. of N. J.): Has consideration been given to the effects on the coefficient of friction of brake shoes and the wear resulting from continuous contact between the shoe and wheel in heavy grade service? It is a fact that a large percentage of brake-shoe consumption occurs on roads operating on heavy grades, and it is also difficult to handle extremely heavy cars successfully on 2.5 or 3 per cent grades, with the usual coefficient of friction or braking power.

I have observed in handling such cars on heavy grades that the braking seemed to be much less effective toward the foot of the grade than at the summit, leading to the conclusion that there is a probable appreciable drop in the coefficient of friction due to continued rubbing. The question of the coefficient of friction is very important.

J. P. Young (Pennsylvania): Under the recommendations for the coefficient of friction, I would like to ask if the committee has considered the use of steel or steel-tired wheels in freight service. They have given a test for steel-tired wheels apparently to be used in passenger service only. I believe it would be advisable to have a test for steel wheels, or steel-tired wheels, used in freight service, at least corresponding in a measure to the cast-iron wheels for which they have given a specification. There are a number of steel wheels now being used in that service. The mention of steel wheels is entirely omitted from the recommendation, steel-tired wheels only are mentioned, and I believe they should be included.

The committee on brakes recommends an allowable brake pressure of 18,000 lbs. The committee on brake shoes gives the coefficient of friction for 12,000 lbs., and makes no mention of the braking pressure which the other committee specifies is the allowable pressure. It would seem to me, to make it consistent, that if we specify 18,000 lbs. as the allowable braking pressure in one case, we should in the other report give the coefficient of friction for the 18,000 lbs., to make the two reports consistent.

F. W. Sargent: If the last speaker will look at the back of the report he will find the record there giving the coefficient of friction at 18,000 lbs. load, or 400 lbs. to the square inch of shoe face; tests made on the American Brake Shoe & Foundry machine.

Professor Schmidt: I am not sure how far I may reflect the opinion of the committee in my answers to questions. There is no question but that the coefficient of friction decreases as the shoe gets hot. The report proposes no specification under those circumstances, and I do not know that the results at the pressures proposed can be assumed to offer an indication of the relative standing of the shoe as regards the coefficient of friction under continuous application. It is a fact that the shoe which meets the specification at one or two pressures proposed, is very likely to meet them at the lesser and higher pressures, unless those lesser and higher pressures are far removed from the pressures represented in the tests

Answering Mr. Young's criticism, that the pressure range is not carried sufficiently high in the tests on the steel wheel, it is my understanding that 6,840 represents severe freight conditions, and 12,000 the modern passenger conditions. There again the shoe meeting 12,000 lbs. pressure will meet it at 18,000 lbs. pressure. That is not always true, but in so far as it is true, it constitutes a defense of the committee's action in omitting a variety of pressures. It eliminated a number of the older pressures, as they were too close together to add any additional information; and the proposed change simplifies the making of tests. There is no reason to believe that the coefficient of the rolled steel or steel-tired wheel would be materially different, and therefore it has not been thought necessary to differentiate or to use more terms.

The President: The summary of the committee's conclusions, as far as brake shoes are concerned, is given in the report. They suggest new specifications for brake shoes to be substituted for our present standard specifications.

F. W. Brazier (N. Y. C. & H. R.): I move that the report of the committee, as far as it refers to brake shoes and its recommendations, be referred to letter ballot. The motion was carried.

Professor Schmidt: Referring to that part of the report referring to brake beams: If such a change in the current specifications appears to be desirable, it would result, probably, in a change of the specifications to read as follows: "Apply a test load of 6,500 lbs. and measure the deflection. The desired maximum deflection is .0625 in., and in its variation, 1/100 or 5/1000 in. is allowed." That proposal was received by the committee too late to receive adequate attention, but Professor Goss desires to have it presented at this time for such consideration as you wish to give it.

The committee makes one more recommendation: "In concluding this report, the committee desires to express its opinion that if its recommendation be accepted, it considers its work to be finished for the present; and it suggests therefore that the committee, as a standing committee, be discontinued."

Mr. Seley: I have in mind an objection, which has been largely removed by the later remarks of Professor Schmidt, that was, the exact determination of deflection. We all know that the old idea of 1/16 in. was that it would cause undue piston travel by too much deflection of the beam, and I believe in early proposed specifications they started to put it at 1/32 in., but it was found that that would make an unduly stiff, expensive and heavy beam, and 1/16 in. was decided on. I do not believe these people had the idea of .0625, right down to the last figure beyond the decimal point: in other words, .0625, or .0627, or .0628 would be satisfactory. I have penciled a modification of this section so as to read: "Apply a test load of 6,500 lbs., and under this load measure the deflection, which is desired to be .0625 in., but shall not exceed 0.07 in." That would apply in the tests of both the No. 1 and No. 2 beams.

The third paragraph under "a" and "b" for Beams No. 1 and No. 2 applies to all lots of beams of five hundred or less purchased, which would mean the testing to destruction of one beam in each lot, no matter what the size of the lot might be. If the lot is small, we may say we will waive the specification,or we will waive the whole specification. I believe it would be very much better if we would eliminate that sentence, "Next load the beam until failure occurs," and say instead "if desired, the beam may then be loaded until failure occurs." That would make a destructive test optional instead of obligatory. Any road desiring it could put it in their specification.

It would seem to me that amounts named under the destructive tests are a little high. I do not know very much about it, but it occurs to me, with very high ultimate limits, we might lead manufacturers to the use of hard, brittle material, that would give results under test, but would not be desirable as a practical proposition for brake beam material, and it would seem that a factor of 3 to 1 on the test load would give a sufficiently high amount. I would like to make a motion that the recommendation of the committee regarding the expression of the deflection and also the necessity for the destructive testing of the beam being obligatory, be changed as I have quoted in my remarks.

There is one thing more. I do not understand the date under recommendation 4, "After January 1, 1908." I think that must be an error."

Professor Schmidt: That is an error, but I do not know that I can explain fully the reasons on which the date is determined.

T. H. Curtis (L. & N.): Were tests made looking to any specification for the transverse strength of the brake-beam?

Professor Schmidt: There were no tests made in connection with this report, concerning the strength of the beam other than in the line of pull.

Mr. Seley's motion, which provided that the report of the committee be amended and submitted to letter ballot, the amendment consisting in a slight additional allowance to deflection and making destructive tests optional, was carried.

In the absence of A. Kearney (N. & W.), the secretary read the report of the committee on Rules for Loading Materials.

W. L. Russell (P. & R.): I move the report of the committee be accepted and referred to letter ballot, after the convention has taken such action as to strike out that portion referring to the height of superimposed loads, and also that part of the report requiring the use of metal spacing blocks exclusively, for the reason that the part of the committee proposing those suggestions has given good reasons why they should not be adopted.

In looking into the matter, we find that of the number of cars with low sides to permit such loadings, the Pennsylvania System owns 21,000 cars with 30 in. sides of 100,000 lbs. capacity; the New York Central owns 3,850 of the same type of cars; the Erie owns 1,000; the Baltimore & Ohio owns 3,006; the Philadelphia & Reading owns 500; the B. R. & P. owns 250. If the proposed change is adopted, it makes the height of loading 9 ft. 3 in. from the top of the rail to the center of the load, and that will legislate out of service for this kind of loading 266,863 cars with 40 in. top sides and higher. Those cars are owned by various roads throughout the country outside of the Pennsylvania system. In obtaining further information on this subject, I had advice from the traffic manager of the Carnegie Steel Company, that they have had as high as one million dollars' worth of finished products on their floors at one time awaiting cars for loading. If this proposed change is made, it will work as great a hardship on the manufacturer as it does upon the railways. With these conditions before us, I do not think this convention will agree to such a radical change in the rules at this time. It has been said by the committee that it finds the railways better able to take care of superimposed loads of 9 ft. 3 in. center of gravity than heretofore. That is true, but it is not so to the extent required. For that reason, I think that part of the report should be stricken out.

As to the metal-spacing blocks, it has been the desire of all railways and their managers to facilitate the movement of freight. If we adopt the rule requiring railways to use metal-spacing blocks instead of wooden ones in certain cases, we will restrict the freight movement further; and for that reason I move that those two clauses be stricken out.

Julius Krause (P. R. R.): When you get the center of gravity up so high, and run over curves with six and seven inches elevation, and you are not running very fast, you are getting a lot of weight on the side-bearing on the low side of the car; and then you want to look out for trouble. Now, as to the wooden spacing block; we have had a lot of trouble during the last few years with those blocks; as our cars and engines have grown in size, the wooden spacing block does not do. I have had to renew them as high as three times in twenty-five miles. You may ask why I didn't let them run? Well, you place your lading seven-tenths between the bearings and three-tenths over, and strike a curve, and what is the result? The wooden spacing block will squash and your load begins to creep one inch at a time, but if it creeps ten times in a minute, it dont take long to spill. I have had two instances in three months where a good wooden car was so badly overloaded that it has broken down.

J. J. Tatum (B. & O.): I have a great deal of sympathy with my friend, Mr. Krause, for I have shared troubles with him; but I do not believe in increasing troubles; and by this addition to the rules, we are getting more. I think the trouble, instead of being with the center of gravity of the superimposed load being placed above 9 ft. 3 in., has been that we have not loaded cars according to the rules adopted by the Association to safely retain the load on the cars. We have investigated the matter very carefully, and we find we have had trouble with but one load, and that was not secured to the car in accordance with the rules of loading long material.

J. J. Hennessey (C. M. & St. P.): It seems to me that in putting the center of gravity at 9 ft. 3 in. we are taking a step backwards. We have run under the rules of loading long material for a long time, and I have not heard of a serious accident. Certain roads are unfortunate enough to have such sharp curves and such poor tracks that they cannot carry a load beyond a certain height, but for that shortcoming the roads of the country should not be punished. The pressure on us is to keep cars moving; suppose we establish the height of 9 ft. 3 in., and a car comes to some point of interchange and is one inch above the established center of gravity—you will have the car held up. I do not think we should go on record as being in favor of any such a proposition as that. I see no necessity for it in the rules to-day; and I move that that portion of the rules be stricken out.

S. Lynn (P. & L. E.): I am from a Pittsburg district, and we know we are hauling loads higher than the limit proposed in this rule; but we are handling them successfully. I do not think this convention should place a limit on the height of the load. I am in favor of the metal-spacing block. It is a good thing.

I. S. Downing (L. S. & M. S.): The Lake Shore gets the bulk of the material loaded on top of the high side coal cars from the Pittsburg district. I do not recall, in an experience of eighteen years, ever having had an accident on account of such lading. The lading is joined in the center of the cars. I think a wooden block reinforced with iron is better than a cast-iron block that may break in two. I do not think we should go to metal-spacing blocks for that reason.

E. A. Miller (N. C. & St. L.): Before this matter goes to a vote, I wish to say that I feel it would be unfortunate should the recommendation carry. Ours is only a small road, and we have built in the last few years a large number of gondola cars, especially for the steel trade. Our first gondolas for that trade were low-side cars. We afterwards built a gondola that was 87 in. from the top of the rail to the top of the box. We reduced that on our next lot of gondola cars to 81 in. from top of rail to top of box. We have known of no trouble on our own road, and we have heard of no trouble with these cars on adjacent lines or the lines with which we do business.

The President: Mr. Tatum's motion was that the proposed change in Rule 15-C be eliminated, the modification of Rule 26 be eliminated and the remainder of the recommendation be submitted to letter ballot.

Mr. Tatum: The motion in substance was that the report of the committee be accepted with the elimination of the reference to the rule fixing the center of gravity at 9 ft. 3 in., and the elimination of the reference to the spacing block.

The motion was carried.

The President: If there is no further discussion on the report, it will be referred to letter ballot.

THURSDAY, JUNE 16.

President Clark called the third session of the Master Car Builders' Association to order at 10:15 a. m.

The President: The next business in order will be the reception and discussion of the report of the Arbitration Committee on the decisions rendered by the committee and the report of the Revision of Rules and Interchange, which was, in part, as follows:

Revision of Rules of Interchange.

Last year the committee was instructed to submit a rearrangement of the rules that would bring the related parts closer together. This has been done, and the recommendation of the committee is shown in the Appendix to this report. The suggestions as to revision of the Rules of Interchange are as follows:

Preface.—(a), that the third paragraph of the Preface be changed to read: "Inspection of freight cars for interchange and method of loading will be in accordance with this Code of Rules and the Rules for Loading Materials issued by this Association;"

(b), that Rule 2 be changed as follows: "Cars offered in interchange must be accepted if in safe and serviceable condition, the receiving road to be the judge in cases not provided for in Rules 3 to 56, inclusive, and if loaded, when loaded in accordance with the Rules for Loading Materials;"

(c) the addition of a new rule: "Improperly loaded or overloaded cars—delivering company responsible." This rule is similar to provision (b), of Rule 15, of the American Railway Association.

Rule 3.—Add "Facing the 'B' end of car, the journal boxes in their order on the right side of car shall be known as R1, R2, R3 and R4, and similarly those on the left side of car should be known as L1, L2, L3 and L4."

Rule 4.—Change to read: "Defect cards shall not be required for defects for which owners are responsible, except for missing material on cars offered in interchange. as provided for in Rules 27, 32, 35 and 42, or in cases of defective air-brake parts, as specified in the latter part of Rule 30. Defect cards shall not be required of the delivering road for improper repairs that were not made by it, with the exception of the cases povided for in Rules 29, 33, 43, 44 and 45."

Rule 5.—Change to "If a car has defects for which the owners are not responsible, but do not render it unsafe to run, nor unsafe to trainmen, nor to any lading suitable to the car, the receiving road must require that a defect card be securely attached to the car, as per Rule 3."

Rule 6.—Substitute the following: "Duplicate defect cards must be furnished promptly on request for lost or illegible cards."

Rule 7.—Change to read: "Shelled out: Wheels with defective treads on account of cracks or shelling out spots 2½ in. or over, or so numerous as to endanger the safety of the wheel."

Rule 9.—Change as follows: "Worn through chill: When the worn spot is 2½ in. or over in length. Care must be taken to distinguish this defect from flat spots caused by sliding wheels."

Rule 10.—Change to read: "Worn flange, cast-iron or cast-steel wheel: Wheels under cars of less than 80,000 pounds capacity, with flanges having flat vertical surfaces extending 1 in. or more from tread, or flanges 15-16 in. thick or less, gauged at a point ⅜ in. above tread. Wheels under cars of 80,000 pounds capacity or over, with flanges having flat vertical surfaces extending ⅞ in. or more from tread, or flanges 1 in. thick or less, gauged at a point ⅜ in. above tread.

"Worn flanges: Forged steel or steel-tired wheels: Flanges having flat vertical surfaces extending 1 in. or more from tread, or flanges 15-16 thick or less."

Rule 11.—Change last line of this rule to read, "standards of 1907 and 1909."

Rule 19.—Change to read: "Flat sliding—cast-iron wheels: if the spot caused by sliding is 2½ in. or over in length. (Care should be taken to distinguish this defect from worn through chill.)

"Flat sliding—steel or steel-tired wheels; if the spot caused by sliding is 2½ in. or over in length. A defect card shall be furnished for the labor of turning. The delivering company shall also furnish a defect card at the time, to be forwarded to the car owner, covering loss of service metal."

Rule 21.—The committee recommends a complete revision of this rule, in order to bring the various illustrations referred to closer together and in their regular order, as follows: The determination of flat spots, worn flanges and chipped treads shall be made by a gauge and its application to defective wheels. The determination of thick flanges for all wheels cast prior to the M. C. B. Standard tread and flange adopted in 1907 shall be made a gauge shown in Fig. 6 (old Fig. 2), and for all wheels cast after January 1, 1908, shall be made by a gauge shown in Fig. 7 (old Fig. 2a).

Rule 22.—Recommends that subheading preceding Rule 25, reading, "Parts of trucks which justify repairs," etc., be changed to read, "Parts of cars which justify repairs if owners are responsible, or repairs or carding if delivering company is responsible," and that it be made the principal head, and the word "Trucks" be made a subhead.

Rule 32.—Change to read: "If the car has air signal or train-line steam pipes, the hose, pipes and couplings are at owner's risk unless the car is stenciled that it is so equipped.

Rule 33.—Change to "Cars equipped with air-brake hose other than M. C. B. Standard 1⅜ in. and labeled, as shown by cut on preceding page.

"Note.—Cars will be accepted in interchange with 1¼-in. M. C. B. standard hose and so labeled, if date is cut out showing application prior to September 1, 1909, or if date is not cut out and the label shows date of manufacture prior to September 1, 1909."

Rule 35.—Omit the sentence reading, "Also pressure retaining valves and pipe when damage to car denotes rough usage," as they are already included in the first part of the rule.

Rule 37.—Change to read: "All freight cars offered in interchange must be equipped with air brakes. All cars built after September 1, 1910, must be equipped with M. C. B. Standard 1¼-in. train line and angle cocks," and that delivering company be made responsible.

The committee recommends that the subheading preceding Rule 38, reading "Parts of bodies which justify repairs," etc., be eliminated, inasmuch as the heading preceding Rule 25 has been modified to cover all parts of cars.

Rule 38.—Change first part of rule to read: "Locks, side doors, end door, roof doors, grain doors, water troughs and attachments and all inside or concealed parts of cars missing or damaged under fair usage," etc.

Add paragraph as follows: "Steel cars offered in interchange not equipped with card boards for repair and defect cards (owners responsible)."

Rule 0.—Change to read: "Running boards in bad order or insecurely fastened. Sill steps, ladders, grabirons bent, broken, missing or insecurely fastened, except when car has been wrecked or sheathing raked. Handholds or grabirons must be of wrought iron or steel and secured by bolts, rivets or lag screws."

Rule 47.—Add after "29" in line four, the figures "23," because wrong air-brake hose has been made a delivering company defect. Eliminate the words, "and also in case it should be necessary to replace stem or spindle with pocket attachment," and include in Rule 61.

Rule 49.—Change to read: "Damage to coupler body accompanied by damage to draft timber or its substitute or end sill."

Rule 53.—Committee recommends that the combined front and back coupler stop be cut out of this rule.

Rule 56.—Change to read: "Damaged corner and end posts if necessitating the renewal of, or repairs to, more than two posts."

The committee recommends the appointment of a special committee to propose at the 1911 convention a schedule of prices for labor and material covering repairs to steel cars; also to recommend a combination of damages to steel cars which denote unfair usage.

Rule 58.—Omit the words "and stubs" in fifteenth line.

The committee recommends the consolidation of Rules 58 and 59, inasmuch as both refer to the manner in which repairs shall be made to foreign cars, as follows: "Repairs to foreign cars shall be promptly made, and the work shall conform in detail to the original construction, and with the quality of material originally used, except as provided for in Rules 59 and 62."

Rule 59 (new).—"In repairing foreign cars, M. C. B. standards may be used when of dimensions that do not impair the strength of the cars, in lieu of the parts forming its original construction.

"When using materials for repairs to foreign cars for which the Master Car Builders' Association has adopted specifications as a standard, the materials must comply with the requirements of these specifications.

"Malleable iron, M. C. B. standards, may be substituted for gray iron, M. C. B. standards, but the net cost to car owner in such cases must be no greater than if the original kind and weight of material had been applied. Gray iron, M. C. B. standards, may be substituted for malleable, M. C. B. standards, but in such cases the debits and credits must be for what is actually applied and removed. Repair cards must state kind of material applied and removed.

"When necessary to renew brake beams, any metal brake beam meeting M. C. B. specifications may be used, provided that the beam applied is as strong as the beam standard to the car and does not require any change in hangers or other details.

"Cast-iron brake shoes may be replaced with reinforced brake shoes in repairs to foreign cars.

"White pine, yellow pine, fir or cypress may be used when repairing siding on foreign cars when of equal grade and quality to the material standard to the car."

Rule 61.—The committee recommends a rearrangement of this rule, to cover the change of couplers as referred to in Rules 47, 61 and 62, as follows:

"Couplers of the vertical plane type other than M. C. B. standard, when replaced with M. C. B. standard, the expense of alteration thus necessitated shall be chargeable to car owners.

"Couplers with stem attachments may be replaced with pocket attachment.

"Couplers that exceed the distance of 5⅛ in. between point of knuckle and guard arm, measured perpendicularly to guard arm, must be repaired, in which case owners are responsible, except on cars offered in interchange. (See drawing.)

"When M. C. B. couplers of another make are applied to a car, the uncoupling arrangement shall be made operative at the expense of the company making the repairs."

Rule 12.—The committee, having transferred first sentence of this rule to Rule 61, would suggest a rearrangement of the last sentence, as follows: "In making repairs to foreign cars, the following materials shall not be used: Malleable iron couplers, open knuckles, malleable or steel backed filled journal bearings."

Rule 64.—Add: "When bill is to be rendered, the height of car before and after altering must be shown on repair card."

Rule 65.—Mention should be made that sills must not be spliced between cross ties.

Rule 66.—The word "new" be cut out of first line of second paragraph.

Rule 70.—The last line of this rule be changed, to include the capacity, maximum weight or limit weight of the car.

Rule 71.—Insert the figures "1⅜."

Rule 72.—Rearrange rule, as follows: "If light weight of a car is obliterated or if found to vary more than 500 pounds from stenciled weight, the car should be reweighed and restenciled at owner's expense, and owner notified of old and new weights. Car must be cleaned before reweighing."

Rule 73.—Rearrange rule as follows: "Cars undergoing extraordinary repairs, such as sills, resheathing, roofing, etc., must be weighed and stenciled by the company having the car in its possession. If the repairs are chargeable, the expense of reweighing and restenciling may be included in the bill, as per Rule 106."

Rule 75.—Change rule to read: "When two or more cars chained together with switch chains and couplers blocked out with metal spacing blocks are delivered at an interchange point, the receiving road shall deliver to the delivering road at the time, an equivalent number of switch chains and metal spacing blocks of the same size as the chains and blocks used on the cars delivered, or in lieu thereof furnish a defect card for such chains and metal spacing blocks."

The committee recommends a new rule, following Rule 75, covering the use of defect and repair cards and their location on car, as follows:

"The end of car toward which the cylinder push rod travels shall be known as the B end, and the opposite end shall be known as A end.

"Facing the B end of car in their order on the right side of car, the journal boxes or their contained parts shall be known as R1, R2, R3 and R4, and similarly those on the left side of car shall be known as L1, L2, L3 and L4.

"Defect and repair cards must be securely attached to the car with four tacks, preferably on the outside face of intermediate sill between cross-tie timbers on wooden cars, and on steel cars to cardboard located either on cross-tie under car or on inside of side sill at the end of car.

"Duplicate defect or repair cards must be furnished promptly on request for lost or illegible cards."

Rule 76.—Revise as follows: "When repairs of any kind are made to foreign cars, a repair card must be securely attached to car, as per rule (new rule following Rule 75). This card must specify fully the repairs made and reason for same, the date and place where made and name of road making repairs; also show location of parts repaired or renewed (as per new rule following No. 75).

"If no bill is to be rendered, the billing repair card must be attached to the monthly bill, with the words 'no bill' written across the face of the card. In case no bill is to be rendered, the words 'no bill' shall be written across the face of repair card."

Rule 77.—Change to read: "The Repair Card shall be 3½ by 8 in., made in triplicate, to be known as 'Repair Card,' 'Billing Repair Card' and 'Record Repair Card.' The Repair Card to be tacked on car shall be of cardboard, printed on both sides in black ink, and shall be filled in on both sides, one side of which must be filled in with ink or black indelible pencil, and items of repairs made and why made shall be filled in on both sides in writing. The items of repairs must be in writing. The Billing Repair Card shall be printed on one side and show the same information as the Repair Card, and shall be attached to the bill as authority for charge. The Record Repair Card shall be retained by the party making repairs."

Rule 78.—Change to read: "Any road making partial repairs of defects on a car which are covered by defect cards will have the defects repaired crossed off the original card with ink or indelible pencil and card replaced on car. A copy of the card accompanying the bill, with the defects which were not repaired crossed off, will be sufficient authority to bill."

Rule 79.—Combine with new rule following Rule 75.

Rule 80.—Add in next to last line the word "billing" before word "repair" and omit word "stub."

In accordance with the suggestion of the Association of American Railway Accounting Officers, as referred to under Rule 98, it is recommended that the following be added as a note to this rule.

Rule 81.—Omit the word "stub" in second line and substitute the words "billing repair card."

Rule 85.—Eliminate the next to last sentence, referring to A and B ends of car, as it is already included under new rule following Rule 75.

Rule 87.—Revise to read: "Bills may be made against car owner for the labor only of replacing the following material, when lost on the line of the company making the repairs, viz.: Brake beams, including shoes, heads, jaws, key bolts, brake pins and hangers, when lost with beam. Brake levers, lever guides, top and bottom brake rods, whether or not they are lost with the brake beam. Couplers, including yokes, springs and followers, when lost with coupler."

Rule 91.—Add the words "or statements" after the first word, making rule read: "Bills or statements for wheel and axle work must make specific mention of each axle and wheel removed or applied."

Rule 92.—Add the words "or statements" after first word, making rule read: "Bills or statements which do not embody all the information called for by the headings," etc.

Rule 94.—Insert the figures "1⅜ in. in the reference to air-brake hose.

Rule 97.—Omit the word "above" and substitute the words "in Rule 94."

Rule 98.—Under the heading of "Instructions for Billing," the following be embodied as a note to Rule 80, and that the present Rule 98 be eliminated: "The following rules of the Association of American Railway Accounting Officers should be observed when rendering or correcting bills":

Add the word "billing" in second line, and add letter "s" and omit words "and stubs" in same line.

Rule 101.—Eliminate, inasmuch as this provision is covered in Rules 94 and 107.

Rule 102.—Change the last sentence to provide that the credit for brake beam parts released from service in good condition must be 50 per cent of the prices when new.

Rule 103.—Omit the words, "the above list," and the substitution of the words, "Rules 89 and 94."

Rule 105.—Eliminate this rule and incorporate the prices for altering height of car and putting on handholds in Rule 94.

Rule 106.—The committee approves the suggestion that the note following draft timber bolts be inserted between center plate and column bolts on page 54; the recommendation regarding center sills, as follows:

"1 center sill, spliced, per end, ordinary car, 16 hours; refrigerator cars, 20 hours.

"2 center sills, spliced, same end, ordinary cars, 22 hours; refrigerator cars, 26 hours."

Rule 108.—Add "Coupler lock."

Rule 109.—Inasmuch as Rules 109 and 110, and first paragraph of Rule 111, specify where no additional labor can be charged, the committee recommends the consolidation of these three items under the head of Rule 109. Add: "No additional labor to be charged for end siding when end plate or end sill under siding is renewed or replced."

Rule 111.—Insert first paragraph under Rule 109. Change the second paragraph to read: "Where one or more carrier iron bolts over 4 in. long are replaced, where pocket coupler at same end of car is removed and replaced, the regular labor charge should be reduced one hour, except when one or both draft timbers are replaced.

Rule 112.—Add new item: "Triple cylinder bushing, renewed, $1.12," and further it should be included in Rule 94.

Rule 113.—The committee suggests that the heading of the list of car prices reading "bodies—wood" be changed to read "bodies of eight-wheel cars" for both wood and steel cars, and that the words "car—eight-wheel" be eliminated from each item under these headings.

Change third paragraph, page 69, to read: "Where the capacity of any car other than a gondola is 60,000 pounds or over, 10 per cent should be added to the above price for the car bodies."

Change fifth paragraph to read: "Where cars are equipped with metal center sills, the following prices should be added to the values of bodies for the cost such sills:

"10 inches or less....................$60.00
Over 10 inches.................... 80.00"

Also add: "Where cars are equipped with two metal draft members not less than 7 in. depth, continuous from end to end of car in combination with metal needle beams, $30 shall be added to the value of body of car for the cost of such metal draft members."

Also add a new price, as follows: "Flat car, wooden floor, metal underframe, 8-wheel, 30 tons' capacity, 34 feet or over, $500."

Rule 115.—The committee recommends that the item of "tank cars, except the tanks," be eliminated, and that a depreciation on tanks of tank cars of 5 per cent per annum be fixed in Rule 114.

Rule 121.—Suggests the elimination of the time limit of 60 days.

Discussion on Rules of Interchange.

F. W. Brazier (N. Y. C. & H. R.): I move that the report of the arbitration committee be accepted and adopted, which includes the acceptance of the decisions rendered by the arbitration committee. The motion was carried.

F. W. Brazier: At this time I think it would be proper to make another motion relating to this report. I think many of the members do not realize the amount of work and time that the arbitration committee has put in—to my knowledge, five or six days in Chicago—and I think they are entitled to a vote of very strong thanks, because they really are our Supreme Court. I move that we give the arbitration committee a rising vote of thanks for this report and for the arduous duties performed in the past year.

The Secretary: The arbitration committee has held five sessions for the preparation of its report, which has been presented to this meeting.

The Chairman: This motion is timely. The arbitration committee certainly does a lot of work and are entitled to a good deal of gratitude on the part of the members for the valuable work they do.

The motion was carried.

Mr. Hennessey: On behalf of the arbitration committee would say that the vote of confidence which has just been passed is fully appreciated. The duties of the arbitration committee are not pleasant. In every case that is arbitrated, one side must lose. For every recommendation that is made there are usually a half dozen conflicting recommendations. We have tried to do our duty under all conditions and circumstances. I want to thank the convention for this vote of confidence.

(President Clark in the chair.)

W. F. Bentley (B. & O.): At the meeting of the arbitration committee yesterday, I was requested, after the adoption of the rules, to bring to the attention of the convention certain difficulties which the different inspectors are experiencing in endeavoring to find the label of the size and marking on the hose badge by reason of its location. Sometimes, unless the inspectors uncouple the hose, they must lie on their backs to read it.

Several roads have already taken steps to place the badge so that the inspectors can read it very readily in approaching the hose; that end is being accomplished by placing the reading on the hose in a different position, and instead of placing it upside down they are turning it around on the quarter, so that when the hose is coupled up the inspectors can read it. It was thought by bringing this subject to the attention of the different representatives of the railways at this convention they would give it some consideration after they got home, and see to it that the badge on the hose is so placed that the inspectors can save time in inspecting the trains in reading the hose.

The President: That seems to me to be a good suggestion. It would appear easy to fit up the hose, as suggested by Mr. Bentley, so that the inspectors can read the badge conveniently.

Mr. Hennessey: It seems to me to be a recommendation of considerable importance. It would cost a railway company no more money to mount the hose so that the label could be easily read than it would to mount the hose in any other way. I move that each member of the Master Car Builders' Association, when he returns home, take up these matters with the hose mounting department, and instruct the men in accordance with the suggestions of Mr. Bentley.

The motion was carried.

Mr. Hennessey: While there has been an apparent improvement during the past year on account of the very earnest discussion in connection with this subject at the last convention, there is still much room for further improvement. If the members of this association would talk on this floor as they write to the Arbitration Committee, I think they would talk the balance of the day on this subject; but it seems when they come here and must look a man squarely in the eye they do not have the moral courage to say what they say to the members of the Arbitration Committee. They write us that such and such roads are not applying repair cards. I understand, of course, that the resolution that was passed last year gave them the right to take this matter up with the Executive Committee, but it seems, as Mr. Lewis says, that they do not like to make these direct charges personally. There are others who go so far as to say that bills are rendered to them for work that has not been done. Now, the life of this association depends entirely on the honesty of its members—everything should be done by every member of this association to secure the most absolute honesty in these matters. If any master car builder has subordinates who are inclined to adopt tricky practices or customs to keep down the expenses, that man should be called. I do not believe for a minute that there is any head of a car department in America who encourages such practices, or who would for a moment retain in his employ a man who indulges in them if he knew that this thing was going on, but it is believed by many that it is a custom of some roads not to put on the repair cards, and in cases not to make the repairs at all, but to render the bills.

Jacob Christopher (T. H. & B.): The road I am connected with is today holding six cars. We have held them for six months waiting for the representatives of a certain road to come and give us evidence to substantiate certain bills for repairs which have been charged against our road. We have the evidence that we were charged for brasses, drawbars and brakebeams, and we have positive evidence that the brakebeams and brasses were never removed. We have several other points of evidence bearing on the same bills, and yet we have not been able to get the parties interested to come and pass on the cars and verify the bill. We are holding the cars so that we can stand pat on the point we take. We have been charged for material and labor that never was furnished.

F. W. Brazier: I said last year, and I repeat it now, I want every cent that belongs to the New York Central, but we do not want one penny that does not properly belong to us. If you instruct your subordinates to that effect, there would not be any further complaints in this connection.

F. H. Stark (Pitts. Coal Co.): There is one detail that might stand investigation, that is the cleaning, oiling and testing of air-brakes. We have only a small equipment and are able to check the repairs made more closely than most roads. It is interesting to find how frequently air-brakes become dry and dirty. We have some cases where they are cleaned twice by the same road at the same station on the same date. It is common practice to have them cleaned more than once in thirty days. If the air-brakes are cleaned, oiled and tested, and in 10 days the brakes are not operative and the triple is taken down, and it is found that some repairs are necessary, a charge is invariably made, in addition to the repairs, for the cost of cleaning, not only to the triple, but of the cylinder. It would seem that if a triple passes inspection and a charge is made by one road, and it becomes inoperative in a month, that the owner might properly be charged with repairs, but it does not seem right that he should be charged with the cleaning. This is a matter that each one of us should consider for ourselves, and it would be a good idea if, in addition to the date of cleaning, the road should be required to put its initials on the cylinder so as to indicate who did the work. That would assist in tracing the matter. This may seem like a small matter, but if you really know how many duplicate charges you are paying for, you would take a greater interest in the matter.

Mr. Schroyer: We started to check up on our equipment of sixty thousand cars, the cleaning that had been done on all the triples, where it had been done, by whom and when. My attention for one whole year has not been called to any such condition as Mr. Stark describes. As to cleaning the car twice in one day, that may be a case of two men working on piece-work and each of them turning in a slip for the cleaning of the car. The worst thing that has come to my attention in connection with the handling of cars and billing for work supposed to have been performed, was certain instructions, which were supposed to have been issued by the head of the car department to the inspectors and repairers at interchange points, to the effect that they must perform work enough to get cars enough from the connecting line to pay their salaries.

Mr. Stark: I can send Mr. Schroyer hundreds of repair cards verifying what I have stated.

H. L. Trimyer (S. A. L.): We have the remedy in our own hands, as we have been instructed to bring such matters to the attention of the executive committee. If we did this, some action would be taken to stop the trouble. On the road with which I am connected we have had some bills refused payment on account of no repair cards attached to the cars. We proceeded to remedy the trouble, and possibly if we did that a little more, we would get better results. In addition, I have had a lot of correspondence in regard to improper bills, claiming repairs made which were not made. If we would bring some of these well defined cases which have been referred to, to the notice of the executive committee and some action was taken by the executive committee, we would have no further trouble. As far as the Seaboard Air Line is concerned there has been a wonderful improvement since the action last year. A close checking of our repair bills shows some discrepancies, and many were brought to our attention which we proceeded to remedy. We have instructions out that we will discharge any man in the service who sends in a report claiming repairs which have not been made, and we cannot take any further action until such matters are referred to us. If a case where there is sufficient evidence to justify the charge is referred to the executive committee, and some road is penalized for violation of the rules, it will stop the whole business.

A. E. Manchester (C. M. & St. P.): I have discovered what I felt was a case which should go to the executive committee, a case which seemed to justify such action more than a number of the cases which have been mentioned. In each instance where it was a clear case it would come back to us and be reported as an error, a clerical error. When you get that kind of a report, and the party withdraws his bill or corrects his bill, you have nothing to take to the executive committee. When you catch that same condition coming from the same road with great regularity, it at least leads to a suspicion that there is undue carelesseness that ought to be corrected.

Morris La Rue (C. R. I. & P.): There is one point which has not been touched on; that is, in interchange some roads will make a claim for a defect card or missing material, and after the card is on their line they bill the owner for the same material that they have asked a defect card for. That may be honest, but it looks to me as if the man who would do it is too crooked to sleep in a roundhouse.

C. E. Fuller (U. P.): The members of this association should be ashamed of themselves. We are charged with the maintenance and repair of cars, and if we are crooked we ought to be straightened out. The members were requested to file any cases they had with the executive committee. During the last year there was only one case brought up, which would indicate one of two things—either that the members were unduly suspicious of one another, or else they are afraid to present their cases. It does not seem to me that the question of mistakes ought to be charged as dishonesty. I presume the line that I represent sends out bills that are questioned; in fact, I know we do. We receive bills that we question, and we do not charge dishonesty. The only time we charge dishonesty is when we know the work has not been done. We have not had a case in the last year that we felt was a case of dishonest work. Too much has been said on the subject, and the members should do as they are requested and file their cases. If there is any member of this association that is paying the salary of his card department by dishonest billing, I believe we can stop it; and the only way to stop it is to give us the ammunition. I move that the members of this association give the executive committee the cases, if they have any, by letter.

F. F. Gaines (C. of Ga. Ry.): We may be morally certain that we are getting dishonest bills. If there was some way by which we could identify actual cases of dishonesty, which I know from my personal experiences are still going on, there might be more cases referred to the executive committee. It is pretty difficult to get your evidence.

Eugene Chamberlain (N. Y. C. & H. R.): The superintendents of car departments and of motive power have been derelict in their duty. It is not the case of the inspector. This action seems to have produced up to the present time simply a moral effect, and it has not gone any further with one case only before the executive committee. It seems to me that the motion of Mr. Fuller is very pertinent at this time, that the superintendents of motive power and of car departments may not continue to be derelict in their duty, but that they may get after these cases.

The motion was carried.

FRIDAY, JUNE 17.

President Clark called the closing session of the Master Car Builders' Association to order at 9:5υ p. m.

The President: As announced yesterday, the election will take place today. The polls will open at 10 o'clock and close at 11:30. I will appoint three general tellers, who will count the votes for the officers and deliver the votes for other candidates to the respective tellers. The three general tellers will be, R. V. Wright, George Goodrich and W. O. Thompson; for members of executive committee, two tellers, H. L. Trimyer and I. S. Downing; for the committee on nominations, two tellers, S. T. Park and J. J. Tatum; for associate and life members, two tellers, C. A. Seley and R. L. Kleine.

The Secretary read Article 8, Section 10 of the constitution, relating to elections, and explained the method of balloting provided for putting a name before the Convention. That is, for life membership. For associate membership there is only one name, Professor Endsley. That was proposed a year ago.

I would like to say that the committee on nominations, on account of the withdrawal of Mr. Parish from the Railway Service, proposes in his stead the name of D. F. Crawford, general superintendent of the Pennsylvania lines west of Pittsburg, for president. The candidates for president, as proposed by the committee on nominations, are Mr. Curtis, Mr. Stewart, Mr. Crawford. For vice-president, in place of Mr. Parish, the name of Mr. E. D. Bronner has been proposed. The list of vice-presidents in nomination is: Mr. Curtis, Mr. Stewart, Mr. Crawford, Mr. Fuller, Mr. Bartlett, Mr. Bronner. You can vote for three of these, or three others that you may choose.

Of course, gentlemen, you understand at the first day's session we read a communication from Mr. Kirby, in which he asked to have his name withdrawn as a candidate for treasurer. He is now 87 years old, and he does not very often come to convention, and he asked to be relieved from service. Have I made myself clear to all the members as to the voting?

The President: I will ask the general tellers to distribute the ballots. The general distributers are R. V. Wright, George Goodrich and W. O. Thompson, and I will ask the general tellers, in addition to canvassing the vote for president, to canvass the vote for treasurer.

The next order of business is the reception of the report of the committee on consolidation of Master Car Builders' and Master Mechanics' Associations.

The secretary read the report of the committee, which, in part follows:

Consolidation.

Apart from any legal questions, it may be granted that neither the Master Car Builders' nor the Master Mechanics' Association would agree to being absorbed by the other. Both have a long and honorable history. Founded in 1867 and 1868, respectively, each has accomplished magnificent results in the investigation of the multitude of problems that have arisen in the gradual development of American railway rolling stock, and in the determination of national practice in design and operation. Both are today progressive and successful. There is no question of either needing the assistance of the other to ensure its continuation or development. They stand as pre-eminent examples of voluntary associations of men employed by the railway companies of the country who have labored and studied for the benefit of those companies as a whole.

Such being the case, if it be decided that, for the benefit and convenience of the members of these associations, it is advisable that their work be continued by one united society in place of two separate ones, the only feasible plan would be to form a new association to take the place of the two older ones, and independently and voluntarily terminate their existence. The legal questions involved in such proceedings require investigation, and it is possible that technically some different arrangements would have to be made. This is not, however, material, and we assume that the question for discussion is not that of absorption or consolidation, but the formation of a new and united association, which, including in its members employees of both the car and locomotive departments of our railways, may be called The American Railway Mechanical Association.

A change of this kind is important and should, we believe, if carried out, be only made after the most careful consideration. There are, no doubt, however, powerful reasons in favor of such a movement; reasons which have developed from the change which has taken place in the organization of the mechanical departments of the railway companies themselves during the existence of the two associations.

The appointment of a joint official in charge of both car and locomotive departments has led to the same man being largely in charge of the design, construction and maintenance of both cars and locomotives. The consequence is that men are attending the Master Car Builders' Association in connection with car matters, and the Master Mechanics' Association in connection with locomotive matters. To a great extent, therefore, the reasons that previously existed for the maintenance of two separate associations have been gradually removed.

Mr. McKenna's remarks last year undoubtedly require the most careful consideration. They may be regarded not only as a personal opinion, but as expressing that of a large proportion of the membership of the association over which he presided. They describe the Master Car Builders' and Master Mechanics' Associations as having separate and distinct fields of action; the Master Mechanics' as being technical in its nature, while the Master Car Builders' has rather that of a legislative body. There is, no doubt, a great deal of truth in these distinctions, and yet it is questionable whether they do not refer rather to conditions existent in the past than those of today. The legislative nature of the Master Car Builders' Association is entirely caused by the successful action of a voluntary association in organizing the rules governing the interchange of equipment between the railway companies of the country. These rules have been so wisely drawn and fairly administered that, without any direct powers having been granted to the associations by the railway companies officially, their accedance has in practically all cases been obtained, and the Master Car Builders Association is today recognized as the organization empowered to formulate regulations required to enable the transfer of cars from road to road with the greatest dispatch consistent with the respective interest of owner and user. This has been but one part, however, of the work of the Association, although it has been so well done that it has secured the admiration and endorsement of all railway managements and has led to this being regarded, perhaps, as its greatest field of usefulness. The other, and equally important, part has been that of a great technical society specializing on subjects connected with the car department and thus supplementing the work of the master mechanics in the locomotive field. The subjects being investigated by committees this year are, with the exception of those pertaining to the interchange of cars, just as much the work of a technical association as are those in the Master Mechanics' Association. The condition actually is that two large engineering societies are in existence: the one investigating matters connected with the design, construction and maintenance of locomotives, the other with similar subjects for cars, while the latter at the same time determines the rules governing the interchange of equipment.

Now, the question really is: Are these lines of action separate and distinct? Are the particular fields of these two associations diverse? Such a question would certainly be answered in the affirmative were different departments of the railways concerned, such as is the case with mechanical work and that under the charge of members of the Engineering and Maintenance of Way or the Association of Railway Accounting Officers; such as was the case with the work handled by members of the Master Car Builders' and Master Mechanics' Association.

That it should be answered in the affirmative under present conditions is more doubtful. It is indisputable that the car and locomotive departments in our railways have very generally been united under one head, and that year by year more of the men who are interested in the work of one association have become interested in that of the other. This is, perhaps, more clearly illustrated in the representative membership of the Master Car Builders' Association than in any other way. There are 276 representative members, representing 2,318,607 cars, of which 89, representing 71,550 cars, are officers of other than the car or locomotive departments or of private car lines. Of the balance of 187 members, representing 2,247,057 cars, 162 or 86½ per cent are officers of both the car and locomotive departments, while the number of cars represented by them is 1,705,276 or 75.8 per cent, compared with 541,781 represented by members bearing car department titles only. While not to the same extent, the same is true of the membership as a whole. Out of a total of 515 members whose titles indicate their employment in the mechanical department of a railway, 320, or over 60 per cent, are connected with both car and locomotive affairs.

The conclusion is evident that the distinction between the work of the two associations is only in kind. It is not a distinction that necessitates the employment of different men with different training, belonging to different departments of the railways. Each is engaged in a portion of the work of the mechanical department, with the same men in charge, interested in the subjects discussed in each and bearing their share of the investigations and experiments in both.

It is difficult, therefore, today, to justify the continuation of two separate associations on the ground of the difference in their fields of work or the variation in their memberships. The strongest opposition to such a change is in the statement made by Mr. McKenna: "Unless improvement is possible, change should not be favored." Apart from any question of sentiment, it is a serious matter to disturb the successful operation of over forty years. The question for consideration is really whether the attendant advantages are sufficient to justify the change. The most important is the possible saving in time. Under present arrangements, to attend the first convention means, for the majority of our members, that they must leave home on the Monday or Tuesday night, and, if they stay for the second, they can not return until the Thursdays or Friday of the succeeding week. Practically, therefore, attendance at both conventions means that two weeks must be given up to the work, and, under present conditions, this is frequently more than can be spared, important as these conventions are recognized to be.

The attendance of both conventions suffers from this unreasonably spread-out arrangement, especially that of the Master Mechanics. The regulations of the rules of car interchange by the Master Car Builders' Association introduces a business element into its affairs of an importance that almost necessitates the attendance of the officials in charge of the car departments, apart from any consideration of the value of the technical questions handled in both associations. Apart, however, from any consideration as to which convention suffers most, it may certainly be taken for granted that both are well worth attending and that both associations need the attendance of the men in charge of car and locomotive departments to retain their representative nature and continue their development in the most efficient way. If, therefore, the substitution of one association for the two existing ones can enable this attendance to be obtained, it is certainly a reason in its favor.

The present arrangement takes three days for the Master Car Builders' Association and three for the Master Mechanics', there being two idle days in between. At each meeting the convention is called to order at 10 a. m., and about an hour and a half is occupied in the opening addresses, and in the transaction of routine business of the association. On the second and third days the convention meets a 9:30 a. m., and from the third day at noon the election of officers and other closing business usually occupies the time until adjournment. As the convention adjourns each day at 1:30 p. m., the total number of hours occupied by the meetings is twelve, of which about nine are available for the business which the association is organized to transact.

It would be entirely feasible to provide the time thus required by the two associations in the case of one association meeting at 10 a. m. on the Monday, and 9:30 a. m. each succeeding day, adjourning as at present at 1:30 p. m. Allowing, as before, three hours for the opening and closing business and adjourning at 1:30 p. m. on Friday, there would be sixteen and one-half hours available for the transaction of business. If not sufficient, the election of officers, etc., could be held on the Saturday, or, as would probably be considered preferable, meetings could be held on one or two afternoons during the week, which would certainly afford ample time for any work which may reasonably be expected. There is no objection to one or two afternoon sessions, especially in an association discussing both car and locomotive subjects, but the fact that both classes of subjects are being handled in one convention would in itself save a certain amount of time, as the discussion of the same or similar subjects in two separate conventions would be done away with. It may be stated, therefore, definitely, that one association, by the reduction in time required for opening and closing exercises and routine business, would enable a convention to be conveniently held during one week that would afford as much time for the transaction of business as the two conventions do at present. This would enable the members in the majority of cases to attend the entire convention with an absence from their homes of not over one week, thus effecting a considerable economy in the time required by busy men in attending a meeting of importance to them and correspondingly insuring a more representative attendance.

The existence of one executive committee in place of two would reduce the demands on the time of the men engaged in carrying on the business of the associations, and would facilitate the work of selecting subjects for investigation by committees and the names of the members composing them. Under present conditions, it is practically necessary to hold the meetings of the two executive committees either jointly or in communication with each other, both for this purpose and for business connected with the carrying out of the convention arrangements. One executive committee would be more efficient in handling any matters connected with both car and locomotive departments than are two, and, if selected from various sections of the country, would form a strong and representative body for any work in which their services might be of use.

The discussion of similar subjects in two associations would be done away with. Apart from the committees on Consolidation and Arrangements, there are today three subjects, Safety Appliances, Lumber Specifications and Train Brake and Signal Equipment, which are being investigated by committees from both associations. In two cases the membership of the committees is practically the same, a recognition by the executive committees of the desirability of reducing as much as possible the time demanded from our members in carrying on this work. There are other subjects on which committees have been appointed on which joint action would logically be required, were it not for the recognition of the unnecessary work involved in considering the same subject in both conventions. Those referred to are: the Revision of Standards, Brake Shoe Tests, Coupler and Draft Equipment, Car Wheels, Train Pipe and Connections for Steam Heat, Mounting Pressures for Various Wheels and Axles, Widening Gauge on Curves, Steel Tires, all of which might be classified as subjects for joint investigation from the fact that decisions reached by one association will practically be adopted by the other. Subjects on which joint action is required will probably increase in number rather decrease. The time has largely passed when on practice obtained in the car and another in the locomotive department unless there is a good and valid reason for the difference. The agreement on a uniform practice, if possible, or the acceptance of a reason for divergence, can be far better discussed in one association than in two, apart from the saving in the time of the members of the committees, the duplication of reports and experiments.

In a joint convention the time allotted to the various subjects could be better allotted than when the two are separate. The work in each varies from year to year, and, while, no doubt, it has a tendency to increase, there is sometimes a question whether the investigation of a subject is not carried out in order to arouse interest in the convention, rather than on account of its pressing necessity. With one executive committee the subjects could be determined on with less reference to the time at disposal and with more consideration to their relative importance. It would also be possible and advantageous to avoid the tendency to hurry the discussion on what may have proved to be a more important and contentious subject than was anticipated, which now frequently occurs in order enable the program to be completed on time. With double the time at their disposal, the meeting could give each subject the attention it requires, and gain on a subject which did not develop the expected discussion the additional time occupied on one which exceeded expectations.

Discussion on Consolidation.

F. F. Gaines: I move that the report be accepted and referred to letter ballot.

C. E. Fuller: I second the motion.

G. W. Wildin (N. Y. N. H. & H.): I rise to a point of order on that motion. It is out of order. You cannot refer this matter to a letter ballot. This question affects every member of the association, and not only the representative membership which is entitled to a vote on the question by letter ballot. If you refer this to letter ballot the majority of the members could not vote on the subject.

F. F. Gaines (Cent. of Ga.): I amend my motion that we accept the report of the committee, and further move that we act on the report of the committee and consolidate the two associations.

Mr. Wildin: I think, as stated in the report, that this matter requires consideration, and there should be more thought given to the matter. I also think we should have an expression of opinion from the members present today as to their attitude in the matter. Therefore, I move that it be the sense of this association that a consolidation take place and that the matter be referred to the executive committee for their final disposition and report at some future date.

C. A. Seley (C. R. I. & P.): I believe it is stated in the constitution that both of the associations, on any matter affecting a constitutional change, are to have six months' notice. That ought to be considered in this case. I agree with the ballot idea, but believe we should have an individual ballot. I believe every member of this association, whether able to attend this convention or not, or any convention, has a right to an authoritative expression as a member of this association on this question, and I was hopeful that Mr. Gaines, in amending his letter ballot motion, would make that an individual motion.

Mr. Gaines: If I may be allowed to make a further amendment, I suggest that the matter be referred, not to letter ballot, but to each individual member, not on the basis of representation. That will give every one who is a member of the association a chance to have a vote. If it is referred to the executive committee, as Mr. Wildin suggests, I do not see how the individual members will be given an opportunity to vote on the question.

Mr. Wildin: I did not expect to see this matter rushed through at the present time, but we could easily tell whether it is necessary to refer the matter to letter ballot, or individual ballot, if you put the motion to vote, as an expression of opinion. I believe the members who are both for and against this proposition are very well represented here, and I believe we ought to have an expression of opinion from this meeting.

The President: I do not think we are in a position to decide without some further discussion on this matter as to the merits and objections to this plan, whether we want to put it through or not. Neither do I think that we are in a position at present to settle the matter of letter ballot. The constitution of the Master Car Builders' Association provides that the constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that written notice of the proposed amendment has been given at a previous meeting, at least six months before. The report of the committee constitutes the notice required by the constitution, but it has not been presented to the association at a period six months in advance of this meeting. Consequently I do not see how it is possible for us to take action now, which would settle the matter one way or the other. It is something, I think, which will have to go over for a year, unless someone finds a way out of it, and perhaps the best use we could make of our time at present would be to consider the entire matter, and determine, if possible, how we can handle it in such a way as to take action next year, if it seems that such action is desirable.

F. W. Brazier (N. Y. Cent.): I do not believe today, we are ready to take a snap judgment on this. I was going to move that the report be accepted and laid on the table for one year, to give us time to think it over and talk it over. We are too much like people in politics, finding fault with the men they elect, while they never attend a primary to select the right man. Now, let us not go too fast on this. I advocated it at one time. Conditions are changing all the time, and I do not believe today that I really am clear as to whether we want to consolidate or not. I think possibly it is going to be the right thing, but let us take time to consider it. I see no harm in accepting the committee's report and letting it lie on the table for another year. I so move.

Mr. Schroyer: In explanation of my seconding that motion, as an approval of the same, I want to say to you that it occurs to me right here that if this consolidation is effected and the attendance of these meetings is increased to the extent that it necessarily will be by that consolidation, you will have a difficult time finding a place to meet. That is one of the thoughts that comes to me. This room is now filled and has been filled at every session of this association. Suppose there were three or four hundred more members here, while it may be true that we could get a room big enough to meet in, what are you going to do about hotels? I think we will overreach ourselves. Another thing: what are you going to do about attending these meetings, two long sessions a day, for four or five days of the week? These manufacturers come here with their exhibits and display the modern machinery, improvements on the old, modern appliances of all kinds, which affords us the very best opportunity we can have to see these appliances combined in such a way that we can get beneficial knowledge in a short time—if you consolidate these associations, we will leave home on Saturday and will return home on Monday, and will have to do a lot of hard work in the meantime. So that I think there are many things to be considered in this connection, and it would be a very wise thing to allow this report to lie over for a year.

A. E. Manchester (C. M. & St. P.): The applause that Mr. Schroyer received is in line with my thoughts, that every member of this association who is not a member of the Master Mechanics' Association will not be in favor of the consolidation. I believe they have good and just reasons for feeling that way. The heads of the railroads rarely come from the car departments. They are either from the locomotive or the engineering departments of the roads, and the thought occurs to me that with that as a fact, there will be a danger of the Master Mechanics' Association finally predominating. I believe it would be a bad thing to have it that way. If there has been effective work done by either of the two associations, we are all, I think, agreed that the most effective work has been done by the car association. I fear that any movement that consolidated the two would have a tendency to weaken the car association, and not materially strengthen the Master Mechanics'.

George L. Fowler: Some years ago there was a paper read before one of the railroad clubs that was a little tiresome, and Mr. Forney, in discussing it afterward, said he had often heard of the fact that if you strained a piece of metal beyond a certain point, you would exceed its limit of elasticity, and it would very soon break. It seems to me as though, if the work of these two conventions were to be compressed into one week, the condition of the members at the end of that week would be very much like that of a piece of metal that had been strained beyond its limit of elasticity, and that the work it was doing on the last two or three days would not be as efficient as it would be if they had a recess in between. We find, in teaching school, that it is necessary to give children a recess in the middle of the day, and it seems to me quite reasonable that an audience, even so vigorous as this, would have to have a recess in between three or four days of such hard work as comes in these conventions. You put the convention on the floor here at nine o'clock in the morning, keep it in session until half-past twelve, then pick it up and do the same thing again in the afternoon, and by the end of the third day you have a tired lot of men that are doing just about as efficient work as your fireman would do after being out on a 150-mile run firing a big engine without assistance. They cannot do the work properly.

Then, there is another point. It has been a matter of universal concession, time out of mind, ever since these conventions were organized, that the discussion among members in between the sessions is of as much benefit personally and individually, and, in fact, of as much value to their railroads, as anything which they get from the conventions themselves. If you take up all the time in the conventions, as will be necessary in order to get through in a week, you cut out that outside discussion and members do not have a chance to get acquainted with one another socially or in a business way, as they will if they have a little more time to themselves.

And, finally, the point that Mr. Schroyer brought out, the fact that these magnificent exhibits are placed here on the pier—it seems to me it is very doubtful whether the manufacturers would go to the expense that they do now, running up into the thousands of dollars every year, to bring these exhibits down here, to show the latest things that have been developed, if their exhibits had to be opened on Monday morning and closed practically on Thursday night; because we all know that although this convention closes formally on Friday noon, the last morning amounts to nothing so far as the manufacturers are concerned.

In view of those three points alone, that an audience simply cannot be got together and kept standing up to the performance of this kind of work for four or five consecutive days; that the members will not have a chance to become acquainted with one another, which the conventions are the most valuable means in the country to bring about, and that the manufacturers will not be able to bring their exhibits together—in view of those considerations, the subject ought to be very carefully considered before we get together and try to effect the impossible.

W. A. Nettleton (C. R. I. & P.): As a member of the committee of your association, I have been asked a great many times my opinion on this matter, and I have talked with a great many people. I cannot find, really, that there is any consensus of opinion on the matter. The principal arguments seem to be the saving of time and the saving of expense, and I do not see how we can act on this thing precipitately, because we do not know whether the young lady is going to like us or not. I should say that if we do get together and try to save time, it should be something in the nature of a trial marriage, a committee appointed by both associations to see whether the duplicate subjects could be cut out, or something along that line.

J. F. DeVoy (C. M. & St. P.): I have looked at this matter for a considerable period at an angle altogether different from that at which almost anyone else has looked at it. You never can convince me for a minute that a truck horse could have the ability to win a derby race. If you have appendi-distribution of steam, valve motion and all that thing, is a scientific study which requires a specialist, and a man that knows the distribution of steam may not know anything more about the strains on the centre sills of a car or draft gear than a mule does. I know just what I am talking about. It is getting to be pretty nearly impossible to get a man that can even lay down the clearances for a car. They will run a pipe through the wheels if they can get it through there. This argument that the supply men should have a show to exhibit hasn't anything to do with it.

W. F. Bentley (B. & O.): I think this matter is one that is deserving of serious consideration. If the railroad companies are to be benefited by consolidation, the change certainly ought to be made. The saving of money for the railroad companies is what the members of this association, I believe, as well as the Master Mechanics' Association, come here for. If by placing additional burdens on the Master Mechanics' Association, giving them additional duties while they are here, they can accomplish the work and do it properly in the same time, they certainly ought to be given the opportunity to do it. It certainly should be a saving in money to the railroad companies from that point of view. Assuming that the Master Mechanics' Association has not sufficient time and the subjects brought before it are worthy of greater consideration, I imagine that it could not do the additional work that has been done by the car department people, with their assistance, in the same amount of time. There is a point that occurred to me that was brought out in the report, that it seemed might serve both associations to good advantage if considered. The point is that there seems to be a lack of understanding between the two executive committees, and therefore they appoint committees to investigate the same subjects. Possibly a conference between the two from time to time might result in good to both, when the subjects are being selected. I do not think any sentiment should enter into the matter of consolidation, but I believe that the motion Mr. Schroyer has made, that the matter be held over for another year, and be given further consideration, is a good one. It would seem fair, too, that the individual members should be given a vote on the matter at that time, if it is considered by the officials of the railroads represented that they are competent to vote. I assume that by reason of their having become members of the association, with the consent of the railroads, they would, in the majority of cases, at any rate, be considered competent to vote and to pass judgment. I do not think that the railroad companies would want to consolidate simply as a matter of sentiment, but as a matter of dollars and cents. If they can advance ideas and perfect constructions by a consolidation and better conditions in general throughout the country, I think it would be their intention to do so; and I think whether a man is a member of this association or the Master Mechanics' Association, he should, after giving the thing proper consideration, give his vote in the way he thinks the interests of the railroad companies would be best promoted.

J. J. Hennessey (C. M. & St. P.): In the principal line of thought that has been given expression, the only good reason that I have heard advanced for the consolidation of the two associations is the saving of time. I have tried to figure out how much time would be saved. Practically about all the time that can be saved is the time taken up by the presidents' addresses, and the organization of the two associations. I do not know whether an hour or an hour and a half on an important subject like this is worth considering. Both the Master Mechanics' Association and the Master Car Builders' Association have made a record. They have accomplished a great deal of good in their own lines, and I question very much whether we are going to get, by consolidating, as good results in the car department as we are getting today. When it comes down to dollars and cents, it is the car department that spends the railroad's money. There will be another tendency, possibly, if the two associations are consolidated, and that is, to make a great many of the younger members in the Master Car Builders' Association become indifferent. The crying need today in this country is to interest more young men in the car department. I believe I voice the sentiment of nearly every man of experience in this hall, when I say it is almost impossible today to select young men that have the proper training, so that you can give them charge of a large shop in a car department. Why? For the reason that for years the opportunities for young men to come in and learn the car trade have not been as good as they have been in the locomotive department. By the time one apprentice gets through his time, his salary is far above the salary of the apprentice in the car department. The result has been that the brightest young men have drifted into other departments, and the car department today is really at a loss for the proper material to conduct its business as it should be conducted. I believe any movement looking to the consolidation of the two associations is going to be a still further drawback to the department that spends more money than any other department of the railroad business.

G. W. Wildin: It seems to be the burden of the argument which we have heard that someone is going to lose money by consolidation. I do not see that we are going to wipe the car men off the face of the earth, nor exalt the locomotive men. What we are trying to do is to get a first-class railway mechanical association that will embody in its membership all men who care to take part in it, without fear or favor to any.

With regard to the question of a man not knowing anything about cars because his principal work is with the locomotives, it is quite evident that Mr. DeVoy has not read the report of the committee very carefully, and the other committee reports presented at the meeting, or he would see that about 95 per cent of the committee men in the M. C. B. Association are really locomotive men and have never had any experience with car matters. If you select such men for committee men it is because they are capable of doing the work which is required of them. Take, for instance, the committee on Air Brakes and the committee on Train Brake Signal Equipment, and you have not a single car man on these committees doing the work of the association here; not a single car man, and I do not think you would find much better committee men than are on these committees if you look the entire car departments over. Take the committee on Brakeshoe Tests, what car man is there on that committee? Take the committees on Coupler and Draft Gear. You have two men, one connected with a private car line, yet they do not have any motive power man, and the other member is with a railroad company. Take your committee on Rules for Loading Material. You have one car man on that. Take the committee on Car Wheels, you have one car man on that. Take the committee on Safety Appliances, you have two car men on that—two car men out of seven members. It is evident that the executive committee of this association is either mistaken in selecting committee men, or some people are mistaken in their ideas of what constitutes a proper man to handle the work of these committees.

Now, there are other things besides the mere matter of wiping out the two associations. I am for consolidation, and I do not think that either association is going to lose anything. I think we should go further, although we did not think it quite proper to put these suggestions in the committee's reports. I think there are other associations that should be dealt with in this connection, and should be consolidated. There is no reason that I can see why, in the consolidation of the M. C. B. and M. M. Associations, we should not include the Traveling Engineers' Association and the Air-Brake Association. Each of these associations has a committee engaged in air-brake work. There is only one body that can do air-brake work and do it properly, and that is the Air-Brake Association, and that association ought to be a part of this proposed consolidated association. It should be a part of us, so that what work it does will have some weight. If it is endorsed by this association, it will have weight. As it is now, it formulates policies and practices, and each man goes home to his superintendent of motive power and tries to put these policies and practices into operation, and the matter has no weight whatever. The committees of that association are doing good work. The Traveling Engineers' Association have a Committee on Air-Brakes. That is also a good working committee, the Traveling Engineers' Association is a good working association, and it ought to be a part of this association in order to enable it to do its work most effectively. Then we have a General Foremen's Association, which has more to do with shop practices than any other organization—the superintendents of motive power are not in touch with them. They have a separate association, and in order to secure the greatest value from the work of that association, it ought to be a part of this association. We have associations all over the country that should be in this General Mechanical Association, and I believe it is only a matter of sentiment that keeps us from consolidating all of these associations. There is nothing to be lost by such a consolidation, and it will have to be made eventually. Every one of these other associations can give its actions no force without our endorsement, and if we endorse their work it will go into action. If they are a part of the new organization, the result would be that we would have more uniform and general practice.

Mr. Schroyer: I call for a point of order on this question. We are all out of order. We are not talking to the question —the question is, whether this report should be laid over for a year.

The President: The point of order is well taken. The chair has allowed this discussion to run along, because he thought it was desirable to get the expression of the members on the question. If there are two or three other members who have something to say, and you will permit the discussion to proceed, I think perhaps it had better be done.

H. H. Vaughan (C. P.): As a member of the committee of the Master Mechanics' Association on this subject, I would like to say that we thoroughly agree with the remarks made by Mr. Hennessey; but I do not believe that that point of view is one that affects the present question very seriously. The way we looked at it was that the question of the advisability of offering better lines for promotion to men in the car department was not one that was going to be affected by any action taken by these two associations. The only way we can look at this matter is that the consolidation of the car and locomotive departments under one heading has already been effected on the majority of railroads. The question of the advisability of that consolidation is one that we did not consider; we have to take things as they are and not as we might like them to be.

I am not by any means prepared to advocate the advisability of the consolidation of the car and locomotive departments. I do not think that is the question at issue. The chief question is, whatever our opinions of the matter may be, that on the majority of roads the car and locomotive departments are under the charge of a mechanical officer. They are two different departments, it is true, but they are under one general superintendent. We have to admit, from the facts which exist, that a large majority of the railroad companies have felt that to be the advisable method. It seems to me that the general feeling of a railroad executive is that he wants a mechanical officer to look to for the direction of both car and locomotive matters. He has his operating man on operating matters, his accounting man on accounting matters, a chief engineer on permanent way matters, and the chief executive of a railroad wants his mechanical man on car and locomotive matters; in other words, on most of the railroads of this country a mechanical department has been organized, and the car and locomotive departments have been merged into and combined in it.

I do not want to enter into any discussion of the relative merits of car and locomotive men in handling either car or locomotive matters. The discussion this morning has shown us distinctly that we have one man who is a locomotive man who knows all about car matters. I am sure he is a locomotive man because his title is such, at the same time he has no objection to coming here and taking a keen interest in the matters of the car department. I feel that is our general proposition—that whatever may be the advisability or non-advisability of the course, we have, as a rule, the same men interested in both car and locomotive matters.

Mr. Wildin has called your attention to the fact that we have mostly locomotive men on a great many of the committees of this association. I do not like that way of putting it. I must disagree with Mr. Wildin. I would say that the mechanical department is represented by a large number of men on the committees of the M. C. B. Association, and that a large number of the same men are on the committees of the M. M. Association. I also call your attention to the fact that your presidents and vice-presidents are men equally eligible to be officers of either the M. C. B. Association or the M. M. Association, and to a large extent the same men are interested today in both organizations. As Mr. Hennessey said, the car department is the department on the railroad that entails the expenditure of the most money. I do not think there are any railroads concerning which this is not true, and the consequence is that the officer in charge of the mechanical department of the railroad is practically compelled to attend the meetings of the M. C. B. Association on account of the large amount of interest he has in its meetings. He may have been a car man originally, or he may have been a locomotive man originally, through whichever line he has come up. He is obliged to take a deep interest in the convention of the M. C. B. Association because the proceedings of that association affect his road to such a vital extent.

I cannot but feel that the tendency has been for the meetings of the M. M. Association during the past few years to suffer from the fact that mechanical officers have been called upon to attend the M. C. B. Association on account of the importance of the subjects discussed at its meetings, and also on account of the spreading out of the time occupied by these two associations. It has been a quite frequent occurrence that these men have been obliged to go home, after attending the meeting of the M. C. B. Association, and neglect the meeting of the other association.

My feeling very keenly is that the M. M. Association is the one that needs this consolidation more than the M. C. B. Association. The M. C. B. Association has an amount of business interest to the railroads that compels the attendance of the mechanical department officers, while the M. M. Association, being more technical in its character, naturally suffers through the lack of attendance of these representatives and their failure to take the same interest in its proceedings which they take in the proceedings of the other association.

As far as the question of time is concerned, I do not want to paint any picture of how good an association we might have, or how much time would be saved, but I do feel that one association would be stronger and would have certain advantages over two. I do not think we would be straining beyond the breaking point by attending a convention in one week, instead of spreading it over two weeks, or what practically amounts to two weeks. It seems to me, if the associations were consolidated, that the man who is chiefly interested in locomotive subjects would stroll out and have a look at the exhibits while the question of the splicing of sills was being considered in the convention. On the other hand, the car man might not be interested in the question of superheat for the locomotive, and while that subject is being discussed he would have an opportunity to look at the exhibits. I firmly believe that the attendance at the exhibits would be improved by holding the convention within the period of one week.

I do not believe there is any necessity for regarding the report of the committee as final, but really, if you will look at the present convention, you will see that up to noon on the first day, the time was occupied in preliminary business, and there are only three and a half hours available on the last day, so that the time actually available in these conventions for discussing car and locomotive questions is really very limited when you consider the time that is spent by the members in getting to the meetings. The majority of mechanical officers who live, say twenty-four hours from Atlantic City, have got to give up practically two weeks to these conventions if they want to attend both of them. I feel that both conventions are of sufficient importance for us to attend them. We all feel that way, but I am quite sure that some of our executive officers do not feel that way. They think if a man consumes a week in attending these conventions, that is about all the time that should be consumed; and while I do not want to give the impression that the officers of the

Canadian Pacific are less willing to allow their men to take two weeks in attending the conventions than any other railroads, I do know they have a slight feeling that if I leave home on Monday and do not return until the second following Friday, I am putting in more time in attending the conventions than seems to be necessary. If I could leave home on Saturday and return on the second following Monday they would feel that that might be reasonably all the time that could be expected to be given to the work, and I cannot help feeling that that same sentiment is shared by the officers of other roads. I think they would like to see these associations handled in such a way that their mechanical officers could attend the meetings and not give up more than one week's time in doing so. Two weeks in a year is four per cent of your total time to attend these mechanical conventions as now conducted.

I would like to speak with regard to Mr. Schroyer's motion for a minute, if I may. When this matter came up, the committee had to consider if a consolidation was deemed desirable, how it could be effected. I regret to say that we were entirely unable to arrive at any decision in that matter. There are a number of legal questions involved, and, as I think you will realize from the motions made this morning, no one has any clear idea as to how this thing could be handled or in what way the vote should be taken.

It is a question in my mind as to whether the vote of the membership as a whole is constitutional, whether an amendment to the constitution would not have to be introduced to make such a vote effective. I must confess that I do not understand the legal standing of the M. C. B. Association, and I do not know that anybody else does. All these questions will have to be considered. My feeling, personally, is that Mr. Schroyer's motion is an exceedingly wise one, and it is exactly what should be done with this report—action on it should be delayed for a year to give everybody a good chance to think it over and come to some conclusion about it. It is too serious a thing to jump into without proper study. Your committees never desired any such action as would bring the consolidation about rapidly. All we expected was that the matter would be carefully considered, and carried along for a year or two, so that everybody interested could have a full and unlimited opportunity to thresh it over and see whether or not such a thing was desirable.

I believe we should add to Mr. Schroyer's motion, that the matter should be laid over for a year and, also, that it should be referred to the executive committee for further report and consideration, so that the committee may be in position to look up the legal questions concerning which, owing to a good many delays, we were unable to obtain any information. They might also look up the action that could be taken if a consolidation is deemed desirable. I think that is a matter for the executive committee to deal with. We were unable to do it on account of the delays in getting the consensus of opinion of the various members of the executive committee, and there again is an instance of the desirability of one good, strong executive committee. We took quite a lot of time in securing the consent of the executive committees of the two associations in order to procure authority to secure legal advice in the matter.

F. W. Brazier: As mover of the original motion, I will be only too glad to accept Mr. Vaughan's suggestion, and I want to thank Mr. Vaughan for the clear and concise way in which he stated the matter, without becoming excited. I believe it will do no harm to let the matter lie on the table for another year, and let the committee consider it. I am sure if the officials of the railroads were to attend our meetings and see our exhibition they would not have the opinion that we come here with any other purpose than that of a most serious desire to do the work mapped out for the meetings. All of the railroads of the country get the benefit of the work which we do. On the New York Central lines we are anxious to have our men attend these meetings, and the road gets the benefit of their talents and the knowledge which is secured at these conventions. If a larger number of the higher officials of the roads would attend the conventions occasionally, I am sure that they would have a very high opinion of the value of the work which we perform.

The President: The motion, as modified by Mr. Brazier, is that the subject be laid on the table for another year, that the executive committee of the association be instructed to consider the legal and other aspects necessary to put the matter through, and that the members be given an opportunity to further consider the matter.

The motion was carried.

The Secretary: In your voting for associate and life membership, the associate member proposed is Prof. Endsley, and the life member proposed is Thomas Millen. Inasmuch as there is only one candidate for each form of membership, you can vote "yes" or "no," no matter whether you put the name of the candidate on the ballot or not.

The President: The next business is the report of the committee on Classification of Cars, of which James Milliken (P. B. & W.) is chairman.

The report was read, approved and referred to letter ballot.

The report of the committee on Salt-Water Dripping from Refrigerator Cars was discussed briefly by E. W. Pratt and J. J. Hennessey and was then referred to letter ballot.

The report of the committee on Mounting Pressures for Wheels was accepted and ordered printed in the Proceedings, no action being taken.

The committee on Train Lighting submitted a report which was accepted after a short discussion. The committee was continued.

Lumber Specifications.

The report on Lumber Specification provoked a considerable discussion, which follows:

The Secretary: We have with us Mr. McCarthy, purchasing agent of the Rock Island, who is a member of the Storekeepers' Association, and Mr. Waterman, president of the Storekeepers' Association, both of whom are interested in this report. I would suggest that the privileges of the floor be extended to these gentlemen.

J. H. Waterman (C. B. & Q.): This is not a manufacturer's specification. We conceived the idea of having a joint committee of the three associations, the Railway Storekeepers', the Master Car Builders' and the Master Mechanics', to adopt uniform specifications for lumber and thus assist the storekeeper and everybody else in receiving, inspecting and grading lumber. That the committee has done a great deal of work you will note from the report, and especial mention should be made of Mr. McCarthy, who has given it a great deal of personal attention.

C. A. Seley (C. R. I. & P.): I regard this matter of the lumber specifications as one of the most important additions to our literature. The matter of selection and choice of lumber has gotten to such a critical period that we need exact definition of the different kinds of lumber to be used and exact definition of the various gradings covering the entire country. The following minor corrections and changes in the specifications are suggested by Mr. McCarthy:

Paragraph 24:—It is generally recognized that loblolly pine is not suitable for car material. These specifications cover car material only. Paragraph 24 will lead to considerable confusion and controversy, especially the following sentence: "Long leaf pine is descriptive of quality, and if Cuban short leaf, or loblolly pine is grown under such conditions that it produces a large percentage of hard summer wood, so as to be equivalent to the wood produced by the true long leaf, it would be covered by the term long leaf pine." The term "large percentage" is vague. After a piece of timber is cut and delivered it would be very difficult to prove or even indicate under what conditions it was grown.

Paragraph 1:—Same objections to this paragraph as outlined above.

Paragraph 36:—Would recommend that the word "or" be inserted between "large" and "coarse" Make this item read as follows: "Rot and large knots or coarse spike knots."

Paragraph 37:—There might be some objection to including 8 foot and 9 foot lengths in car lining, although of course this could be provided for in specifying, particularly in ordering, as to the lengths ordered.

Paragraphs 37, 38, 39, 40, 41, 43, 44, 45:—All of these grades include the admission of firm red heart. This is about the only defect admitted that might be considered as a form of rot or decay, at least in the earlier stages, and might be objected to for car siding, lining, roofing and decking.

Paragraph 47:—This specification prohibits doty or rotten red heart, which is construed probably as admitting firm, red heart. On the ground that red heart in any form is the first stage of decay, it would seem that it might be objectionable, either firm or doty, and especially in car sills where strength is required.

Paragraph 46:—There might be some objection to including 8 foot and 9 foot lengths in car lining, although of course this could be provided for in specifying, particularly in ordering, as to the lengths ordered.

Paragraph 48:—This specification prohibits doty or rotten red heart, which is construed probably as admitting firm red heart. On the ground that red heart in any form is the first stage of decay, it would seem that it might be objectionable, either firm or doty, and especially in car sills where strength is required.

Paragraph 49:—You will note the specifications as drawn call for ½ ft. full over the dressed sizes required. At the present time I think a number of roads are purchasing sills and framing ¼ in. full over the dressed sizes, and I give you below difference in price of 5x9 sill 36 ft. long, at $20.00 per M:

5¼ in. x 9¼ in. x 36 ft. = 144.2 = $2.88

5½ in. x 9½ in. x 36 ft. = 156.9 = 3.14 = 26.

If the sills are only cut ¼ in. full over the sizes, there would be places where they would not dress smoothly, but this might not be objectionable in the construction of the car, and further from the fact that sills will probably only be used hereafter for repairs.

Exhibit C:—These diagrams are not intended to represent the actual sticks, but simply theoretical conditions which show how the percentage of sap in hardwood should be measured.

Section V (C):—Objection might be made to the admission of any defect "on 20 per cent of the pieces in each car shipment." If the defect is one that is omitted or excluded on one piece, there should be no reason why it should not be the same on every other piece for the same purpose, inasmuch as each size is ordered for a specific purpose or part of a car and has an individual use. In a car loaded with large sizes and small sizes mixed, it would be very difficult to apply this rule satisfactorily to all parties on account of the various sizes and wide range of number of pieces of each that might be included in any one shipment

Paragraph 43:—There might be some objection to including 8-ft. and 9-ft. lengths in car lining, although, of course, this could be provided for in specifying particularly in ordering as to the lengths ordered.

This list of modifications or suggestions has been gotten together since the report was put in print. I know somewhat of the arduous work that has been done by the committee, and the amount of expense and travel and study they have put upon it, and I doubt very much if it would pay us to go into an extended discussion of these details. In general, however, considering the importance of the question of having a lumber specification, or at least the start of one, I make a motion that this specification be put into the Recommended Practice of the association, together with notes covering the features or suggestions which have been read, so they can be in completed form, and that the committee be continued or made a standing committee.

J. F. DeVoy (C. M. & St. P.): I spent all the time I possibly could in assisting in this work. There is no man familiar with lumber but who can find fault with some portions of the report, and I do not believe that any explanation at this time will make the specifications any more clearly desirable. It has taken an awful lot of work, and it appears to me that the committee has done all in its power at this time to give you what it thought best, in a specification, for at least a starter, and I would like to see the report at least passed to Recommended Practice.

Mr. Seley: I move that the report of the committee, together with the suggestions that have been submitted, be referred to letter ballot as Recommended Practice of the association, and that the committee be continued.

Mr. Brazier: We are very much indebted to the Storekeepers' Association for the good work they have done. There must have been a tremendous lot of work on the report. I think the thanks of the association are due to the committee as well as to the Storekeepers' Association for the work they have done.

F. H. Stark (Pittsburgh Coal Company): Would it not be well to have the suggestions made by Mr. Seley referred back to the committee, so that it could be given the privilege of considering them and correcting the report accordingly? During the next twelve months the railways will have these specifications printed. The lumber dealers will have become accustomed to them, more or less, and it seems to me that it is placing a burden on the railways as well as on the dealers. There are one or two points that Mr. Seley has brought up, especially with reference to adding one-half inch to the finished dimension, which I think are excessive. If we could refer it back to the committee I am quite sure it would recognize those points.

Mr. Seley: The suggestions which I have submitted are not my own. They are the expression of the chairman of one of the committees which had the matter in hand. While I do not believe that any matter so extended as this specification would in all respects meet the necessities or the requirements of all the railways, yet we have a framework of a very fine definition and specification for lumber.

Mr. McCarthy: If this specification is accepted by the convention we will ask the various lumber associations to adopt it as their standard. They will print and issue it, and it will not be necessary for the railway companies to go to any expense; they can purchase lumber under these specifications or under their own, if they desire. If they will use these specifications they will find it much easier to get the lumber, and I think they will get it cheaper. It is the intention to have a book printed showing the lumber specification adopted by the Master Car Builders' Association, and issue it to the trade.

The motion was carried.

F. W. Brazier (N. Y. C. & H. R.): I think many of us were very much surprised when we got our notices of the convention to find that we were going to have a morning and an afternoon session, so provided in the By-laws as to require notice a day in advance to make it one session. I would like to move that this article of the By-laws be changed to read: "The regular hours of session shall be arranged by the Executive Committee, and published on the programme for each meeting." Next year the Executive Committee can call us together the first day, from ten o'clock to half-past one, and, if necessary, we can have an afternoon session and convene the next day at nine o'clock. I would rather get to work early in the morning, get through and have the time in the afternoon than to have the meetings called at ten o'clock. This will simply lie on the table, and next year, if you do not like it, you can kill it.

The motion was carried.

Election of Officers.

The President: As a result of the election, I declare T. H. Curtis elected president; A. Stewart, C. E. Fuller and D. F. Crawford, vice-presidents; John S. Lentz, treasurer; J. D. Harris, C. E. Fuller and C. A. Seley are elected members of the Executive Committee. As members of the Committee on Nominations: J. F. Deems, A. W. Gibbs, C. A. Seley, W. H. Lewis and J. F. Walsh.

Gentlemen, in turning over the gavel to my successor, I want to thank you for your attendance at this meeting and for the way in which you have assisted me during the session to conduct the business of the association, and also for the assistance rendered during the year in conducting the general business of the association. I want particularly to thank the members of the various committees for the work they have done. I now take pleasure in presenting your new president, T. H. Curtis.

President Curtis: I understand that before we adjourn E. M. Grove, chairman of the Supply Men's Association, desires to say a few words.

Mr. Grove: I wanted to say to your past president a lot of very nice things concerning the manner in which he has conducted the business of the association during the past year, and how well he has done it. We have all appreciated his good service, and personally I have thoroughly appreciated the very good offices that he has extended to the officers of the Railway Manufacturers' Association. His very harmonious treatment of us has lessened our labors. I want at this time, Mr. Clark, to present to you an emblem of our appreciation of that service, which I trust you will treasure, not from its intrinsic value, but as an expression of the good will not only of the members of this association, but also of the Railway Supply Men's Association. I feel that you have deserved it. We are very glad to have you receive it, and I know you will wear it with honor to yourself and credit to both associations; and now, sir, on the eve of your departure across the briny deep, we wish you God-speed, a pleasant journey and a safe return.

Mr. Clark: Gentlemen, I felt at the time of my election last year that I did not adequately express my appreciation of the honor conferred upon me, and I want to say to you that the sense of the honor then conferred has been growing upon me ever since. The work of the association is exceedingly important, and as I indicated a moment ago, I have had a growing appreciation of that fact. I feel in retiring that you have done me a great honor. I appreciate it, and I appreciate the emblem which has been presented to me, and assure you that I shall always wear it with great pleasure, and feel honored in being able to wear it. I thank you, gentlemen, and the gentlemen of the Railway Supply Men's Association, for the kind words of their president, Mr. Grove.

Mr. Brazier: Before we adjourn I would like to move that a vote of thanks be extended to Mr. Clark, our retiring president, for the dignified and able manner in which he has presided over our meetings. Associations of this character are judged by the men who are at their head, and the M. C. B. Association has been honored by the fact that Mr. Clark has been its president.

The motion was unanimously carried by a rising vote.

Adjourned.

List of Exhibitors and Their Representatives, Atlantic City Conventions.

The exhibiting concerns at the mechanical conventions this year number 228 as against 200 of last. The names of the companies and representatives at the pier are as follows:

Acme White Lead & Color Works, Detroit, Michigan.—Railway paints, enamels, colors and varnishes. Represented by D. E. Robinson, K. J. Bowers and H. C. Cater.

Adams & Westlake Company, Chicago, Ill.—Electric, gas and oil car lighting fixtures; basket racks; car hardware; white Ajax metal washstands; signal lamps and lanterns; white Represented by E. L. Langworthy , G. L. Walters, C. B. Carson, F. N. Grigg and E. H. Stearns.

American Arch Company, New York, N. Y.—Booth for reception of visitors. Represented by Le Grand Parish, C. B. Moore and J. W. Nicholson.

American Balance Valve Company, Jersey Shore, Pa.—Jack Wilson balanced high pressure slide valves; semi plug piston valves; Walschaert valve gear, and Wilson Stevens valve gear. Represented by J. T. Wilson, Frank Trump and C. C. Young.

American Brake Company, St. Louis Mo.—Automatic slack adjustable and flexible metallic joint for use between the engine and tender. Represented by E. L. Adreon.

American Brake Shoe and Foundry Company, Mahwah, N. J.—Locomotive brake shoes; locomotive brake heads; coach brake shoes; car brake shoes. Represented by Otis H. Cutler, J. S. Coffin, J. B. Terbell, F. W. Sargent, E. W. VanHouten, W. S. McGowan, E. L. Janes, E. B. Smith, G. R. Law, R. M. Brower, A. H. Elliot, F. H. Coolidge, R. E. Holt, E. A. Gregory, F. L. Gordon, J. S. Thompson and L. R. Dewey.

American Car and Foundry Company, New York, N. Y.—Booth reserved for social purposes only. Represented by Scott H. Blewett, S. S. DeLano, William C. Dickerman, Clark D. Eaton, John McE. Ames, A. E. Ostrander, George A. Johnson, William F. Lowry, H. P. Field, Jr., and William H. Hager.

American Car Screen Company, Pittsburgh, Pa.—Adjustable car window screens. Represented by L. S. Klein.

American Engineer and Railroad Journal, New York. N. Y.—Represented by J. S. Bonsall, F. H. Thompson, E. A. Averill and Oscar Kuenzel.

American Locomotive Sander Company, Philadelphia, Pa.—Leach locomotive pneumatic track sanders. Represented by Morris B. Brewster, C. B. Ford, C. L. Mellor, J. S. Mace, H. M. Wey and E. Curtiss.

American Mason Safety Tread Company, Boston, Mass.—Mason safety treads; Empire treads; Karbolith composition floors for coaches and buildings. Represented by Henry C. King.

American Nut and Bolt Fastener Company, Pittsburgh, Pa.—Diamond truck equipped with Bartley positive fasteners; stand showing application of multiple and wood fasteners, and other designs of Bartley fasteners. Represented by Milton Bartley, Harvey Bartley, Edwin M. White, Christopher Murphy and Robert Spencer.

American Radiator Company, Chicago, Ill.—Steam and hot water boilers; radiators; tank heaters; hot blast heaters; improved car heaters; packless valves; temperature regulators and automatic air valves. Represented by James H. Davis and J. H. Ives.

American Railway Steel Tie Company, Harrisburg, Pa.—Steel ties. Represented by S. S. Blair, Jno. G. Snyder and J. E. Striewig.

American Steel Foundries, New York, N. Y.—Andrews side frames; cast-steel bolsters; Simplex bolsters; Susemihl side bearings; springs; brake beams; R. E. Janney coupler; Simplex couplers; Davis steel wheels; Economy draft arms; miscellaneous steel castings. Represented by Wm. V. Kelley, R. P. Lamont, W. W. Butler, Geo. E. Scott, D. W. Call, R. H. Ripley, J. C. Davis, T. D. Kelley, J. V. Bell, G. F. Slaughter, F. K. Shults, W. Ross Gravener, Geo. C. Murray, P. J. Kalman, Theodore Cook, D. T. Harris, J. W. Dalman, A. R. Brunker, W. A. Blanchard, A. S. Crozier, T. H. Hopkirk, R. E. Janney, P. M. Armendaris, G. G. Floyd, F. B. Ernst, C. E. Bauer, J. Soule Smith and Louis E. Jones.

American Vanadium Company, Frick Building, Pittsburgh, Pa.—Vanadium alloys; vanadium iron and steel products, such as railway machinery and engineering steels; vanadium steel forgings; vanadium steel castings; vanadium cast-iron cylinders, bushings, piston rings, valves, etc.; vanadium brass, bronze and aluminum. Represented by James J. Flannery, Joseph M. Flannery, Wm. J. Bird, Geo. L. Norris, C. L. Hastings, R. B. Steele and M. V. Prendergast.

Exhibit of Ford & Johnson Co.

Exhibit of the Carnegie Steel Co.

Mr. and Mrs. Burton W. Mudge and Burton, Jr.

Anchor Packing Company, Philadelphia, Pa.—Metal and fibrous packings and mechanical rubber goods. Represented by L. E. Adams and W. R. Haggart.

Armstrong-Blum Manufacturing Company, Chicago, Ill.—Marvel power hack saw machines; portable grinders for lathes and planers; lever punches and shears; metallic weather strip for coaches. Represented by Francis J. Blum and George J. Blum.

Armstrong Brothers Tool Company, Chicago, Ill.—Tool holders, ratchet drills and machine shop specialists. Represented by Paul Armstrong and James W. Barber.

Barco Brass and Joint Company, Chicago.—Flexible joints and steam connections between engine and tender and between cars; exhaust horns and valves for gas and gasolene engines, inspection cars, etc. Represented by F. N. Bard.

Besly & Company, Charles H., Chicago, Ill.—No. 14 Besly spiral disc grinder, Helmet spiral circles, temper taps, oil and babbitt. Represented by Edward P. Welles, Charles A. Knill and W. H. Allen.

Bettendorf Axle Company, Davenport, Iowa.—One 50 ton, single center sill Bettendorf steel underframe mounted on Bettendorf trucks; one 40 ton, double center sill Bettendorf steel underframe mounted on Bettendorf trucks; one model of all steel box car; one Bettendorf truck for demonstrating how easily same can be assembled and dismantled. Represented by J. W. Bettendorf, E. Bettendorf, J. H. Bendixen, A. F. Macpherson, G. N. Caleb, E. E. Silk, W. G. Ransom and C. J. W. Clasen.

Bird & Company, J. A. & W., Boston, Mass.—Repolin signal joint paper; refrigerator felt; red and black paper.

Bowser & Company, Inc., S. F., Ft. Wayne, Ind.—Oil storage system complete; long distance, self-measuring pumps; power pumps; automatic registering oil meters; oil storage tanks of all sizes and shapes, with pumps for handling and measuring all kinds of lubricating, paint, and other oils, including gasolene, etc.: suitable for storehouses, machine and paint shops, round houses, engine rooms, signal towers, automobile garages. Represented by C. A. Dunkelberg, L. F. Johnson, W. T. Simpson and F. T. Hyndman.

Boyle & Company, Inc., John, New York, N. Y.—Bayonne roof and deck cloth, a scientifically treated cotton duck for car roofing; cotton ducks, cotton drills and sheetings for head linings, upholstering, etc. Represented by E. L. Dayton and W. F. O'Connor.

Brill Company, J. G., The, Philadelphia, Pa.—Brill No. 27-M. C. B. 3 truck, a Master Car Builders' type of truck for high speed, electric and steam passenger service; solid forged wheel pieces, including pedestals; woven cane, canvas lined and unlined, for car seats. Represented by J. W. Rawle, W. H. Heulings, Jr., A. H. Pease, S. M. Wilson and J. N. Nind, Jr.

Brown Automatic Hose Coupler Company, Cleveland, Ohio.—Hose couplers.

Buck Boring Bar Company.—The Buck boring bar.

Buckeye Steel Casting Company, Columbus, Ohio.—Major, Columbia and Universal couplers; truck and body bolsters; truck frames; journal boxes; pivoted yoke. Represented by J. C. Whitridge, Geo. Groobey, G. T. Johnson and F. L. Allcott.

Buffalo Brake Beam Company, New York, N. Y.—Brake beams for all classes of cars, locomotives and electric equipment, meeting Master Car Builders' standards and railway companies' requirements. Represented by S. A. Crone, Edwin Strassburger, Thomas E. Carliss, Roland C. Fraser, C. E. Barrett and C. J. Zacher.

Burroughs Adding Machine Company, Detroit, Mich.—Burroughs adding machine, electrically driven, for railroad accounting. Represented by F. A. Willard, E. G. Griffith and A. H. Cato.

Butler Drawbar Attachment Company, Cleveland, Ohio.—Friction draft gear; Piper patents for 9⅛ yoke; the same for 6½ yoke narrow sill spacing; Piper's patents combined with Farlow attachment; Tandem spring draft gear. Represented by Geo. L. Weiss and W. B. Waggoner.

Buyers' Index Company, Chicago, Ill.—Purchasing agents' buying list. Represented by Lloyd Simonson, D. J. Beaton, F. B. Cozzens and H. E. Frame.

Carborundum Company, Niagara Falls, N. Y.—Carborundum and Aloxite wheels, sharpening stones, rubbing bricks;

"Bob" Patterson and J. T. McGrath, Master Mechanics of the Grand Trunk and Survivors of the Broken Triumvirate.

Exhibit of the Chicago Ry. Equipment Co., G. M. Sweringer, David Newhall and C. H. Williams, Jr. The Man with the Dark Complexion is T. Stanley Hicks, Owner of the Exhibit.

Buffalo Brake Beam Co., A. C. Crone, P. H. Minshull, W. H. Kenney and A. C. Summers.

Carborandum paper and cloth; Garnet paper; Carborundum valve grinding compound. Represented by George R. Rayner, C. C. Shoemaker, Charles Nicholson, R. H. Hogg and C. C. Lathrop.

Cardwell Manufacturing Company, Chicago, Ill.—See Union Draft Gear Company.

Carnegie Steel Company, Pittsburgh, Pa.—One section of standard railway track laid with 100 pound rails and Du-Duquesne joints; nickel-plated samples steel sheet, piling, one section portable track for industrial railways laid on steel cross ties; various samples of rails, cross ties and Duquesne joints; nickel-plated samples steel sheet piling; pyramid of spike and bolt kegs bound with patent steel hoops; pair of high record Schoen freight car wheels; 33-in. Schoen steel engine truck wheel with large back hub; 36-in. Schoen passenger train car wheel; 33-in. Schoen tender truck wheel; 34-in. Schoen steel wheel for street railways; 34-in. Schoen steel wheel for interurban railways; 33-in. freight car wheels rolled to a finish—one made by the Schoen process and one made by the Slick process of manufacture; exhibit of soft welding and threading steel, composed of car truck section, arch bars, locomotive and car forgings, with samples of screw stock. Represented by H. P. Bope, Samuel A. Benner, John C. Neale, W. G. Clyde, L. C. Bihler, W. A. Bostwick, E. E. Slick, John McLeod, E. S. Mills, R. B. Woodworth, V. S. Yarnall, N. B. Trist, John W. McGrady, L. W. Conroy, W. F. Evans, Charles Orchard and James B. Bonner.

Carter Iron Company, Pittsburg, Pa. Stay-bolt iron, chain cable iron, engine bolt iron. Represented by Christopher Murphy and Robert Spencer.

Celfor Tool Company, Chicago, Ill.—Celfor high-speed drills, reamers, countersinks, three-lipped drills. Rich flat drills, Celfor duplex and precision chunks, reamer sockets, etc. Represented by E. B. Clark, William Brewster, M. L. Hanlin, J. J. Dale, Chas. A. Bucher and Edwin B. Ross.

Central Electric Company, Chicago, Ill.—Okonite wires, cables, cords and tapes, car fans, wall, oscillating and exhaust car lamps; tungsten, tantalum and gem shallow flush switches; train connections with automatic runaround opalus shade. Represented by Charles E. Brown, J. M. Lorenz and D. Woodhead.

Chase & Company, L. C., Boston, Mass.—Goat brand car plushes in plain and frieze effects; Angora mohair showing process of manufacture; Chase's car seat duck. Represented by Frank Hopewell, R. R. Bishop, Jr., and W. P. Underhill.

Exhibit of the American Car Screen Co., L. S. Klein.

One of the Westinghouse Exhibits.

Chicago Pneumatic Tool Company, Chicago, Ill.—Air compressor and four special drills. Represented by Thomas Aldcorn, C. E. Walker, G. A. Barden and A. B. Inness.

Chicago Car Heating Company, Chicago, Ill.—Vapor system of car heating; atmospheric pressure heating system; multiple regulation heating system; heating systems for sleeping cars, private cars and special cars; steam-hose couplers; end train-pipe valves; control valves; supply valves; cut-out valves; vertical steam traps and car heater fittings. Represented by Egbert H. Gold, Jos. E. Buker, Thos. F. Downing, Frank F. Coggin, Edw. A. Schreiber, W. H. Hooper, B. A. Keeler, Eugene E. Smith, C. B. Benson and J. R. Reniff.

J. Faessler and Tom Plunkett.

Chicago Railway Equipment Company, Chicago, Ill.—Brake beams of the "P. C." Creco, "E. L." Creco, Creco, Diamond National Hollow, Kewanee, Drexel, Reliance, Sterlingworth, Ninety-six and Monarch types; Monitor bolsters; Creco roller side bearings; Creco slack adjuster; Creco journal box and lid; automatically adjustable brake heads; Rigio removable leads. Represented by E. B. Leigh, Arthur Wyman; F. T. DeLong, F. G. Ely, B. F. Pilson, Raymond H. Pilson, G. A. Sweringer, C. P. Williams and C. H. Williams, Jr.

Chicago Steel Car Company, Chicago, Ill.—Models of tank car, steel underframes and reinforcements. Represented by J. E. Chisholm and H. C. Priebe.

Chicago Varnish Company, Chicago, Ill.—Car sides, showing "Ce Ve Process" of saving in cost of painting cars. Represented by O. H. Morgan, O. R. Ford, T. M. Murray, Geo. S. Bigelow and F. L. Olds.

Chisholm & Moore Manufacturing Company, The, Cleveland, Ohio.—Complete line of our cyclone high-speed chain hoists, from ½-ton to 30-ton, inclusive; also some of our matchless 1 beam trolleys; a working model of our 5-ton cyclone hoist with cover removed, showing the internal construction of this hoist. Represented by H. E. Dickerman and W. E. Ludlow.

Cleveland Car Specialty Company, Cleveland, Ohio.—Pressed steel carlines for freight cars; pressed steel end tie bands for freight cars; pressed steel side posts, window posts, door posts; upper and lower deck carlines, main carlines, etc., for passenger cars; pressed steel carlines for baggage and express cars; pressed steel spring plank for car

W. P. Chrysler, J. E. Chisholm, E. Hacking, and W. H. Hooper. The Three First Named are all Past Heads in the Chicago Great Western Mechanical Dept.

and tender trucks; pressed steel automobile side frames and braces. Represented by Geo. L. Weiss, W. S. Bidle, Jos. A. Costello and W. B. Waggoner.

Clow, James B. & Sons, Chicago, Ill.—Automatic closets; drinking fountains; lavatories; Triumph heaters for signal cabins; Buena radiators. Represented by J. L. Ponic and L. J. Elliott.

Coe Brass Manufacturing Company, The, Ansonia, Conn.—Extruded metals in great variety of intricate designs especially adapted to railway car construction and ornamentation; also for use in electrical and other apparatus. Represented by E. J. Steele, Charles E. Van Riper, William W. Cotter and William H. Rippere.

Coe Manufacturing Company, W. H., Providence, R. I.—Coe's ribbon gold leaf and Coe's gilding wheels.

Commercial Acetylene Company, The, New York City, N. Y.—Acetylene headlights; markers and tail lights for locomotives; acetylene signal lamps and car lighting system; acetylene safety storage tank, showing asbestos packing; flashing apparatus as used by U. S. Government for buoys, beacons and lighthouses, with sun valve, which automatic-

Fairbanks, Morse & Co., G. J. Akers, A. A. Taylor, J. W. Motherwell, F. M. Condit, A. C. Dodge and E. M. Fisher.

Walker & Bennett Mfg. Co., John Havron, S. A. Walker, K. D. Hequembourg.

ally shuts off and turns on the gas. Represented by H. G. Doran, R. J. Faure, Oscar F. Ostby and E. T. Sawyer.

Commonwealth Steel Company, St. Louis, Mo.—Catalogues; printed matter; models, etc. Represented by H. M. Pflager, Geo. E. Howard, Boone V. H. Johnson, Frank S. Barks and C. F. Frede.

Consolidated Car-Heating Company, Albany, N. Y.—Steam couplers with automatic locks; steam traps, both vapor and pressure; electric heaters and switches for 600 and 1,200 volt operation; automatic safety train signal; consolidated buzzer system; electric boilers. Represented by Cornell S. Hawley, W. S. Hammond, Jr., Thomas Farmer, Jr., and H. L. Hawley.

Consolidated Railway Electric Lighting and Equipment Company, New York, N. Y.—Type "d" equipment 4 K. W., capacity for either 60 or 30 volts in connection with Kennedy regulator. Type "F" equipment 2 K. W., capacity for 60 or 30 volts in connection with Kennedy regulator, besides separate parts of all machines showing their construction. Represented by P. Kennedy, J. L. Watson, Thos. L. Mount, L. J. Kennedy and W. R. Hungerford.

Continental Railway Equipment Company, Chicago.—The Murray draft gear. Represented by George C. Murray.

Cooper Hewitt Electric Company, New York, N. Y.—Mercury vapor lamps and rectifier for operating same. Represented by J. P. O'Shea, F. R. Fortune, F. M. Haviland and M. B. Buckman.

Crane Company, Chicago, Ill.—Cranetilt steam traps; motor operated valve; Crane blow-off valve; locomotive safety valve; locomotive cab hose valves; automatic quick opening locomotive blower valves; locomotive cab valves; brass valves of all kinds; malleable and cast-iron fittings. Represented by F. D. Fenn and G. S. Turner.

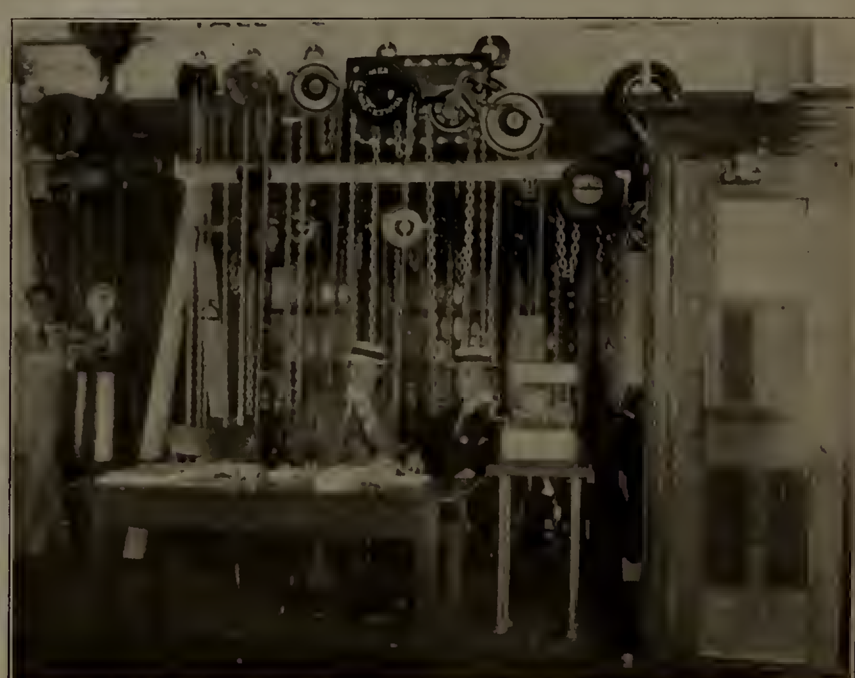
Crosby Steam Gage and Valve Company, Boston, Mass.—Locomotive safety valves, gages and blow-off valves: Testing instruments. Represented by E. C. Kenyon, J. J. McCormick and A. B. Carhart.

Curtain Supply Company, The, Chicago, Ill.—88 ring fixtures; 86 roller tip fixtures; full line of curtain materials; "CSCO," "REX" and "VICTOR" diaphragms; Number 6 roller bearing hooks, and automatic releasable handles for vestibule passageway curtains. Represented by W. H. Forsyth, R. F. Hayes and S. W. Midgley.

Damascus Brake Beam Company, Cleveland, O.—"Waycott Special" high speed beams; Waycott freight beams (Nos. 1 and 2); all steel trussed beam with forged steel heads and forged steel fulcrum (no castings); adjustable brake heads, etc. Represented by Albert Waycott, P. T. Handiges and E. S. Smith.

Davis Solid Truss Brake Beam Company, Wilmington, Del.—Davis solid truss brake beams; solid steel brake shoe backs; Davis universal air brake; specially designed deflec-

Chicago Varnish Co., Mr. and Mrs. T. M. Murray.



Yale & Towne Exhibit, C. W. Beaver and H. Gilbert.

Spencer Turbine Cleaner Co., E. W. Muzzey and G. H. Noble.

Miss Daisy Gallagher, Geo. W. Clancy, and Mrs. G. W. Clancy on the Pier.

tometer for accurately measuring deflection of brake beams. Represented by Nathan H. Davis, Thos. C. Davis, C. Theo. Buchholz and Chas. F. Perkins.

Dearborn Drug & Chemical Works, Chicago, Ill.—Water treating preparations for the prevention of scale, leaking, foaming and corrosion in locomotive boilers; water analyzed and treatment specially prepared to suit conditions. Represented by George R. Carr, Grant W. Spear, J. D. Purcell, A. W. Crouch, W. S. Reid and H. G. McConnaughy.

Detroit Hoist and Machine Company, Detroit, Mich.—Pneumatic and electric turntable tractors; geared pneumatic hoists. Represented by J. C. Fleming and Frank B. Fleming.

Detroit Lubricator Company, The, Detroit, Mich.—Locomotive lubricators, Numbers 0, 5, 11, 21, 31, 41 and 61; single, double and quadruple feed types of sight feed air cylinder lubricators; transfer system for filling lubricators; visible sight feed guide cups; automobile and gas-engine mechanical valveless force feed oil pumps. Represented by F. W. Hodges, Herbert I. Lord and A. D. Homard.

Dickinson Inc., Paul, Chicago, Ill.—Dickinson cast iron smoke jack; fire-proofed wood smoke jack; cast iron ventilators; cast iron chimneys. Represented by W. E. Chester, A. J. Filkins, Edward W. Hodgkins and J. A. Meaden.

Disston & Sons, Inc., Henry, Philadelphia, Pa.—Metal cutting saws and hand saws of all kinds; regular and superfine files; try squares; screwdrivers and spirit levels. Represented by Geo. Koon, W. T. Lindsey and E. A. Platt.

Dixon Crucible Company, Joseph, Jersey City, N. J.—Graphite products especially adapted for railroad work, including the Dixon pure flake lubricating graphite; graphite greases; silica-graphite paint; crucibles; belt dressings and pencils. Represented by Wm. J. Coane, H. A. Nealley, R. R. Belville, F. R. Brandon, J. J. Tucker, Wm. A. Houston, H. W. Chase and L. S. Snyder.

Dressel Railway Lamp Works, The, New York, N. Y.—Locomotive headlights; engine classification lamps; train tail lamps; coach lamps; switch lamps; semaphore lamps; caboose lamps; station lamps; gauge lamps. Represented by F. W. Dressel, Robert Black, H. S. Hoskinson and F. W. Edmunds, Edward W. Hodgkins, B. P. Claiborne and M. B. Williston.

Duff Manufacturing Company, The, Pittsburg, Pa.—Barrett track jacks; automatic lowering jacks; geared ratchet jacks; Duff ball bearing screw jacks; Duff-Bethlehem hydraulic jacks; Independent pump hydraulic jacks. Represented by T. A. McGinley, G. A. Edgin and E. A. Johnson.

Duntley Manufacturing Company, Chicago.—Duntley pneumatic en-route car cleaner; Duntley air purifier for passenger coaches. Represented by G. A. Graber, A. S. Foote and G. P. Foute.

American Metal Hose Co., J. Kahn.

Landis Machine Co., J. G. Benedict.

Exhibit of Paul Dickinson. Left to Right.—John Nicholson, J. A. Meadows and A. J. Filkins.

F. W. Miller and C. D. Bauers. Busier than they look.

Durbin Automatic Safety Car Coupler Company, The, Fort Scott, Kans.—Automatic safety car coupler or draw bar. Represented by C. T. Hunn, V. S. Durbin and J. F. Durbin.

Edwards Company, The O. M., Syracuse, N. Y.—Car window fixtures; sash balances; shade rollers; metal cash; metal trapdoors; sheet metal specialties and railroad padlocks. Represented by O. M. Edwards, E. F. Chaffee, J. J. Edwards, C. H. Rockwell, W. C. Bradbury, E. W. Edwards, 2d, Harold Edwards and T. P. O'Brien.

Electric Hose & Rubber Company, Wilmington, Del.—Braided fabric rubber hose. Represented by A. W. Archer, Jr., Wm. M. Sibley, E. F. Brownworth, C. R. Blanchard, C. D. Garretson and J. DeW. Archer.

Electric Storage Battery Company, The, Philadelphia, Pa. —Storage batteries for car lighting, signal, vehicle propulsion and automobile ignition service. Represented by J. R. Williams, Charles Blizard, E. L. Reynolds, F. L. Kellogg and H. E. Hunt.

Faessler Manufacturing Company, J., Moberly, Mo.—"Boss" improved sectional tube expanders and the Smith driving box. Represented by J. W. Faessler, C. F. Palmer and L. K. Smith.

Fairbanks, Morse & Company, Chicago, Ill.—Gasolene section and inspection motor cars; telescopic standpipe and sectionalized valve; chain hoists; tools; rail drills; power pump and motor; line of Geared Ratchet; Ratchet; ball and cone bearing screw jacks and hydraulic jacks. Represented by A. A. Taylor, Geo. J. Akers, E. M. Fisher, F. M. Condit and A. C. Dodge.

Flannery Bolt Company, Pittsburgh, Pa.—Tate flexible stay-bolts; installation tools for applying Tate bolts; radial crown stays and button head crown stays; "F. B. C." nut locks. Represented by B. E. D. Stafford, Geo. E. Howard, Tom R. Davis, Barton H. Grundy, J. Rogers Flannery, Wm. M. Wilson and Thos. J. Leahey.

Flower Waste & Packing Company, New York, N. Y.—Resilient journal packing. Represented by Frank D. Waller and George T. Hanchett.

Ford & Johnson Company, The, Michigan City, Ind.—Car seats of various types; cane webbing used in car seats; reed and fibre rush chairs for railroad service. Represented by A. D. Martin, G. T. Paraschos, Wm. E. Murphy, B. H. Forsyth and C. A. VanDerveer.

Foster, Walter H., New York, N. Y.—Bolt turning machine; staybolt threading and reducing machine; one Potter & Johnson bolt altering machine; staybolt drilling machine; automatic nut-tapping machine; one chaser grinder; lathe dog. Represented by Walter H. Foster and C. K. Lasseter.

Forsyth Brothers Company, Chicago.—Forsyth centering device; friction draft gear; cast steel yoke for freight cars; pressed steel doors; Brinkerhoff side construction for pas-

Walter Macleod & Co. W. T. Dunning, W. A. Hicks and Walter Macleod.

General Ry. Supply Co. D. Dunbar and C. A. Carlson.

Exhibit of the Dearborn Drug & Chemical Co.

senger cars; pressed steel mouldings and sash. Represented by A. H. Sisson and Mr. Davidson.

Franklin Manufacturing Company, Franklin, Pa.—85 per cent magnesia boiler lagging and pipe coverings; corrugated asbestos roofing or sheathing; asbestos "Century" shingles and asbestos building lumber; asbestos "Century" smoke jacks; "Ambler" asbestos ring air pump and throttle packings; asbestos pipe coverings and asbestos supplies; "Springtite" corrugated copper gaskets; composition metallic gaskets; "Chapman" circular glass cutter; Perfection journal box packing; wool and cotton waste. Represented by R. J. Evans, E. R. Rayburn, L. B. Melville, Geo. S. Stuart, H. S. Hayward, Jr., and Fred Alford.

Franklin Railway Supply Company, New York, N. Y.—Booth containing files of daily papers from different parts of the United States. Represented by J. S. Coffin, Samuel G. Allen, A. G. Elvin, C. L. Winey, R. G. Coburn and W. L. Allison.

Frost Railway Supply Company, The, Detroit, Mich.—Harvey friction spring gears in different sizes; Detroit metal weather strip. Represented by Harry W. Frost, George A. Cooper and George L. Harvey.

Galena-Signal Oil Company, Franklin, Pa.—Reception booth. Represented by S. A. Megeath, C. C. Steinbrenner, E. V. Sedgwick, Harry Hillyer, J. W. Bunn, E. H. Baker, J. P. Ferguson, F. A. Guild, B. H. Grundy, A. I. Gifford, E. W. Grieves, Wm. Holmes, E. G. Johnson, Geo. L. Morton, W. E. Maher, Robert McVicar, L. H. Palmer, J. S. Patterson, P. H. Stack, W. A. Trubee, W. J. Vance, John A. Wilson and W. J. Walsh.

Exhibit of Jos. W. Dixon Crucible Co.

Garlock Packing Company, The, Palmyra, N. Y.—Throttle packing; air pump packing; new process sheet packing; new process gaskets; metal packing; hydraulic packing and steam hammer packing. Represented by H. N. Winner, F. S. Bulkley, Philip Arnold and F. P. Dunham.

General Electric Company, Schenectady, N. Y.—Portable air compressor (100 lbs. pressure) with pressure regulator; 12 ampere G. I. flaming arc lamps; 6½ ampere multiple magnetite arc lamps; 6½ ampere intensified arc lamps; "Mazda" lamps; monogram sign with lamps; Curtis turbo generator for car lighting; cabinet containing an exhibit of train lighting lamps; mercury arc rectifier; 25 Kw. hardening furnace; emery grinder; motor generator set with starting and field rheostats; soldering irons; glue pot; solder melting pot; oil tempering bath; G. E. 212 railway motor; KT-BD-2 motors; motor driven machine tools; switchboard. The apparatus will be shown in operation. Represented by W. J. Clark, J. G. Barry, C. E. Barry, H. L. Monroe, C. A. Raymond, R. E. Moore, W. O. Kellogg, C. C. Pierce, H. D. Hawkes, Frank H. Gale, A. J. Totten, and W. S. Taussing.

General Railway Supply Company, Chicago, Ill.—Stub end of a vestibuled passenger car and working models of railway car devices, as follows: Metallic (steel) sheathing; National steel trap doors; Flexolith composition flooring; Imperial

American Brake Shoe & Foundry Co., P. T. Handiges, F. W. Sargent and W. E. Magraw.

Exhibit of the Nelson Valve Co.

F. K. Shults of the American Steel Foundries Reviewing the Field After the Battle.

car window screens; Perfection sash balances; Resisto insulation; roller desk sash ratchets; National standard roofing; National vestibule curtain catches. Represented by F. L. Wells, H. U. Morton, W. S. Humes and J. F. Oelerich.

Gilbert & Barker Manufacturing Company, New York, N. Y.—Self-measuring pumps; oil storage tanks; oil storage systems for oil houses, store rooms, etc.; siphons; transfer pumps; storage indicators and lubricating oil tanks. Represented by C. F. Hatmaker.

Gold Car Heating & Lighting Co., New York, N. Y.—Car heating and lighting apparatus and car ventilators. Represented by E. B. Wilson, A. B. Strange, W. H. Stocks, Geo. F. Ivers, J. M. Stayman, J. O. Brombaugh, F. H. Smith, F. A. Purdy.

Goldschmidt Thermit Company, New York, N. Y.—All materials required for making welds on locomotive frames, driving wheel spokes, connecting rod and other broken wrought iron and steel sections; samples of welds made on steel bars, trolley rails; standard and extra heavy pipes, etc. Metals free from carbon produced by the Thermit process, including chromium, manganese, molybdenum, manganese-copper, manganese-tin, manganese-zinc, ferro-titanium, chromium-copper, manganese-boron, ferro-boron. Cans of heating thermit for reviving dull iron in the ladle, making semi-steel, keeping metal in risers liquid, etc.; cans of titanium thermit for purifying molten iron, increasing its fluidity and enabling the pouring of castings of greater density and higher quality. Represented by H. S. Mann and Wm. Aldrich.

Gould Coupler Company, New York, N. Y.—M. C. B. Couplers; Gould malleable iron journal boxes; freight friction draft gears; passenger friction draft gears; Hartman ball bearing center plates and side bearings; Gould cast steel side frames; passenger cast steel end sill with friction buffer; passenger couplers; steel draft beams; Moritz coupler; cast steel truck bolsters; Gould cast steel freight end sill with friction back of coupler horn; pin type coupler and friction draft gear; Gould cast steel draft beams with friction draft gear; couplers and friction striking plate; 80,000 lb. freight truck with cast steel side frames; angle iron ties; 5 x 9 journal boxes; truck bolster; 5 x 9 axles; Gould car lighting equipment and storage batteries. Represented by F. P. Huntley, Geo. G. Milne, H. N. Loomis, C. E. Rood, W. F. Richards and Dr. C. W. Gould.

Greene, Tweed & Company, New York, N. Y.—Palmetto packing; favorite reversible ratchet wrenches. Represented by H. S. Dearmest, F. E. Ransley and B. M. Bulkley.

Grip Nut Company, Chicago, Ill.—Grip nuts. Represented by E. R. Hibbard, president; J. W. Hibbard, treasurer; B. C. Wilt, J. W. Cuddy and E. A. Magurn.

Hale & Kilburn Manufacturing Company, The, Philadelphia, Pa.—Seats for all standard types of railway cars; all-steel seats for steel cars; reclining seats for chair cars; steel interior finish; steel doors; steel sash; everything in steel for the interior of the modern steel passenger car. Represented by H. T. Bigelow, A. F. Old, B. F. Pilson and C. W. Laskay.

Hammett, H. G., Troy, N. Y.—Trojan metallic packing; Trojan bell ringers; radius grinder; triple valve bushing roller. Represented by H. G. Hammett, E. C. Sawyer and A. O. Van Dervort.

Harlan & Hollingsworth, Wilmington, Del.—One finished steel coach and one steel coach frame. On exhibit track.

Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.—Peerless hoists; screw hoists; differential hoists; plain and geared travelers to run on lower flange of I-beam. Represented by Roger Sherron, W. J. Somerset, J. A. Slaughter, M. W. Christian and A. M. Harrington.

Heywood Bros. & Wakefield Company, Wakefield, Mass. —New complete line of universal car seats, showing latest pressed steel features. Represented by Bertram Berry, R. F. Fowler and E. C. Lang.

Hobart-Allfree Company, The, Chicago, Ill.—A working

R. L. Mason of Hubbard & Co. on the Board Walk.

Another of the Westinghouse Exhibits.

The Pilliod Co. Exhibit, Frank H. Clark and R. H. Weatherly.

model of a locomotive, ¼ size, showing the running gear complete and demonstrating the Allfree system of cylinders, valves and new radial outside valve gear. Represented by J. B. Allfree, Frank Smith and W. H. Belmaine.

Home Rubber Company, Trenton, N. J.—Black sheet packing; high and low pressure diagonal rod packing; hydraulic packing; flax packing; gum core packing; ring and combination packings. Represented by A. R. Foley.

Hunt-Spiller Manufacturing Corporation, South Boston, Mass.—Hunt-Spiller gun iron castings which have been in service and removed for exhibition purposes, such as piston valve rings; piston valve bushing; cylinder packing rings; eccentrics and eccentric straps; crosshead shoes; driving box. Also Hunt-Spiller gun iron castings in the rough, such as superheater header; piston head; gear, etc. Represented by Frederic Parker, W. B. Leach, J. G. Platt and A. J. O'Connor.

Hutchins Car Roofing Company, Detroit, Mich.—Samples of roofing sheets and photographs of cars equipped with the Hutchins roofing. Also track exhibit in the P. & R. R. R. side tracks, showing N. Y. Central & Hudson River R. R. car No. 106,986 equipped with Hutchins all-steel steel carline roof. Represented by D. W. Hawksworth and W. D. Thompson.

Independent Pneumatic Tool Company, Chicago, Ill.—Thor piston air drills; pneumatic riveting, chipping, caulking and flue-beading hammers; the Thor stay-bolt driver. Represented by James B. Brady, W. O. Jacquette, J. D. Hurley, R. S. Cooper, Geo. A. Gallinger, R. T. Scott, F. W. Buchanan, J. J. Keefe, H. F. Finney, T. J. Carroll and J. P. Bourke.

International Correspondence Schools (Railway Department), Scranton, Pa.—Booth attended by students from various Southern railway apprentice instruction classes exhibiting specimens of the work of the students in mathematics and mechanical drawing. Represented by W. N. Mitchell, Ed. M. Sawyer, R. S. Mitchell, G. B. Moir, J. F. Cosgrove, A. E. Sweet, J. E. Drennan, G. H. Brown and N. B. White.

Jenkins Brothers, New York, N. Y.—Jenkins Bros. brass globe valves, regular and extra heavy; brass gates, medium and extra heavy; brass "Y" valves, regular and extra heavy; automatic Graber gauges; radiator valves and air valves; iron body globes, gates, etc.; safety car discs; "96" packing; pump valves and Jenkins discs. Represented by A. C. Langston, Frank Martin, C. B. Yardley, Jr., and B. J. Neely.

Johns-Manville Company, H. W., New York, N. Y.—High and low pressure sheet; packings; high and low pressure pipe; coverings; insulating cements; refrigerator car insulation; steel passenger car insulation; asbestos roofings; car and engine cab roofings; asbestos smoke jacks; asbestos lumber; electrical fibre conduit; underground pipe covering; J-M

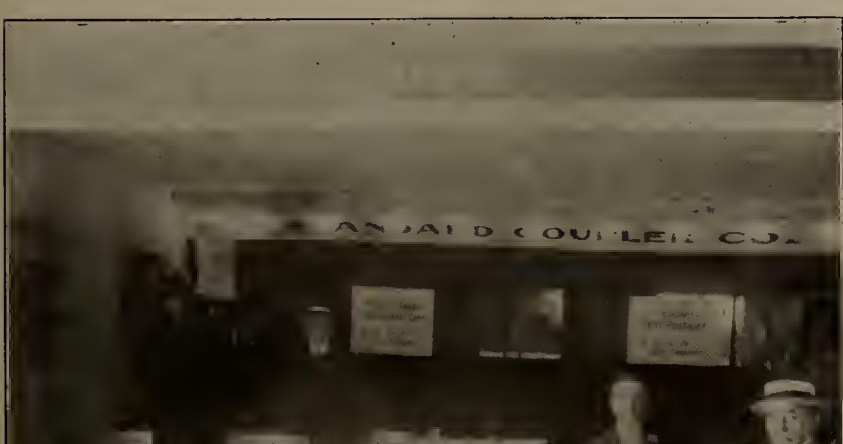


Exhibit of the Standard Coupler Co.

Barco Brass & Joint Co., R. E. Bard and F. N. Bard.

H. H. Schroyer of the Acme Supply Co., and H. U. Morton of the General Ry. Supply Co.

H. G. Hammit and F. F. Gaines on the Pier.

sanitor seats and tanks; vulcabeston throttle and air pump packing; vulcabeston caskets; locomotive boiler laggings; vitribestos pipe coverings; bridge deckings; J-M asbestos sill covering; train pipe coverings; furnace cements. Represented by J. E. Meek, manager; J. C. Younglove, G. A. Nicol, H. G. Newman, F. M. Gilmore, Geo. Christenson and C. W. Gearhart.

Joliet Railway Supply Company, Joliet, Ill.—Huntoon light and heavy freight brake beams; special freight brake beams; locomotive and passenger brake beams; all steel brake beams; "P. C." and "L. N." high-speed beams; standard U freight beams; Perry passenger and freight roller side bearings, both new and after service. Represented by H. M. Perry, C. A. Huntoon, E. A. Laughlin, J. D. Granville, W. C. Munn and R. C. Fraser.

Joyce-Cridland Company, The, Dayton, O.—All types of railroad jacks. Represented by Geo. M. Llewellyn, Edwin Romeiser, P. J. Ford and Nicholas Kohl.

Kelly-Arnold Manufacturing Company, Wilkes-Barre, Pa. —Automatic air and steam connector; metal conduits and auxiliary parts. Represented by George F. Royer and John J. O'Donnell.

Kerite Insulated Wire and Cable Company, New York, N. Y.—Kerite insulated wires and cables; kerite tape. Represented by R. D. Brixey, Azel Ames, P. W. Miller and J. A. Renton. Western representatives, Watson Insulated Wire Company, J. V. Watson, B. L. Winchell, Jr., R. A. Patterson, Chicago.

Keystone Drop Forge Works, Chester, Pa.—Keystone connecting links; safety shackle hooks; wrenches; hoist hooks; shafting collars; thumb screws; thumb nuts; eye bolts; machine handles; special drop forgings. Represented by Geo. H. Berlin and Chas. F. H. MacLaughlin.

Keystone Lantern Company, Philadelphia, Pa.—The Casey standard railway hand-lantern.

Kilbourne & Jacobs Manufacturing Company, Columbus, Ohio.—Automatic M. C. B. air dump construction car. Represented by F. W. Hubbard and A. C. Stansill. On exhibit track.

King Automatic Car Platform Company, Inc., Washington, D. C.—Models of sliding platform extensions for passenger coaches of steel, steel underframe or wooden construction. Represented by J. C. Mayo.

Jenkins Bros., Frank Martin, Mrs. A. C. Langhorn and C. B. Yardley.

The Duff Mfg. Co., E. A. Johnson.

Love Brake Shoe Co.

Lackawanna Steel Company, New York, N. Y.—Rails; rail joints; tie plates; beams, channels; angles; steel plate; steel forging; corrugated and deformed bars; twisted squares; the Abbott base plate; sheet piling. Represented by F. E. Abbott and A. H. Weston.

Landis Machine Company, Waynesboro, Pa.—Double head motor driven bolt threading machine; single head open belt type high speed bolt threading machine; automatic die head for turret lathe; semi-automatic die head for pipe threading machines, and demonstrations of thread cutting and samples of threaded products. Represented by J. G. Benedict, Ira D. Grove and H. L. Fisher.

Landis Tool Company, Waynesboro, Pa.—Cylindrical grinders; one gap grinder 16 x 72 in operation, made for railroads; one number 2 universal grinder. Represented by J. H. Hollinger.

Linde Air Products Company, Buffalo, N. Y.—Oxy-Acetylene welding and Oxy-Coal gas cutting apparatus and wrecking equipment. Represented by G. E. Kershaw, F. Schoonmaker, J. A. Warfel, M. S. Plumley, E. E. Radcliffe and W. J. Fritz.

Love Brake Shoe Company, Chicago, Ill.—Armbrust brake shoes for driver brakes, passenger freight and coach brakes; also motor brake and traction brake shoes. Represented by C. W. Armbrust and John F. Stevens, Jr.

Lunkenheimer Company, Cincinnati, Ohio.—Engineering specialties, including brass and iron gate, globe, blow-off and swing check valves. Represented by C. Davies, E. R. Ritter and William Hood.

Lupton Sons Company, David, Philadelphia, Pa.—Lupton rolled steel skylight; Lupton steel sash; Pond continuous sash and Pond operating device for pivoted sash. Represented by Clarke P. Pond and H. R. Wilkinson.

Macleod & Company, Walter, Cincinnati, Ohio.—Lights for wrecking outfits and construction work; portable oil burners; sand blast machines; oil furnaces; tire heaters; water softening apparatus. Represented by Walter Macleod, F. A. Saylor, P. H. Wilhelm, W. B. Woodbridge and William Hext.

Manning, Maxwell & Moore, Inc., New York, N. Y., and its subsidiary companies, The Hancock Inspirator Company, The Ashcroft Manufacturing Company, The Consolidated Safety Valve Company, The Hayden & Derby Manufacturing Company, and The Shaw Electric Crane Company.—Hancock inspirators; main steam valves; boiler check valves; hose strainers; blow-off valves; globe and angle valves and locomotive trimmings; Consolidated safety valves; Ashcroft steam, vacuum, pressure and recording gauges and Tabor indicators; one F. E. Reed Company 24-inch special heavy pattern motor driven engine lathe; one Foote-Burt 24-inch high duty belt driven shaper; one Foote-Burt 36-inch swing high duty belt driven drill; one Cincinnati 26-inch x 8-ft. single head motor driven traverse shaper; one Gridley 4¼-inch single spindle motor driven turret lathe; one Gridley 1¼-inch four-spindle turret lathe; one Hendey No. 4 motor driven milling machine; one Hendey 16-inch geared head engine lathe; one Hendey motor driven shaper; one Dreses 5-foot motor driven full universal radial drill with tapping attachment; one National 1½-inch wedge grip heading and forging machine; one National motor driven double head bolt cutter; one National die sharpener; one Elmore high duty ball bearing single spindle sensitive drill, motor driven. Represented by James B. Brady, W. O. Jacquette, J. N. Derby, C. E. Randall, R. A. Bole, M. A. Sherritt, P. M. Brotherhood and C. L. Lyle.

McConway & Torley Company, The, Pittsburg, Pa.—Pitt freight coupler; Janney "X" freight coupler; Pitt passenger coupler; a new swivel head coupler with McConway centering device as being applied to new steel passenger coaches of the Pennsylvania railroad; Pitt tender coupler; Pitt pilot coupler; Buhoup steel truck side frame; Buhoup 3-stem coupler, and the McConway steel wheel. Represented by Stephen C. Mason, E. M. Grove, H. C. Buhoup and I. H. Milliken.

McCord & Company, Chicago, Ill.—The following Journal boxes; cast steel passenger; vanadium grey iron passenger; malleable iron steel inserted passenger; pinless lid; mal-

Peter Maher Explains How He Uses the Automatic Stoker.

F. K. Shults of the American Steel Foundries and Auto Party.

leable iron with outside metal dust guard. Locomotive force feed lubricator; lubricating driving box; national equalizing wedge; McCord draft gear; and McCord spring dampener; McKim gasket. Models of universal windows for wood and steel cars; universal weatherstripping; gravity wedging sash locks; universal wedging sash locks; universal extension sash locks; one special design metal sash; universal deck sash ratchets. Represented by D. W. McCord, J. A. Lamon, Morrill Dunn, R. L. McIntosh, B. McClellan, W. G. Wilcoxson, F. S. Nickerson, D. J. McOsker and W. J. Schlacks.

McGraw Publishing Company, New York, N. Y.—Electric Railway Journal and Engineering books.

Midvale Steel Company, The, Philadelphia, Pa.—Rolled steel wheels. Represented by W. P. Barba, E. Harrah, T. W. Illingsworth, S. Griffith, C. Tietze, James Thompson, M. W. Welsh and L. Wells.

Milburn Company, The Alexander, Baltimore, Md.—Rail-

Booth of the Geo. E. Molleson Co., Geo. E. Molleson, H. N. Gilbert and F. M. Patterson.

road construction light, 5,000 candle power; lights for wreckers, cranes, steam shovels, etc.; fire lights; miners' lights; construction lights up to 10,000 candle power. Represented by A. F. Jenkins, Charles Pollard and I. E. Stansbury.

Modoc Soap Company, Philadelphia, Pa.—Perfectol car and locomotive cleaner.

Molleson Company, Geo. E., New York, N. Y.—Tyler charcoal iron boiler tubes; everlasting blow-off valve; spiral staybolt. Represented by Geo. E. Molleson and Huntly H. Gilbert.

Moran Flexible Steam Joint Company, Louisville, Ky.—Flexible joints for steam, air, gas and liquid steam coupler for use between engine and dynamo car.

Nathan Manufacturing Company, New York, N. Y.—Injectors; lubricators; boiler checks; fire extinguishers; boiler washers and testers; Klinger water gauges; oil cups; feed water strainers; ejectors; water gauges; whistlers; air brake lubricators, and miscellaneous appliances for use on locomotives. Represented by Sanford Keeler, J. S. Seeley, J. C. Currie, Chas. R. Kearns, James E. Minor, M. Stettheimer, Edward S. Toothe and Alfred Nathan.

National-Acme Manufacturing Company, The, Cleveland, Ohio.—Automatic screw machine—"Acme-Multiple-Spindle." Represented by W. S. Chase, E. C. Woolgar, L. M. Waite and J. F. Judd.

Booth of the Landis Tool Co., A. J. Gardner, Jr., Wm. Bawden and J. H. Hollinger.

Model of a Steel Car in Booth of Bettendorf Axle Co.

Booth of Ward Equipment Co., J. E. Ward, J. B. Culner, Mrs. J. B. Culner and R. B. Lowther.

National Lock Washer Company, The, Newark, N. J.—Sash locks; curtain fixtures; sash balances; spring parallel sash guides and lock washers; chain attaching device for sash balances. Represented by: William C. Dodd, Frank B. Archibald, John B. Seymour and Daniel Hoyt.

National Malleable Castings Company, The, Cleveland, O.—Sharon, Tower, Climax and Latrobe couplers. Represented by S. L. Smith, W. E. Coffin, F. R. Angell, J. V. Davison, R. T. Hatch, J. H. Jaschka, J. H. Merrell, Jr., G. V. Martin, H. D. Hammond, L. S. Wright, C. A. Bieder, K. R. Johnston, B. Nields, Jr., R. H. Pilson, E. O. Warner and J. A. Slater.

National Railway Devices Company, Chicago, Ill.—Uncoupling apparatus which includes positive release of coupler in case of "pull out" (Duplex uncoupler and automatic release); fire door and door operator. Represented by Jay G. Robinson, J. W. Luttrell and J. A. Good.

Nelson Valve Company, Philadelphia, Pa.—Valves in bronze, iron and steel; a complete unit of testing apparatus in actual operation; twelve-inch electrically operated valve with complete control will be shown running; a super-heated steam steel gate valve, absolutely tight after thorough trials for two years. Represented by Carlisle Mason, M. D. Baldy,

Oscar F. Ostby, Sales Mgr., Commercial Acetylene Co., Closing Hours of the Convention. There was still some "Light of Day on the Right of Way."

W. J. Spencer, R. E. Thomas and H. C. Baynard.

Newhall Engineering Company, George M., Philadelphia, Pa.—Photographs of wrecking and locomotive cranes; pillar and transfer cranes; pile drivers; transfer tables, rail saws, etc., as manufactured by the Industrial Works, Bay City, Mich.; "NB" hose connections for air brake, signal and steam hose; Pahlow pneumatic hose appliances, and Vance steam trap. Represented by David Newhall, Morton L. Newhall, William L. Brown and Glenn B. Harris.

New York Air Brake Company, The, New York, N. Y.—Automatic control equipment for locomtive and tender; automatic control equipment for passenger cars; type K triple valve for freight service; type J triple valve for passenger service; self-locking angle cock handle; combined brake pipe strainer and cut-out cock; improved hose coupling; Forsyth automatic connector and New York producer gas engine plant. Represented by H. F. Bickel, N. A. Campbell, J. E. Forsyth, W. T. Henry, G. O. Hammond, J. A. Hicks, G. A.

Exhibit of the Smith Premier Type Writer Co.

Henry Diston Sons' Booth, Geo. Koon and Wm. Lindsay.

Geo. Nichols and Henry Friese.

Kleifges, C. P. Lovell, C. E. Leach, Geo. Marlow and F. M. Whyte.

Nichols & Brother, G. P., Chicago, Ill.—Electric turntable tractor. Represented by Geo. P. Nichols and Henry Fries.

Nickelized Casting Company, Pittsburgh, Pa.—One 36-inch and one 33-inch worn nickelized chilled car wheels; two 33-inch nickelized chilled car wheels cast from open hearth furnace and double annealed. Represented by Robert C. Totten, George L. Fowler.

Niles-Bement-Pond Company, New York.—This exhibit includes also an exhibit of the Pratt & Whitney Company.—A 20-inch La Blonde engine lathe with all-geared head; new type cone head for same; La Blonde universal milling machine; pneumatic tool clamp for steel tire lathe; Pratt & Whitney small tools, gauges, etc. Represented by J. K. Cullen, J. T. McMurray, D. J. Normoyle, G. F. Mills, E. L. Leeds, N. C. Walpole, E. S. Cullen, D. H. Teas and Frank Miles.

North Brothers Manufacturing Company, Philadelphia, Pa.—"Yankee" tools; ratchet screw drivers; spiral screw drivers; automatic push drills; hand drills. Represented by F. A. Mutchmore.

Norton Company, Worcester, Mass.—Large show case

The Norton Co. Exhibit, Geo. C. Montague, Geo. A. Stone and H. Wickstrom.

Exhibit of the Gold Car Heating and Lighting Co.

containing an assortment of alundum grinding wheels and India oil stones; alundum in grains. Represented by Geo. C. Montague, Geo. Stone, H. N. Cudworth and Hans Wickstrom.

Norton, Incorporated, A. O., Boston, Mass.—High speed ball-bearing lifting jacks. Represented by H. A. Norton, J. O. St. Pierre, R. D. Bates, H. J. Wilson and R. L. Skidmore.

Official Railway Guide, New York, N. Y.—Represented by Geo. E. Armstrong and E. Bjerregaard.

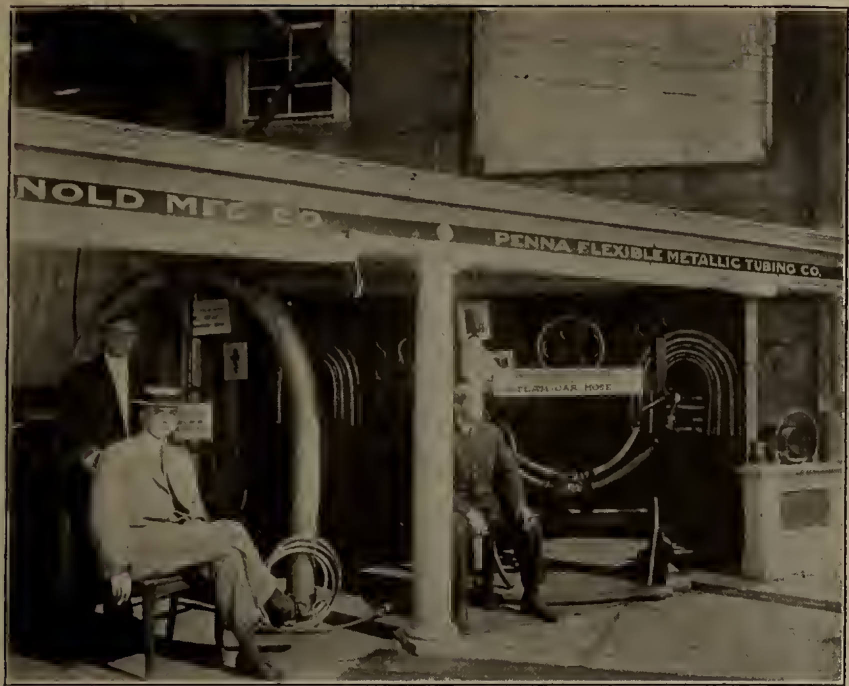
Okonite Company, The, New York, N. Y.—Specimens of all kinds of cables and wires for electric light, power, transmission, telephone, telegraph, etc. Also specimens of crude fine Para rubber. Represented by Lewis G. Martin, John Langan and F. J. White, assisted by J. M. Lorenz, of Central Electric Co., Chicago, Ill.

Pantasote Company, New York, N. Y.—Pantasote curtains and materials; Pantasote upholstery fabrics; Agosote millboards for headlinings, interior trim, etc. Represented by John M. High, W. A. Lake and W. S. Barrows.

Parker Car Heating Company, Detroit, Mich.—Parker anti-freezing and hot water system with automatic discharge; complete systems for all classes of equipment. Represented by Thomas Parker, J. M. McEvoy and C. S. Parker, Jr.

Parkesburg Iron Company, Parkesburg, Pa.—Photographs of mills showing process of manufacture; also samples of charcoal iron boiler tubes. Represented by H. A. Beale, Jr., C. L. Humpton, J. H. Smythe, W. H. S. Bateman, George

Modoc Soap Co. Booth, H. Roever and J. D. Holtzinger.



Pennsylvania Flexible Metallic Tubing Co.

Franklin Ry. Supply Co. Booth, S. G. Allen, John Gill and C. L. Winey.

Thomas, 3rd, H. C. Hunter, J. A. Kinkead and L. P. Mercer.

Pay Within Car Company, Chicago, Ill.—Center door of the Interboro subway cars of New York. Represented by F. H. Lincoln and H. Hellyer.

Pennsylvania Flexible Metallic Tubing Company, Philadelphia, Pa.—Flexible metallic hose for steam connection between cars; blower and washout hose. Represented by J. M. Odenheimer.

Pilliod Brothers, Toledo, Ohio.—Quarter size model of the Pilliod locomotive valve gear in operation. Represented by C. J. Pilliod and H. J. Pilliod.

Pilliod Company, The, Swanton, Ohio.—Baker-Pilliod locomotive valve gear. Radial locomotive ash pans. Represented by R. H. Weatherly, R. F. Darby, F. E. Pilliod, A. Pilliod and J. W. Albeck.

Pittsburgh Equipment Company, Pittsburgh, Pa.—Cast steel double web truck bolster; cast steel truck side frame; interlocking cast steel journal boxes; cast steel interlocking spring plank; cast steel draft casting; aluminum model of center plate and side bearing. Represented by H. V. Seth, John Allison and E. R. Williams.

Pocket List of Railroad Officials, New York, N. Y.—Pocket list of railroad officials. Represented by Chas. L. Dinsmore and Harold A. Brown.

Pressed Steel Car Company, Pittsburgh, Pa.—Photographs of various products in booth. On Philadelphia & Reading track, Mississippi Avenue, an ore car. Represented by O. C. Gayley, C. E. Postelthewaite, J. H. Mitchell, L. O. Cameron, G. T. Merwin, J. S. Turner, Victor von Schlego 1, W. H. Wilkinson, M. S. Simpson, J. G. Bower, H. S. Hammond, Geo. W. Restine and Charles A. Lindstrom.

Pugh, Job T., Philadelphia, Pa.—Augers, bits and chisels. Represented by Job T. Pugh and Geo. A. Phillips.

Railway Age Gazette, New York, N. Y.—Represented by William H. Boardman, Edward A. Simmons, Henry Lee, Frank S. Dinsmore, Lucius B. Sherman, John N. Reynolds, Cecil R. Mills, Samuel O. Dunn, Bradford Boardman, Roy V. Wright, William Forsyth, George L. Fowler, William E. Hooper, Francis E. Lister, Francis W. Lane, William D. Horton, L. B. Mackenzie, Fred W. Bender, George A. McKeague, T. E. Crossman, A. B. Weaver and J. C. Marriott.

Railway and Engineering Review, Chicago, Ill.—Represented by Willard A. Smith, A. E. Hooven, P. G. Stevens, John M. Lammedee and G. E. Ryder.

Railway List Company, The, Chicago, Ill.—Monthly Official Railway List and Railway Master Mechanic. Represented by W. E. Magraw, C. S. Myers, L. F. Wilson and C. C. Zimmerman.

Railways Materials Company, The, Chicago, Ill.—Reception booth. Represented by George L. Bourne, T. B. Cram, C. M. Mendenhall, J. Schurch and Geo. Hoeffle.

Exhibit of the Duntley Mfg. Co.—A Popular Booth.

Booth of Chas. H. Besly & Co., W. H. Allen and E. P. Welles.

Part of the Exhibit of Manning, Maxwell & Moore, F. B. Smith, C. E. Randall, P. M. Brotherhood and W. Dow.

Rapp Company, John W., New York, N. Y.—Steel car doors and mouldings. Represented by C. A. Leonardi.

Restein Company, Clement, Philadelphia, Pa.—Fibrous packing for steam, water, ammonia, hydraulics, oil, gases, acids, etc. Represented by Clement Restein, William J. Cromie and Norman B. Miller.

Revolute Machine Company, New York, N. Y.—Continuous electric blue printing machines. Represented by J. V. McAdam and C. J. Everett.

Rockwell Furnace Company, New York, N. Y.—Furnaces for railroad shops.

Royersford Foundry & Machine Company, Inc., Royersford, Pa.—Punch and shearing machines and Sells roller bearings. Represented by Y. C. Freed, A. Loomis and John D. Sells.

Safety Car Heating & Lighting Company, New York, N. Y.—Latest type single mantle lamps; axle-driven dynamo electric lighting equipment; lighting fixtures; demonstration of vapor lighting equipment for branch line service; and the Safety heating system for passenger trains; revolving gas mantle buoy. Represented by R. M. Dixon, J. A. Dixon, L. R. Pomeroy, R. C. Schaal, G. E. Hulse, J. S. Henry, Wm. St. John, D. W. Pye, J. M. Town, R. C. Moore, C. B. Adams and W. L. Garland.

Schoen-Jackson Company, Media, Pa.—Flexible metallic steam hose; water hose; air hose; air brake hose, and flexible metallic hose for every purpose wherein rubber hose is now used. Represented by Charles T. Schoon, M. R. Jackson, W. R. Wood, R. B. Ross and E. C. Pollard.

Scullin-Gallagher Iron & Steel Company, St. Louis, Mo.—Cast steel bolsters and truck side frames. Represented by Thomas M. Gallagher, Frank L. Norton, George L. L. Davis, Frank W. Graves, S. M. Dolan, Ed. M. Fitzgerald. S. R. Fuller, Jr., L. C. Ullrich, P. J. Howard, H. H. Waldron, O. G. Mueller and T. W. Aishton.

Sellers & Company, Inc., William, Philadelphia, Pa.—Locomotive injectors and accessories; model of the original Giffard injector; ball and socket hanger; hanger boxes and couplings; set of three drivers for our extra high power 42-inch car wheel lathe, mounted upon a temporary wooden face plate; a turret rest of this lathe, and a pair of wheels turned by the lathe; a turret rest of our extra high power locomotive driving wheel lathe. Represented by Strickland L. Kneass, John D. McClintock, Clinton B. Conger, Charles T. Wilson, Edward L. Holljes and Frederick W. Ancona.

Sherwin-Williams Company, Cleveland, Ohio.—Sherwin-Williams passenger coach systems. Represented by E. M. Williams, W. B. Albright, E. M. Richardson, Thomas Madill and F. A. Elmquist.

Simplex Railway Appliance Company, New York, N. Y.—In booth with American Steel Foundries.

Smith Premier Typewriter Company, Syracuse, N. Y.—Billing and bookkeeping machines; machines for way billing and railway expense billing; new visible typewriter. Represented by H. J. Seddon, A. N. Ashmore and a staff of operators.

Spencer Turbine Cleaner Company, Hartford, Conn.—A 5-horsepower vertical direct driven turbine cleaner; new pressed steel vacuum cleaning tools. Represented by E. W. Muzzy, Guy Noble and R. B. Smith.

Sprague Electric Company, New York, N. Y.—Flexible steel armored air brake hose; flexible steel armored signal hose; flexible steel armored steam, pneumatic, hydraulic and water hose and fittings for shop use; electric conduit supplies; electric fans. Represented by A. C. Bakewell, D. C. Durland, H. H. Hornsby and Henry W. Uhl.

Standard Car Truck Company, Chicago, Ill.—Barber standard lateral motion truck; Barber double action truck and Barber roller bearing center plates. Represented by J. C. Barber, J. T. Milner, L. W. Barber, F. L. Barber and E. W. Webb.

Standard Coupler Company, New York, N. Y.—Standard steel platforms; Sessions-Standard friction draft gears; Standard slack adjusters. Represented by George A. Post, E. H. Walker, A. P. Dennis, R. D. Gallagher, Jr., and C. D. Jenks.

Standard Steel Car Company, Pittsburgh, Pa.

Standard Steel Works Company, Philadelphia, Pa.—A reception booth. Represented by H. DeH. Bright, Charles Riddell, George F. Jones, E. B. Halsey, C. H. Peterson, H. W. Sheldon, F. W. Weston, E. Sidney Lewis, W. H. Pugh, Jr., and H. G. Pearce.

Stoever Foundry & Mfg. Co., The, Myerstown, Pa.—One number 2 automatic pipe bending machine, motor driven, capacity 1 in. to 2 in.; one number 2 pipe threading and cutting off machine, motor driven, capacity ¼ in. to 2 in. Represented by W. E. Farrell, Ed. R. Euston and J. F. Morris.

Storrs Mica Company, Owego, N. Y.—Samples of mica headlight chimneys for oil and acetylene headlights; mica chimneys for use on caboose, cab, station and switch lamps; mica lantern globes; collection of samples of mica from various parts of the world. Represented by A. P. Storrs and Charles P. Storrs.

Strong, Carlisle & Hammond Company, Cleveland, Ohio.—Randall graphite sheet lubricator; Strong's steam specialties, including steam and vacuum traps, pressure reducing valves,

Booth of S. F. Bowser Co., C. A. Dunkleberg, F. T. Hyndman, W. T. Simpson and L. B. Sherman.

G. H. Williams and His Exhibit of Clamshell Buckets.

steam separators and the Handy wrench. Represented by B. E. Carpenter and Homer Whepley.

Symington Company, The T. H., Baltimore, Md.—Farlow draft gear; journal boxes; flexible dust guards; roller side bearings. Represented by T. H. Symington, W. A. Garrett, J. F. Symington, C. J. Symington, E. H. Symington, Donald Symington, W. W. Rosser, T. C. DeRosset, D. F. Mallory, I. O. Wright, B. S. Johnson, A. H. Weston and S. L. Kamps.

Talmage Manufacturing Company, Cleveland, Ohio.—Talmage system ash pan cleaner. Represented by J. G. Talmage, E. H. Janes, J. F. Walker and C. F. Kahler.

Taylor Manufacturing Company, James L., Bloomfield, N. J.—Car, boilermakers' patternmakers' and machinist clamps. Represented by James L. Taylor and Edward C. Blake.

Templeton, Kenly & Co., Ltd., Chicago, Ill.—Simplex car and track jacks; simplex geared jacks, and the component parts of the simplex jacks. Represented by Alfred E. Barron, J. H. Hummel and F. A. Barbey.

Tindel-Morris Company, Eddystone, Pa.—Paragon cold saw machine; standard and structural type "Tindel" inserted tooth cold saws; saw grinder. Represented by Lincoln W. Gruber and David G. Nixon.

Titan Steel Casting Company (formerly Benjamin Atha & Company), Newark, N. J.—Body and truck bolsters; tank car saddle; manganese steel gears and pinions. Represented by

James B. Clow & Sons, L. J. Elliot at Desk.

Louis A. Shepard, G. T. Paraschos and Chas. W. Owston, Jr

Toledo Pipe Threading Machine Company, The, Toledo, Ohio.—Hand operated threading tools, threading 12-inch, 8-inch and 4-inch standard steel pipe; several smaller threading tools, vises, vise-mounts and pipe cutters. Represented by W. C. Longnecker, S. S. Thornberry and Clarance A. Popp.

Tyler Tube & Pipe Company, Washington, Pa.

Underwood & Co., H. B., Philadelphia, Pa.—Portable cylinder boring bar; portable crank-pin returning machine; new portable crank-pin rivet head facer; portable rotary boiler tube cleaner; locomotive pedestal facing machine. Represented by A. D. Pedrick and D. W. Pedrick, 2d.

Union Draft Gear Company, Chicago, Ill.—Cardwell friction draft gear; Cardwell rocker side bearings. Represented by J. R. Cardwell, L. T. Canfield, J. D. Ristine, W. G. Krauser and J. E. Tarleton.

Union Fibre Company, Winona, Minn.—Linofelt, for the insulation of refrigerator cars; fireproof lith; rigid linofelt and steel car linofelt, for the insulation of steel coaches; waterproof lith and flax lith board, for the insulation of ice houses. Represented by F. J. Bingham, S. E. McPartlin, H. W. Leeds and J. H. Bracken.

Union Manufacturing Company, New Britain, Conn.—

Exhibit of the Rockwell Furnace Co., W. S. Quigley and F. S. Bostwick.

Booth of the Independent Pneumatic Tool Co., J. J. Keefe, J. D. Hurley and J. J. McCarthy.

National Malleable Castings Co., L. S. Wright, Geo. V. Martin, W. E. Coffin and S. L. Smith.

Lathe; planer; drill; boring mill; car wheel and valve chucks. Represented by M. L. Bailey, A. F. Corbin, E. I. Stevens, H. H. Wheeler, J. W. Carlton, W. F. Curtis and C. S. Newman.

Union Spring & Mfg. Company, Pittsburg, Pa.—Elliptic and coil springs; pressed steel spring plates and journal box lids; all-steel Kensington journal boxes; steel castings. Represented by A. M. McCrea, L. G. Woods, C. S. Foller, A. Pancoast, H. B. Darlington, A. C. Woods, T. B. Arnold, H. F. Ayers, E. W. Snowdon and W. F. La Bonta.

U. S. Metal & Manufacturing Company, New York, N. Y. —Feasible drop brake staff; diamond tapered steel pole; Owen-Cochran pressed steel journal box; Empire pressed steel bolster; Detroit car door; Barol wood preservative; St. Louis surfacer paint panels; Columbia lock nuts; M. C. B. repair and defect card box; New York Central box car equipped with Hutchins all-steel—steel carline roof on exhibition track. Represented by B. A. Hegeman, Jr., Charles C. Castle, Frederick C. Dunham, Edward D. Hillman, Arthur Masters and Harold A. Hegeman.

United States Metallic Packing Company, The, Philadelphia, Pa.—United States multiangular metallic packing and King type metallic packing for locomtive piston rods and valve stems. Collmar pneumatic locomotive bell ringers; valve stem clamps; braided cotton swabs; "Indestructible" oil cups. Represented by Morris B. Brewster, C. B. Ford, C. L. Mellor, J. S. Mace, H. M. Wey, and E. Curtiss.

Vanadium Metals Company, Pittsburgh, Pa.—Vanadium metals, comprising vanadium bronze shown in castings of bells, brasses, cold drawn rods and sheets; Vanadium non-corrosive silver metal shown in ornamental fittings; Vanadium anti-friction metal. Represented by J. Rogers Flannery.

Von Kokeritz & Company, R. G., New York, N. Y.—Durable high-pressure sheet packing and gaskets; leather high-pressure piston packing; hydra hydraulic packing; cosmos paint; glardon clips. Represented by R. G. Von Kokeritz, N. P. Hill and J. A. Carson.

Walker & Bennett Manufacturing Company, New York, N. Y.—Simplified car seats. Represented by John Havron, K. D. Hequembourg and S. A. Walker.

Walworth Manufacturing Company, Boston, Mass.

Ward Equipment Company, New York, N. Y.—Car heating apparatus. Complete locomotive steam heat equipment, including reducing valves, starting valves, steam heat gauges and steam couplers with locks. Complete equipments for heating all classes of cars, both steel and wood. Direct steam systems. Ward's ideal heating system, end train line valves, automatic steam traps, steam couplers and special fittings. Ward's car ventilator and Ward's yard plug and car receptacle for charging storage batteries on electrically lighted cars. Represented by John E. Ward, Alfred W. Kiddle, George B. Culver and Richard Voges.

Watrous Company, The (not inc.), Chicago, Ill.—Car water closets; wash stands; and other sanitary specialties. Represented by E. G. Watrous and S. D. Barnett.

Watson Insulated Wire Company, Chicago, Ill.—With Kerite Insulated Wire and Cable Company. Represented by J. V. Watson, B. L. Winchell, Jr., and R. A. Patterson.

Watson-Stillman Company, The, New York, N. Y.—Shop jacks; wrecking jack; journal box jack; outside and inside pump and independent pump type jacks; telescopic motor lift jack; portable hydraulic beam punch; hydraulic T rail bender; 125 ton crank pin press; 200 ton motor-driven hydro-pneumatic wheel press; 30 ton portable axle bearing press; portable shaft straightener; 4 twinvolute turbine pumps in operation; working model Chambers locomotive throttle valve. Represented by Geo. H. Gillon, Frank Clark, Edwin Stillman, H. A. Prindle, Austin Stillman, Chas. Howells, J. O. Meeks, Richard Baker and A. Eugene Michel.

Waugh Draft Gear Company, Chicago, Ill.—Full sized draft gear, 600,000 pounds capacity, as applied to steel underframe cars; two full sized cased gears, 250,000 and 450,000 pounds capacity. Represented by Anson L. Bolte and Samuel T. Rowley.

Welsbach Company, Gloucester, N. J.—Incandescent gas lamps for railway station, yard and shop lighting; incandescent gas mantles. Represented by Chas. W. Wardell.

West Disinfecting Company, Inc., New York, N. Y.—Soap dispensers; disinfecting appliances for toilet rooms; fumigating apparatus. Represented by E. Taussig, Geo. L. Lord and Chas. F. Pierce.

Western Railway Equipment Company, St. Louis, Mo.—Acme brake slack adjusters; Western sill and Carline pockets; Western brake jaws; Republic draft gear; Acme pipe clamps; Linstrom eccentrics; Linstrom syphon pipes; Western flush car doors; interchangeable car doors; Western angle cock holders; Hoerr car doors; St. Louis flush car doors; Security dust guard; Downing card holders; Economy slack adjusters; Western bell ringer; car door fastenings; fish hook tie plates; brake pins and the dating nails. Represented by Louis A. Hoerr and S. H. Campbell.

Westinghouse Air-Brake Company, Pittsburgh, Pa.—Seven-car passenger train rack, operative, equipped with the P. C. equipment; in connection with this rack is an electric sign

Wheel Truing Brake Shoe Co., Dr. G. M. Griffin.

Exhibit of the Okonite Co.

showing braking power and curves for the purpose of comparing the P. C. equipment with the high-speed equipment in the stopping of modern passenger trains; empty and load brake equipment as applied to cars operative; centrifugal dirt collector and suction demonstration. Represented by A. L. Humphrey, J. R. Ellicott, E. L. Adreon, E. A. Craig, W. V. Turner, C. F. Street, H. F. Woernley, C. C. Farmer, F. V. Green, W. S. Bartholomew, C. J. Olmstead, S. J. Kidder and P. H. Donovan.

Westinghouse Automatic Air & Steam Coupler Company, St. Louis, Mo.—Sample of their automatic air and steam coupler.

Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.—Motors, controllers, transformers, switchboards and arc lamps. Represented by Chas. Robins, R. F. Moon, H. C. Mack and J. J. Dorney.

Westinghouse Lamp Company, Bloomfield, N. J.—Incandescent lamps for all classes of railway service; tungsten and carbon filaments, two watts to five hundred watts. Represented by B. F. Fisher, Jr.

Westinghouse Machine Company, Pittsburgh, Pa.—Le Blanc condenser and Le Blanc vacuum pump, turbine driven. Represented by E. H. Sniffen, E. Yawger, L. L. Brinsmade, H. Van Barcolm, C. H. Paine and H. P. Childs.

Exhibit of the General Electric Co.

Wheel Truing Brake Shoe Company, Detroit, Mich.—Abrasive brake shoes. Represented by J. M. Griffin.

Whipple Supply Company, New York, N. Y.—Reception booth. Represented by A. L. Whipple.

Williams Company, J. H., Brooklyn, N. Y.—Drop forgings.

Wilson Remover Company, New York, N. Y.—Varnish remover and instruments. Represented by I. McNeal Wilson.

Wood, Guilford S., Chicago, Ill.—Wood's flexible nipple and hose protector; monogram bracket and samples of rubber tiling. Represented by Guilford S. Wood and D. F. Jennings.

Wright Wrench Manufacturing Company, The, Canton, Ohio.—Wright monkey and pipe wrenches. Represented by Geo. H. Kittoe.

Yale & Towne Manufacturing Company, New York. N. Y.—Electric hoists, triplex chain blocks, I-beam trolleys, electric triplex hoists, padlocks, car door checks, night latches, builders' hardware. Represented by C. W. Beaver, C. H. Van Winkle, H. C. Spaulding, H. R. Butler, R. T. Hodgkins and W. C. Allen.

STEEL CARS IN SERVICE, P. R. R.

According to an announcement made recently, the Pennsylvania Railroad has in service on its lines, or on order, nearly two thousand passenger cars of all-steel construction. These cars have been added to the company's passenger equipment since June, 1906, when it was announced that all future additions to passenger equipment on the Pennsylvania system would be of all-steel construction. The lines of the Pennsylvania system, on all of which steel cars will be operated, include the Pennsylvania Lines East and West of Pittsburg, the Long Island R. R., the Cumberland Valley R. R., the New York, Philadelphia and Norfolk R. R., the Vandalia R. R., and the Grand Rapids & Indiana Ry.

The Pullman Company is at present constructing a sufficient number of steel sleeping and parlor cars to equip the entire Pennsylvania system. These cars are now being delivered at the rate of from 50 to 60 a month. Already there are in service on through trains 75 sleepers, and five combined parlor and baggage cars. When the present order is completed there will be in service on the Pennsylvania system some 600 all-steel Pullman cars; this number is included in the 1988 cars now in use or on order.

The steel passenger cars on the Pennsylvania system have been called "Dreadnaught" cars by reason of their construction. They weigh some 118,500 pounds as against 85,000 pounds in the standard vestibule wooden coach. This increase in weight very greatly reduces the vibration of the car, thereby adding to the comfort of passengers. The cars are non-collapsible, their principal feature being a central box girder twenty-four inches wide by nineteen inches deep extending throughout the entire length of the coach; this girder, in collisions, prevents telescoping. The cars are fire-proof, containing only about 125 pounds of wood; the latter is used for window frames and arm rests in the seats.

In the steel equipment now in service, there are 457 coaches, 22 dining cars, 34 passenger and baggage cars, 33 baggage, 78 postal and 80 Pullman cars. In addition to these there are on order or under construction at the present time, 502 steel coaches, 28 steel dining cars, 83 passenger and baggage cars, 83 baggage, 39 postal, 28 baggage and mail, 1 combination motor car, and some 520 Pullman cars.

With the 704 steel cars in use at present, and the 1,284 cars on order, the Pennsylvania system will shortly have available for use on its lines East and West of Pittsburg a total of 1,988 solid steel passenger equipment cars.

Proceedings of the 43rd Annual Convention of the American Railway Master Mechanics' Association

The first session of the forty-third annual convention of the American Railway Master Mechanics' Association was held on June 20. President G. W. Wildin (N. Y. N. H. & H.) called the meeting to order at 9:40 a. m. The Rev. Newton W. Cadwell, pastor of the Olivet Presbyterian Church of Atlantic City, opened the exercises of the morning with prayer. Franklin P. Stoy, mayor of Atlantic City, delivered an address of welcome. Eugene Chamberlain replied on behalf of the association.

Address of President Wildin.

It is with keen pleasure, augmented by a high sense of gratitude and appreciation, that I am permitted this morning to extend to you, one and all, a most hearty welcome to the opening exercises of this, the forty-third annual convention of the American Railway Master Mechanics' Association. As an association we are to be congratulated because of the many good things that have come to us during the year just passed, that we are again privileged to meet for the fifth consecutive time in this beautiful and exhilarating spot, "Atlantic City," a place where hospitality is not stinted nor wholesome privileges curtailed.

As a body we have formed a manly regard for an association of individuals who make it their business to look out for the welfare of this great city, and well may the city be proud of them. Mr. Bell, on behalf of this association, I extend to you and your associates our hearty good will and admiration. Second only to the Master Mechanics' Association do we regard your organization of "Hotel Men," and in this respect our impression is made more indelible every time we observe you thrust forth that strong right arm of unity and rake in the shekels in the form of added conventions. To these you are entitled because of your fairness and liberality.

Friends of the supply fraternity, your good work and influences we fully recognize and appreciate. The splendid exhibits you have arranged at untold expense speak for themselves, and I am sure I voice the sentiment of a unanimous membership when I assert that without exception they constitute the greatest practical educational privilege ever accorded railway officials and men who may care to avail themselves of the opportunity afforded. It is to be hoped that more of our managers and those high in the council of railway operation will interest themselves to a greater extent in this particular feature of our convention and will encourage rather than discourage the attendance of their subordinates, that they may take advantage of and prosper by your generous assemblage of all the latest devices known to the mechanical art.

You are the representatives, if not the actual heads, of concerns who compose an organization we railway men very much admire—"The Railway Business Association"—organized primarily to protect the interests of its own members; but which has, at the same time, assisted the railways throughout this country in an eminently legitimate manner. The good work already done, although the association is yet in its infancy, is certainly commendable, and we cannot but wish it Godspeed in the noble work it has undertaken.

The general conditions under which we meet at this convention are quite gratifying as compared with those of one and two years ago. We are again operating under normal conditions, with good prospects for the continued and even increasing prosperity of our country. Railways are yet in the limelight of legislation and the good old mill is grinding out its usual gist of new, oppressive, and hampering regulations, still I feel like recording my optimism in this direction and prophesying that the ship of state will again right itself and for some time to come sail on an "even keel."

Our progress during the year just passed shows all the characteristics of that of former years. We have made substantial increases in all directions, financially, in numbers and in power. The several committee reports and individual papers to be presented at this meeting will indicate clearly the good work that has been done by those in charge. It is hardly necessary that I dwell longer upon the past history of the association, as to most of you it is fresh in memory, and I am quite sure I can add nothing to the remarks of my predecessor in office, to whose annual address I most respectfully direct your attention as being the most complete and concise history of the association and its work ever written. Suffice for me to say that none of our past prestige has been lost, but instead another well directed and painstaking year of work has been added to our record.

There comes a time in the history of all organizations when important changes must be inaugurated both in the method of conducting business and in the scope and magnitude of the work to be covered. I feel at this time that as an association we have about reached that point. It is hoped, therefore, that you will pardon my seeming presumption if I enter upon a mild criticism of our usual methods and customs. In doing this, however, I wish to be most clearly understood that far be it from my intentions, and much less my desire, to detract one jot or tittle from our standing in the mechanical world, or from our past achievements. Disloyalty only would brand the man who as presiding officer of this association would wantonly exercise his prerogative for that purpose.

We have faithfully observed the injunction placed upon us by the framers of our original constitution and by-laws, who in preparing the preamble to it expressed themselves as follows: "We the undersigned railway master mechanics believe that the interests of the companies by whom we are employed may be advanced by the organization of an association which shall enable us to exchange information upon the many important questions connected with our business." Excellent reasons were these for the establishment of this association, and efficient are they for continuing its existence. But there is urgent need for extending our operations beyond the mere confines of the exchange of ideas and methods.

As a technical association we stand unique and alone in the field of railway mechanical engineering, no other country to my knowledge having a like organization performing like work. True, we have an esteemed body in this country known as the American Society of Mechanical Engineers, of which I have the honor to be a member; but the work of that society and its field of research are so far removed from the practical everyday problems in railroading that as a society it is of but little value to the railway mechanical fraternity. It is therefore, incumbent upon this association to assume a stronger role, and, in addition to holding our annual experience meetings, to get closer together and concentrate our efforts on unifying mechanical opinions on matters of design, construction, specifications, formulæ and polities.

Possibly we have not had the encouragement we should have received from our superiors, and have not been drawn upon heavily enough to arouse within us the latent powers we possess; consequently without this call upon us we have, as might be expected, assumed a more or less dormant attitude in relation to research work. But it is safe to predict that, with the past two or three years of both national and state legislative activity subjects the consideration of which properly belongs to this body, we will in the near future be called upon for action much more strenuous, exacting and positive than we have ever experienced before.

With this idea in view, and realizing the many vexing problems we as mechanical men will have to solve, I wish to advocate for your most serious consideration the establishment of a permanent centralized technical bureau within our association to be composed of active members of the association having strong technical and practical training, and to members ex-officio. This body should be clothed with authority to act for the association on all important questions arising in the interim between our annual meetings, making a full report to the association in convention assembled at the first opportunity.

I would further suggest for your consideration that one member of this bureau be a salaried incumbent, the permanency of the office and the emoluments to be such as to permit of its acceptance by an individual fully equipped through experience and training to cope with any and all questions demanding his attention, and who will at all times keep the central body well posted as to the general happenings of interest throughout the country, collect such data as may be required by the body and direct such investigations and research work as may be assigned to him.

It is also quite necessary that we as an association be more of a unanimous mind on questions that are likely to call for or be made the subject of either federal or state legislation. Such questions should be anticipated and acted upon as far in advance as possible, and then when real legislative action is begun a precedence will have been established, so that the dominating and impelling forces which shape the opinions and recommendations of legislative committees will not emanate from the leader of some political clan or labor organization, but will be found recorded in our proceedings and practices as the crystallized judgment of the members of this great engineering body, whose opinion cannot long be ignored.

Examples covering the points I have tried to make with reference to getting together are many and varied. Your attention is called to a few which seem to cover the ground fully and will, I hope, substantiate the position I have taken.

A bill recently introduced in Congress, known as the Federal Boiler Inspection Bill, has created quite a furore and not a little anxiety among railway managers throughout the country. This bill was forced to the front by politicians urged on by labor organization leaders, and it was necessary on the part of this association to take some action in opposition to the forces at work. To this end, although resembling quite closely an eleven hour repentance, a committee on boiler design, construction and inspection was appointed at the first meeting of our executive committee held at Cleveland last July. This committee has done splendid work in collecting and tabulating data which we hope will enable the American Railway Association committee finally to prosecute successfully its contentions before the House and Senate committees having the bill in charge, but it is well known that the data furnished the committee by the various railways lacked harmony. The opinions and suggestions offered were often diametrically opposite and the whole presented such a lack of uniformity and agreement that it was bewildering, and to glean anything tangible from the mass required almost superhuman effort.

As members of this association we have had more or less to do with the design and construction of locomotive boilers during the past forty-three years, and as railway mechanical men many years longer, yet we are not agreed on the very simple and fundamental question of the factor of safety for locomotive boilers. As a consequence of this lack of agreement some of us are now facing the peculiar dilemma of strengthening locomotive boilers now in service both new and old or of prevailing upon the Public Service Commission to reduce the requirements which they arbitrarily established in the absence of an authoritative standard.

The locomotive headlight question has furnished legislators in many states with a big stick of harassing proportions. On this question, as on many others, we as an association have about as many opinions as we have members, the opinions ranging from the declaration by some that the headlight is an expensive nuisance and should be abolished to the declaration by others that it is a necessary and valuable adjunct and should be of several thousand candle-power.

It is my opinion that such questions as I have mentioned, as well as purely technical questions, covering design and construction are well within the work to be covered by this association, and especially the work of the bureau I advocate. Similar problems will arise as long as railways operate, whether the motive power be steam, electricity or something else, and it is our plain duty to provide some medium through which all vital subjects can at all times be fully and thoroughly investigated, and to be in a position at all times to present a united front on all questions involving the common interests of all railways.

Since we last met in convention, one year ago, ten members of this association have passed to that unknown beyond from whence no traveler ever returns. All were good men and true and while proper recognition will be given each in our usual obituary notices, I feel that I would be most derelict in the performance of my duty and most ungrateful for the association I have had with him if I did not in some manner express my deep feeling at the untimely and tragic death of our friend and past president, Peter H. Peck. Not since the hand of that mad assassin felled the lamented Pulaski Leeds has this association been so deeply shocked at the death of one of its members. The taking of these two stalwarts in such a tragic manner in the fullness of their manhood, vigor and usefulness brings us close to that feeling that man knows not what is in store for the morrow. Peter Peck was struck by a locomotive while crossing the Rock Island tracks at Seventy-ninth street, Chicago, on Sunday, November 28, 1909, sustaining injuries from which he died the following morning. He was a man of whom it could truly be said his friends were legion and his enemies few. A manly man, typifying in the highest degree those noble characteristics of the true American citizen and patriot, a loving husband and indulgent father, always ready to extend the right hand of fellowship to those seeking assistance and wise counsel. In his death this association has sustained a great loss. We will, of course, long cherish his memory, and his words we have permanently recorded and securely lodged in the archives of the association, which we must consider truly a golden heritage.

In closing I feel I should be very ungrateful and unappreciative if I did not recognize with thanks the assistance and full co-operation given me by the officers of the association, the executive committee and the several committees and individuals who have prepared reports for this meeting. To one and all my heartiest thanks are given.

The report of the secretary showed the membership to be as follows: Active, 952; associate, 20; honorary, 37; total, 1,009. During the year the secretary received $5,466.56 and expended $5,433.40, leaving a balance of $33.16. The treasurer's report showed the balance on hand June 20, 1910, $6,229.94.

The executive committee recommended that the dues for the coming year be the same as heretofore, $5 per member. The recommendation was approved.

The Secretary: In accordance with the usual custom, we extended an invitation to the traveling Engineers' Association to have a representative present at this meeting. I am instructed by the secretary of that association that J. A. Talty will represent it.

J. A. Talty: It is the custom for the president of the Traveling Engineers' Association to attend your convention. We do not design locomotives or any part of the power employed by the railways; we try to have the men under our charge render 100 per cent service with the appliances given them, and the traveling engineer who will devote his attention to educating the men under his charge to run the locomotive economically and thoroughly post himself on the equipment that is attached to the engine, so as to ferret out the defects, is an able adjunct to the master mechanic, and for that reason we feel that the Traveling Engineers' Association is an important auxiliary to your association.

The following members were elected on the nominating committee: J. F. DeVoy, C. H. Rae and A. W. Gibbs.

The president appointed the following committee on obituaries: On Peter H. Peck, the secretary; on Jno. Harrison, Henry Tregelles; on Davis Witherspoon, C. E. Chambers; on W. H. Stulb, F. F. Gaines; on A. B. McHaffie, W. D. Robb; on George Whale, John W. Cloud; on John McKenna, William Garstang; on John Hewitt, the Secretary; on John F. Devine, J. S. Chambers; on Henry Elliott, Jacob Johann.

The committee on Correspondence and Resolutions is G. M. Basford, Le Grand Parish and C. A. Seley.

The following applications for honorary membership were acted upon by the Executive Committee, and are presented to the Association with the approval of that committee: Edward V. Sedgwick, who has been a member since 1885; Thomas Millen, who has been a member since 1885; C. E. Rettew, who has been a member since 1892; Walter L. Gilmore, who has been a member since 1883; James W. Hill, who has been a member since 1887; E. W. Roberts, who has been a member since 1882.

J. F. Walsh (C. & O.): I move that the action of the Executive Committee be approved, and that these members be transferred to the list of honorary members.

The motion was carried.

The report of the Committee on Mechanical Stokers, which will appear elsewhere in the Railway Master Mechanics, was read and discussed as follows:

Clement F. Street (Cleveland, Ohio): All that it would be becoming for me to say is that my stoker is doing business. The machine has been in regular service. The first experimental machine was put out about a year and a half ago. This machine ran for one year and was gradually developed to a point where a second machine was applied, in February of this year, which has since been operating daily, and at the present time is in regular service, taking any engineer and any fireman that comes along. It is necessary, of course, to have a slight amount of instruction, but the firemen have taken the locomotives without ever having seen the stoker run except as the locomotive was standing. The traveling engineer has gone over the machine and showed the fireman how to operate it, and has gotten off the locomotive and the fireman has made the complete round trip with the stoker, putting all of the coal in the fire-box with it, no hand-firing being necessary. The machine will do this, and is doing it, right along.

The stoker is now working between Ashtabula and Youngstown on the Lake Shore and Michigan Southern. I am applying six more machines, all of which will be in operation inside of the next two or three months.

D. R. MacBain: On behalf of the Lake Shore & Michigan Southern I wish to extend an invitation to any of the members of the Association who feel that they would care to look over Mr. Street's stoker as it is now working on our lines to do so.

John Tonge (M. & St. L.): Is a representative of the Iowa

Central here? I would like very much to have him tell us what difficulties they had with stokers. The report says: "It is generally regarded that the failures experienced were largely due to the enginemen being inexperienced in operating the machine." In all my experience with the stoker I have come to the conclusion that there is very little work for the men to do, and that such work as is necessary is very easily done. I feel that the stoker is a success under many conditions, not under all conditions, but I do believe that it is possible to make it a success under all conditions.

C. E. Gossett (I. C.): I am responsible for the statement in the report to the effect that the difficulties we have had in the operation of the stoker are largely due to the enginemen being inexperienced in the operation of the machine—that these difficulties are caused by a lack of familiarity on the part of the enginemen and firemen with the details of the operation of the stoker. The experience required in the operation of the stoker is, first, the amount of steam to be admitted to the stoker, which is graded by an ordinary globe valve. To get a uniform stroke, you must have a uniform pressure or a uniform supply of steam. If the steam pressure on the boiler varies five, ten, or fifteen pounds, it is very noticeable in the action of the stoker. Therefore, the throttle must be regulated, which is done by an ordinary globe valve. Another important feature is the lubrication of the machine; it has got to be well taken care of. Again, in making reports of the failures that occur, when arriving at the terminals, it is important that the enginemen be able to explain what is wrong with the machine—whether it is not making the proper distribution of the coal, or has failed altogether. That is why I have commented upon the experience which I regard as necessary on the part of the enginemen in the satisfactory operation of the stoker.

J. A. Talty (Traveling Engineers' Association): Has a mechanical stoker ever been applied to an anthracite coal burning engine, or an engine burning pea coal?

T. O. Sechrist (C. N. O. & T. P.): We have the Hanna stoker, which is now applied to a Mallet locomotive, which runs a division 138 miles long between Oakdale and Danville, Kentucky. This division is made up mostly of heavy grades, and there are 23 tunnels on the division. We have used nothing but a nut and slack coal. The 22 x 30 in. engines all use regular run of mine coal which costs $1.35 per ton, and the nut and slack coal costs 90 cents per ton; the actual saving in a forty days' run was 30 per cent in the fuel consumption.

These tests were conducted by the college of mechanical and electrical engineering of the State University of Kentucky, at Lexington; the maximum boiler pressure was maintained at all times on every day of the forty days' run. The firing is light and continuous. We have had several representatives of various railways in the West ride on this engine, and they have all been very well pleased with it; in fact, they have expressed themselves very strongly regarding its efficiency. We have also applied the stoker to the 22 x 30 in. engine, and a test was made for forty-five days; every trip was made without a failure, it not being necessary to use a hook or rake the grates at any time. At the end of a 138-mile run we never found over six inches of fire in the fire-box.

Any extra fireman will handle it as easily as the regular man who has been assigned to it. The tests on the Mallet locomotive were made during rainy weather, very wet rail, and no allowance was made for the amount of water that was absorbed by the slack coal. During the test without the slack coal and without the stoker the weather was very good; in fact, it was clear every day the test was made.

We have installed twelve more of the Hanna stokers on the division between Oakdale and Danville, and I believe it is the intention to equip all of the 22 x 30 in. engines and the Mallet engines with it. Before we placed the Hanna stoker on the Mallet engine, it was necessary to use two firemen; they were unable to keep the steam up, and the flues leaked very badly before the end of the trip; since applying the stoker on both engines, we have never found occasion to roll or caulk the flues. One each of the other divisions, it is necessary to do this at the end of every trip. The regular run of mine coal costs $1.35 per ton, and the slack 90 cents per ton, so you can readily see where we show a reduction of thirty per cent in fuel cost.

J. F. DeVoy (C. M. & St. P.): The Chicago, Milwaukee & St. Paul has had a Strouse stoker in operation a little over a year. From March 1, 1910, we have had five Strouse stokers operating on consolidation locomotives; we have kept a detailed record of the performance of these stokers. I would like to read a few extracts from a report which has been made on their performance. In the first place, we believe that a stoker will fire as well or better than a hand-fired engine. There is no question but what an engine equipped with a stoker will arrive at the home terminal in much better condition than other engines. We have come to the conclusion that when the stoker is properly handled there is no trouble with the steaming on any of the engines. Here are a few reports on the stoker: May 20, 1910, fine coal, hard pulling train, engine steamed O. K., fireman handled stoker properly. May 21, 1910, stoker O. K. and handled O. K. May 23, 1910, good coal, steamed good, fireman and stoker O. K. May 27, 1910, engine hot all the time, did not take coal at Watertown Junction, fireman started to fire too heavy. Was instructed that has been the cause of any failures we have, and you all know that there are many green firemen being continually put on engines; it is due to their not being instructed in the stoker that has caused most of the failures. May 27, 1910, good coal, steamed good, fireman economical, nice fire, heavy train.

A statement showing the number of pounds of coal for engines equipped with stokers, and engines not equipped with stokers, on eastbound runs, shows that stoker engines made an average of 10.42 lbs., against 9.64 lbs. for other engines. On the westbound runs they averaged 11.03 against 11.17 pounds for 100 ton-miles. This test represented 68 trips with stoker engines against 97 trips of engines without stokers. It does not show that the stoker engines have any advantage in coal performance. We now believe, as a general proposition, that the stoker will show very material benefit in performance, so far as leaky flues are concerned, and that it is possible in pinches to get a little more out of the machine, so that the performance altogether is rather favorable to the stoker. This applies to what we think may be accomplished by any form of stoker. It refers to the stoker problem in general.

C. F. Street: I have been following the stoker business pretty closely, and, so far as I know, a stoker has not yet been applied to an engine burning anthracite coal. The problem of firing anthracite coal with a stoker should be much easier than with the bituminous coal, owing to the uniform grade of the coal. A uniform grade of coal cuts out two or three of the most difficult propositions for the stoker. Run of mine coal, with very large lumps mixed in with very fine slack, presents a more difficult problem.

D. J. Manning (D. & H.): What is the maximum grate handled up to the present time and the amount of coal handled per hour? In connection with the statement of Mr. DeVoy, I would like to know the grate surface of the engine with the stoker, the kind of coal and about how much they burn per hour.

Mr. DeVoy: The fire-box of the five engines equipped with stokers is 108 in. long by 66 in. wide. We burn Illinois run of mine coal in any shape. Observations lead me to believe that the finer the coal, the better. The stoker will handle the Illinois run of mine coal of poor quality better than the hand-fired engine will do, and the good lump not so well as the hand-fired engine will do. Some of the engines used about eight tons of coal in two hours.

J. F. Walsh (C. & O.): We are using five Strouse stokers. They are in service on the ordinary wide fire-box engine, with about 50 square feet of grate area. We are burning about 2,500 lbs. of coal per hour. These engines haul 4,500 tons on the river grade, and bring back 55 to 65 empty cars. The engines are worked at full capacity all the time. We get as good results, so far as economy of coal and evaporation of water is concerned, from the Strouse stoker as we would from ordinary hand-firing. We burn coal that probably runs from 65 to 90 per cent slack, and I believe, on the whole, you get better results with the stoker where the coal is fine. Some of the parts fail occasionally, but on the whole they perform very satisfactorily. The stoker, in order to be made a fixture on the engine, must be made more attractive to the fireman. There must be some means furnished by which the coal can be carried from the tender to the hopper. This will do much towards making the stoker a fixture on the engine. As the matter now stands, the firemen complain to some extent of the height to which they have to raise the coal—the stoker hopper stands 24 to 26 in. above the footboard, and the firemen have to lift the coal a little higher than they would to put it in the fire-box. In burning the same quantity of coal they claim the only thing to their advantage is the relief from the heat of the furnace which, on a forty-five hundred ton train, is a decided advantage in hot weather.

M. D. Franey (L. S. & M. S.): The stoker should leave the fire-door in such a position that in the event of the stoker failing the fireman can proceed to fire by hand without any delay. When we realize that the stoker conveys the coal from the tender to the hopper on the boiler-head, that it distributes the coal to any point of the grate surface, that it does this satisfactorily and provides a saving of 75 per cent in the labor of the fireman, and that the fireman does not have to lift the coal above the floor of the tender, we can readily understand the difficulties attending the design of the mechanical stoking machine.

The Street stoker was applied to one of our locomotives as described in the report, with a grate area of 55 square feet. It was first applied May 14, 1909, running on the L. E. A. & W. division, 88 miles in length. The road at this point has a ruling grade of 78 feet to the mile, with a maximum grade of 105 feet extending for a distance of one mile; on that one mile a pusher is provided. The tonnage handled is 45 empty cars, or 800 tons. Regular crews were assigned to this point, and the engine gave very good service. The engine was brought to the shop and the improved stoker was applied January of this year. It was then assigned as a hill pusher at Ashtabula on a grade of 72 feet per mile. Two engines were required to haul 25 cars with 1,400 tons, both working to full capacity. We obtained an excellent performance with regular crews, with 75 per cent less work than with hand-firing. This is the statement of the engineer and fireman that operated the engine. The engine was then assigned to service on the division between Ashtabula and Youngstown, a run of 59 miles, with a ruling grade of 15.8 ft. to the mile. No tonnage tests have been made, but the engine gets the average train as made up, and has made seven trips in this service.

I fired the engine 50 miles during the month of March. It had a load of 3,400 tons, and at the time I started out, early in the season, I had on a heavy overcoat—the weather in the morning was cool, but during the day the temperature increased to about 75 degrees. We had several delays on the road—I did not feel uncomfortably warm—and we did not put one shovel of coal through the fire door, did not touch the fire with a rake or shake it once during the entire trip. About 70 per cent of the coal was slack; at the start we had lump coal; then run of mine, and then it ran down to 60 or 70 per cent slack. I examined the fire several times, and it had the appearance of a well-raked garden bed, with little pebbles, probably the size of a marble; a great deal of the coal appeared to be burning in suspension.

On one of the trips we had sixty-two cars, 3,760 tons, and made the trip in five hours and a half. There was a delay of one hour and a half on account of train movement, and the actual time running was four hours, with six tons of coal consumed. This consumption of coal is simply an estimate. There was 200 lbs. of steam at all times. The firing in this particular case was all done by the stoker; there was no raking, and there was a light, clean fire at the end of the trip. The engine had a mileage at this time of 30,000 miles; everything about the operation of the engine was entirely satisfactory.

The engineers and firemen in pool service state that the stoker saves 75 per cent of the firemen's labor, in addition to protecting them from the heat of the open fire-box door, and that the engines fire equally as well with slack coal as with lump coal. The engineers claim that this engine can be worked, and is worked, harder with the stoker than would be the case if fired by hand. This should increase the efficiency of the locomotive, and especially at the end of trips after being on the road a number of hours with a tired fireman on a very hot day.

Observations indicate a considerable saving of coal with the stoker over hand firing. No test has been completed to verify this, although one is now being made. The amount of black smoke emitted is constant when firing heavy and is of a lighter color when firing lightly, but it is constant and in proportion to the amount of coal fired per unit of time. No attempt has been made to correct this feature. I understand from Mr. Street that he is now considering the smoke feature. The depth of fire carried on the grates is about six in. On account of such light firing it is free from clinkers. The stoker seems to give better control than hand firing. It fires slack under conditions where poor results are obtained by hand firing. The use of the hook and grate shaking are seldom found necessary. The firebox door is seldom opened, and a good many trips have been made without opening the firebox door for the entire trip. The cinders discharged from the stack are very much smaller and have the appearance of being more nearly consumed than those emitted from the stack during hand firing. The maintenance of the Street improved stoker is light, no higher than can be expected of any machine of the same number of working parts which is carefully designed. The stoker will do the hard work of the fireman, though, of course, some skill is necessary to properly operate it. A variation of pressure on the boiler makes no difference whatever in the distribution of the coal. The coal is fed by the conveyor, it dropping into the hopper and is distributed independently of the steam pressure. The stoker is so satisfactory that we are applying three more of them.

H. T. Bentley (C. & N. W.): There is no question that the automatic stoker is going to suit the conditions of engine firing more and more as improvements are made, and I believe this stoker more fully meets the requirements than any I have heard of, notwithstanding the fact that we have been experimenting for ten years. I understand the Crawford stoker is in operation on the Pennsylvania and doing very satisfactory work. I understand further that they are going to put it on the testing plant at Altoona, and a good many of the things we are confused about can then be tested out. For instance, the question of coal—I do not believe it would pay to try the stoker with only one kind of coal, and I feel satisfied that the Pennsylvania officials will be as anxious to try it with all kinds of coal as anybody else would be. The stoked should be built to handle the coal that is nearest to the point where it will be used.

One thing that is very important to us at this time is to find out how much coal the stoker can use under the most severe service. The reason for this is that we have just had a firemen's arbitration board in Chicago, and some of the stories the firemen told about the amount of coal shoveled into the stoker were astonishing.

As to Mr. Gossett's statement that the machine on the Iowa Central is doing very good work, I heard incidentally that Mr. Maher, on the Alton, was taking off the Strouse stokers. I do not know that that is a fact, but it seems to me funny that they should be giving such good service on one road, and be taken off of another road. I think Mr. Walsh made a statement in this hall last year, that if anyone wanted to buy some stokers cheap they could have them.

I do not agree with Mr. Tonge about the experience matter. Everyone who has spoken this morning says it is necessary for the fireman to have experience. You cannot make a cup of coffee unless you have had experience in doing it. There is no question, Mr. Tonge, as Mr. DeVoy said, that a green man is the cause of most of the difficulties, and if you have green men operating the stokers you will have trouble. I do not care what you put on the engine, you must have men with some experience to operate it. The machine which requires the least amount of experience to operate is the best machine to put on the engine. The difficulty one gentleman complained about, due to variation in the steam pressure, is a serious thing; last winter I heard of one or two engines that went five or ten pounds below normal pressure, and that five pounds variation would make considerable difference in the operation of the machine. The question of smoke is one of the most serious things, and I hope Mr. Street and everyone else connected with the stoker business will give it very serious consideration. In the cities of Chicago, New York and Philadelphia, the biggest job that some of us have is the smoke question, and it is no use going around with an automatic stoker, if it will not reduce the amount of smoke emitted.

John Tonge (M. & St. L.): I had the privilege of riding on a flyer engine, as they were called, on the Alton fast train, and also on heavy freight trains, and I want to say that a boy or anyone you could pick up on the street could do the work on that engine. The needle didn't move during the entire trip until I requested that it be moved. I said, "Put some coal in the engine and let us see whether you have the needle fastened or not." The best thing we can do is to advocate, and to work ourselves, for the success of the stoker. In starting out from Minneapolis and running to Albert Lea there would be no variation in steam, no variation in the tonnage of the train, just merely the matter of lifting the coal up and putting in the scoop.

D. R. MacBain (L. S. & M. S.): We ought not to lay too great stress on the matter of economy. What we are after at present is to get something that will do more than a man will do towards supplying fuel to one of the modern locomotives. During the past ten or fifteen years there have been wonderful strides in the weight of equipment, and an effort has been made to keep up with it in designing locomotives that will haul it at higher speeds. Having these things in mind, I would suggest that the Association, for the time being, lose track of the economy feature. It has been my greatest trouble for the past year to get enough coal burned. I have found that with the big Pacific type engines, with heavy trains, the difficulty was in getting a man who could put coal into the firebox fast enough. We ought to work for an efficient stoker, regardless of the economical feature, and take care of the economical feature after we have succeeded in getting something that will take the place of the best man we can find on the locomotive at the present time, and do better than he can. I believe the difficulty with smoke can be largely overcome by making a heavier fire. I have ridden but one stoker locomotive, and on that occasion the engine was belching out a quantity of smoke that was covering the country through which we were running. When we made the first stop I asked how they were getting along; the steam pressure was dragging back to 150 or 160 lbs., and, looking in the firebox, I found the grates barely covered, so the cold air was getting through and the gases had no chance to be consumed. and were being carried out of the smokestack. We increased the thickness of the fire about one hundred per cent, and decreased the emission of smoke in the same proportion, or better.

This Association ought to use its efforts and lend its support to those who are trying to develop a stoker that will take the coal from the tender. The firemen claim the only benefit they have from most of the stokers so far produced is that they do not suffer from the heat. More attention should be given to the matter of carrying the coal from the tender into the hopper. By the time a successful device for that purpose is developed, the stoker will be on a sound enough footing to stand.

W. C. Hayes (Erie): Our experience with stokers so far has not justified any very great expression in their favor. We have five or six in operation, and it is part of my duty to look after them. So far we have had but poor success. It takes about one-third more coal to operate our stokers than it does by hand-firing. If we do not give any more attention to perfecting the work of the stoker after we get it installed, than we have given to the education and perfection of the fellow at the wooden end of a scoop shovel, our stokers are going to be of but little use to us, except to make the fireman expect that you are going to do something for him, and continue to do it indefinitely. I believe that if we were to bend our energies more in the direction of perfecting the work that can be performed by the fireman, we will do more than can possibly be done by the perfection of the stoker. In some specific instances where we made experiments, weighed the coal, indicated the engines, and kept as accurate account of the test as possible, it showed a difference of something like 33 per cent in favor of hand-firing. That may not be exactly fair to the stoker. Everything that we have done is yet in very much of an experimental stage, and we have tried our best to get the stoker on an equal footing with the fireman, but so far we have been unable to do so.

We are trying a stoker with a grate surface, as I now remember it, of something in the neighborhood of sixty-five square feet, on a consolidation engine, 22 x 30 in., with forty thousand pounds tractive effort. We have five of them on that class of engine, and the coal used is prepared especially for the stokers. With the stokers that we are using, with the worm feed, we have to prepare the coal in a certain size or it cannot be handled. They will not take the run of mine coal.

George L. Fowler: I have been waiting to hear something in regard to the Pennsylvania stoker, Mr. Crawford's. It was my pleasure a short time ago to ride on an engine that was equipped with that stoker, as well as to watch it from the side of the track when the crew on the engine did not know that they were being watched. The stokers that I had ridden on the engine with before, were noted for the tremendous amount of smoke that they were belching out over the country. The Pennsylvania stoker is practically smokeless. I stood at the head of the grade at Sewickley, just west of Pittsburg the other day; the engine came up the grade with a fully loaded train and was working as hard as it could be worked. The steam of the exhaust was being condensed by the coolness of the atmosphere, and it was quite possible during the entire run, standing in front of the engine, to look between the steam and the stack and see the landscape beyond perfectly clear. There was no discoloration to the smoke whatever, except at one point, where the fireman opened the door and raked down his fire.

The next day I rode the engine from about twenty miles west of Pittsburg, nearly to Crestline, or about 150 miles. During all of that time, there was no smoke coming from the stack that would have discolored Pittsburg atmosphere. The fireman had nothing to do except to open the valve that would start the stoker engine, each stroke of the engine putting about 28 lbs. of coal into the furnace. The coal is taken from the tender. It is crushed, carried forward and put into the fire. The fire-door is perfectly free, so that hand-firing can be resorted to instantly by the fireman; the men on the engine were emphatic in the declaration that if the stoker did not keep up steam, and if there was any failure whatever, there would be no use in resorting to hand firing because the stoker would bring the steam up better than the hand firing would. That is an example of what is being done with the mechanical stoker on the Pennsylvania Lines West.

The officials are not inclined to say anything as to the efficiency of the stoker until they have had the machine on the testing plant, but the general estimate is that the stoker runs at from five to eight per cent less coal than is used on the hand-fired engine. There is one thing that it does beyond all peradventure, and that any one can see who sees the engine pass by or watches it on the road, and that is that it is practically smokeless. There is a faint brown coming out of the stack almost all of the time, which would run about one-half of the first diagram of the Ringelmann chart, so that there would be no trouble whatever in the use of this stoker, if it worked in the way in which I saw it worked, through any city, no matter how severe or strenuous its smoke ordinances might be.

David Brown (D. L. & W.): I am surprised to find that the information on this subject is rather meagre as yet, that some of us have had no experience and that others have had a little. There is no doubt that we could continue this line of discussion all day, and there is no doubt but that the stoker has come to stay, especially with the narrow fireboxes. There is no trouble whatever in spreading the fire as you want it over a narrow firebox. On the other hand, the wider you get the firebox, the more difficult it becomes, and you can go to the extreme. I know we have fireboxes on which you could not use it at all under any circumstances.

Education an Essential of Fuel Economy.

W. C. Hayes, superintendent locomotive operation, Erie, presented an individual paper, an abstract of which follows:

The engineers and firemen should be required to fully post themselves as to proper methods of combustion, making such a study of the subject, from time to time, as will enable them to apply in everyday practice its cardinal principles. Literature of a well-known character and value can easily be secured that will assist in a study of all branches of the subject. This lays the foundation for progressive examinations of enginemen in fuel economy. The best plan is to furnish a good theory of combustion, that will clearly develop the scheme of progressive examinations by giving to all enginemen a printed list of questions, answers to them being required in writing, upon which a well-developed plan of oral examinations can and will be based. These examinations to be made either by a committee composed of the master mechanic, road foreman or some general officer who may be delegated for that duty by proper authority, or through any other medium that may suggest itself.

Railroads carrying a sufficient force of road foremen to properly supervise the work, so that they are able to ride with and instruct each individual engineer and fireman, personally, in the proper performance of their duties, in order to see that object-lessons that are given as examples of correct work are being absorbed and instructions are faithfully adhered to, will find that even this sort of supervision can be materially reinforced by holding periodically schools of instruction. Class lessons can be arranged from time to time for the purpose of discussing any one or all of the subjects under which an improvement in fuel and other economies can be made that are directly under the control of the engine crew. This arrangement will enable the road foreman of engines to cover a much larger field than would be possible under any other plan except an increase in the number of road foremen.

The writer does not wish to be understood as not being in favor of having a road foreman's territory restricted to about seventy-five or one hundred crews and one hundred miles of main line, when that number of crews are used to that mileage, as being the limit that one man can cover in the way of close supervision that will give the best results. Supervision at long range and in the abstract, or by proxy, does not begin to fill the bill as well as a thoroughly thought out, concrete plan; but where an increase in the force cannot be made, then one hand must be made to wash the other, so to speak, by the road foremen of engines meeting in as large classes as can be mustered periodically all the engineers and firemen under their jurisdiction. They must be prepared to instruct, as well as discuss with the men all matters of vital importance concerning the performance of their duties.

Of course, the subjects can with advantage be divided, so that any one subject may be exhausted and definite conclusions reached as to the best method of handling. For instance, take fuel consumption. Plans could be formulated for reducing the amount consumed by securing the co-operatin of engineers and firemen and all concerned, in making a reduction in the amount consumed per ton and per locomotive mile. If their performance is not checked and they are not required to know how much fuel it takes to haul the trains over different sections of the road and under varying conditions, then their best efforts cannot be aroused over what the author thinks is the unit basis of use. Object-lessons that occur in the experience of every road foreman can be made use of to exemplify every phase of every practice in locomotive operation, stimulating effort in all directions that will be of material benefit to all concerned.

G. H. Baker (President American Correspondence School, Brooklyn, N. Y.): Mr. Hayes said in regard to firemen who had had preparatory instruction, that, "In fact, in comparison with men who have been employed as firemen on this same division for three, four and five years, their work, in amount of fuel consumed, is more than favorable, and at this time these men are taking a far greater interest in their duties as firemen than are the older men." That simply refers back to any old farmer's motto, that, "as you would have the tree grow, bend the twig." If you ever want to have your enginemen be amenable to instruction, willing to study instruction, willing to pass examinations on instruction, I think you would find it a great deal easier if you would begin their instruction before they were ever employed. Then they are ready to bow to instructions all along the line, even when they become engineers. One further matter in regard to the proper instruction of men in fuel economy is that it lightens labor. A man who knows how to fire an engine properly and with the least coal, works less, worries less. That enables a young man who may be of light physique to keep an engine hot successfully with less labor and less discouragement than some heavier man would put into the same work. I think that carried out, it would reduce a number of necessary replacements of firemen, because there would be more men stick to their job. It is the experience of all employing officers of firemen that a large proportion of the men employed usually leave the service in the first few weeks, or the first month or two, of it. They get tired out and discouraged with the hard work and the hardships.

About thirty years ago I was made over from a train boy into a fireman on the Missouri Pacific by the plan Mr. Hayes describes in his paper as the "old hit and miss" plan. That is I was sent out to ride around on engines for a week with other firemen to learn the signals and how to fire an engine. During that time a good deal was said about avoiding "popping," because the engineer didn't like the noise. Nothing was said about "popping" being a waste of fuel, or that fuel was ever or could be wasted, or that coal cost the company any money. I fired on six different railways in the following five years, and later was a locomotive engineer for six years, but in all that experience I never heard any engineer or officer say to any man so much as: "Be careful of the coal, it costs money." Now, occasionally, instructions respecting fuel economy are given the engineers and firemen on some railways, but the old plan of hiring and "breaking in" firemen still prevails, with some improvements regarding required physical and mental fitness, but with practically no improvement respecting any required knowledge of the principles of coal burning, or rights of ways of firing, or coal economy.

As a train boy I often participated in the hand braking of passenger trains before even the straight air brake came into general use. I well remember the two foot chasms which then usually existed between the abutting platforms of passenger cars (necessitated by link and pin couplers), which were spanned by gang-planks about four feet long, reaching from platform to platform. Then nearly every locomotive had two pumps to feed the boiler, and an occasional engine had an injector in addition that was usually used only to replenish the boiler when standing, to aovid "pumping up" by uncoupling and running the engine up and down the track five or ten minutes with both pumps working.

Such conditions as these are unknown now. They are but memories of the past in the minds of the older railway men. They have disappeared before a march of progress that has brought about marvelous improvements in nearly every detail of locomotive and car construction, and in railway operating standards all along the line. But in the employment of new firemen the old-fashioned plan of thirty years ago prevails, of letting these comparatively ignorant young men begin the work of burning up each railway's most expensive supply—coal—with no other preparation than to send them out on the road to make some trial trips with experienced firemen.

By this plan a new fireman's schooling for his coming important work consists simply of what he picks up about it during the trial trips. He thus partly "learns the road," but what he learns about firing is limited and shaped by the habits of the fireman he is supposed to copy. If he knows nothing himself about the principles of combustion or right ways of firing—then the firemen he rides with become the pattern by which he is shaped as a fireman. Is the pattern perfect? If so, it is well for his future work. But imperfections in the pattern are bound to be imparted to him. He will learn some good things about firing, but he will also probably learn all the bad habits of the men who are his teachers. Is not this practice much like taking a used and worn wheel as a pattern for a mould to cast new wheels? If so, then such a plan, that would be instantly condemned in mechanics by every mechanic, cannot justly be defended when it is applied to mould the working habits of a man, who probably is to spend some years of his life in daily consuming a quantity of coal that exceeds his wages in value several times over.

Now the fact is, that the common wasteful habits of locomotive firemen—which are plainly as much in evidence today as they were 25 and 30 years ago—are the natural result of this very practice of shaping the work of new firemen by that of old firemen, thus perpetuating their imperfections through new relays of firemen, year after year. We all know how easily bad habits are formed; also how hard it is to break away from such habits when once acquired. In my experience as an engineer I have known the best disposed firemen to occasionally relapse into old bad habits—long after they realized how evil they were. Under such conditions—How can we expect to accomplish a general permanent improvement in the important work of firing the 60,000 locomotives on North American railways, which daily consume about $600,000 worth of coal, unless we begin the needed improvement at the source of the stream of new firemen who are daily entering and recruiting the locomotive service at the average rate of about 2,000 men a month, or 25,000 a year?

Let us make a rough estimate of what it costs the railways, in coal and money, to "break-in" and educate this army of green firemen annually. Probably few, if any, locomotive men will dissent from the statement I shall make—that a new fireman will ordinarily burn an extra ton of coal a day in firing engines during his first month's service, due to his ignorance and lack of judgment in the work. If so, then he will waste about 25 tons of coal in the month. With the average cost of coal, say $1.50 a ton on the tender, this waste will aggregate a loss to the company of $37.50.

If this estimate is approximately correct, then the 25,000 new firemen annually "broke-in" on all our railways cost the companies about a million dollars ($973,500) a year in wasted coal. Crude and imperfect as this estimate may be, because based largely on observation and belief, yet there is enough of evident truth in it to teach the necessity of some radical reform being now made in the general practice of employing new firemen, to insure that they shall have not only physical fitness for the work, but that in addition to this they shall also acquire—before employment—an intelligent conception of the importance of the work they wish to do, and the value of the fuel they will consume. By all means they should be required to clearly understand the easily obtained and easily understood knowledge of how coal burns, and produces either its greatest possible heat in perfect combustion (with sufficient air), or but one-third as much heat in imperfect combustion for want of sufficient air, the air, or the oxgen in the air, being as much the "fuel" of the fire as the coal. It is, and always was the worst fault of all careless firemen that they disregard the needed supply of air for the fire, and shovel on the coal regardless of waste, because of ignorance of the chemical processes occurring in combustion. This and many other wrong and wasteful practices in firing continue, and are handed on from old to new firemen who know and learn no better, and who in turn teach their successors, as the superstitions of old were handed down by the ignorant from generation to generation.

I therefore respectfully submit this motion:—That a committee be appointed to investigate and report to the next convention upon: First, the desirability of preparatory instruction for locomotive firemen, to be mastered before employment. Second, the value in fuel economy and superior service, if any, effected, by such instruction, as shown by actual comparison of the services of instructed and uninstructed firemen. Third, the subjects which proper preparatory instruction should teach. Fourth, the character of examination (oral or written) to ascertain if applicants properly understand the instruction, and should they be permitted to enter service without such examination, same to be completed within first month of service. Fifth, examine and report upon the merits and defects of any systems of preparatory instruction for firemen now in use.

T. E. Adams (St. L. S. W.): A discussion of this subject might be divided under two heads:

1. What is coal and the best recommended practice for using it.

2. The method of instruction; the application of this method and to see that it is carried out.

First.—It is agreed by those whose authority is recognized, that the study of the fuel question is not founded on concrete ideas. The opinions, generally speaking, of what coal is and how to use it are varied, and the line of instructions issued for the use of it equally so, to the extent that numerous engine failures, whether due to the misuse of it or not, are attributed to it (this will apply to either anthracite or bituminous coal in general use), when, as a matter of fact, if proper methods were introduced the difficulties would have been materially reduced, and many of these failures would have been eliminated. The question of the intelligent use of fuel is one of such vast importance and has such far-reaching effects that nothing should be done or any data furnished, in any capacity, which would convey a wrong impression and lead to the improper use of it.

Coal as it comes from the mines is intended for the use of mankind, and it would seem that all that would be necessary would be to notice the action of nature itself, but we pass by and do not see the object lesson. Take for example a pile of coal in the open air, of size sufficient to maintain combustion. Has anyone ever seen large clinkers form in such a pile of coal when allowed to burn without being disturbed or poked, notwithstanding a large amount of co-called impurities, such as dirt, sulphur, etc.?

It might not be out of order at this time to make a few remarks on the inspection and testing of coal. This subject has been discussed in various ways, as well as put into practice; some are in favor of it and maintain a force of inspectors at the mines; others are opposed to any inspection, leaving the coal to speak for itself in the use of it and studying the quality of the ash at the ash pit, which is the most accurate way to determine the quality of the coal.

Generally speaking it is a hard proposition for an inspector to inspect for impurities, etc., in coal, and intelligently pass on any grade of coal, when he has but a faint conception of what coal is. The principal duties of an inspector at the mines are to see that the equipment furnished for loading does not contain refuse, that is not damaged in loading, checking weights, and to see that the provisions of the contract are fulfilled. In taking the testing of coal up with the secretary I find that this association has never had a test made, nor do we find that an absolute concrete test has been made in any other direction, as to what coal is and how to use it; this we consider the starting point of this great question. As an example, in bulletin No. 403, of the U. S. Geological Survey, in connection with the test of run of mine coal, the statement is made "Fire had to be raked after every other firing and sliced about every fourth or fifth firing, in order to keep it loose."

The New York Central Lines established in 1903 a set of first, second and third-year progressive examinations for firemen, which can be better described by reading the preface as given in the examination books, which reads as follows: "It is the policy of railways to employ men as locomotive firemen who will be capable in time of becoming locomotive engineers. This requires that a man should have at least a common school education, good habits, and be in good physical condition. He should also be quick and alert and a man of sound judgment. Having these qualifications, advancement will come to those who are conscientious in the discharge of their duties and who devote some of their leisure hours to study. As an aid to this end and in order that there may be derived the highest efficiency from a man engaged as a locomotive fireman, there is placed in the hands of every man who is employed as a fireman a code of questions, and it is expected that in the preparation necessary for correct answering of the questions a course of study will be necessary which shall fit him for the work which he is expected to perform. His answers to the questions will indicate how well he has progressed.

"When a man is employed first as a fireman, he will be given the questions on which he will be examined at the end of the first year. Having answered these questions satisfactorily he will then be given the questions for the following year. Having passed this one, he will be given a third and final set of questions on which he will be examined before being promoted to engineman. It is not expected that a man will answer these questions without assistance, and in order that he may understand them properly there has been established a school of instruction in the use of the air-brake, to which all employes are invited; he is also invited to ask the master mechanic, general foreman, road foreman of engines (or traveling engineer), also air-brake supervisors (or instructors, or any other official), for such information as may be required on any of the questions or on any points in connection with the work. He is not only invited, but is urged to do this as the more knowledge the firemen possess the better the results which can be obtained. He will have ample time to study each set of questions, therefore there is no doubt but that with a reasonable amount of study each week the information required to answer satisfactorily the entire list of each series of questions can be easily mastered in the time given.

"In connection with this examination the work done by the firemen during the time of his service and how the work compares with that of other firemen engaged in the same class of service will be noted carefully; also his record as to the use of coal, oil, etc., will be taken into consideration. It is hoped that he will give everything in detail the consideration it merits and realize fully that it is by looking after the little things that a man succeeds. It should be borne in mind that it is only by filling well the position that one has that a person is entitled to the confidence that makes beter positions possible."

The following describes the method and time of holding these progressive examinations: "When a man is employed as a fireman, he shall be given the first series of questions and be notified that at the end of the first year of the service he will be required to pass a written and oral examination thereon, under the direction of the division mechanical officer and air-brake supervisor or air-brake instructor. After passing the first series of questions, he will be given the second series of questions and be notified that at the end of another year of service he will be required to pass a written and oral examination thereon, under the direction of the division mechanical officer and air-brake supervisor (or air-brake inspector). If a man fails to pass the first and second examinations, he shall be dropped from the service. If a man has passed 80 per cent or more in all examinations, he shall be given a diploma. When he has passed the second series of questions he will be given the third series of questions and be notified that before being promoted and within not less than one year he will be required to pass a written and oral examination before a general board of examiners. At the third examination, if a man shall fail to pass 80 per cent of the questions asked, two more trials, not less than two months apart, will be given him to pass the same examination. If he then fails to pass by a percentage of 80 per cent, he shall be dropped from the service. Firemen passing the third and final series of questions will be promoted in order of their seniority as firemen, except that those who pass on the first trial shall rank, when promoted, above those who pass on the second or third trial, and those passing on the second trial shall rank above those who pass on the third trial. Enginemen employed shall be required to pass the third series of questions before entering the service."

Self-Dumping Ash Pans.

H. T. Bentley (C. & N. W.) opened the topical discussion on self-dumping ash pans as follows: Are self-dumping ash pans entirely satisfactory, and if not what should be done to make them so? In accordance with Federal requirements we equipped our engines with self dumping or legal ash pans, and had all in operation by January 1 of this year. Before going into the application of them we made a careful study of the situation, and went over the drawings of practically every self dumping pan that was then in use, and decided, as we had a number of new engines from the locomotive builders equipped with the bottom slide apparatus, that it would be the most satisfactory arrangement for such engines. Therefore, after considerable thought, we worked up a design that would answer for the largest number of engines, and made standard for those engines the slide, hopper casting, operating rods, cranks, etc.

We had to settle a number of things that came up, such as an arrangement that could be worked from either side, a device that could not be opened from the deck so as to overcome the possibility of dumping live cinders on bridges, etc., where they might cause trouble; make provision for thawing them out in winter, and provide sufficient openings for air to enter without letting fire out. We designed every part amply strong and felt that we would be rewarded by having a device that would be reasonably free from causing us trouble, but have been disappointed, and in making inquiries from our neighbors find they have all had more or less difficulty with pans warping and getting out of shape, so that live cinders were dropped, setting fires, and causing other trouble. During cold weather the slides would freeze solid, notwithstanding the fact that we had a heater attached to each one to overcome this difficulty.

It has been suggested that we make the hopper entirely of cast iron, but in looking over pans on other roads we find they have tried this and had to abandon its use, substituting cast steel, which apparently is very little better. On a road having all steel bridges, and running through a well settled territory, the dropping of a few live cinders is not a serious matter, but out in the country, with wooden bridges, dry grass, etc., it is a different proposition. It has been proposed that we have a water connection from the boiler to the ash pan so that occasionally the live cinders can be wetted down. This may be satisfactory in summer, but in winter it might cause trouble. Some people have turned the injector overflow in the pan, which may be satisfactory in the south, but in the north the pan might freeze up.

A number of roads use a steam jet for blowing cinders out of flat bottomed pan, and we understand it works satisfactorily with certain kinds of fuel, but with Iowa or Illinois coal we are afraid the clinkers could not be blown out with steam. The object of this paper is to bring about a discussion as to the difficulties or troubles experienced as a result of the ash pan bill that was passed, and what can be done to overcome them.

J. F. DeVoy (C. M. & St. P.): One of the most serious problems we have ever had on the Milwaukee road has been the ash pan question, and if this convention does not do anything else, it should enter a protest at this time against the passage of bills making railways apply devices which are an absolute detriment, not only to the locomotive, but to the country in general. The idea of making a railway spend $50,000 or $75,000 for a device, in connection with the use of which there is no return, to my mind comes pretty near being confiscatory, if that is the proper term. I do not know whether we can prevent such bills being passed, but the least we can do is to voice our sentiment against such things.

By experimenting with all the ash doors, we obtained the most successful results from the door operating mechanism used by the Chicago, Burlington & Quincy; it is the only ash pan among a dozen we have used with which we have had absolutely no trouble up to date. It has not been on more than ninety days, but it is a good thing.

I know I will be found fault with by the Chicago & Northwestern in the statement I am about to make. They operate nearly everything in the line of an ash pan that can be dug up in any institution in the world. The Smithsonian Institute should get hold of everything they have, because I want to tell you now they are gems, some of them; some are all right. I do not know that I can say anything appropriate on the ash pan question; it is a shame to make a railway company go into anything like that, and it is pretty nearly time that a commission or something of that kind be appointed to determine what is the proper thing to do, because when we were compelled to go into this the federal authorities knew nothing about it, and we knew less.

This is one of the greatest practical problems that confront the railways. We are burning stations and everything we come in contact with. This is a serious matter. You and I do not want to take a chance in riding over a railway when the destruction of a bridge may destroy our equilibrium. It is a serious question, and it was a mistake for Congress to make us put in a self-dumping ash pan at that time, as the device was not developed as it should have been before the railways were compelled to adopt it.

Mr. Bentley: This is the happiest day of my life. I have actually gotten Mr. DeVoy to agree with the Northwestern, and I would like him to give the names of the ash pans which he found were good. I would like to look those up and investigate this matter further.

Mr. DeVoy: I do not know that any were good. I believe I said they were all poor, but the best one I saw was on the Chicago, Burlington & Quincy.

A. E. Manchester (C. M. & St. P.): I did not intend to say anything on the ash pan question, but if there is anyone who has something that is right up to G and will not give trouble, and will not freeze up or scatter fire along the road, and will not do any of the things some of us have trouble with, they should be the men to occupy the time of this meeting, because they are the fellows we want to hear from. We want them to tell us about this ash pan.

Mr. Bentley: There is an arrangement for an ash pan which has a locking device, so that when you carry the lever over it is impossible for it to work away, and I think any well regulated railway should have a safety device of that character put on its ash pan.

D. R. McBain (L. S. & M. S.): Our greatest difficulty with the automatic dumping pan has been to have the fireman close it after cleaning the fire on the road. We have had some difficulty with the slides coming out, but so far as the dropping of fire on the right of way is concerned, we have had no serious difficulty, except in the matter of the discipline of the men. The men are careless about it, and it requires a long campaign of education to have those who operate the locomotive understand the necessity of keeping the hoppers closed properly at all times.

Mr. Gibbs: Our experience has been along the same line that Mr. Bentley has outlined. When Congress had this question up, we showed that the fatalities caused were very slight—we fully explained the troubles about getting a very satisfactory ash pan—we went into the things that caused the trouble, but since the matter was agitated in Congress we have been giving close attention to it and expect that all the difficulties will finally be overcome.

Training Apprentices.

F. W. Thomas, Supervisor of Apprentices, Santa Fe System, opened the topical discussion on Training Apprentices as follows:

The awakening of the railway and manufacturing companies to the importance of educating and training young mechanics to recruit their depleting ranks to fill their expanded shops, has been until three years ago very slow—not until the supply had fallen far behind the demand or until they were sorely pressed for men. There has never been a time when the demand for good, all-around, skilled mechanics was greater than it is today. Railways have felt the need of such men. Advertising in the daily want columns and searching the employment agencies for machinists, boilermakers, blacksmiths, and carpenters have become fruitless. We were warned of this approaching desert years ago, by the persuasive logic of G. M. Basford, through the pages of the railway magazines. He argued and pleaded with the railways to educate and train apprentices for their future needs. He warned us of the approaching time when we would sorely need these young men. His prophecies have become realities.

Three years ago we were astonished to see a full description of the "apprentice schools," which had been quietly inaugurated on the New York Central Lines. The opening and establishing of a school in connection with their shops, giving the boys instruction in the shop and in the school room, and paying them while attending school, seemed almost revolutionary. Indeed, it was revolutionary, revolutionizing the methods and means of making and training mechanics. The shop foreman of today is not the easy-going, fatherly old man of years ago; he is no longer a sentimentalist; he no longer has time to stop and show a new, green, bashful boy; he is a live-wire today, impatient with delays and responsible for the output of the shop. Years ago every man, every foreman, had time to stop and show a boy how to gear up his lathe, grind a tool, or chuck a piece of work. Competition and the introduction of piece work and of bonus and merit systems have left the boy alone to "root, hog, or die." It was really the survival of the un-fittest.

A new order of things has come. The New York Central project was not a failure; it was a success from its inception and has grown more successful, more prosperous, more remunerative and more indispensable every day. Other roads began to give the new scheme a trial. The road which I have the honor of serving has an apprentice school at every mechanical point; not only all of its larger shops but even the isolated places, having only four or five apprentices, have their apprentice schools, where the boys are taught to use their heads along with their hands; and instead of being a drawback, an expense, or an appreciable loss of time, they have become indispensable, a joy and a pride to every foreman and master mechanic on the system. Each points with pride to his apprentice school.

An apprentice system to be fruitful must be practicable; it must be elastic, it must be humane, and must pay a living wage. It must have the backing of the highest operating officials to insure the co-operation of the subordinates. It must have one head, someone with authority. It must be practicable in the subjects taught in the school room. Shop arithmetic and the simpler elements of mechanics, freehand and mechanical drawing to enable the boy to read a blue print intelligently and to make a working sketch, are the subjects which should predominate. Subjects foreign to the trade should not be taught, or, if taught at all, only sparingly. The apprentice should be taught the various parts of an engine, car, or machine, and the function of each part. He should be taught and drilled in mentally adding and subtracting the fractions of an inch occurring in the divisions of a machinist's scale, and not be allowed to pinch the divisions with thumb nails, a practice so common in shops, and so wasteful of time.

The school room should be close and convenient to the shop, and all instruction should be during the regular shop hours, preferably the first hours of the morning. Boys of this age are restless and active; an abundance of red blood is coursing through their veins; they must have some time for recreation and play. Any shop which requires the boys to attend night school is flirting with failure. You have little control of the apprentices after the regular day's work is done. The hours after six o'clock in the evening are their own, and should be. After a boy has worked all day in the shop, he is physically unfit for night study. By requiring him to return and study three hours, you teach him to dislike the school work, and soon he will look upon it as a drudgery. While history records a few men who in boyhood endured all kinds of hardships and privations for the sake of obtaining an education, these are exceptionally rare cases and the autobiographers deemed it of sufficient importance to record the fact. The extraordinary ambitious boy will rise under any condition, but we are dealing with the average boy, and the natural inclination of the average boy is to play and have a good time while he is young. I would urge daylight instruction and let the boy have the evening as his own.

In the shops there should be an instructor for at least every twenty-five boys, his entire time to be spent with the apprentices, guiding and directing them. It is the shop foreman's duty to allot the job and the instructor's duty to direct the apprentices in machining, erecting or finishing the job. The instructor should be an active boy-loving man, one who naturally demands respect, and yet one who instinictively draws the boys to him. He should be able to take hold of any machine or work on the floor and bench, and demonstrate to the boy the correct and quickest way of completing the job in hand. He should from the very beginning insist on the job being mechanically and workmanly correct. Cleanliness of person, tools, and machine makes a clean, accurate mechanic. The shop instructor has another duty no less important than the purely mechanical training. He should be a father and a master of the boy, responsible in an influential measure for the moral habits of the young man; he should be a companion to the boy; should listen to his tales of joy or sorrow, and should be ready to advise or lead him when in trouble. These win the boy's confidence, and when you have this you can lead him anywhere and mould and shape his young life into the most desirable cast.

One-third of the apprentices who enter a shop, whether through necessity, whether through parental influence, or the good wages paid, are unfitted for the trade they are indentured to learn. The school and shop instructors are quick to find out the boy's qualifications. If he is unfitted for the trade, he is transferred or dismissed. The weaker, slower and plodding boy, who will eventually make you the best man, is handled to develop the best features of his make-up, and gradually strengthened in his weaker points until the talent which lies dormant is aroused. The boys are treated as individuals and not in classes; they are advanced as they merit it. The brighter and quicker boy will move along faster and the slower boy should not hold him back.

The apprentice school should be a part of your shop organization. No special appropriation should be made for its maintenance, but it should be classed and treated as a department of your shop, similar to the manner in which you organize and maintain your tool room, or your power house. It is just as necessary to make and train the most valuable element of your shop as it is to make and repair tap dies, drills, or jigs, for you can buy these, but you can't buy good, all-around men.

The expense of the project has kept a number of roads and manufacturing establishments from venturing into it. Take my word for it, and the experience of a road which has made a trial, the scheme is a paying proposition for any road and any shop. I have watched the average efficiency of apprentices increase from 65 per cent efficiency at the opening of our apprentice schools to 90 per cent efficiency at the present day. By efficiency here I mean the work done by apprentices as compared to journeymen. The bonus system in vogue on the Santa Fe enables the company to determine each day the actual value of all its mechanical employes, and this includes the apprentices; and when I state that the efficiency of apprentices has been increased from 65 per cent to 90 per cent under our system of apprentice instruction and education, it is not an estimated statement, but one based on facts and figures.

The following reasons will justify you in establishing and maintaining a system of apprentice instruction and education as outlined in this paper:

First—The undesirable and unfitted materials will be weeded out quickly.

Second—With the aid of an instructor the apprentice earns his wages from the very beginning.

Third—With the assistance of an instructor, important and expensive machines may be operated during the temporary absense of the operator, say for half a day, a day, or a week, for it is not always convenient or profitable to put a man on a temporary job.

Fourth—A better class of boys will be induced to enter your shops.

Fifth—The training of a set of men, educated, and schooled into your methods, ways, and standards.

Sixth—The improvement in the moral tone of your shops by injecting into the body first-class, clean-moraled young men.

Seventh—The brightening of the "esprit de corps" of your shop men by graduating into their midst a lot of men made by you clean honest, and loyal, and capable of doing any job, or operating any machine.

The following companies have this system, or some modified form in vogue: New York Central Lines; Canadian Pacific; Grand Trunk; Erie; Pennsylvania; Union Pacific; Delaware, Lackawanna & Western; Southern; Missouri Pacific; Santa Fe System, and others; also the Westinghouse Air Brake Company, General Electric Company, Geo. V. Cresson Machine Company, Philadelphia, and other manufacturing concerns. These have adopted the modern method of training apprentices, and each speaks well of the success of its venture. None who have started have turned back. The labor organizations have recently strongly urged more practical features for the manual training courses in our public school systems.

When you can offer such a training, when you tell the boys the most healthful and fascinating occupation is railway work, that the earnings of your graduate apprentices are greater than of the average doctor or lawyer, that the diploma you give them is a bread-earning parchment, insuring them a permanent good wage occupation the moment they are graduated, then you will attract the brightest and best boys to your service.

C. W. Cross (New York Central Lines): In devising the plans for the shop training of apprentices it is exceedingly important that we do not permit our enthusiasm to override our judgment. A natural error would be to attempt to develop the training to an ideal condition from the standpoint of the instruction department and make the shop part of the school when the school must be part of the shop.

It is necessary to remember that the purpose of the shops is to repair locomotives and cars, and any system of apprenticeship to be successful must be handled in a manner to contribute to the output rather than to exploit any theories of instruction. The purpose of the apprenticeship system should be to produce workers who can make money for themselves and their employers; to develop mechanics; to train thinking workmen; to supply capable constructive citizens who will understand that good workmanship is of itself and for its own sake sufficient inspiration for the best endeavors of which humanity is capable.

The boys must be made to realize that they must not get in the way of the output. They must be made to feel they have a part to take in keeping up the output to the maximum. This being desirable on the part of the shop management as well as on the part of the boys, they cannot be allowed to work slowly or spoil work and cause delay thereby.

The course of instruction in the shops must necessarily be a local matter as regards the progress of the apprentice through the several stages of the trades, and no detailed schedule could be adhered to for general use. It is the duty of the shop instructor to give the boys experience on each part of the work with the object of making them competent all-around workmen at the completion of the course.

In the matter of training of men it is less a question of today's efficiency than it is a matter of today's preparation for results which must be forthcoming tomorrow. The specific value of this plan of apprenticeship is that it enables the railroads to reap an immediate benefit by using the boys in important work, as well as an ultimate benefit from the work done by apprentices due to the special training they receive, both in the shop and schoolroom. Of course, it is not expected that an instructor can be personally expert in all trades, but he can supervise the instruction in a manner to give the apprentices an opportunity to perform a generous proportion of the good work and thereby acquire skill in the trade. The foreman cannot spare the time to instruct the apprentices, but if he gives his approval and support to the instructor the results will be satisfactory to him as well as to all others concerned.

No detailed code of rules for shop instruction can be used successfully in all shops. A better plan is to allow some flexibility, but adhere to the general principles as adopted by this association at the convention of 1908 as recommended practice. The principles referred to are as follows:

1—To develop from the ranks in the shortest possible time carefully selected young men for the purpose of supplying leading workmen for future needs, with the expectation that those capable of advancement will reveal their ability and take the places in the organization for which they are qualified.

It is much easier to make the statement than it is to carry out the principles. To do this requires the most complete scheme possible with facilities to check up at each point to see that it is carried out.

2—A competent person must be given the responsibility of the apprenticeship scheme. He must be given adequate authority, and he must have sufficient attention from the head of the department. He should conduct thorough shop training of the apprentices, and in close connection therewith should develop a scheme of mental training, having necessary assistance in both. The mental training should be compulsory and conducted during working hours at the expense of the company.

The person in charge of the school should be one who will feel he has under his care the men of the future and a responsibility of no mean order.

3—Apprentices should be accepted after careful examination by the apprentice instructor.

The scheme would be such as to produce a waiting list from which only the most promising boys should be selected.

4—There should be a probationary period before apprentices are finally accepted; this period to apply to the apprentice term if the candidate is accepted. The scheme should provide for those candidates for apprenticeship who may be better prepared as to education and experience than is expected of the usual candidate.

This involves the opportunity for most intimate knowledge of every boy and his work, this being the point of weakness in most organizations.

5—Suitable records should be kept of the work and standing of apprentices.

Records should not only be kept but used and be of such a character as to enable those in charge to determine accurately on candidates for promotion.

6—Certificates or diplomas should be awarded to those successfully completing the apprentice course. The entire scheme should be planned and administered to give these diplomas the highest possible value.

The greatest value of the diploma is indicated by its acceptance by those issuing it as proof positive of competency. If the road places a high value on the diplomas the boys are surely likely to do so.

7—Rewards in the form of additional education both manual and mental should be given apprentices of the highest standing.

Those who have put the idea into effect have benefited most thereby. This feature constitutes a means of encouragement not to be provided in any other way. It is not essential that those receiving this reward should remain in the service in order to receive great benefit from the idea. It has already proved effective in providing encouragement for those who do not obtain the rewards themselves.

8—It is of the greatest importance that those in charge of apprentices should be most carefully selected. They have the responsibility of preparing the men on whom the roads are to rely in the future. They must be men possessing the necessary ability, coupled with appreciation of their responsibility.

Herein lies the greatest problem connected with apprenticeship. In the future even greater efforts must be made to secure the right kind of instructors.

9—Interest in the scheme must begin at the top, and it must be enthusiastically supported by the management.

A number of promising apprentice systems have been started. It is now up to those systems absolutely to justify continuation of enthusiastic support from the management.

10—Apprenticeship should be considered as a recruiting system and greatest care should be taken to retain graduated apprentices in the service of the company.

There will always be considerable danger of losing the best boys after graduation. Herein lies a problem in organization to make the railroads having apprenticeship systems the best possible organization for young men to work for, so that they will not be enticed away into other lines of activity which opportunity promises greater rewards but less permanent and less satisfactory in the long run than is the railroad service.

Apprenticeship is now started in a number of places, and it is up to those who inaugurated the system to make their job good and thorough. After all, the fundamental problem in apprenticeship is shop instruction in the trades. We all need to go much farther than we have gone in giving attention to systematic shop instruction, this being a new field of effort in which all of us need development. In fact, we need shop instruction methods which will be better than the old kind of apprenticeship when the master had but one apprentice and when it was clearly to the interest of the master to teach the apprentice the maximum of trade knowledge in the minimum of time. We can make spectacular progress in class room work and yet fail, if the trade instruction in the shop is lacking.

H. Gardner (N. Y. C. & H. R.): The financial success of the apprenticeship system depends upon the boys' output in the shop. They must earn as well as learn, and to ensure a profit to the company there must be sufficient shop instruction and supervision to enable each boy to work most advantageously at all times. Exploitation must be discouraged and boys must be given a maximum of experience with a maximum return per hour or machine. To accomplish this more shop instructors are necessary. A shop having fifty machinist apprentices should employ at least two instructors in the shop, and to obtain a maximum output at all times one instructor to every twenty boys is to be recommended. Too many instructors would be objectionable, as the boy would lose in self-reliance and initiative if his every more was directed by the instructor.

Small groups of boys in trades not largely recruited may be supervised by an instructor in some other trade. It is not as essential that the instructor be an expert in that trade as it is for him to have the tact and ability to interest the foreman and journeymen and to obtain their hearty co-operation. In this way the best classes of work will be given the apprentice and opportunities to learn, if not actual instruction, will be afforded them. A competent instructor may increase the output of the boys working at a trade with which he is unfamiliar an amount greater than he could hope to obtain had he a full knowledge of the trade but was dependent upon his unaided efforts for results. Great care should be exercised in the proper selection of instructors. They should have many qualities combined with an ability to identify undesirable boys and to promptly eliminate them.

The school or classroom instruction of apprentices speaks for itself. Much has been written upon the acknowledged benefit derived from this training—education means efficiency, and efficiency means output. But the school work must not be academic; practical shop problems should be taught and the work of the school instructor should be intimately associated with and supplement the work of the shop instructor. Courses should be given which will bear directly upon the trade; for example, if a boy is required to figure the cutting speed when chipping a certain amount of material in a given time, he will attempt to obtain that speed when actually performing the operation in the shop. Problems on cutting speeds and feeds of machine tools with different materials and different classes of work will stimulate similar results in actual practice. The school instruction from the standpoint of immediate profit must be subordinated to the shop instruction, but for ultimate results it may rank first in importance.

The graduate apprentice cannot be held by promises of future reward or promotion. He can only be permanently retained by adequate compensation or by placing him at once in a position of responsibility. The average boy wants money, and he will go where he can get it, unmindful of his present good standing and the advantages incident to railway work. If there is justification for continuing the apprenticeship system the majority of boys upon graduation should be superior in many ways to journeymen not having had similar advantages, and they should be given a journeymen's rate; in some cases for exceptional boys the maximum rate should be given. This recommendation is significant when it is borne in mind that the graduate is beginning his life's work fully prepared for advancement to higher positions.

Too much stress cannot be laid upon the proper selection of apprentices. The shiftless inert boy will not develop the loyalty and make the friendships which will bind him to the company after graduation. Such boys should be promptly dismissed during the probationary period, thus lowering the percentage of desertions. The worthy boy of good habits will become attached to his work and environment; his training has made him contented, and he will hesitate to run after a little more pay or wander about seeking adventure. It is erroneous to state as a permanent loss the percentage of boys who leave the company after graduation. Records prove that a certain percentage of these boys, after obtaining experience in other shops will return to the original railway work improved and broadened by their contact with the world.

C. E. Fuller (U. P.): I can very strongly endorse the benefits derived from the apprenticeship system of instruction. I doubt if there is anyone in the room who has handled apprentices but what has been confronted with the statement that the apprentice who is out of his time is not worth journeymen's pay. The state of affairs existing that will allow an apprentice boy to go through the shops for a period of four or five years and then not be a mechanic is certainly one which reflects on the management of the shops. It is a moral obligation, if nothing else, that we owe the boys. Further, I presume you have all had the experience of being unable to obtain competent foremen. You are hunting the country over for that class of labor. It is another thing, I think we are to blame for, and ought to be ashamed of. If you want good foremen, you must make good men, and to make good men, you have got to start with the boys.

Our experience with the apprenticeship system as inaugurated on the Union Pacific, not exactly the same as the Santa Fe or New York Central, but similar, is such that we have a system requiring a report as to the standing of every apprentice once in each three months, and if the boy's standing is not what it should be, he is cautioned and given three months in which to make up what he has lost, and come up in line with his class. If he fails, he is dropped. The result of this system is that the boys who are not worthy are dropped in the first six or nine months of their apprenticeship. By maintaining an apprentice instructor, the conditions are just as the paper states, the instructor becomes a sort of father to the boys, and the boys feel that they are obtaining something that is worth while, and they realize that their future is in his hands and in their hands. The result is you do not have to scold the boys or call them up for discipline very often. They take hold of their work in a cheerful way, and we have apprentices today that we are proud of. They will do any work that any mechanic in the shop can do, do it as quickly and do it as well. We would not think of abolishing the present apprenticeship system. It is making something for the railways that we have all wanted for years, and in case of those of you who have not tried it, if you do not want to go to the full extent of it, put a good, competent, honest instructor in your shop to instruct your apprentices. I can say without contradiction that you will never be without an apprentice instructor again. The value of his services are greater to you than even your shop foreman.

TUESDAY, JUNE 21.

President Wildin called the second session of the Master Mechanics' Association to order.

Widening Gage of Tracks at Curves.

In 1906 a committee was assigned to act jointly with a committee of the American Railway Engineering and Maintenance of Way Association, to consider: "The proper amount to which the gage of track should be widened on curves of different radii, and to secure the best results with engines having different lengths of rigid wheel base." The present membership of the committee has been continued from year to year since the date of first appointment.

Various joint meetings have been held, and the committee of this association has from year to year reported progress to the convention. At the present time, however, it is possible to make the final report for your approval. The substance of the report was reported by the American Railway Engineering and Maintenance of Way Association, at their meeting last winter, and was adopted, so that, inasmuch as the subject interests the maintenance of way department more than it does the motive power department, it would appear to remain for this association only to approve the report and the action taken. The recommendation is as follows:

"Curves eight degrees and under should be standard gage. Gage should be widened ⅛ inch for each two degrees or fraction thereof over eight degrees, to a maximum of 4 feet 9¼ inches for tracks of standard gage. Gage, including widening due to wear, should never exceed 4 feet 9½ inches. The installation of frogs upon the inside of curves is to be avoided whenever practicable, but where it is unavoidable the above rule should be modified in order to make the gage of the track at the frog standard."

The report was signed by: F. M. Whyte (N. Y. C. Lines), chairman; F. C. Cleaver, W. H. Lewis.

J. A. Talty (Traveling Engineers' Association): I have noticed in riding locomotives that they do not seem to take the curve in the winter time as they do in the summer. They seem to nose more on the wheels, especially when the rail is frosty. I assume that the adhesion between the rail and the wheel has greatly decreased and they seem to slip from one side to the other and not take the curve, which would indicate a very severe strain being brought on the rails. There is a question in my mind if widening the gage on curves would not bring a greater strain on the rails, especially in winter time.

C. A. Seley (C., R. I. & P.): Inasmuch as this matter has been passed on by the Maintenance of Way Association, a discussion of it would hardly be fruitful of results, and I move that the report of the committee be adopted and that committee be discharged.

The motion was carried.

Steel Tires.

The committee appointed to consider specifications for steel tires has been in communication with the tire manufacturers, some of the committee visiting the tire works with the idea of trying to work out specifications which it would be possible to enforce and not impose unnecessary hardships on the manufacturer or excessive cost to the purchaser. The results have not been encouraging, and we feel that any specification we could get up, to give any practical results, would require a test to destruction of at least one finished tire out of each heat. In view of the cost of carrying out a specification containing this requirement, we hesitate to offer it, and, unless it is the opinion of this association that such a requirement, with the expense of enforcement, would be justified, we ask that the committee be discharged.

The report is signed by: A. Stewart (Southern), chairman; A. S. Vogt (P. R. R.), William Moir (N. P.), E. D. Bronner (Mich. Cent.), and H. D. Taylor (P. & R.).

F. M. Gilbert (N. Y. C. & H. R.): Our tire troubles have been very numerous during the past year. It is not necessary to enumerate the troubles. Most of the members have had their share of them. Apparently the wheel load is in excess of the strength of the material, and the tires do not give good service, at least large numbers of tires do not do so, possibly due to the increase of the loads. Some of the manufacturers, when you get them into a corner, say they can make tires that will stand the service and that they can make them in commercial quantities; others say that if they should endeavor to make them in commercial quantities, they could not begin to furnish the necessary tires to meet the demands.

Mr. Bentley: Have any of the members made a special request for particularly hard or soft tires, according to the service into which the engine is going? It seems to me, an engine in switching service would require a very different tire from that of an engine in road service, and I believe some of the manufacturers recommend certain tires for certain service. How has this worked out in actual service?

H. H. Vaughan (C. P.): Steel tires are not like bar iron, or firebox steel, or other material that can practically be purchased in the open market. The number of manufacturers is limited, and it is a question in my mind whether it would pay us to go into the matter of specifications for steel tires. I think most tire-makers are giving us steel of good composition in the tires. The price we are paying for the tires is sufficiently high to make the question of the quality of steel put into them comparatively unimportant to them, and it has seemed to me that the chief thing about a tire, in our experience, is the amount of discard from the ingot that is used in making it, and the temper of the finishing process. We had a great deal of trouble with a certain class of tires from one manufacturer—the tires shelled out, which is, I presume, one of the troubles Mr. Gilbert refers to—and we discovered in conference with the manufacturer, that the tires that were made on a new mill, which had been installed, were giving considerable trouble from shelling, while the tires made on the old mill were always free from that trouble, the inference being that the tires on the new and more powerful mill were finished at a higher temperature, and were not in as good condition for service as those finished on the old mill, in which a long time was taken in rolling down the tire. Now, it would be a difficult thing to demand anything of that sort in a specification, it is one of the things in which the manufacturer must work in co-operation with the user, and find out from the user which tires are giving the best results.

We often get misled on the tire question if we go too much on the basis of 1-16-in. tire wear according to mileage in the case of tires from different manufacturers. The natural tendency, if you are driving the manufacturer to give a high mileage per sixteenth inch, is for him to furnish a tire high in carbon, a hard tire. I feel that in comparing the service of tires we should obtain the composition of the tire from the manufacturer, and then judge results on tires of somewhat similar composition. If we do that we will get just as good results as by endeavoring to enforce a specification that very few of us would probably want to check up closely. It is a much easier thing to make a specification than it is to check it up on every shipment, and I believe that for tires we can get along just as well by keeping in touch with the people from whom we are obtaining them, and working with them, as by putting any specifications in force.

We have our share of shelling out, and it has certainly become serious, especially under heavy tenders. We have found that the method of finishing the tire exerts considerable influence on it. The quality of the steel makes very little difference, so far as we can determine. We have had open-hearth steel of different methods and crucible steel, and all gave us trouble in shelling out if made on a rapid finishing mill. Either of the materials were much more free of that trouble if finished at a lower temperature and more care was taken in the finishing. It is a strange thing that on driver tires, so far as I know, we never have any trouble from shelling out, even with the excessive wheel loads we carry on the drivers. The trouble seems almost entirely confined to tender tires, and on the Canadian Pacific we notice a great difference between the summer and winter months. We have a large amount of track that gets frozen almost as hard as rock in winter, and during that time our shell-outs become a great deal more frequent. It is a question in my mind whether carbon steel can be made that will really stand that service under heavy tenders. At the same time we do notice a difference between different tires, and that makes us feel that the trouble is one that is really up to the manufacturer and can be overcome by sufficiently careful workmanship and treatment.

I am not sure that we are not giving the manufacturers rather too severe a job in expecting them to produce tender tires that will stand up on small wheels under heavy wheel loads, but there is a very great difference between different tires, or, perhaps, tires of the same material finished under different processes, in the matter of shelling out, and that makes it look as though it were partly due to the structure or the quality of the steel.

John Tongue (M. & St. L.): There is one point Mr. Vaughan has not touched upon, which no doubt he will recognize, and that is in the hard tire you don't get the tonnage load over the roadway, as a rule, that you would with a softer tire on the same engine. It will make a material difference in the tonnage on the level, and more especially on the grades.

G. R. Joughins (Intercolonial): One of the most remarkable things we have noticed is the fact that we have very little trouble with driving tires. It is nearly all with either car wheel tires or tender tires, all of a small size, and I concluded from that, in the same way that Mr. Vaughan has, that it depends very much on the work which is put on the steel. Whether it is due to the much greater rolling which the driving tire receives, compared with the small tire, I don't know, but we have tried a good many makes of steel, and some of them have been very expensive. We have bought steel tires which were the highest priced in the market, so far as we could find—of course, I mean the Canadian market, and that includes tires which we get from Europe—and the results have been no better with the high priced tire than with the cheap one. We are in very serious difficulty in the matter, because in the winter time a large number of tires give us trouble and breakages, and we are a little afraid of what the results will be. In the summer time we have practically no trouble.

C. E. Fuller (U. P.): We have had the same trouble, and in discussing it with one of the large tire manufacturers, a man of a great deal of experience, he admitted that the tire for a tender wheel or car wheel was not suitable as a tire for a locomotive, and a locomotive tire was not suitable for a car wheel. The punishment that the tender wheel receives is terrific, and he intimated that the manufacturers could and would have to make a tire that would stand up under tender service. I believe that this committee should not be discharged, but should be requested to work with the manufacturers and experiment to get a tire that will stand up under tenders. We have just gone through a severe winter and have had all kinds of trouble. If the wheel men realize that they have to correct the trouble, they will correct it. They are just as anxious to correct it as we are, and I know of no better way for them to get in touch with the true situation than to do so through a committee. I make a motion that this committee be extended and instructed to work with the tire manufacturers with a view of getting a better tire made for tender and car service—one that will overcome this trouble.

C. E. Chambers (C. R. R. of N. J.): Have any of the members had any experience with vanadium tires?

H. T. Bentley (C. & N. W.): We have a set of tires on a switch engine, and from a report received the other day from the master mechanic, it appears as if there was very little, if any, difference in the wear of the vanadium steel tires as compared to other tires on the same engine, put on at the same time. The manufacturers, of course, try to tell us that the shelling out of tires is due to the locomotive department; that we are responsible for it. One man came to me and told me positively that if our wheels didn't slide we would never have any shelled out spots. He happened to come around one day when we had a very bad case of a shelled out tire on one wheel, and on the other wheel there was absolutely no indication of sliding. Have any of the members used a heavier tire than 3½ ins. in thickness? If so, have they received better or worse service? We are afraid that by getting a very thick tire, like 4 or 4¼ ins., the rolling would not be as good as would be possible with a thinner, or a 3½-in. tire, such as we are using.

Mr. Tonge: In the fall of 1884 we put two different tires, 5 ins. thick, in passenger service, the engine running every night. One of the men that ran the engine is now in the room. There was a great difference in the service of the two tires. One set, at the last report, had run over a million miles and they were still 2¾ ins. thick. The other set, when they were about one-half worn, showed cavities around the rim.

F. F. Gaines (C. of Ga.): Several years ago I applied some 4-in. tires to heavy switch engines; the results were not altogether satisfactory. The tires were unquestionably softer and wore faster, and they wore irregularly; they didn't seem to be uniform and were evidently not as well worked as the tire of less thickness. Since that time I have kept down to 3½ ins.

Mr. Chambers: What class of engine were the tires applied to which Mr. Tonge mentioned? We have had in service for ten or eleven months a set of vanadium tires on a consolidation engine weighing about one hundred and eight tons. They have not been turned as yet, but I see no perceptible difference in the wear of these tires from that of the ordinary steel tire.

Mr. Tonge: Our engine weighed 40 tons, was in our Chicago train service, running from St. Paul to Albert Lea, connecting with the Rock Island.

Mr. Gilbert: Mr. Vaughan has, I think, recently introduced some passenger trucks on tenders, and I would like to ask if anyone can give any information as to whether the character of the track has any effect on the wear of the tires. I know that we have comparatively little trouble on passenger equipment where we use passenger trucks, but since the introduction of the Diamond truck and high speed tenders, our troubles seem to have increased.

Mr. Bentley: The tire I mentioned as having been very badly honeycombed on one side, and not on the other, was under a pedestal type truck.

Mr. Gaines: Is not the chief object in using vanadium steel to ensure a tire that will not break, rather than for adding to its wearing qualities? Has anyone any information as to the relative strength of the vanadium steel tire as compared to the ordinary tire?

Mr. Chambers: I have no figures, but I would not care to pay the difference in the price of the tires to have the little assurance that when they got to a certain size they would not break. We have very little trouble with breakage of tires above the scraping limit.

Mr. Bentley: We had during this last winter several cases of 3½-in. new tires breaking a clear break, something I never saw before in my railroading experience.

Mr. Vaughan: I am not sure, but I have a feeling that there is a difference between the diamond truck and the pedestal truck in causing tires to shell out. We used the diamond truck on tenders, and as an instance of how severe the service is, on a rock bottom road bed in very cold weather we really gave up the diamond truck because we were not able to maintain it. We would chew the threads off the column bolts and even took pieces out of the oil boxes and that sort of thing. It was something awful. But the pedestal truck has given better service and those troubles have largely gone. On the division I am referring to, which is our worst division for those conditions, we have had less trouble recently with the pedestal truck with shelled out wheels, than we previously had with the diamond truck. Whether it is due to the tire having been made differently or not, or due to the truck, I am really unable to say, but I have a feeling that there is something in the amount of dead weight on the diamond truck which is pretty high.

Theoretically, and I believe practically, the tender service is the most severe service we put the tire to. Theoretically, the strain on the tire is inversely in proportion to the diameter of the wheel, with a given load. For instance, the tires on a 34-in. wheel under tender weighing 20,000 lbs., are practically strained as severely as the tires on a 69-in. wheel under a tender weighing 40,000 lbs.

We are blaming the tires for breaking, many times, when the trouble is really due to the wheel centers. We have had several cases of tires breaking during winter service, and in every case but one they have been of a light type of cast steel wheel center. If you will try shrinkage tests on the type of wheel center that was in use four or five years ago, with a light rim and spokes thinned down, you will find that it will collapse under the tire almost as much as you want.

There is very little strength in the center to resist the force due to the load on the wheel. Many of the light designs of cast steel wheel centers will spring under the load of the engine in heavy winter weather and the tire will take part of the strain and bend. You cannot keep on bending a 3½ in. tire with the weight of the engine on it, without starting a crack. It is my conviction that, in the case of the thick tires which crack, the cracks are due to light designs of cast steel wheel centers. When we had the cast iron wheel center, although it was not as strong as the cast steel, it would stand up under the load, not deflect; whereas when the builder began to lighten up the cast steel wheel center, there was a chance for the bending action. There is the same chance for the bending action in a good many designs of the forged steel wheel centers. We have found that the forged steel wheel center will collapse under the tire to an almost indefinite extent. We make our cast steel wheel centers as stiff as the old cast iron centers, and believe it is the right thing to do. We have also stiffened up the tender wheels by making them of heavy steel castings, to get sufficient rigidity to hold the wheels in shape under the loads they are subjected to. We have less trouble with tire breakages, in the case of the thin tire almost worn to the scrapping line, than we have with thick tires.

Mr. Gaines: All our breakages, with few exceptions, have been new tires or tires that had not been a very long time in service. It is seldom that a tire which has worn down near the limit of service will break. I also agree with Mr. Vaughan as to the pedestal type tender truck. I am a firm believer in that truck, and, in so far as the maintenance of the tender is concerned, it is cheaper and easier to maintain than the diamond truck, and this must have its effect on the tire.

A. E. Manchester (C., M. & St. P.): We have had our tire troubles, and we have had a few cases of the shelling out of the tires; our greatest trouble has been with uneven wear. This uneven wear occurs in the spongy, soft portions, which we have laid to the impurities in the tire, or, in other words, the ingot was not cropped close enough. We have no means of determining the different value of the different trucks, having in use but one type.

C. E. Fuller: I move that the subject be closed and referred to the executive committee for such action as they see fit to take.

The motion was carried.

The committee on Superheaters introduced a very comprehensive report which will appear elsewhere in the RAILWAY MASTER MECHANIC.

A paper by Prof. C. H. Benjamin on Locomotive Performance Under Different Degrees of Superheated Steam was presented and the discussion follows:

Discussion on Superheaters.

H. H. Vaughan (C. P.): We have with us Mr. Hoffman, of the Schmidt Superheating Company of London, England. While the Schmidt superheater is to a certain extent a specialty, yet Mr. Hoffman has had so much experience in the application of superheaters to locomotives in Europe that I ask that he be given the privilege of the floor.

L. Hoffman: Of all the data furnished by your committee, the figures given with relation to the saving of coal obtained by the various superheaters will probably be of the most interest to you. With the exception of a few railways, which have used superheaters for very low degrees of superheat all railways report a pronounced saving of coal, amounting to about 20 per cent on the average for simple engines.

Only one railway, the Atchison, Topeka & Santa Fe, has made experiments with the application of superheaters to compound locomotives. The coal saving in their case is stated to have been more than 30 per cent. This is, of course, an exceptionally high figure, especially if the moderate degree of superheat obtained with this particular type of superheater is taken into account. I believe the superheat amounted to only 20 or 30 degrees on the high-pressure side and to about 100 degrees Fahr. on the low-pressure side. In European practice, using superheaters which superheat the steam to more than 200 degrees, the best coal economy so far obtained by the application of a high degree of superheat to compound engines has been between 15 and 20 per cent. The high figure on coal saving given for the Santa Fe test above referred to is probably owing to the special conditions under which those particular engines were tested and are probably only the result of a test of short duration. In the "American Engineer and Railroad Journal" of June, 1910, I find a complete report of the tests with this particular engine and it is stated that the decrease in coal consumption averages 20.8 per cent for upgrade runs and 11.5 per cent for downgrade runs; this would give an average of about 16 per cent. This would be more within the limits of the coal savings obtained with European compound engines.

I find a further note in the committee's report concerning the application of superheated steam to compound engines, which says: "That the tests on the Santa Fe prove that greater efficiency can be obtained from superheaters giving superheat between the high and low-pressure cylinders, than from superheaters giving superheat to high-pressure cylinders only."

The above note probably refers only to low degree superheaters; in such case the result claimed would be quite natural. Taking for example the steam pressure on the high-pressure side at 220 lbs. per sq. in. and on the low-pressure side at 60 lbs. per sq. in., the temperature of the high-pressure steam would be about 395 degrees, whereas the temperature of the low-pressure steam would only be 307 degrees. A superheater in the case referred to, which is only able to superheat the high-pressure steam 20 degrees, could probably superheat the low-pressure side more than 100 degrees and would therefore be of greater advantage on the low-pressure side. But if a high degree superheater is applied, able to superheat the high-pressure steam, say 200 degrees, then it is better to superheat the high-pressure steam only, in order to get and maintain dry steam in both cylinders, the high-pressure side as well as the low-pressure side, whereas in the arrangement recommended by the Santa Fe the losses through condensation in the high-pressure cylinder are not abolished. Receiver-superheaters have the further disadvantage, that they must provide for a much bigger volume of steam to be superheated than a high-pressure superheater. The steam section in receiver-superheaters must therefore be much bigger, or else wire drawing of the steam in the receiver takes place. These are the principal reasons why, in about 500 compound locomotives equipped with the Schmidt superheater in Europe, only the high-pressure steam is superheated.

I have here an official report of the Belgian State Railways, a road which has about 400 Schmidt superheaters in service, and which has had experience with Schmidt superheaters extending over 5 or 6 years. It is officially stated that practically no coal saving has been obtained with low degrees of superheat, i. e., with only 60 or 70 degrees. Mr. Schmidt has been advocating high degrees of superheat for the past 20 years; many scientific researches bearing on this question have been made and the same conclusion drawn. There are now nearly 6,000 Schmidt superheater locomotives in service or in course of construction in Europe, all of them using high degrees of superheat. In Europe we have gone through a development similar to that which I believe you are going through now. When superheat on locomotives first came up, many experts believed that it was quite sufficient to get only dry steam in the cylinders. Later on it was believed that the steam would be superheated sufficiently high to remain dry during the cut-off, and now experts are glad if they have stil some superheat in the exhaust steam.

Comparatively little heat is required to superheat the steam to a high degree. If we take for instance steam of 200 lbs. pressure, about 1,200 heat-units would be required to generate dry steam of this pressure. Taking the specific heat of superheated steam of 0.6, it would require an additional 30 heat-units to superheat to 50 degrees and 120 heat-units to superheat to 200 degrees. In other words, there is required only about 7 per cent more heat-units to generate highly superheated steam of 580 degrees Fahr. than is required to generate a low degree of superheated steam of only 430 degrees Fahr. Thus the additional heat expended in order to highly superheat the steam does not amount to anything compared with the greater advantage gained by the higher degree of superheat.

The most important point in the whole superheater question is the increase in power obtained by the application of a superheater. This item is not mentioned in the different comparison sheets of the report, but it is touched upon in the final conclusions, which state that "The superheater engine gets its load over the division in far better form and in better time than the non-superheater engine." Giving you a conservative figure obtained in many years' service with thousands of Schmidt superheaters, we can say that the increase in power obtained with a high degree superheater is between 20 and 30 per cent. In other words, one ton of iron in a well-proportioned superheater engine gives 20 per cent more power than a ton of iron in a saturated steam engine. That is the principal reason why superheating has come into so much favor on European roads, and I believe it will prove the principal reason for the general introduction of superheated steam on locomotives in this country.

F. J. Cole: Superheating for locomotives has passed the experimental stage, and from figures contained in this report and other sources it can be demonstrated that the repairs and maintenance of the apparatus are very slightly, if at all, in excess of an engine using saturated steam. Because the demand for steam on the boiler to perform a certain amount of work is less when superheated steam is used, the boiler repairs, especially in combination with the low steam pressure commonly used on superheater engines, will more than offset any slight additional charge for the maintenance of the superheater apparatus.

The conclusions of the committee are of considerable interest, especially the statement that "superheater engines get their load over the division in far better form and in better time than the non-superheater, and are a more snappy machine all around."

While it is a fact that the number of superheater locomotives running in the United States is very small in proportion to the total number, it is interesting to remember that one or two years where probably only one engine in a lot would be built with a superheater, it is now a very common thing to build 20 to 25 or more engines in one lot all equipped with superheaters.

The number of different types of superheaters built by the American Locomotive Company in service or under contract is as follows:

Vaughan-Horsey		215
Cole (old)	103	
Cole (new)	130	233
Schmidt		73
Emerson		5
Special		2
Total		528

One of the most important possibilities of locomotives equipped with superheaters has not received the attention it justly deserves; namely, the increased hauling capacity and the greater efficiency which can be obtained than from locomotives using saturated steam. There is no doubt that this is the most important feature of all, and while great economies in fuel and water are obtained, yet the fact that for a given weight of locomotive having a high factor of adhesion it is possible to make a machine of at least 20 per cent greater hauling power, overshadows all other considerations. This is a fact of obviously more importance than the mere question of economies in coal and water.

Nearly all railways are confronted with the problem of hauling the greatest possible tonnage within certain narrow limitations of weight on driving wheels or total weight of locomotive. Any improvement in a locomotive which will increase its power without increasing its weight is manifestly of vast importance in transportation problems.

The boiler is usually the controlling factor in most locomotives, because the power of a locomotive is largely a question of boiler capacity to furnish steam in sufficient quantities for the cylinders. Superheating by doing the same work with less fuel and water, without the addition of moving parts or any complication to increase the labors of the engineer and fireman, accomplishes the same results as if the boiler capacity was increased. Therefore, for a given amount of fuel burned and water evaporated, a material increase in the capacity of tractive power of any locomotive may be affected, provided the factor of adhesion is sufficiently high.

In designing locomotives for the use of superheated steam, the best results are obtained by lowering the boiler pressure to about 170 lbs., making the cylinder diameters large enough to give an increase of tractive power over similar saturated steam locomotives. It needs no argument to point out the greater advantages which result from increase of power without increase of weight. We have built superheater locomotives for Brazil, the Argentine Republic, the Natal Government in South Africa and for Cuba. We are advocating the use of superheat, running from 175 to 250 degrees.

C. A. Seley: Our main efforts have been directed towards the practical development of the superheater engine as a road machine, and to remedy the troubles incident to carrying out Godfrey Rhodes' idea that "the first principle of railroading was to get the trains in on time." What we want, when we use superheater engines, is to know that the trains come in on time. The Rock Island had six superheater engines, delivered three or four years ago; for some little time that was the largest number of superheaters on any one road in this country, but not to be compared at all with the record of our friend, Mr. Vaughan, across the line.

The first two years of operation of these engines were years of experiment, trying to keep them in service without the loss of time. It finally required quite a little modification and change to do this, which has resulted in a performance which I believe is now very satisfactory. We are evidencing our faith in the superheater by an additional order for these engines, which are now being built.

J. A. Talty: I was connected with a road at one time that had a superheater slide-valve engine and a superheater piston-valve engine. I fully agree with the report of the committee in that the engines were a little more snappy—the slide-valve engine was so snappy that if you went to change the cut-off it was liable to snap you out through the window. We experienced all kinds of trouble in getting a constant supply of lubricant to the valves. The only way in which we were able to lubricate the slide-valve engine was by using a long cut-off and a light throttle, but with a heavy throttle and an economical cut-off the locomotive would only run a very short distance before the valves would get very dry and cut; in fact, it was necessary to face the valves on the locomotive every trip or two. With the piston-valve engine we did not experience as much trouble in obtaining satisfactory lubrication, and in pulling the trains over the road the locomotive would attain a higher rate of speed with a low pressure, perhaps 150 to 160 lbs., than a saturated steam engine. In heavy passenger service, that is, where the time is keyed up good and tight, and the engineer must run right up against the locomotive, there is trouble in obtaining constant lubrication.

H. H. Vaughan (C. P.): The committee's report on the coal-saving on the Canadian Pacific is a little bit mixed. It gives 42 per cent in one case and 3 per cent in another. These figures are widely varying. I understand that they have been obtained by following two engines. I have always objected to following an individual engine. I do not think our coal records are kept with sufficient accuracy to make comparisons between two engines of any value, so I had the figures compiled for a number of engines, some of which had been converted from 10-wheel passenger engines which were originally built as simples. These engines have been running in and out lately on two divisions, and without any change whatever except with the addition of the superheater, which gives us a temperature from about 530 to 550 degrees. On our Quebec section the non-superheater engines used 2,500 tons of coal during the period for which the records were taken, and the superheater engines took 2,000 tons, so that it was a fairly good test, as it extended over three or four months. The saving in fuel was 15.5 per cent for the superheater over the non-superheater. On another section, involving rather less coal, the saving was 33 per cent. I consider that excessive, and possibly due to the engines on that section having been through the shop later, or something of the sort. I see very little reason for questioning the figures we have got, and believe that you can depend on a saving of 10 to 15 per cent in freight service and 15 to 20 per cent in passenger service, by the use of superheater locomotives.

In the use of superheaters in Europe, they reach temperatures up to 600 degrees and over. We are using temperatures of 520 to 580 degrees, what would be known in Europe as moderate superheat. If you want to get any real benefit from superheaters you must go to a reasonably high temperature. I would like to see all of our engines give a superheat of 550 degrees and, if possible, a little more. When you go up to that temperature you get the real benefits from superheating. When you use 40 degrees, 50 degrees or 60 degrees of superheat you get a little better working engine, but you have not really got into the superheating business at all and are simply playing with it. You might as well get into the business and use a reasonable amount of superheat and get the results that are obtained from the use of a moderate or high degree of superheat on locomotives.

The statement has frequently gone out in newspapers and pamphlets to the effect that high superheating—and I believe these statements refer to what I call moderate superheating—involves a number of new processes in the locomotive, and increased cost of repairs, etc. According to our experience these statements are absolutely wrong. We have put superheaters on ordinary simple piston valve engines without any change whatever other than the putting of the superheater into the boiler, and we really find no difference in the maintenance of the engine, with one exception, and that is the renewal of the piston rings. We have to replace piston rings more frequently on the superheaters than on non-superheating engines. The difference is especially noticeable in bad water districts, where there is considerable foaming. Both the piston and the valve rings wear out more quickly under these conditions on superheaters than on non-superheaters. We get from a month to six weeks' service out of the rings in very bad water districts, while they average from two to three months in good water districts, and they run as high as twelve to fourteen months. I am of the opinion that the ring question is largely a question of material, and you can get from three to six months' service in ordinary water from piston rings in superheated locomotives.

The valve rings, which gave trouble on superheater locomotives, did not give trouble in good water districts. We run our valve bushings, as a rule, through two shoppings, and the rings are frequently run from shopping to shopping without attention. In other words, there is very little difference between the valve rings on superheaters and the valve rings on non-superheater locomotives.

We are unable to furnish figures as to the actual cost of repairs, for the reason that we have no simple engines with which to compare our superheaters. Based upon the size of the engine, or the tractive power, the cost of repairs of the superheater engine has been decidedly lower than the cost of repairs of simple engines. I have always felt that that result was due to the superheater being applied to locomotives of more modern type, and, of course, newer engines than the saturated steam-engines, and consequently the figures were not reliable. I have, however, the cost figures for several months of these 10-wheel passenger engines equipped with the superheaters, and the cost for repairing superheater engines was only 3.47 cents a mile, and the non-superheater engines were 3.5 cents, so that the cost was practically identical.

That substantiates what we have always felt, and that is while there is a slight additional expense for the maintenance of superheater locomotives on account of piston rings, there is a slight gain from the fact that you are always working dry steam, and these two things offset each other to a large extent. The only real additional expense in superheaters is a periodical testing of the front end. Our regulations call for a testing every three months to see that everything in the front end is tight. I do not know that it is entirely fair to call that an additional expense, because I do not think it is a bad thing to test the front end of the locomotive, whether it has a superheater or not. It is simply taking a proper precaution instead of waiting for failure. Before we adopted this method of testing we used to run through the summer months very successfully, but when the hard winter weather came on we had complaints of the engine being short of steam. We usually found the steam pipe leaking, or something of that sort. By making a periodic test in a systematic manner you overcome that condition, and keep the engines in good condition right along. I believe there is money in doing this. Another expense is keeping the tubes clean. We clean out the fire tubes every round trip, and, as far as I know, that is carried out religiously. It is only a half-hour's work for a man, a cheap class of labor, and it is not a very great expense.

As far as lubrication is concerned, we notice very little difference in using sight-feed lubrication, between the superheater and the non-superheater. We do not use slide valves on superheaters. It has been tried many times, and in every case it is found to give trouble. You have practically got to put up with piston valves if you go to the superheater locomotive, and I do not know that there is very much objection to using piston valves.

I have had the mileage made by superheater locomotives in passenger service on the Canadian Pacific, Eastern lines, recorded for March and April. There were 790,000 miles made in the passenger service, and there was not a failure due to superheaters. That is a pretty good proof that there is no need for failures due to superheaters, if you will keep after them. Last year I gave figures that showed that we made over two million miles, and that there was no failure due to a superheater, that is, a passenger failure due to superheater itself.

It is a certain amount of satisfaction to me to feel that when we went into this business first we were criticised for putting so much apparatus in the front end. During the past few years everybody's opinion seems to have changed on that, and there seems to be no objection to putting in two or three front ends and filling them with apparatus. We have used the intermediate superheater, by which I mean a boiler with an evaporating section at the back, the superheater in the middle. I won't say a feed water heater, but a front section into which the water is delivered. That engine was originally built as a reheater engine; in other words, the superheater was put in between the high and low pressure cylinders. We subsequently changed it over and put the superheater ahead of the high pressure cylinder. With the superheater acting as a reheater, we are getting ninety degrees superheat in the low pressure steam chests. With the superheater ahead of the high pressure, we obtained from 480 to 580 degrees in the high pressure steam chest; that is, a superheat of 100 to 200 degrees, varying, I think, according to the amount of water that was lifted by the engine, but we obtained very fairly uniformly 30 degrees of superheat in the low pressure steam chest. We didn't make any test on the two engines with the two arrangements. Our opinion was that it simply was not necessary. You could tell by the engine, by the fireman, that there was no comparison between the compound engine using the superheater ahead of the high pressure cylinder and one using no superheat in the high and superheat in the low. It made a different engine out of it. We shall not worry very much about experimenting with reheating. If you can run with 100 to 150 degrees of superheat on a high pressure cylinder, you are fairly safe in knowing that you are going to have a certain amount of superheat in the low pressure steam chest, and that there will be sufficient there to entirely avoid any water trouble in the low pressure cylinder. I feel that if we put in so much of a superheater that we get more superheat than we want in the high pressure steam chest, there is no advantage in going to reheating. We had better put all our heating surface where it does the most good.

I would like to ask Mr. Cole where he has proven that lowering the steam chest pressure is an advantage. I can see that lowering the boiler pressure is an advantage, if the boiler pressure is so high that you are having an abnormal amount of trouble with the boilers. We are running engines with two boiler pressures. In other words, we build a 21-in. engine with 200 lbs. pressure, and a 22½-in. engine with 175 lbs. pressure. We really set the pops at 180 on the lower pressure engine, to avoid the objection made by the engineers that they couldn't get the work out of the 175-lb. engine that they did out of the 200-lb. As a matter of fact, I think there was nothing to that, but their idea was that the more pressure they had, the more business they could do, it didn't make any difference what the size of the cylinder was. In order to avoid criticism, we gave the other engine 5 lbs. more so that she could pull just a little more. I watched those engines very carefully, and I do not see either theoretically or practically, any advantage whatever in reducing the boiler pressure unless you want to do it to save the boilers. In good water districts we certainly do not have trouble enough with the 200 lbs. pressure to make it any serious advantage to go to 180. In bad water districts we do notice a difference and we arrange to use engines with 175 or 180 lbs. pressure, but where you have reasonably good water, I fail to see any advantage whatever in reducing boiler pressures. I grant you that with superheated steam, you can reduce boiler pressures without losing efficiency, a thing that you could not do if you were using saturated steam; but I do not see any reason for obtaining greater efficiency, and I do feel most distinctly that the lower pressure engines, with bigger cylinders, are not as fast or as good as engines with the high pressure. I do not believe there is any difference in the pressure at the nozzle on either engine, and with the big cylinder you lose a greater percentage due to back pressure.

We have not built our passenger engines with 180 lbs. pressure, simply because we felt that a 200 lbs. engine was a faster and a better one. I have heard the statement made a number of times that you can obtain greater economy by reducing the boiler pressure, and I would like to know how it has been proved out, and why it is.

James Christopher (T. H. & B.): Does Mr. Vaughan have to bore out the cylinders more frequently with the superheater than with the simple engine? Is he enabled to run a larger nozzle tip with the superheater than with the simple engine?

Mr. Vaughan: We use bushings on all our cylinders, and we have not noticed extra wear on the bushing as much as we have on the rings. I really haven't any figures to show whether we do bore out more often or not. We use a smaller nozzle tip with the superheater. At least, that is our general experience. If you are using less steam you generally require a smaller nozzle, but the engine will run more freely.

We have plenty of evidence to support Mr. Hoffmann's view that you can obtain additional capacity out of a superheater. The same engine changed from a saturated steam engine to a superheated steam engine will take, say, one car more in six, or one car more in seven, without any question, and make the same time. There is no question whatever but that the engine will run more freely, run faster, and run faster with a smaller nozzle. We have found it necessary to cut the nozzles down some for superheater locomotives. I put that down to the fact that, in spite of everything that has been said, the question of draft is nothing but the number of pounds of steam at the nozzle. It is a question of steam and pressure. You have to have a certain pressure of steam at the nozzle to get a sufficient draft; if you are going to get that pressure with a smaller quantity of steam, you have got to contract the nozzle so as to hold it in enough to get the pressure.

Prof. Endsley: All the tests run at Purdue were run upon a slide valve engine. We ran a wide open valve, 240 lbs. pressure. We were all around the engine and could tell if a valve was sticking; we did use a considerably larger quantity of oil to keep the valves from sticking with the superheater than with the non-superheater, but have never cut a valve, and the engine has run some 15,000 miles with the superheat varying from 120 to 140. We had to decrease the size of the nozzle from 4¼ to 3⅞ ins. in order to get the engine to steam. It is a 16x24-in. engine. Our engine is equipped with two valve pipe cups. The one on the right side broke after about a month, and in order to run a test I cut it off entirely and doubled the amount of oil used. Since that time oil has never been put into that side of the cylinder. Looking at the steam chest and at the cylinder from day to day, I find that side just as bright as the other side. We never have had any trouble from the rings, but we find it cheaper in the way of repairs. We have had no trouble with the cylinders or valves, and we use a slide valve engine.

Mr. Vaughan: We have trouble with the slide-valve engine at that temperature. I think very likely it may depend on the type of slide-valve used as much as on the type of lubricator used. Most continental engines use forced lubrication, and are able to run the passenger engines with sight feed lubrication.

Mr. Chambers: What speed per hour did Prof. Endsley attain in his tests, the maximum speed the engines are required to make?

Prof. Endsley: We ran 30, 40 and 50 miles an hour in most of our tests. We do not attempt to get a high speed. We just decide what speed we are going to run at, and put a load on to keep at that speed, but we have found a great increase of power, from ten to fifteen per cent, by using superheat in the Purdue locomotive. In the test this year, we ran at 30 miles an hour, because we had some trouble with hot boxes, because of the engine standing still at the heavy pressure. The results at 30 miles an hour were comparatively the same as at fifty, so far as steam economy was concerned. The tests reported last year were run at 30, 40 and 50 miles an hour, at 240 lbs. pressure, with 200 degrees of superheat.

Mr. Vaughan: Ours is not a high speed road. Most of our passenger traffic is very heavy and is run at slow speed. The highest record we have for a superheater engine, 75-in. wheel, is 75 miles an hour. I mean, sustained speed over long distances. That probably wouldn't be very high, Mr. Chambers would say, but we have handled heavy trains, four or five hundred-ton trains, at 70 miles an hour on the level over quite considerable distances, ten or fifteen miles and the general feeling among our enginemen—and it has been stated in this convention frequently—is that the superheated engines are very much freer running engines than the saturated steam engines.

The nozzle is not very much of a factor in it, I should say, from the fact that we have tried a variable exhaust on our superheater locomotives and found that it was almost impossible to tell from running an engine when the nozzle was increased. The superheater engine is less sensitive to the size of the nozzle than the saturated steam engine. There is no trouble in getting speed out of them. We had some Atlantic type engines with an 84-in. wheel. We changed some of those engines to superheaters—they were previously compounds—and the enginemen told me they were never afraid to run the engine as fast as it would go, though they didn't like to when it was a compound.

Mr. Chambers: I was wondering how it would affect a road that needed to get up to 85, 87 and sometimes 90 miles an hour. In making our tests several years ago we had a great deal of trouble for a few days in trying to get the speed up to 80 miles an hour. We commenced with an 18x26-in. cylinder, 84-in. wheel, 4½-in. nozzle. After the first day we increased the nozzle to 4⅝ ins. and kept on increasing up to 4⅞ ins. Then we could make 84 miles an hour very easily.

Mr. Vaughan: Mr. Steele, of the American Locomotive Company, came down with us, with a 600-ton train and on practically level road; we made mile after mile at 63 miles an hour, with a 63-in. wheel. That is going pretty good for a small wheel.

Henry W. Jacobs (A., T. & S. F.): In the past ten months we have conducted some very extensive road tests. One of these tests was conducted on an engine that had formerly been a saturated steam engine. We put a superheater in it to give an average of 60 degrees of superheat. The conclusions that we drew from these tests were that they would not warrant us in putting in superheaters unless we could get at least 90 degrees of superheat; our practice at the present time is to build our superheaters to get from 90 to 125 degrees.

F. F. Gaines (Cen. of Ga.): My experience is limited to a very low degree of superheat. We have found, however, since making tests indicated in this report, that by raising the pressure from 160 to 180 lbs. we are getting better results. While we have made no tests, it seems to be the consensus of opinion that the engine is more economical than it used to be, and we probably now show an economy over the simple engine. There is no question, however, that with the small degree of superheat we are using the engine is very much favored by the engineers. It really costs us less for repairs, and, whether it is due to the lower pressure we have used, or what, the fact is it has cost us less for running repairs and it is a more snappy engine, gets over the road more easily, and the engineers all want to get it if they can. Has Mr. Chambers not been running an engine between New York and Philadelphia during the past winter that has been carrying a high degree of superheat? Has he any data on the subject?

Mr. Chambers: I have no data to offer.

O. M. Foster (L. S. & M. S.): We have a couple of superheaters on the Lake Shore. They are piston valve passenger engines. We use about twice as much valve oil as we do on the saturated steam engines of the same class for the same work, but we do not experience any difficulty in lubricating the engines successfully. The only trouble is that when new valve bushings are applied we have to be a little more careful in getting them down to a bearing. After we once get a good working condition established we never have any more trouble with them. The engines carry 200 lbs. pressure. These two engines are better than any other engines of their class, and this is agreed to by everybody. So far as the fuel consumed is concerned, they are more economical, and, so far as hauling trains is concerned, they are better engines. As to maintenance, we do not find any appreciable difference. The failures we have on account of superheater tubes breaking off are not worth mentioning. We have not had more than four such failures in six years. We do not believe there is anything gained, so far as the performance of the engine is concerned, by increasing the size of the cylinder and decreasing the steam pressure. In fact, I am inclined to think that there is a distinct loss in the capacity of the engine, aside from any question of economy. I am led to believe this from the recent experience that we have had in applying superheat to another engine of another class. We have not tested this proposition out sufficiently to be able to say a great deal about it, but we reduced the steam pressure to 180 lbs. and increased the diameter of the cylinder from 22 to 24½ ins., which we thought would be about right. The engine has not done what our experience with the other engines would justify us in expecting in the way of performance. It is not much better, so far as hauling trains is concerned, than other engines of its class. We investigated and found apparently that it was on account of the low steam pressure. I do not believe you can run engines fast with low pressure. If you want a fast engine you want fast steam. We are going to put the cylinders back to the original size and put the pressure up. The engine saves coal and is doing better work, but it is not a distinctly better engine on passenger trains, and that is what we expected to get, along with economy.

F. J. Cole (American Loco. Co.): Answering Mr. Vaughan's question about the low steam pressure. We feel that the use of the moderate boiler pressures is some advantage in boiler repairs. Of course, with the superheated steam you can get any required temperature, and apart from any question of steam there is no advantage in a superheated engine carrying the same pressure. Of course the question of boiler repairs has got to be determined over a long period of time. We felt the moderate steam pressure of, say, 170 or 175 lbs. would, other things being equal, be more economical in boiler repairs than the high pressures of 200 or 210.

L. R. Johnson (Can. Pac.): One of the gentlemen who spoke of the different details in connection with the superheater said it was a pity the committee had not touched upon or given figures to show the increased power of a locomotive equipped with a superheater. The different members of the committee have their own ideas. As a committee, we felt we would be treading on rather dangerous ground in giving figures such as would have to be given. It would tend to make the members think we were rather boosting the superheater as a superheater, and we thought that was somewhat out of our province. I think the figures and information given in the report, together with the results which have been brought out by the discussion, will leave no doubt in the mind of anyone present that the superheater is an advantage to any locomotive which may be equipped with it, whether it is low temperature or high temperature.

The report shows that not only in America—and when I speak of America I mean the whole continent—but also in Europe, the experience has been that it is impossible to use slide valves with any high degree of temperature in the superheater. Mr. Schmidt suggested that it is not altogether the question of lubricator, but that the superheater makes the slide valve work on the valve seat to such an extent that it will break, and that not due to water lubrication so much as from the warping by the increased temperature. The experience given by the gentleman from Purdue is rather astounding, in the face of what we have already heard, but if it is investigated a little further, probably there will be a reason for his success.

I want to express the appreciation of the committee for the very able way in which Mr. Jacobs, of the Santa Fe, came to our assistance and placed his technical facilities at our disposal in order to make the report as interesting as possible by producing these drawings of the different classes of superheater.

Locomotive Frame and Driving-Box Construction.

H. T. Bentley, assistant superintendent motive power, Chicago & Northwestern, read a paper on "Locomotive Frame Construction, Including Design of Driving Boxes and Contained Parts," as follows. The subject is treated under two heads:

First: The investigation of the design of driving boxes, brasses, shoes, wedges, blinders and frames, that will give increased mileage to locomotives between shoppings.

Second: Frame construction for engines with outside valve gear.

It is getting to be quite a problem to keep our heavy locomotives running without having frequently to drop wheels and refit driving-box brasses, take up lateral wear, line down wedges, etc., and the object of this paper is to bring out a discussion as to what has been, or can be, done to keep engines off the drop pit, and increase their life between general repairs. If it were possible to keep our driving-box brasses, shoes and wedges snug, and free from pounding, there would be less trouble with frame breakage, and our rod brasses would not need renewing so often.

With this in mind, I am giving a few suggestions that may possibly enable us to keep an engine out of the shop until such time as the driving axles need renewing, unless a frame breakage occurs to take the engine out of service. To get the best results, driving boxes should be made of cast steel, and designed of such proportions in shoe and wedge fit as to give long life, and with an adjustable or removable hub liner, so that lateral motion could be taken up with wheels in place. The driving-box brasses should be made of ample size and made of suitable material for obtaining long life, and of a removable type so that it will be possible to quickly replace them without having to drop the wheels.

Shoes and wedges should be of such a size that a large bearing surface will be in contact with the driving boxes. With the ordinary design, the shoe and wedge face is altogether too small, and the wear very rapid. Flangeless shoes and wedges should be used to overcome the trouble experienced with flanges breaking. To facilitate the lining down of wedges, arrangements should be made so that they can be removed without disturbing the binders, or underhung springs; the wedge bolts should be of sufficient strength and so arranged that in case of breakage it will be an easy matter to replace them. Binders to be so designed that they will securely hold the frame jaws together, and prevent movement, but yet of such construction that they can readily have wear taken up when necessary.

Frames.—Most roads have more or less trouble with frame breakages, and, if these could be eliminated by either improving the design or making them of some material that would stand up under the shocks they are subjected to, a step in the right direction would be made. I noticed an article some time ago on the great amount of frame breakage that was occurring with engines having a Walschaert valve gear. Upon looking into this on our own road, I found we are not having the slightest trouble; not a single case of frame breakage has occurred on any outside gear engine during the past four years.

Frame Construction for Engines with Outside Valve Gear.—As most locomotives are now being built with outside valve gear, there is very little difficulty in designing a suitable cross bracing that will add materially to the strength and life of frames.

The replies to a circular of inquiry are summed up as follows:

No. 1. Have you any suggestion to make in the way of improving the driving box now in general use, and, if so, what do you recommend? Of twenty-six answers sixteen replied "No," whereas the balance suggested using heavy steel boxes, except in one case, where it was recommended that the pedestal jaws be spread farther apart, so that heavier cast-iron boxes could be used.

No. 2. Have you any way of taking up lateral wear in driving boxes without removing them? Very little has been attempted in this direction, although replies indicate there is a great need of something that will enable it to be done.

No. 3. Are you using driving boxes with brasses that can be taken out without dropping wheels? Notwithstanding the desirability of such an arrangement, only five roads report using anything of the kind, and all are using the same patented device, experimentally; in three cases satisfactorily, in one case it has not been in service long enough to report on, while the fifth user did not find it entirely satisfactory, but did not state in what respect it failed.

No. 4. What mixture or special metal do you use in driving-box brasses, and is it entirely satisfactory? Do you use grease for lubricating switch engines, and is it giving satisfaction? In the first section of this question, most roads reply that they are making their own mixture (copper 80 per cent, tin 10 per cent and lead 10 per cent), with very satisfactory results, while a few are purchasing special brands, which give good service. In answer to second part of the question there appears to have been a difficulty experienced while using grease in switch engines, and it early became evident that the kind of grease and perforated plates working satisfactorily on road engines would not answer the purpose for the slower moving switch engine, and, therefore, a thinner grease and perforated plates with larger holes were introduced, and this combination appears to give better results.

No. 5. Do you use adjustable or solid shoes and wedges, and are they satisfactory? The general practice appears to favor the solid shoe with adjustable wedge, and, as a whole, it is satisfactory, although with limited bearing surface considerable wear takes place. With engines having Walschaert or other outside gear, there is no reason why the frame jaws cannot be designed to get a width of eight to ten inches, if desired, so that the pressure per square inch could be greatly reduced. On a large number of European engines a solid pedestal of great width is used, with very satisfactory results.

No. 6. Do you have much shoe and wedge flange breakage? If so, how do you overcome it? Considerable trouble appears to have been experienced in this direction and has been overcome in some cases by using bronze shoes and wedges; in others, by thickening flanges where possible, and, on most roads, frame jaws are now rounded off so that a good fillet can be left in shoes and wedges. We have entirely overcome the breakage of flanges by simply leaving them off, and using side plates riveted on the frame, the flanges of the driving box coming in contact with these side plates, instead of the flanges of shoes and wedges, as formerly.

No. 7. What width of bearing face do you have on shoes and wedges where they come in contact with driving boxes? The replies indicate that this varies on different engines and roads, the minimum being 4 ins. with 7¾ ins. as a maximum, depending on the size of engine. With consolidation engines in service on the Chicago & Northwestern we have a wedge face of 8¼x17½ ins., with a pressure per square inch of 122.8 pounds, as compared with our former standard freight engine with 6¼x17-in. wedge face, with a pressure of 184.72 pounds per square inch.

No. 8. With outside valve-gear engine, have you tried to increase the width of shoe and wedge face, and, if so, how? In no case does there appear to have been an attempt made to increase frame jaws on engines having outside valve gear, and yet it is a simple proposition, and by doing so increased wearing surface could be obtained.

No. 9. Have you any way of taking down wedges without removing binders or driving box? In no case has this been attempted, although it can be accomplished by using flangeless wedges and cutting away the inside flange of the driving box on the wedge side; what was formerly a four or five-hour job, depending upon size of engine, can be accomplished in less than an hour.

No. 10. Do you use brass or cast-iron shoes and wedges? The general practice appears to favor cast iron for this purpose, but a number of roads prefer bronze shoes and wedges where steel boxes are used, while a few people seem to like a bronze liner on a steel box, and then use a cast-iron shoe and wedge. With this latter arrangement, we have not had very good results, account of difficulty in keeping liners fast on the box; our present practice is to use cast-iron shoes and wedges against steel boxes in freight service, and bronze bearing on passenger engines.

No. 11. Can you line down shoes and wedges without taking them out to apply liners, and, if so, how? The replies are practically the same as to question 9, except that occasionally loose liners are inserted behind the wedge, which, however, can only be done by taking the binder down, so that what should be a simple job is a difficult and expensive one.

No. 12. With underhung springs can you remove and replace broken wedge bolts without taking binders down? Where underhung springs are used, it seems impossible on most roads to remove or apply wedge bolts without removing springs. We had a similar difficulty, and practically overcame it by making binders with slotted holes, which enabled us to take out and replace wedge bolts with springs in place, thus reducing the job from a big to a small one.

No. 13. Which type of binder do you find the most satisfactory? The pedestal cap type meets with most favor, as replies from fourteen roads indicate it is their preference, and that frame breakage is reduced where it is used. The strap binder is next best, seven replies being in favor of it. The clamp over the frame jaw lugs is used on four roads on account of simplicity, and only one road is in favor of using the thimble and bolt. My personal preference is for the pedestal cap type.

No. 14. Have you anything to suggest in the way of a binder that will take up wear without having to be upset and refitted? The replies indicate that the pedestal cap type binder does enable the wear to be taken up with less trouble and expense than any other make, in which conclusion I concur.

No. 15. What suggestion have you to offer in regard to frame construction on engines with outside valve gear? The proper cross bracing of frames is the most logical use to make of the space that was formerly taken up by valve gear, and will do more to overcome frame breakage than almost anything else. One suggestion is to use upper and lower rails over the cylinder casting. This design can and is used, however, with engines not having outside valve gear, and is a great help in reducing front frame breakages and loose cylinders.

No. 16. Do you have as much trouble with frame breakage when using outside valve gear as you do when using Stephenson gear? There seems to be a reduction of frame breakages with engines having outside valve gear, on account of their being provided with suitable cross bracing. In our experience with engines of exactly the same size and make, one having the inside and the other the outside gear, the former are continually in the shop with broken frames, while the latter, with Walschaert gear, have never given us a minute's trouble in this direction; but the frames are braced laterally, which we consider the cause of our freedom from breakage.

No. 17. Do you use cross bracing between frames of outside gear engines. If so, does it stiffen up and reduce frame breakage? Where outside gears are in use, the frames are generally braced laterally and with splendid results, judging from replies received. Some roads have had such short experience with outside geared engines that they are not in a position to report intelligently.

No. 18. Have you any suggestions to make that will decrease the breakage of locomotive frames? The suggestions offered are various, and may be summarized as follows: Heavier frames. Keep pounds out of driving boxes. All weight-carrying points on frames to be braced to boiler. Make frames of best material. Increase depth of frame in proportion to the tractive power. Make frames in one piece with large radii where possible. Good material properly used.

No. 19. Do you use steel or iron frames? Which is most satisfactory? Cast-steel frames, when properly designed and annealed, appear to be just as satisfactory as wrought iron. Great strides have been made in foundry practice during the past few years, so that first-class castings can be obtained.

In conclusion, I believe there is a great field ahead for the further study of this subject, so that repairs to driving boxes, shoes, etc., will be simplified, and work now taking several hours can be done in very much less time.

J. A. Pilcher (N. & W.): There has not been any epidemic of breakages, and we have been led to the conclusion that it is better policy for us to adhere to the cast iron boxes, making the box frames very deep to get the strength.

D. R. MacBain: The New York Central Lines some years ago adopted a method of lining steel driving boxes with brass, for the purpose of getting away from the excessive box and shoe and wedge cutting. It was a considerable item of expense and a couple of years ago a committee was appointed to make a series of experiments with cast iron, with a view of determining whether or not we could use cast iron on modern power. The committee has arranged, as I understand the matter, to have about twenty consolidation engines equipped with high grade cast iron boxes, of two different mixtures. Some of the engines have been in service a year, and up to the time I left the New York Central we had not had any failures. The operation of the box so far has been very satisfactory. We simply took out the cast steel box and put in the cast iron boxes with the same dimensions of shoe and wedge.

Mr. Bentley: Mr. MacBain brought up the question of increasing the length of the box and brass, but he seemed to have overlooked what I consider the most vital point in the whole thing, and that is increasing the jaw dimensions. The locomotive builders do not like that kind of an arrangement, because it means a lot of work for them, but if you can increase your jaw fit you will get a greatly increased life from the shoes and wedges.

Mr. Gaines asked about the driving axle. I was reaching rather high probably in trying to make the engines stay on the wheels until the axle was worn out. I saw a driving axle the other day that had only been in service two years, and I do not think that is a long life for a driving axle. It had to be taken out and refitted.

Mr. Fuller spoke about my saying that they put the brass up to the boiler. I did not say that—that was a statement made by one of the gentlemen who replied to my circular of inquiry. We run our brasses up to the boiler over the frame, and instead of riveting them or fastening them on with studs, which causes considerable trouble, we let the boiler rest in an angle iron or T-iron.

Mr. DeVoy spoke about an engine having outside valve gear—he could not see how that would affect the breakage of frames. I did not claim the kind of valve gear we were putting on our engines was responsible for the absence of frame breakages. What I do claim is that the possibilities for cross braces on the outside geared engine is the thing that has helped us.

Mr. Pratt quoted me as saying something that I did not say, and that I did not mean. I did not say anything about a one-piece frame. We have a large number and they are very nice when nothing happens and they do not get into a wreck, but when it becomes necessary to make repairs to one end of a one-piece frame, it is a big job, because you cannot repair the frame in place. I am in favor of a slab connection, where possible, so as to reduce the size of the frame for convenience of repairs.

Mr. Brown spoke of the care given to frames. I understand if you keep the pounding out of the driving box and keep the shoes and wedges snug, that it is giving care to the frames and I do not see that you can give very much further care to them while the engines are in service.

In reply to Mr. Fuller's question. We use a mild steel plate, I think it is about three-quarters of an inch thick and about two inches wide, which we rivet on to the side of the frame, which takes the place of the flanges on the shoes and wedges. The idea of that is whatever wear is caused from the driving box is transmitted to this piece of mild steel, which is easily removed when it is necessary to replace it, and instead of having to repair the frames, we simply take the worn piece of mild steel off and put on another one.

Safety Valves.

The report of the committee on safety valves was read and accepted after a short discussion.

WEDNESDAY, JUNE 22.

President Wildin called the third and final session of the Master Mechanics' Association to order at 9:40 Wednesday morning.

Freight Train Resistance.

Edward C. Schmidt, Assistant Professor of Railway Engineering, University of Illinois, presented an individual paper on "The Relation of Freight Train Resistance to Average Car Weight." The tests which he described were thorough, and the paper includes complete data as to the methods employed, the results and the methods used in calculating them, and a discussion of the results.

Locomotive and Shop Operating Costs.

The committees appointed to report on the subject of Locomotive and Shop Operating Costs considered it advisable to confine itself to one of the various classes of expenses which might be included under that description. Such costs, as a whole, are, evidently, too complicated for the purpose of a single report, comprising, as they do, those of fuel, repairs, engine-house expenses and various other items. They will, therefore, chiefly discuss those included in the account "Repairs of Locomotives," and the method adopted in supervising the expenditures of that description.

Inquiries made of a number of the largest railways show that the appropriation plan for determining pay-rolls is in general use. As a rule, an estimate is prepared by the divisional authorities, stating the amount they require for their pay-roll during the coming month, compared with the actual figures for the preceding month, and corresponding month in the previous year, and an explanation of the reason for any increase desired. These estimates are consolidated into a statement at headquarters, and after any criticism or alteration has been decided on, are approved, and practically constitute an authority for the expenditure in labor called for. Generally, it is understood that such authority is not to be exceeded unless in case of emergency, and in some cases no overexpenditure is permitted without additional authority being obtained. It is evident that such a rule can not be enforced in the case of roundhouse forces, which must necessarily be maintained, but it may be more or less closely adhered to in general repair shops. On several roads, weekly or biweekly pay-roll statements are prepared for the purpose of checking the actual expenditures against the estimates, but this practice does not appear to be usual, although, no doubt, it is carried on locally even if not recognized as part of a regular system. At the end of the month it is usual to compare the actual with the estimated pay-roll and require an explanation of any increase over the figures approved. This system appears to work successfully and enables close control to be maintained over labor expenditures without unnecessary complication, provided it is handled reasonably and firmly. While it deals with the pay-rolls as a whole, it actually limits the expenses on any one account, since the distribution will usually bear certain proportions.

Several roads require estimates to be submitted and authority obtained before shop repairs are made on an engine. In some cases this applies to all shop repairs, in others to all those over a certain amount, varying from $75 upward. The authority of an executive officer may be required for repairs over a limit which varies from $1,000 to $5,000. Notice of an engine requiring repairs may be submitted thirty days before engine is shopped, in order to enable the cost of the repairs recommended and the service of the engine being investigated. In one case, in which each class of engine is given an allowance per mile for repairs, engines may be shopped without authority if the cause of the repairs will not cause the allowance to be exceeded; otherwise, it must be obtained. When estimates are made, their correctness may be checked by comparison with the actual cost when completed and explanation required if exceeded. There are, naturally, many variations in the details with which this work is carried out on different roads, but some system for watching the cost of shop repairs in advance is in general use. The committee would call attention to the fact that the most important question, when an engine requires shop repairs, is the miles made since last repaired. While criticism of the nature of the repairs required may occasionally lead to additional mileage being obtained from an engine by the application of minor repairs, this condition is not usual, and, as a rule, the cost of the repairs can not be economically reduced by estimates made before an engine is shopped. Such estimates are difficult to make accurately, and may tend to limit the repairs to the amount allowed. Limiting repairs that are actually required to put an engine into good condition is not economy. Whatever may have been the reason, after an engine has been taken out of service and sent to the shops the cheapest plan is to then make the repairs properly and thoroughly, so that when turned out the engine will make as many miles as possible before needing to be again shopped. The cost of shop repairs is not properly the cost per repair. It depends on the cost per mile, and the miles made between repairs are, therefore, equally as important as the cost of the repairs when made. When shop repairs are not necessarily those which put an engine into thoroughly good condition, but whatever be their nature, the question of their being justified by the mileage made is one of the greatest importance. For this purpose, information as to the miles made since last general overhauling and the nature and cost of the intermediate repairs received will show whether the class of repairs called for should be necessary or not. The introduction of an allowance per mile has the advantage of presenting the influence of large or small mileage in dollars and cents in place of miles only. Whether this is used or not, a simple statement, involving the shop repairs since last general overhauling, the mileage made and the nature of the repairs required, really gives all the information that can be advantageously used in determining whether the engine has been properly maintained and used and a reasonable mileage obtained from it. If the repairs are actually needed there is little doubt that they should be thoroughly made, and to do this in the most economical way is then a problem for the shop.

The great degree of variation in the amount of work required in making locomotive shop repairs, even though they are classified as being of the same general nature, makes it almost impracticable to watch their cost as a whole. When this is done, the best system in use is that which furnishes the foreman or shop superintendent a daily or weekly statement of the labor applied on the individual engines under repair, usually divided to show that in each department separately. By this means, information is obtained, while the work is in progress, which will call attention to any engine on which the labor is exceeding the expected amount. The difficulty usually experienced is that on account of one engine requiring more work than another the differences are difficult to analyze, and, if thorough analysis is attempted, the work has to be split up into a number of different operations so that the cost of each may be individually known. Where piecework or any of the various efficiency systems are in use, this is, of course, the case, but, apart from any question of rewarding labor, the cost of the individual operation appears to be the only logical basis on which the cost of locomotive repairs can be determined in the shop. It is true that much of the work done, even when divided with considerable detail, still varies to a certain extent from one engine to another, but this variation is not sufficient to prevent knowledge being obtained of what the work is costing and enable any increase being immediately known. Whatever may be the system employed, some method of watching the cost of repairs in detail enables the efficiency of a shop to be supervised in a way that is not otherwise possible. The committee does not believe it is necessary to discuss the various systems in use for this purpose. They have been fully dealt with at other times and are generally known and understood. One point may, however, be referred to. Any operation may be reduced to a series of detail operations, and the time required for those may be determined with considerable accuracy. For instance, in turning an axle, the time required to lift the piece, place it in the lathe, take the various cuts, roughing and finishing, and replace it on the floor, may all be individually recorded and thus compared with corresponding operations on other pieces or with known performances. Such records are now generally known as time studies, and their use enables the time required for numerous operations being checked from known data, in place of depending on the results obtained from the man performing the work or the judgment of the foreman in charge. Locomotive shops have the advantage that the work performed in them is repeated after time, and, under this condition, there are few operations that do not repay time spent in making the proper study of the best method of performing them. What is, however, perhaps equally important, is the means they afford of comparing, for similar operations, the relative costs of different methods or of different types of machines. Such comparisons are evidently valuable when applied to the various repair shops on a railway, and the committee has investigated the possibility of arranging for their exchange among some of the members of this Association. The advantages of such a course are from one point of view, obvious. There are numerous operations which vary but little in different repair shops, and the determination of the best method or result would be far more certain if derived from the experience of the shops on several railways than from those of one. Comparisons of total times of most operations would be misleading, on account of the differences in conditions and practice, but the same objection does not apply to properly determined time studies as the details may readily be adjusted to allow for differences in design, conditions, etc. The opinion of those of our members who have been consulted differs as to the advisability of such an exchange. Some have signified their willingness to co-operate, while others do not care to. There are, evidently, difficulties connected with the course apart from the practice on some roads of not divulging time or piece work schedules. A road giving information would naturally expect to benefit by receiving from others to a reasonably equal extent, and means by which this could be ensured are not easy to devise. The shops in which this work has been carried out are limited in number and in many cases it is only partially completed. The committee, therefore considers that at the present time it would be unwise to recommend any arrangement for the interchange of time studies, although it believes that in the future some benefit might be obtained if a suitable plan could be outlined.

In considering the methods used for watching the results obtained, as opposed to those that have been discussed for watching the expenditures being made, the most important statement is, of course, the performance sheet. The form in which this is made out varies considerably on different roads, and in many cases references are made to units which are evidently retained on account of the familiarity with them of those concerned. Apart from performance sheets there are, however, a number of statements in use which it will be interesting to refer to.

Statements are generally used showing cost of running repairs by classes on different divisions. In some cases cost of individual engine running repairs are not kept separately.

but by classes of engines only. This statement would appear to be of considerable value in comparing results, as it enables a comparison to be made on engines of similar types and service. An allowance per mile is sometimes used for different classes of engines. This has already been referred to, but its use in a statement of this nature has another purpose. When an allowance per mile is used for shop and running repairs combined, the surplus accumulated by each engine may be watched, and knowledge thus obtained as to whether that engine when repaired will have performed its service at the cost per mile expected. If, however, the allowance is separated for shop and running repairs, the mileage made between shopping in itself determines whether or not the engine can receive its shop repairs without exceeding its shop repair allowance, while the performance of the engines based on their allowance for running repairs distinguishes in an easy way between those classes or divisions which are costing more or less than the average. In addition, if the allowance be based on the engine mile, the tractive power mile, or the engine ton-mile, whichever unit may be used in comparing results, such a statement shows which classes or divisions have exceeded or which have run below the allowed rate, and, therefore, enables the causes of overexpenditures to be localized to that extent.

A similar statement may also be used for shop repairs, but in that case a difficulty arises from the fact that the number of engines shopped on a road or a division does not necessarily bear any relation to the miles run. Over a considerable period the condition of the power can not vary sufficiently to make the difference important, but for one month or, indeed, for several, shop repairs may be reduced below those required to maintain the power in a uniformly good condition or may be required in excess of the normal in order to improve it. This difficulty may be remedied by referring the cost of each engine receiving shop repairs to the mileage made by it since last repaired, and working out the cost per mile on this basis, in place of comparing the cost to the mileage run during the month. By this means, the cost for each engine or class of engines determines for those repaired during each month their cost per mile for shop repairs since their last shopping, and thus enables the expensive, or economical classes to be located without respect to the number of them shopped during the month. It is thus possible to prepare a statement which shows the results of this month's shop repairs with the same accuracy as that showing those for running repairs. Evidently in such a statement the cost of the shop repairs may be made to balance with the charges against that account for the month, but the mileage, and, consequently the cost per mile will vary from that run by engines during the month, as it is based upon that made by the engines shopped since last repaired. Over a considerable period the mileage would correspond if no power were purchased or scrapped, but under usual conditions the mileage run exceeds that shopped, owing to that made by new and scrapped engines. The difference is not important, however, and a statement made on this basis has the advantage that the cost per mile for shop repairs is obtained with the same accuracy as that for running repairs, and without reference to the relation between the amount of shop repairs effected in any month and the mileage run during that month. When combined with an allowance per mile or other unit, it is then possible to localize the engines which exceed or are below the average cost and the amount by which they affect the result.

On several roads, while statements showing cost of individual repairs are not prepared separately, the cost per mile for different classes of engines on different divisions is shown in the performance sheet. This can not, however, be said to be general. The performance sheet is usually arranged to show results as a whole rather than in detail, the latter being analyzed by departmental statements. For this purpose there is a tendency to introduce a unit which will afford a better comparison than the engine mile. Owing to the large variation in the size of locomotives now in service and the greater cost of maintaining them as the size increases, the cost per mile no longer compares the expense with the service rendered. The ton-mile is decidedly less accurate, since, while the cost of maintaining the same class of power does not vary greatly on level and hilly districts, the load hauled by them does, and, in fact, the engine that is working on heavy grades, while it may not haul more than one-third the load that it would on the level, costs slightly more to repair per mile run. While, therefore, the cost per ton-mile is important from an operating standpoint, its use in connection with locomotive repair costs introduces a variable which can not be affected by the efficiency with which those repairs are handled. The unit needed is one that takes into account the size and capacity of the engine and those in use are either based on its weight or its tractive power. The weight may be taken as the total weight of the engine without tender, the light weight of the engine or the weight of the drivers. The latter corresponds very closely to the tractive power and appears to be the preferable unit. While the total weight of the engine represents, presumably, the power that is available for hauling trains, as it is reasonable to assume that it has been disposed to the best advantage, whether a small tractive power was required for high speeds or a large one for low, yet, the weight on drivers or the tractive power is more closely proportioned to the cost of maintenance. In the case of two engines of equal weight, one constructed as a ten-wheeler, the other as a consolidation, the ten-wheel engine will not only cost less per mile to maintain, but will usually cost less per mile per pound of the tractive power or weight on drivers. Again, when two engines of equal weight are employed, the one in freight and the other in passenger service, the cost will usually be less for the passenger engine when based on the tractive power per mile, and, as the tractive power or weight on drivers usually bears a smaller proportion to the total weight on passenger engines than in freight, it is evident that if the truth of these two propositions be granted, the unit based on pound of tractive force or weight on drivers, represents more accurately than one based on the total or light weight of the engine, the comparative cost of repairs. As between the two former there is little to choose, but as the tractive power represents more closely the service delivered, the committee feels that it is the preferable unit, and wishes to recommend the more general use of it. It considers that the best method is that in which the tractive power of the engine is expressed as a percentage of 100,000 pounds, so that an engine having a tractive power of 30,000 pounds is called a 30-per-cent engine, the tractive power being calculated at 85 per cent of the boiler pressure. The use of such a unit is valuable in including in the cost of maintenance a factor that varies with the increasing size and cost of power, and, consequently, presents that cost with closer reference to the service rendered.

The report is signed by:—H. H. Vaughan (Can. Pac.), Chairman; W. C. A. Henry (Penn. Lines), M. J. McCarthy (C. C. C. & St. L.), Le Grand Parish and G. W. Seidel (C. R. I. & P.).

C. A. Seley (C. R. I. & P.) presented the following report for the committee on resolutions: "Whereas, The forty-third convention of this association has fully maintained the record for increased attendance and interest at all the meetings as compared to those of former years, successful as they have been; and as it is desired to place on record the appreciation of the association of all who have contributed to the work which has produced these results:

"Be it therefore

"Resolved, That the appreciative thanks of the association be extended to the President for his able address to the officers of the association, especially the Secretary, for duties well done in handling the many details in connection with our convention and various committee meetings; to the committees and authors of papers and reports contributed to this convention; to the committee of arrangement for its effective service in making such complete plans for the meetings; to the railways for courtesies extended; and to the hotel and business men of Atlantic City for their hospitality; to the Railway Supply Manufacturers' Association for the most complete exhibition of railway appliances ever shown; and to the technical press for daily record of all the features of the conventions.

B. R. MacBain (L. S. & M. S.): Some question has arisen in the minds of motive power men in certain parts of the country as regards the standard contour for steel tires for locomotive and cars. Some action ought to be taken on that matter at this time. There is considerable doubt as to the advisability of going to a one-inch flange on a locomotive, especially on the engine and tender trucks.

A motion was carried that the matter be left in the hands of the executive committee.

Election of Officers.

The following officers were elected:

President, C. E. Fuller, Union Pacific.

First vice-president, H. T. Bentley, Chicago & Northwestern.

Second vice-president, D. F. Crawford, Pennsylvania Lines.

Third Vice-president, T. Rumney, Erie.

Treasurer, Dr. Angus Sinclair.

Executive Committee members, T. H. Curtis (L. & N.), F. F. Gaines (Cen. of Ga.), and G. W. Wildin (N. Y., N. H. & H.)

Mr. Sinclair: During the lull, when nothing else is occupying the attention of the association, I wish to make a sort of complimentary motion. I have attended the Master Mechanics' convention 27 times, and in that period I have seen a good deal of difference in the way the meetings have been managed—the facility with which the business is attended to depends very greatly upon how the president performs his duties. I make no reflections upon any man who ever presided over these deliberations, but there are giants among men, and I wish to say that in all my experience I have never seen the york done so properly as it has been done by our retiring president, Mr. Wildin, and I move that we give him a vote of thanks on that account.

The motion was unanimously carried by a rising vote.

On the motion of the secretary the privileges of the floor were extended to George A. Post, who made a speech of presentation and gave to Mr. Wildin the badge that had been voted him.

Adjourned.

What Comprises Good Insulation.

BY LEWIS G. MARTIN.

To a close observer it has always been remarkable that electrical lines of communication perform the work required of them as well as they do. In the first place, only a comparatively short time ago little or no importance seemed to be attached to real insulation, judging by the way wires were run, tapped and connected up, and, in fact, there are only too many instances where like conditions prevail today, although there appears to be a genuine desire for improvement among those who have "looked and seen."

The strangest part is that all electrical men know that to give good service wires must be well insulated, and will demand good insulators if they are purchasing bare or weatherproof wire, and reliable insulation whether paper, varnished cambric, fibre or rubber, if the wires are to be used for interior or underground purposes, and yet how few really take the trouble to determine whether they receive what they actually demand, or to put it another way, how often is the material properly and adequately tested before and after being put into service?

It is all very well to depend upon the honesty and reliability of the manufacturer, and it is comforting to know that there are those who can be absolutely depended upon for delivering what is required and promised, but it is a fact, nevertheless, that these latter are very few compared with those who, in their endeavor to secure patronage at ruinous prices, are willing to take every advantage of the knowledge that no tests will be made on the completed material.

What is the result? Insulators of all kinds that do not properly and lastingly insulate; that is, to anything like the extent the purchaser is led to believe they do. In no case is this more true, perhaps, than in rubber insulated wires, in the insulation of which rubber is the vital ingredient.

Beginning with the so-called code wire we have a product in the covering of which there is the most minute quantity of rubber, and that of the very lowest grade procurable, and in one well known instance absolutely no rubber of any kind in the insulation at all. The next in line is the intermediate and allied grades which contain a slightly greater percentage of the same kind of apology for rubber, in some cases possibly mixed with a small amount of a better grade, or even fine Para; and, finally, there is the 30 per cent fine Para rubber insulation, than which, for durability and reliability, there is no superior.

While the two former classes are suitable for certain kinds of work (on the principle that there is a use for evertyhing) where no risk to life and property is involved, the same interest does not attach to them as to the last mentioned, because they are usually sold for what they really are; but it is different where there is risk to life and property, because it is in such cases the very best of insulated wire should be used.

The best being that of which the insulation is composed of 30 per cent of fine Para rubber, the question as to the means of distinguishing such an insulation from those inferior to it at once arises. Let us see what means there are.

The first and most important thing to be determined is whether the correct amount of the right quality of rubber has been used, and this can be decided by a combination of tests of importance in the order named:

1. Chemical.
2. Mechanical.
3. Electrical resistance.

1. The compound on chemical analysis should show a percentage of resinous extract not greater than hereafter referred to; not more than from 3 to 4 per cent of solid waxy hydrocarbons; not more than .75 per cent of free and a total of 2.75 per cent of sulphur in any form, and should have a specific gravity of not less than 1.75.

2. The compound should stretch well with a moderate "set" and have a high tensile strength.

2. It should have a high electrical resistance, or, as it is more commonly called, high megohms.

If the above conditions are all met there is every practical assurance that the compound is a 30 per cent fine Para rubber.

Now, as to the meaning of these conditions:

Chemical Test.

Pure fine Para rubber contains from 1.5 to 3.5 per cent of resinous matter which slightly increases on vulcanization, so that if a 30 per cent compound shows on analysis not over 30 per cent of the maximum as above of resinous extract, it is reasonably certain that fine Para rubber of best quality has been used.

The limiting of the percentage of solid waxy hydrocarbons is an important feature as preventing the overloading of the compound with large quantities of bulky material which very markedly reduces its tensile strength and electrical efficiency.

The small percentage of free sulphur permissible is on account of its destructive effect (if present in any great quantity) on the copper wire, should the tin or other protective covering become detached from the wire, and the total amount of sulphur allowed is confined to the amount actually necessary to properly vulcanize the compound, which also has a direct bearing on the possible amount of free sulphur.

The high specific gravity is important as ensuring a proper ratio by volume of rubber to filler, a necessary condition of a high grade rubber insulation.

Mechanical Test.

Practically determines the amount and quality of rubber, and decidedly whether properly vulcanized or not. If under-vulcanized the sample will take up an excessive permanent set, while if over-vulcanized it will fail to meet the maximum stretch and tensile test. A fair mechanical test for a 30 per cent fine Para rubber compound is as follows:

Take a sample of the vulcanized insulation four inches, or longer, in length, and place marks on it two inches apart; then stretch it until the marks are six inches apart and immediately release it; then stretch again and breakage should not take place until the marks are at least ten inches apart. The tensile strength should be not less than 1,000 pounds per square inch. Such tests should be made at a temperature of 50 degrees Fahrenheit or above.

Electrical Tests.

A 30 per cent fine Para rubber insulation should give high megohms. This is amply borne out by actual test and is proved by the figures obtained from the grade of wires previously referred to in this article. For a given size and thickness of wall of insulation the results are substantially as follows:

Code wire .... 150 megohms per mile

Intermediate .... 500 megohms per mile
30 per cent of rubber...................... 1600 megohms per mile
30 per cent fine Para.................... 3000 megohms per mile

It is often remarked by the manufacturer of the cheap grade of wire, and even by some who claim to be making a 30 per cent fine Para rubber insulation, that high megohms do not indicate the quantity and quality of the rubber employed. An unanswerable reply to this is that in the comparatively few cases, such as for submarine cables, or where extraordinary flexibility is required and 40 per cent of fine Para rubber is asked for, the megohms demanded are usually twice as high as those for a 30 per cent compound. Another argument frequently heard is that on account of the improved methods of extracting the resins from the raw rubber any kind of rubber can be used in the compound and be equally as suitable as, and defy detection from, the genuine Para.

Apart from the fact that this is not true, and that it is only another means of throwing dust in the eyes of the prospective buyer, it is worthy of notice only in that it is an acknowledgment by inference of the deceptive practices adopted by those putting forward the argument.

In this connection it is not out of place to mention still another fallacious argument used, and that is that the compound is improved by the addition of reclaimed rubber or rubber substitutes, or both. Of reclaimed rubber, Weber says, "The extracted rubber will now be found to have lost almost all its plasticity, elasticity and tensile strength, and to consist of a more or less cohering aggregate of crumbs of vulcanized rubber possessing neither plasticity nor tensile strength; and of fatty substitutes, they reduce the quality of an India rubber article exactly in proportion in which they are present in the article, and the justification of their use lies purely in the popular demand for cheapness."

This seems pretty conclusive evidence of the ruinous effect of the introduction of such material, apart from the knowledge gained in actual experience that the use of inferior grades, or a mixture of inferior and good grades of rubber, or of rubber substitutes, lessens the life of the compound in proportion to the amount introduced.

Having outlined a means of determining high grade rubber insulation it only remains to add that the most important thing of all, after having drawn up rigid specifications on the lines suggested, is to see that the tests are all made and complied with in every particular.

Personals.

W. R. Wood has been appointed engineer of tests on the Great Northern with office at St. Paul, Minn.

J. H. Nash, master mechanic of the Illinois Central at Paducah, has been transferred to Chicago, and made superintendent of the Burnside shops.

J. F. Walker succeeds J. H. Nash as master mechanic of the Illinois Central, at Paducah, Ky.

F. G. Colwell, acting superintendent of Burnside shops of the Illinois Central has been transferred to East St. Louis, as master mechanic of that division.

E. J. Searles has been made assistant to the general superintendent of motive power of the Baltimore & Ohio.

S. B. Smith succeeds L. Bragassa as master mechanic of the Charlotte Harbor & Northern with office at Arcadia, Fla.

M. Flannagan has been appointed master mechanic of the Chesapeake & Ohio with office at Richmond, Va.

Geo. S. Goodwin has been appointed assistant mechanical engineer of the Chicago, Rock Island & Pacific, with office at Silvis, Ill.

J. Q. Kiler succeeds F. L. Regan as a master mechanic of the Kansas City Southern, with office at Shreveport, La.

Wm. Owens has been appointed general air brake and fuel inspector of the Lehigh Valley, with office at So. Bethlehem, Pa.

O. P. Reese succeeds T. R. Cools as assistant engineer of motive power of the Pennsylvania, Northwest System, with office at Ft. Wayne, Ind.

Among the Manufacturers.

NEW LITERATURE.

SELF-TAUGHT MECHANICAL DRAWING AND ELEMENTARY MACHINE DESIGN. By F. L. Sylvester, with additions by Erik Oberg; 330 pages, cloth, 5x7½ inches; published by Norman W. Henley Publishing Co., New York.

For the student who wishes to take up the subject of mechanical drawing and whose theoretical knowledge is limited, this book should prove a valuable help, being written and illustrated in a manner which is plainly understandable. Opening with a chapter on the necessary instruments and materials, the writer follows it with chapters on projection, working drawings, formulas and elements of mechanics, leading up to chapters on the design of cams, gearing, shafts, pulleys and fly wheels. The book is well supplied with illustrations and should prove of value to the practical man and student.

* * *

THE GIRL AND THE MOTOR. By Hilda Ward; 111 pages, cloth, 4½x6½; published by the Gas Engine Publishing Co., Cincinnati, Ohio.

The interesting story of a girl's experiences with gasoline engines as applied to a motor boat and to two automobiles. The book is instructive, particularly to the novice in the operation of machinery and the untechnical person. Miss Ward follows the efforts of her "heroine" to obtain the mastery of her engines from the original purchase of a small power boat to final success in the care of the machinery of a powerful automobile. The work is original in conception and very interesting throughout.

THE MAHIN ADVERTISING DATA BOOK. 494 pages, leather; vest pocket size; published by the Mahin Advertising Co., 125 Monroe St., Chicago.

This little book is replete with information for those concerned with the science of advertising. It gives data as to the circulation of advertising mediums, their closing dates, fields, etc. It is useful for reference in the selection of type for advertisements, in the reproduction of photographs and drawings. Briefly, the book is a valuable instructor for all who would learn of advertising.

* * *

Practical gas analysis will do much to increase the efficiency of boilers. The Carb-Ox Company, of Chicago, in a recent booklet, show a number of instruments for doing this work which are portable and adapted for practical work.

* * *

The latest catalog (No. 6) of the American Nut & Bolt Fastener Co., of Pittsburg, Pa., gives a complete list of the sizes and prices of the various styles of Bartley fasteners.

* * *

Burton W. Mudge & Co., of Chicago, has issued a neat little folder descriptive of the Garland ventilator now being handled by this firm.

* * *

The Ohio Grease Lubricant Co., of Loudonvile, Ohio, has issued a booklet which takes up, step by step, the reasons why Ohio grease lubricators are superior to oil lubricators.

W. S. Avis, Pres., St. Louis Surfacer & Paint Co.

H. C. Avis, Sec. & Treas., St. Louis Surfacer & Paint Co.

C. E. Koons, Gen. Mgr., St. Louis Surfacer & Paint Co.

A. D. McAdam, V. P., St. Louis Surfacer & Paint Co.

C. C. Castle, Mgr. Sales, St. Louis Surfacer & Paint Co.

F. C. Dunham, Special Sales Agt., St. Louis Surfacer & Paint Co.

C. W. Rhoades, Special Sales Agt., St. Louis Surfacer & Paint Co.

H. N. Turner, Mgr. Sales, St. Louis Surfacer & Paint Co.

B. A. Hegerman, Jr., Pres., U. S. Metal & Mfg. Co.

The Komo steam trap, manufactured by the Linton Machine Co., of New York, is somewhat different in construction from the ordinary trap. It is fully described in a booklet recently issued.

* * *

The H. W. Johns-Manville Co., of New York, has published a catalog of J-M fibre conduits which sets forth the advantages of this type of conduit, among which are strength in the body and at the joints, and a smooth bore.

* * *

Bulletin 390 of the National Brake & Electric Co., of Milwaukee, Wis., takes up three types of governors for the electric car air compressor, namely, the oil-pneumatic, the diaphragm and valve-pneumatic.

* * *

Pneumatic geared hoists, cranes, winches and tractors are well described and illustrated in booklet recently issued by the Detroit Hoist & Machine Co., of Detroit, Mich.

* * *

The Jones Positive Nut Lock Co., of Chicago, has issued an attractive booklet showing the many applications and uses of the Jones nut lock.

* * *

The Railway Materials Co., of Chicago, has issued a very neat and well gotten up catalog of eighty pages showing the many different types and styles of Ferguson oil furnaces for flue welding, riveting, forging, case-hardening and annealing. The descriptive matter is easy to read, concise and to the point.

New York Office, St. Louis Surfacer & Paint Co., B. A. Hegerman at Desk.

* * *

The American Well Works, of Aurora, Ill., in bulletin 115, gives complete information, both in general and detail, regarding the "American" air compressor, together with other information of value to one interested in the use of air. The line of air compressors shown is very complete.

* * *

The advantages of the Tate flexible staybolt for locomotive boilers, together with many large clear illustrations showing the various types with their dimensions, are given in a recent publication of the Flannery Bolt Co., of Pittsburg, Pa.

* * *

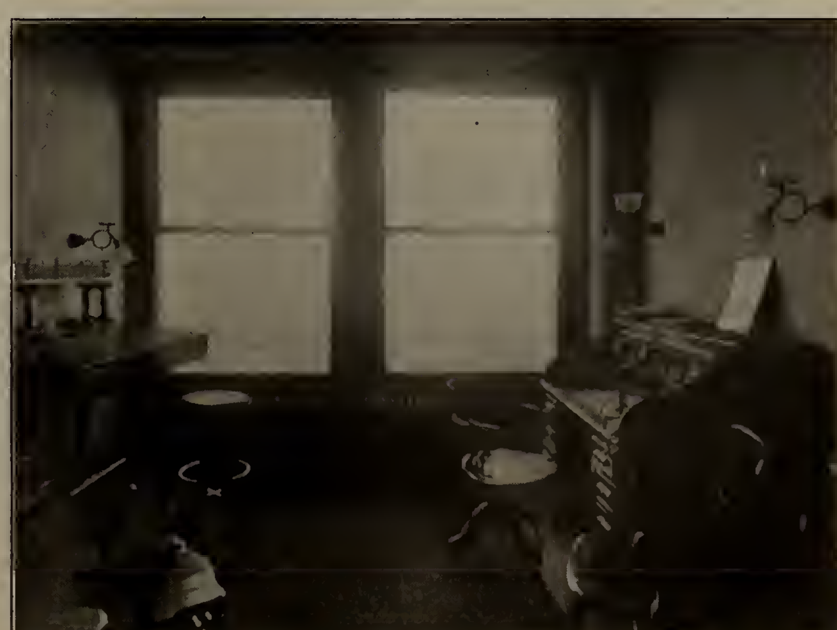
The 1910 catalog of electric fixtures recently published by the Safety Car Heating & Lighting Co., of New York, is a handsome book of some eighty-five pages and is filled with illustrations of a great variety of lighting fixtures. It is printed on enameled paper and shows that no pains have been spared to make it attractive and valuable.

PAINT SPECIALTIES.

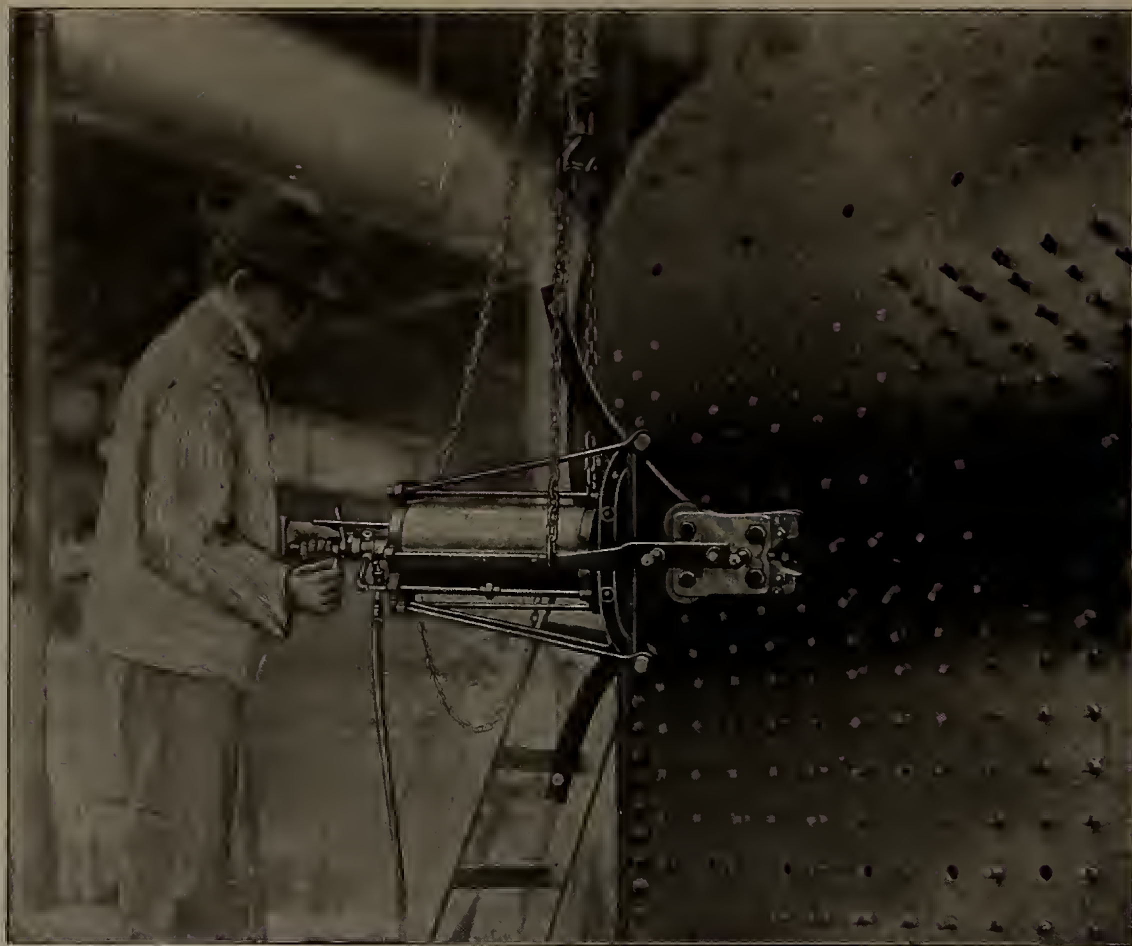
The St. Louis Surfacer & Paint Company, incorporated September 19, 1903, with W. S. Avis as president, H. C. Avis, secretary and treasurer, and C. E. Koons, general manager, started a new business catering wholly to railways and manufacturing only specialties for railway use.

Present Home of St. Louis Surfacer & Paint Co., St. Louis.

Quality, first and foremost, with a practical knowledge of the real needs of the railway paint world enabled the St. Louis Surfacer & Paint Co. to forge rapidly to the front as a manufacturer of this class of paint. Considering its humble beginning in two small rooms, the growth of this firm has been surprising in the few years of its existence, and can only be attributed to the determined stand at the start to furnish nothing but the best, and to give full value for the price. The result has been the confidence of railroad officials in the quality of the St. Louis Surfacer & Paint Co.'s products. Its reputation for strictly following specifications when furnished is beyond reproach, and as to the durability of its own specialties, it fears no competitor and claim a quality second to none. The improved quality of regular lines has always placed the products of this company at the top, and all it asks in the way of new business is a comparative test. The specialties of the firm are fully and satisfactorily meeting the demands of the railroad steel equipment for durability, for both passenger and freight cars, also structural and steel bridge work. The St. Louis Surfacer & Paint Co.'s "Metalsteel" Paint is one of the first special paints put forth for this class of work, and wherever it has been tried and tested it has proven its merits above the common run of paint products. Years of practical ex-



Chicago Office, St. Louis Surfacer & Paint Co.



Helwig Pneumatic Staybolt Clipper.

perience by the heads of this company with the largest manufacturing interests in car building have well fitted them for their work in placing on the market specialties for the protection of railway equipment.

BABBITT METAL.

When we consider how important a factor babbitt metal has become in relation to all mechanical matters, it is surprising that only seventy years have elapsed since it came into existence.

In 1839, when Isaac Babbitt secured a patent for lining journal boxes, he little thought that he should become famous for all time through recommending the use of "Britannia Metal" as a lining for his boxes, and that his patent should have practically been lost sight of, although he was presented with a gold medal by the State of Massachusetts and Congress voted him $20,000.

Mr. Babbitt was born at Taunton, Mass., June 26, 1799, and died in 1862. He was a goldsmith by trade and is said to have been the first manufacturer of Britannia ware in the United States, which accounts for his having recommended the use of that metal as a lining for his boxes. In later years he manufactured Babbitt metal and soap.—American Marine Engineer.

HELWIG PNEUMATIC STAYBOLT CLIPPER.

In boiler shops where there are staybolts to cut off, the Helwig pneumatic staybolt clipper here shown, is a complete and very satisfactory machine for this purpose. This machine cuts off the staybolts square without any jar or injury to the sheet or thread, leaves the bolt as tight in the sheet as when first put in, and leaves the cut the desired length ready for riveting. It can be handled very rapidly from one bolt to another, and will cut as fast as a man handles the machine. It is said that one helper and a boy can cut off staybolts at the rate of 780 an hour. Any length staybolt may be cut as it cuts from the side; this also enables operator to see what he is doing.

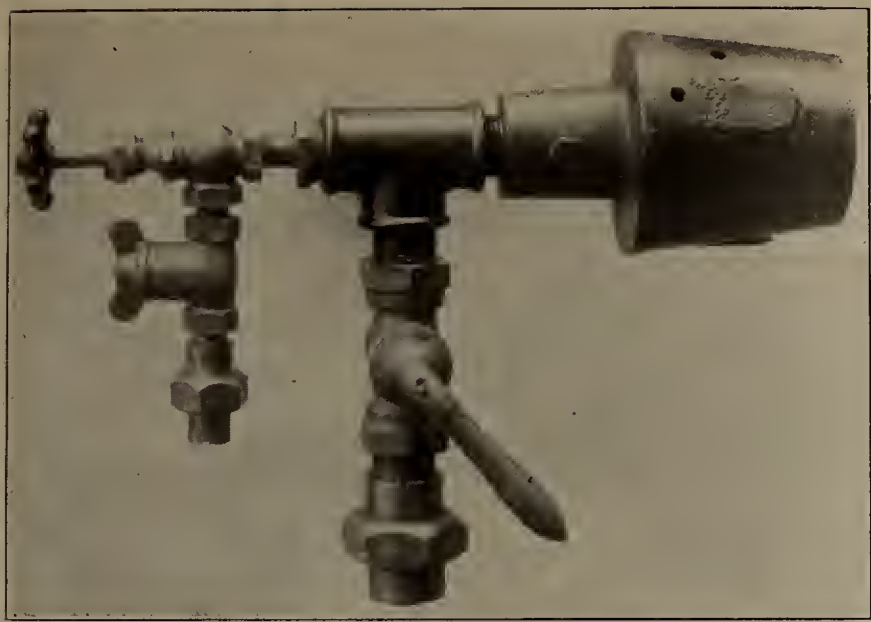
The machine has small inserted knives which, when worn, may be replaced at little cost. One pair of these small knives will cut from 16,000 to 20,000 bolts. It is suspended from a light boiler crane, permitting operator to move it above very rapidly from one bolt to another.

Two sizes are manufactured: No. A, designed for cutting 1½ inch bolts and less, weighs 210 lbs.; No. B cuts 1¼-inch bolts and less and weighs 170 lbs. It is made by the Helwig Mfg. Co., of St. Paul, Minn.

KEROSENE TORCHES.

As is known, gasolene, which is a light grade of petroleum, is inflammable to a high degree and great caution has to be exercised in using it for either industrial or domestic purposes, but owing to its ability to give a strong flame, as also to the fact that heretofore no torch consuming kerosene has been so constructed as to give satisfactory service, gasolene torches have been used almost exclusively for brazing, tinning, melting work, etc. The introduction of the Hauck kerosene torch, however, has rapidly changed this condition. Its efficient, reliable and time saving work, its absolute safety, the economy it affords, owing to the fact that kerosene is cheaper than gasolene, the ease and success with which this torch can be operated, its superior make, strength and dura-

Hauck Combination Coppersmiths' Brazing Forge.



Hauck Low Pressure Furnace Burner.

Hauck Kerosene Torch in Operation.

bility, are features which have gained for kerosene torches an immediate popularity and a rapidly increasing demand. Kerosene is refined petroleum, being the principal product of the distillation of petroleum, and scientists recognize its superiority over gasolene, especially for lines of work as here mentioned, but it was not until the invention of the kerosene torch that a burner was produced which would give a full and ever uniform force of flame, and at the same time admit of the torch tank remaining cool enough to handle. Kerosene as consumed by these model torches, gives, in every way, better service and results than can be obtained by using gasolene, as has been clearly demonstrated in all shops and establishments now using them.

These torches are a product of the Hauck Manufacturing Co., main office and plant at Richards street and Hamilton avenue, Brooklyn, N. Y. In inventing and introducing the Hauck kerosene torches, these people have but added another valuable product to their entire line of well known and extensively used goods.

ALL-STEEL INDEPENDENT CHUCK.

Particularly with reference to the special demands of the railroad machine shops, the Union Manufacturing Co., of New Britain, Conn., has produced an all-steel independent chuck as shown in the accompanying illustration. This chuck has a body of cast steel of over 70,000 lbs. tensile strength and is designed to give strength and durability. The operating parts are all heavy and with strong bearings. The jaws are of extra width, and the screws which operate the jaws are extra large. These chucks cannot be broken in ordinary use. For all kinds of heavy work they will give especial satisfaction. The line is made from 8 in. to 36 in. inclusive, which gives a sufficient range of sizes for different makes of lathes.

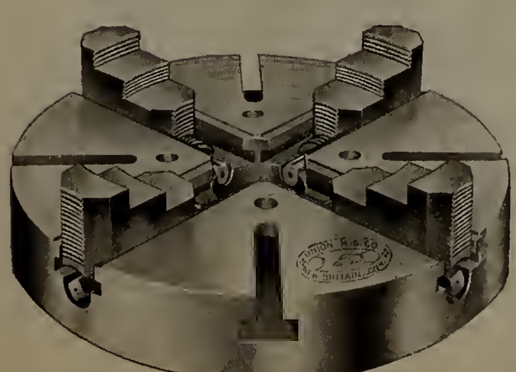
SAFETY CIRCULAR CUTTER-HEAD.

The Fay & Egan Co., 145-165 Front St., Cincinnati, Ohio, has recently issued a catalog (No. 81) devoted to the description of a new cutter-head illustrated herewith. This cutter head is designed with the idea of preventing accidents heretofore so common with the car jointer. The opening between the tables is so nearly closed that the hand of the operator can not slip between the knives.

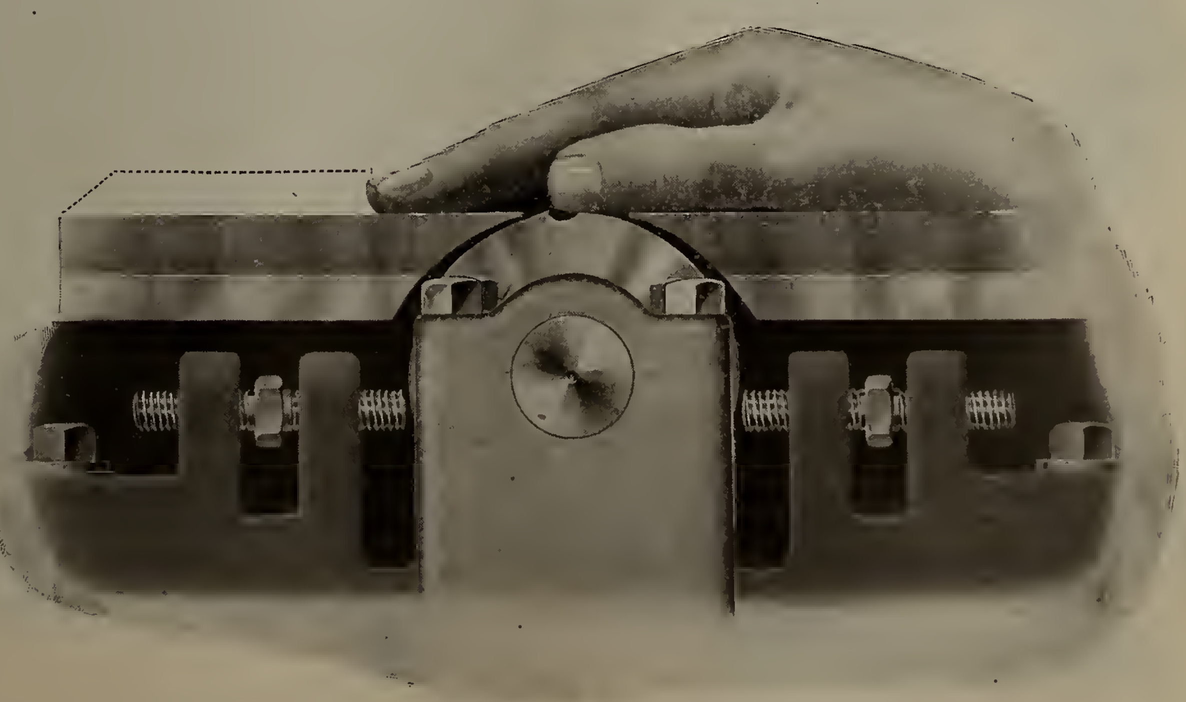
The idea will be appreciated by car shop men who are familiar with the dangers incident to the operation of this class of machinery.

VARNISH FOR RAILWAY CARS.

While the comforts and conveniences of the traveling public are provided for and catered to in a manner suggestive of a luxuriously appointed home, the feature that appeals immediately to the aesthetic eye is the exquisite appearance of the woodwork. While it is true that the choicest of woods are used, carefully selected for perfection of grain and markings, but few people give thought to the manner in which the natural beauties of the wood are preserved. Natural woods possess a latent beauty only, and are like precious stones that require treatment at the hands



Union All-Steel Chuck.



Fay & Egan New Safety Cutter Head.

of the lapidist before their beauties become manifest. The magician that gives life to the dormant charms of natural woods and fills us with admiration at the wonderful revelations of nature's handiwork is varnish. Everyone knows this, but few people realize that if varnish did not exist the modern railway coach would be robbed of its most attractive feature.

The importance of varnish in the artistic treatment of woods, and the unusual demands on the durability of a varnish for railway coaches has led to the introduction of varnishes especially adapted for this purpose. Prominent among those who make special varnishes for railway use is the firm of Berry Brothers, Limited, of Detroit, which has been manufacturing varnishes for over half a century. Berry Brothers' varnishes are widely used in railway shops and their popularity is based on their intrinsic merit, since master painters are intelligent and discriminating consumers. Berry Brothers were well represented at the conventions, where their exhibit was a center of interest.

PORTABLE CLOCK FOR SHOP WATCHMEN.

It has been conceded that the ideal way of keeping track of the movements of a watchman is by the use of a portable clock system, but there has been a crying need for a number of years for a system allowing the use of practically an unlimited number of stations with one clock. Heretofore, owing to the fact that the female die has been in the clock and the male die on the key, each clock was limited to just a few stations. However, Hardinge Brothers of Chicago, in their new Beyer patrol portable clock have overcome this difficulty by using a different principle in portable clock systems. The clock itself contains only the movement, the detective lock and the guide for the key, with no other mechanism. Each key contains its own male and female die and recording mechanism, thus each key is a unit in itself, making it possible to use any number of keys with a single clock from 1 to 100.

No two sets of keys produce the same record on the paper dial, thus there are no duplicate sets obtainable. This is accomplished by using a combination of letters instead of a stock set of figures as in other systems. The movement is made interchangeable so that a new one can be substituted for the old one when the latter requires cleaning. Figure 1 shows the clock closed and ready for service. Figure 2 is a patrol clock station showing the key in position.

AN INTERESTING BOLT HEATING FORGE.

In the accompanying illustration is shown a new oil bolt heating forge made by the Monarch Engineering & Mfg. Co., of Baltimore, Md.

In the design of this forge numerous disadvantages of older types have been eliminated. Among the improvements is noted the following: A method of joining all plates with outside flanges, thus avoiding the cutting of fire brick. By the arrangement of the special brick within the lower chill, these brick cannot become disarranged while forge is in operation, also that these brick can be readily replaced without interfering with other parts of forge. The top or arch is so devised as to act as a retainer for the brick forming the arch over the heating space, and at the same time acts as a protector for the operator. It is not required to construct any extra curtain for protection as is now the case with others. This top is also adjustable making it possible to obtain any desired length of heat up to capacity of furnace. Being adjustable in either direction it is possible to heat any diameter iron desired, by simply raising or lowering this top to height required for entrance of blanks and adjusting pin to keep same in required position. Also this top being water chilled prolongs the life of brick used in same. Blanks as short as ½ inch in length can be heated and withdrawn as rapidly as those of a longer length, this being made possible by the beveled arrangement of this top. By the device of grooves, the blanks can be inserted and kept apart, thus should the operator through some mishap neglect to withdraw the blanks before they become overheated they will not stick together. Shorter tongs can be used than heretofore, thus helping in rapid production of work.

INDUSTRIAL NOTES.

At the recent convention held at Atlantic City the Ford & Johnson display of car seats and parlor and buffet chairs attracted a great deal of attention and favorable criticism. These seats are now in service on many railroads of the

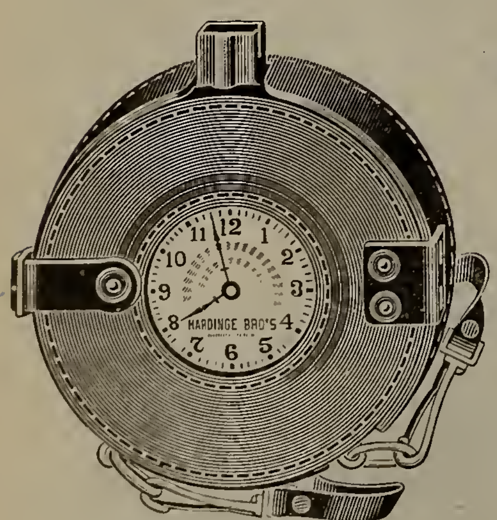


Fig. 1.—Portable Clock.

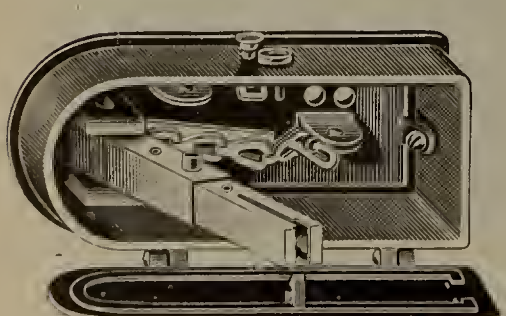


Fig. 2.—Clock Station.

Monarch Oil Bolt Forge.

country and are giving universal satisfaction. The Ford & Johnson Co.'s facilities for manufacturing car seats and making prompt deliveries are unusual, owing to the fact that its large factories at Michigan City, Ind., are fully equipped with the latest type of machinery for doing this class of work.

Adreon Manufacturing Co., St. Louis and Chicago, reports that its specialties are in the specifications for the following locomotives recently awarded by prominent lines: American Gravity Couplings; 65 Missouri, Kansas & Texas Ry. locomotives, 47 St. Louis & San Francisco Ry. locomotives, 29 Atlantic Coast Line R. R. locomotives, 20 Chicago & Northwestern R. R. locomotives, 16 St. Louis Southwestern Ry. locomotives. Campbell Graphite Lublicating System; 65 Missouri, Kansas & Texas Ry. locomotives, 80 Chicago & Northwestern R. R. locomotives, 47 St. Louis & San Francisco R. R. locomotives, 18 Northern Pacific Ry. locomotives.

At the election of officers of the Crocker-Wheeler Company, Ampere, N. J., the following were elected for the ensuing year: President, Schuyler Skaats Wheeler; first vice-president, Gano Dunn; third vice-president, Arthur L. Doremus; chief engineer, Gano Dunn; secretary, Rodman Gilder, and treasurer, W. L. Brownell.

The C. W. Hunt Company, New York, builder of coal handling, conveying and hoisting machinery, has opened offices at the State Bank building, Richmond, Va., and also 607 Rhodes building, Atlanta, Ga., with Mr. W. F. Lee, for several years preliminary engineer to the company, in supervision.

William L. Austin has been made president of the Baldwin Locomotive Works, succeeding John H. Converse, deceased. Mr. Austin has been chief draftsman of the company.

The Asbestos Protected Metal Co., Canton, Mass., has recently opened an office at 100 Broadway, New York. P. M. Stewart, formerly building commissioner of New York, is resident manager.

Mr. C. T. Anderson has been appointed manager of the Chicago office, 1616 Fisher building, of the C. W. Hunt Company, New York, builders of coal handling, conveying and hoisting machinery.

The Northern Engineering Works, Detroit, Mich., crane builders, reports that it has recently installed, in the power stations of the Tunnel & Terminal Ry. Co., New York, two 25-ton, 40-ft. span traveling Northern cranes, and also one of 10 tons capacity.

Announcement is made that a combination of German and American capital has been brought together for the building of a Balata belting factory in the United States. Though hundreds of thousands of feet of Balata belting are in service for transmission purposes in the United States at the present time, not one foot of this kind of belting is manufactured in America. All of it is put together in factories in Germany or England and imported here. The announcement, therefore, that a syndicate has been formed to introduce this new manufacturing interest into the United States will be of considerable interest to manufacturers generally and especially to those who at the present time are using large quantities of this kind of belting. The corporation behind the new enterprise is known as the Victor-Balata and Textile Belting Company. The American interests represented in the new company are Charles E. Aaron and John R. Stein, president and treasurer, respectively of the New York Leather Belting Co. of New York City. The German interests are represented in the new company by William Vollrath, Albert Vollrath and Edwin Vollrath of the firm of C. Vollrath & Sohn of Blankenburgh, Germany. The latter company is the largest of the textile belting manufacturers of the European continent, and the former company were pioneers in first introducing Balata belting upon the American market. The officers of the new combine are Charles E. Aaron of New York, president; Edwin Vollrath of Blankenburgh, Germany, secretary, and John R. Stein, New York, treasurer. The building of the new plant will entail an expenditure of half a million dollars in buildings and equipment, and will be located at Easton, Pa. Work on the first two buildings of the new plant will be begun immediately.

Frederick W. Sivyer, president of the Northwestern Malleable Iron Co., Milwaukee, Wis., and vice-president of the Chain Belt Co., died on June 11 at his home in Milwaukee. Mr. Sivyer was born in Milwaukee on June 18, 1848, and began making his own living at the age of 14 years. In 1873 he entered the iron business, and after being connected with several prominent concerns, in 1882 he founded the Northwestern Malleable Iron Company. He took a great interest in the trade school movement and has done much for the welfare of Milwaukee's young men.

The works of the International Car Co., in Jefferson parish, La., on the Metairie road, will be sold July 12 by court order. The site is 539x3,500 feet, and a valuation of $70,000 has been placed upon the works, tracks, etc.

GUSTAV WIEDEKE,
Pres.

OTTO WIEDEKE,
Gen. Supt.

Officials of Gustav Wiedeke & Co., Tube Expander Manufacturers, Dayton, Ohio.

Railway Mechanical Patents Issued During June.

Nut-lock, 957,931—Henry J. Bond, Pittsburg, Pa.

Brake-beam, 958,060—Henry Ziemss, Jr., Chicago, Ill.

Car journal, sponging shield and oil saver, 958,135—Louis E. Keller, Oil City, Pa.

Sliding grain-door for cars, 958,140—Frank C. Lakin, Manchester, Ill.

Brake-valve, 958,176—William K. Rankin, Philadelphia, Pa.

Car coupling operating device, 958,361—Samuel P. Bush, Columbus, Ohio.

Truck construction for cars, 958,362—Samuel P. Bush, Columbus, Ohio.

Car wheel jack stand, 958,364—De Forrest Champeon, Houlton, Me.

Distance spacing device for freight cars, 958,368—Thomas Conley, Pittsburg, Pa.

Spliced side gondola car, 958,426—Spencer Otis, Chicago, Ill.

Hose coupling lock, 958,437 and 958,438—Henry M. Robertson, St. Paul, Minn.

Side frame for car trucks, 958,462—James H. Baker, Pittsburg, Pa.

Truck side frame, 958,474—Albert O. Buckius, Jr., Chicago, Ill.

Stand pipe for railway water supply, 958,504—Patrick H. Knight, St. Joseph, Mo.

Articulated compound locomotive, 958,516—Carl J. Mellin and Joshua J. Jones, Schenectady, N. Y.

Adjuster for locomotive headlights, 958,522—Olan B. McCoy, Fort Worth, Tex.

Truck side frame, 958,541—Edward M. Richardson, Chicago, Ill.

Convertible box-car, 958,575—John A. Ansley, Thessalon, Ontario, Canada.

Door operating mechanism for dump cars, 959,459—William A. Caswell, Chicago, Ill.

Adjustable brake head, 959,466—Frederick R. Cornwall, St. Louis Mo.

Car door operator, 959,523—Phillip T. Handiges, Cleveland, Ohio.

Forged steel fulcrum for trussed type of brake beams, 959,-524—Phillip T. Handiges, Cleveland, Ohio.

Brake head and shoe, 959,542—Benjamin F. Hysell and Robert M. Cavedo, Middleport, Ohio.

Adjustable brake head, 959,600—Lemuel Porter and Charles H. Williams, Jr., Chicago, Ill.

Smoke conveying attachment for railway trains, 959,777—Allen May, Philadelphia, Pa.

Engineer's valve, 959,798, 959,799 and 959,802—William A. Pendry, Detroit, Mich.

Triple valve, 959,800 and 959,801—William A. Pendry, Detroit, Mich.

Tank car, 959,817—Victor M. Summa, St. Louis, Mo.

Mechanism for operating car steps and doors, 959,873—James F. McElroy, Albany, N. Y.

Headlight, adjustable, for curves, 959,920—Alfred S. Churton, Chicago, Ill.

Draft Rigging, 960,255—William P. Bettendorf, Davenport, Iowa.

Electropneumatic air brake system, 960,361—George Macloskie, Schenectady, N. Y.

Suspension for train lighting dynamos, 960,368—Joseph A. Misland, Bayonne, N. J.

Nut lock, 960,405—Nathaniel J. Rogers, Tuscaloosa, Ala.

Brake, 960,425—William Judson Smith, St. Paul, Minn.

Car construction, 960,502—James R. Cardwell, Chicago, Ill.

Truck bearing, 960,532—August Franz, Passaic, N. J.

Car coupling, 960,538—Albert P. Goldman, Chillicothe, Ill.

Car coupling, 960,550—Gussie Allen Holland and William Frank Barrett, Woodlawn, Ala.

Trussed bolster, 960,639—Phillip B. Harrison, Chicago, Ill.

Draft gear for railway cars, 960,778—George Barr, La Center, Wash.

Boltless locking body for connecting track rail sections, 960,790—Abner M. Benjamin, Dayton, Ohio.

Adjustable brake head, 960,828—Frederick R. Cornwall, St. Louis Mo.

Locomotive cab window, 960,861—James W. Estes, Syracuse, N. Y.

Angle cock support for air brake systems, 960,889—Myers A. Garrett, Chicago, Ill.

Brake beam, 960,935—Charles F. Huntoon, Chicago, Ill.

Dumping car, 960,949—Ulysses Winfield Keech, Enumclaw, Wash.

Smoke consumer, 961,072—Charles F, Harris, Altoona, Pa.

Skidding device for railway cars, 961,098—Samuel P. Bradshaw, Pittsfield, Mass.

Brake power limiting apparatus, 961,257—Willard G. Ransom, Davenport, Ia.

Car roof, 961,301—Willam F. Kiesel Jr., Altoona, Pa.

Means for operating railway brakes, 961,310—Spencer G. Neal and Joseph M. Childress, Los Angeles, Cal.

Air braking apparatus for railways, 961,320—William H. Shesby and Spencer G. Neal, Los Angeles, Cal.

Brake shoe, 961,344—Frederick H. Gibbs, New York, N. Y.

Adjustable head rod, 961,535—Harry F. Roach, St. Louis, Mo.

Slide valve gear for steam locomotives, 961,613—Aurelijusz Jendrusik, Strzemieszyce, Russia.

Steam and air pipe coupling for cars, 961,638—Richard Benjamin Painton, Williamsport, Pa.

Car wheel, 961,639—John Philip Pastre, Steubenville, Ohio.

Train pipe coupling, 961,699—Robert A. Jewett, Boston, and Arthur L. Greenlaw, Malden, Mass.

HOLY MOSES.

By Egypt's banks, contagious to the Nile,
King Pharaoh's daughter went to bath in style;
She shed her duds, and had a pleasant swim,
Then ran along the shore to dry her skin,
(For towels in them days were not invented,
And with an annual bath were folks contented.)
Disporting 'mong the rushes, thick and thin,
She found the basket which the child lay in.
She drawed the ark and child out from the water—
Inspection showed the kid was not a daughter—
Then to her maids she said in accents mild,
"Which of yez ladies is it owns the child?"
'Tis none of yours, ye all are quick to say;
I doubt your word; I've known yez many a day;
But since he have a nose like Hebrew noses,
Bedad, he shall be christened Holy Moses.

—New York Times.

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It is reported that the Southern Pacific will commence construction, as soon as the deeds for the right of way are filed for record, on a branch from Klamath Falls, Ore., to Alturas, Cal., and the road will be in operation in twenty-two months. The road will not end at Alturas, but will be extended to Reno, Nev. Surveyors are now engaged in locating and correcting the route which has been recently surveyed down the Pitt river to establish a permanent line. The Modoc portion of this line will run for a distance of over sixty miles through Modoc county and will follow the Pitt river from Lookout south to Bieber, Lassen county, Cal.

PIECE WORK AND SHOP COST KEEPING.

As the introduction of piecework becomes more and more comprehensively applied to all departments of shop operation, the problems of cost keeping become more and more complex. Unforeseen difficulties are constantly arising in the most carefully thought out systems. From the fact that many locomotive and car repair shops are running smoothly on the piecework plan, it must be conceded, however, that fairly successful cost keeping systems must be in existence. Acting upon the theory that many shop superintendents and master mechanics are now computing pay rolls by means of systems not quite satisfactory but which could be materially improved by the absorption of details from other systems just as imperfect in the whole, the Railway Master Mechanic will be glad to pay somewhat more than regular space rates for ideas and opinions on this subject. It is suggested that these articles could profitably be made to include aspects of piecework systems aside from those of cost keeping alone. Let those who have ideas come forward and give their contemporaries the benefit of them.

If the attempts of the railway executive and traffic officials to prove the necessity of increased freight rates being no other result, the lesson in accounting given the department heads is a valuable one. Chief clerks all over the country have been delving in statistics, and the work has produced many surprises in the increased cost of labor, maintenance and the like usually underestimated heretofore. In the mechanical department particularly the increased expenditures due to regulatory legislation within the past two years have reached fabulous amounts. The information once dug out can be filed in detail in such a way as to prove very useful in event of enforced retrenchment.

DRINKING FOUNTAINS.

The water faucet is receiving more or less of our attention these days, and it should, for plenty of good pure water is essential to health at all times, and especially during the hot summer months. The reform with respect to drinking cups in public places should be extended to our shops, for here are, unavoidably, more chances for unsanitary conditions than at public fountains; the tin cups are generally found to be rusty and greasy, with often a hole or two. It very often happens that there is no cup at all, and in such cases the water is allowed to run full force all the time and the valve is probably turned so that it directs the stream upward. This not only results in a waste of water, but also causes it to splatter and keep the floor about in a wet condition, which, if the floor be of wood, will soon result in its decay. Of course it is not always possible to have model drinking fountains, but suitable fountains built on the "cupless" or sanitary plan can easily be made from the material at hand. They can be provided with a valve which will automatically cut off the water when no one is drinking, and should also be provided with an overflow at the bottom to take the flow should anyone attempt to squirt water by placing his hand over the fountain. A number of modern shops have refrigerating plants for their drinking water lines which is a feature worthy of commendation, although it is not always necessary. However, enough drinking fountains should be located about a plant so that it will not be necessary that a man walk half the length of the shop in order to obtain a drink.

The International Railway Congress

London, July 12th, 1910.

Editor Railway Master Mechanic: In the Grand Hall of Casino at Berne there assembled on July 4th perhaps the most remarkable gathering of railway men yet seen at any International Railway Congress. Analyzing the list of those present I find 38 governments represented, not counting the delegates from British colonies and possessions. The congress has the official adherence of all recognized governments and of 420 railway administrations, including the whole of the railways of Europe and nearly three-quarters of the railways of the world. General railway interests were represented at the congress by some 1,800 delegates. The railways of the United States committed their interests to the charge of 300 directors and members of operating staffs. Great Britain sent over 150 delegates.

The purpose of the congress is to promote the progress and development of railways, and all railway administrations, whether state or private. A permanent commission, the headquarters of which are at Brussels, carries on the business of the association and it is this commission which prepares the programme of questions for discussion at each congress. The plan adopted is to select a list of subjects, to appoint reporters in the various countries interested, to collect information in the form of answers to a series of questions, and to lay the report before the congress for discussion. It follows that the reports embody not merely the individual views of the writers, but the opinions of railway administrators and engineers in many lands.

The list of subjects down for discussion by the Berne congress indicated the trend of modern railway development. To facilitate the work the congress was divided into five sections—Ways and Works, Locomotives and Rolling Stock, Working Arrangements, Light Railways, and General—but this can only be considered a broad classification. In the first section, attention was focused on the voluminous reports which dealt with the strengthening of the track and bridges of railways, an improvement which has been forced on railway managements by the constant increase in the weight and speed of trains. There were no fewer than eleven reports dealing with various aspects of this question. Another interesting series of reports in the same section related to the construction, ventilation and operation of long railway tunnels, including Alpine tunnels, great town tunnels in Great Britain, and submarine tunnels. In section 2 reports on modern aspects of electric traction were down for consideration, and other subjects included high speed locomotives, the use of steel in locomotive and rolling stock construction and improvements in locomotive boilers. Ten reports were presented on this last subject, that dealing with the practice of railways in Great Britain being written by chief mechanical engineer Fowler, of the Midland Railway.

In section 3 statistics were presented with regard to the working costs of rail motor services. Another topic before this section was that of large stations, for both passenger and freight working, and an interesting group of reports dealt with the operation of switches and signals. This is a branch of railway working in which remarkable developments have been recorded during recent years, and the reports are a useful record of experiment and experience in various directions with inventions designed to promote the safety of the traveling public. Among the general matters with which section 4 was concerned first place may be accorded to the reports on railways and waterways. A canal engineer, in the person of Mr. G. R. Jebb, was entrusted with the report for Great Britain, and the report from the United States is by W. E. Hoyt, of the New York Central.

Motor-car services in connection with railways were reported on by J. C. Inglis, the general manager of the Great Western Railway, a company which has more motor-car services in operation than all other British railways combined. The methods now adopted for carrying perishable goods traffic were also discussed, and reference may be made to the excellent report by Mr. J. M. Culp, of the Southern Railway, which deals fully with the practice of American railroads in connection with long hauls of perishable commodities.

The enormous number of reports prevent anything like a comprehensive survey. Chief mention, however, may be made of a few outstanding features. The subject of rail joints has, of course, been specially considered at previous congresses. At the present convention, the reports for English speaking countries were entrusted to Alexander Ross, chief engineer to the British Great Northern Railway, and for other countries to M. Chateau, chief engineer to the Way and Works Department of the French State Railways, and to two other gentlemen. Mr. Ross announced that replies received from ninety companies brought out very clearly the amount of attention which was being given to attempts to reduce the number of rail joints. As far as Great Britain and Ireland were concerned, it would appear that for the near future, at all events, a length of 45 ft. would be regarded as the standard. In the United States the standard length of rail was now 33 ft. while in other English-speaking countries the length of rail used varied from 30 ft. to 40 ft. The suspended form of joint was almost universally employed in Great Britain, but several companies were experimenting with special joints at the present time. In the United States, however, the bridged joint was in common use, and very few companies, indeed, employed supported or suspended joints. The bridger joint was also favored by permanent way engineers in other English-speaking countries. The advantages of a continuous rail were generally recognized, but the answer to the inquiry whether any of the companies interested had any intention of welding rails was in the negative, the general opinion being that the use of long and continuous rails would be unsafe for obvious reasons connected with temperature expansion and contraction. His own view was that much yet remained to be accomplished in the perfection of bridge and other special joints.

Reporting on practice in France, Belgium, Italy, Spain and Portugal, M. Chateau said that the general principles followed favored a considerable increase in the length of rail. The average length of rail in the countries named was 59 ft. and lengths up to 72 ft. 2 in. were employed in some instances. He looked for such an increase in length of the rail, in spite of all the difficulties with regard to expansion, carriage and handling, that the ultimate result would be a profound alteration in the system of joints. This would involve the working out of a good joint without bolts and without friction, and the problem was complicated by the factor of cost. It would also be necessary to adopt means for preventing the fracture of very long rails. The Rench Eastern Company had employed a type of fish joint for Vignoles rails with great satisfaction, and the French Northern Company had experimented with a somewhat similar joint. An ordinary form of suspended joint had been recently introduced on Italian railways, but the twin-sleeper joint was in rather common use in that country. Satisfactory trials of a joint without bolts had been carried out on the Paris Metropolitan. A general tendency was shown to stiffen the joint by placing the joint sleepers closer together. The question of rail curvature was interesting. In service the curvature assumed a nearly uniform character, and this set up shocks at the rail joints. The straightening-out process should be combined with re-cutting the ends of the rails, and if new holes were drilled, and new fish-plates provided, then it would seem that the problem of the worn joint would have been solved.

Practice in Austria-Hungary, Roumania, Servia, Turkey and Egypt revealed a similar tendency to that noted in the case of most other countries to employ longer rails. It was suggested that it would be possible to increase the length up to a maximum of 78 ft. 8 in. if the broken rails could be replaced without hindrance to traffic.

Herr Blum, who reported on all countries not covered in other reports, dealt somewhat fully with German railway practice. Rails of 49 ft. 3 in. were stated to be extensively used in Germany and the Bavarian State Railway and the Dutch State Railway believed lengths of 59 ft. to be admissible. Herr Blum referred to the difficulties of handling and transporting long lengths of rail, confirming what had been said by previous speakers. He also discussed the weight and speed of trains with reference to track problems. With regard to rail joints, most railway administrations had endeavored to strengthen the joint both by strengthening the fish-plate and, when retaining the suspended joint, by reducing the distance between the joint sleepers. Bridge joints had been tried, and on German railways extensive tests had been carried out with different lapped or scarf joints. The Bécherer-Knüttel joint had given satisfactory results on the Prussian Hessian State Railway, even on sections where there was heavy traffic. Crank-flanged fish-plates were being tried on the Alsace-Lorraine lines. The Melaun joint was being tried with fairly satisfactory results at Berlin, and on the Prussian Hessian State Railway. This belonged to the class of bearing fish-plates.

Six reports on the use of steel in locomotive and rolling stock construction came before the meeting. A monumental report was brought up by D. F. Crawford of the Pennsylvania Company, and this was supplemented by one from R. L. Ettinger of the Southern Railway, on the use of special steels of high resistance for locomotive and rolling stock construction. This authority put forward the view, as the result of his inquiries, that the employment of alloy steel for locomotive axles had not resulted in freedom from failure, or in any betterment of the service. Tests were to be carried out with special steels subjected to proper heat treatment after being roled into locomotive tires, and with similarly treated alloy steels for springs, piston-rods and crank pins.

The greater part of Mr. Crawford's report dealt with freight car construction, and, as he pointed out, the growing use of steel for such requirements had served to create a great industry in the United States. In twelve years there had been built by the big undertakings which had embarked in the business 550,000 cars, either all steel or with steel underframes. Open-hearth steel with a tensile strength of from 52,000 pounds to 67,000 pounds per square inch, and with an elongation of from 22 to 29 per cent was employed for the structural shapes and pressed or formed plates of such cars. The phosphorus content was limited to 0.05 per cent. For steel castings a tensile strength of about 70,000 pounds with an elongation of about 15 per cent was specified. The steel car costs more than the wooden car by from 25 to 30 per cent, but the average cost of maintenance was about one-half, being about $30 per car per year for the steel car, and $60 per car per year for the wooden car. Railways in the United States had in recent practice employed steel castings for journal boxes at a cost which compared favorably with malleable iron casting construction. It had also been shown that the use of steel casting side-frames had reduced the initial cost in comparison with trucks of the arch bar type. The forged wheel was favorably regarded by railway engineers, and some hundreds of thousands were now in service. Comparative tests went to show that the solid steel wheel compared favorably with the cost of the cast iron wheel on a mileage basis. In the case of freight cars the center sill construction was designed to resist shocks up to 300,000 pounds, without reaching the elastic limit, while for passenger cars an even higher factor of safety was desirable. The design was therefore based on end shocks equivalent to 400,000 pounds compression. Castings were employed sparingly in parts subjected to heavy stresses, structural and pressed steel shapes being generally specified. For passenger car construction open-hearth steel of low carbon content was used, containing about 0.06 per cent of phosphorus.

Herr Otto Henigsberg reported on countries belonging to the Verein Deutscher Railway system. He ascertained that several administrations were using crucible steel, with an ultimate tensile strength of 85,336 pounds per square inch, for piston-rods, cranks, eccentric-rods, crank-pins, coupling pins, crosshead pins, etc. The Baden State Railway used crucible steel for all the wheels of the recently built express locomotives, as well as for certain classes of goods and shunting locomotives. Martin steel of high resistance was used for the unbraked wheels of older locomotives. Crucible steel was going to be used in the future for all locomotives which had much work to do, or had to carry heavy axle loads. The Saxon State Railway had for some time past been using for its locomotives crucible steel tires with a minimum ultimate tensile strength of 65 kilos per square millimetre—92,450 pounds per square inch—and a minimum elongation of 10 per cent. Good results had followed the use of this material. The Wurtemberg Railway was about to try special steel for the tires of the driving and coupled axles of tank and goods locomotives. The Austrian State Railways used for locomotives and tenders of all kinds tires made of crucible steel and of Martin steel, which is made from better quality scrap, melted in a Martin's furnace, with a little chromium added. Favorable results had been obtained by the Prussian State Railways with pins made of compound steel, or a special mild steel case-hardened on superheated locomotives which did heavy work.

It was announced that data had not yet been secured with regard to the behavior in service of wheel tires of specially high resistance steel, but such isolated tests as had been carried out pointed to special steels with a minimum tensile strength of 99,560 pounds per square inch, having a superiority of 40 per cent, as compared with basic Martin steel, having a minimum tensile strength of 85,336 pounds per square inch, and of 50 per cent over acid Martin steel with a tensile strength of 77,114 pounds per square inch. The Baden State Railway had been latterly using crucible steel of high resistance for all springs, draught and buffing gear included, of the new locomotives. The heavily loaded locomotives of the Bavarian State Railway were also made of special steel. The Prussian State Railway was at the present time carrying out extensive trials with special steel used in plate springs of 8 and 12-wheel corridor carriages, and on the bogie trucks of superheated passenger and goods locomotives.

THOMAS REECE.

The Northwestern Pacific Ry. has definitely determined to push construction work on both ends of the gap in its line in Humboldt county, Cal., at a greater speed than heretofore. To that end contracts calling for the construction of an additional twenty-five miles of road are about to be let. It is stated that fifteen miles of the road will be constructed on the Eureka end and the remaining ten miles on the southern end of the gap. The contracts about to be let will call for the completion of the additional twenty-five miles of road this summer. W. C. Edes is chief engineer of the road, San Francisco, Cal.

Articulated Locomotives for the Delaware & Hudson Co.

The most powerful locomotives ever constructed, have just been completed at the Schenectady works of the American Locomotive Company. These are six of the articulated type built for the Delaware & Hudson Company. They are designed for pusher service on the Wilkesbarre & Susquehanna division of that road, between Carbondale, Pa., and Oneonta, N. Y.—a distance of 95 miles.

On these divisions there is a heavy movement of freight traffic, consisting mostly of loaded coal trains. The grade conditions on this portion of the road are severe and sharp, curves are numerous. Against northbound traffic, in which direction practically all the movement of loaded freight trains takes place, there is a six mile grade of 1.36 per cent from Carbondale to Forest City. From the latter point to Ararat, the summit of the rose, a distance of 14 miles, the road is on a grade averaging .81 per cent. Going down the other side of the mountain it is practically a continuous grade of 51.7 feet per mile, for 75 miles into Oneonta.

Hitherto the freight traffic on this division has been handled by consolidation locomotives, known on the road as Class E-5, having a theoretical maximum tractive power of 49,690 pounds, a total weight of 252,000 pounds and a weight on driving wheels of 223,000 pounds. A single class E-5 engine can very satisfactorily handle a 2,600 ton train from Ararat to Oneonta, but it requires the assistance of two locomotives of the same class, as pushers, to haul this load up the 20 mile grade to Ararat, at which point the pushers cut loose. With this power a speed of about 10 miles per hour can be maintained on the six mile ruling grade from Carbondale to Forest City, and a speed of 15 miles per hour over the remaining 14 miles of the ascent.

With a view to reducing the operating expenses of the division and facilitating the movement of trains, the officials of the Delaware & Hudson Company decided to investigate the efficiency of the Mallet type locomotive for this service. It was their aim to secure a pusher engine of this type of sufficient power to move the maximum train load up the hill with two engines instead of three. In the fall of last year one of the heavy Mallet engines built by the American Locomotive Co. for the Erie Railroad was borrowed and put into pusher service on the 20 mile Ararat grade. A number of test runs were made, which proved that a single Erie mallet engine easily did the work of two of their Class E-5 consolidation locomotives. Following these tests six Mallet engines were ordered from the American Locomotive Co. and put into this service.

These engines are of a straight forward design, embodying but slight modifications from the designs of previous locomotives of this type of lesser weight and power construction by these builders. The wheel arrangement is of the 0880 type, and the design is based on the articulated locomotives built by this company for the Erie Railroad in 1907, with 35,000 lbs. increase in weight, and 10 per cent more power, thus giving a good margin of power to meet the varying conditions of service on the Delaware & Hudson Railway.

The general appearance of the locomotives are shown in the photograph. In working order they have a total weight of 445,000 pounds, all of which is carried on the driving wheels. The high pressure cylinders are 26 ins. in diameter by 28 ins. in stroke, and the low pressure cylinders are 41 ins. in diameter by the same stroke. With the boiler pressure of 220 lbs. and driving wheels 51 ins. in diameter, the theoretical maximum tractive power, working compound, calculated by the American Locomotive Co.'s formula, is 105,000 lbs. As this formula, which is applicable only to articulated locomotives built by the American Locomotive Co., is based on the results obtained from a large number of indicator cards, taken under various service conditions, it is found that the tractive power thus calculated represents very accurately the actual power that the locomotive can develop at a piston speed of not over 250 ft. per minute.

With this system of compounding, the normal maximum tractive power working compound can be increased about 20 per cent by changing the engine into simple. The maximum tractive power of these engines working simple is thus 126,000 lbs. With the same average weight per driving axle and a rigid wheel base 2 ft. 3 ins. shorter, these articulated locomotives, thus under normal working conditions, have over twice the power of the class E-5 consolidation locomotives, and in case of emergency can exert a tractive power more than two and one-half times as great as the latter.

One of these engines as a pusher and a class E-5 locomotive in the lead, will easily take a 2,600 ton train up the grade, where it previously took three class E-5 locomotives. The six articulated locomotives in this order will, therefore, relieve 12 of the consolidations from this service without sacrificing any tonnage, and with a saving in operating expense due to handling less units.

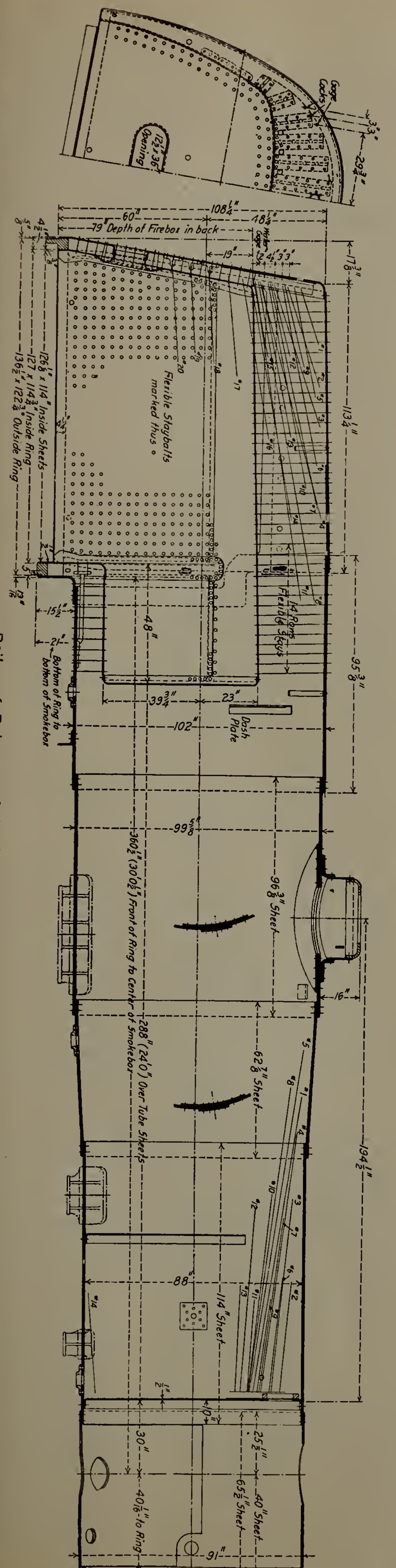
Apart from the increase in size and power, the principal changes in the design here illustrated from that of the Erie engines, are a different arrangement of high pressure steam pipes, and the location of the cab over the fire box. Owing to the large diameter of the boiler, it was necessary in this instance to locate the high pressure steam pipes underneath the running boards. Steam is led from the throttle through a dry pipe to the smoke box, where it is divided in a tee-head and passes into two branch pipes, one in either side of the smoke box, in the same manner as in a single expansion engine. From these branch pipes, to which they are connected through elbows with ball joints, two wrought iron steam pipes extend back underneath the running board, one on either side of the boiler, to the high pressure cylinders. An elbow covers the steam passage in the cylinders, to which the steam pipe is joined by means of a specially designed connection having a ball joint at either end and fitted with a slip joint. This construction permits of the expansion and contraction of the steam pipe, due to variations in temperature, and also facilitates removing and putting it up when repairs are necessary. With this arrangement of steam pipes, the engineman is afforded an unobstructed view ahead.

The design of the cylinders follows usual practice. The low pressure cylinders are the largest ever applied by these builders, being 41 ins. in diameter by 28 ins. in stroke. Steam is distributed to the high pressure cylinders by 14 in. piston valves having inside admission and ample port area to meet the requirements. The low pressure cylinders are equipped with Mellin double ported balanced slide valves which have been used so successfully on the previous articulated engines. Special provision has been made for strengthening the valve yoke. This is stayed by two longitudinal bolts which pass through cored passages in the valve. The bolts, which are one inch in diameter, are fitted with one inch wrought iron pipe thimbles, which act as spacers.

By-pass valves of the builders' standard pattern are provided for the low pressure cylinders. These are located in chambers in the side of the cylinder castings, and automatically establish communication between the two ends of the cylinder when the throttle is closed. The valve gear, which is of the Walschaert type, is reversed by the builders well known hydro-pneumatic reversing gear.

A slight modification from the arrangement employed on previous engines of the articulated type has been made. This modification consists first in connecting the piston rod of the reversing engine to a downward extension of the arm on the main reverse shaft, instead of to the main reverse lever itself. Also, the handle of the main reverse lever which ordinarily projects above the deck of the cab is in this instance cut off, thus providing more room in the cab. A separate handle for the main reverse lever is provided, which can be easily applied in case it is necessary to operate the lever by hand in case of an accident to the power gear.

The frames throughout are of Vanadium cast steel and of large section. The frames of the rear engines have a single front rail cast integral with the main frame, while those of the front system are provided with double front rails, the lower one of which is in one casting with the main frame. Both sets of frames are 5½ ins. in width throughout, except that



Boiler of Delaware & Hudson Mallet.

New Mallet Articulated Locomotive for the Delaware & Hudson Co.—The Most Powerful Locomotive Yet Built.

portion of the lower front rails of the front frame which is underneath the cylinders. This portion is reduced to 3¼ ins. in width, and is reinforced by an auxiliary rail 4 ins. wide, bolted to the inside of the lower rail and extending the full length of the cylinders. Over the pedestals, the upper rails of the main frames are 6½ ins. deep, while between pedestals the depth of section is 5 ins., except at those points where the equalizing beam fulcrum castings are introduced, where it is increased. The bottom rails of the frames are in the main 4¾ ins. deep, except above the pedestal caps, where the depth of section is increased to 5¼ ins.

A single articulated connection is used between the front and rear systems. This is formed by a cast steel radius arm rigidly bolted to a cast steel crosstie between the rear ends of the front frames. This radius arm fits in a steel pocket casting securely bolted to the bottom rails of the rear frames, and which also extends back underneath the high pressure cylinder saddle, to which it is bolted. The coupling is made by means of a vertical pin 6 ins. in diameter, inserted from the top. This gives a very strong and substantial connection between the two engines, and at the same time the use of the single articulated connection permits of the vertical movement of the two frames relative to each other, without any binding in the joint.

An exceptionally strong and substantial system of frame bracing is employed. In the front and back systems there are in all 16 cross braces between the frames, taking into consideration the high and low pressure cylinder castings. All the cross ties are of cast steel and of such a construction as to provide the maximum of strength with the minimum weight. With but one or two exceptions, the several crossties extend down to the bottom rails of the frames and are secured to the frames by both horizontal and vertical bolts.

Two features which have proved very successful in the articulated locomotives built for the Erie Railroad have been incorporated in this design. These are the floating balance device and the side spring buffers at the frame union. The floating balance device which is located between the second and third pair of drivers of the front system immediately back of the boiler bearing which carries the spring centering device, consists of a pair of spring supported columns. These have ball and socket connection at their upper ends with the saddle casting of the boiler bearing to a similar connection at their lower ends with two castings hinged at one end to the bottom of the cast steel cross tie between the lower rails of the frames. The outer ends of these hinged castings rest in "U" bolts and are supported by coil springs seated on the cross tie. These columns serve to support the portion of the weight which would otherwise come on the main boiler bearing thus relieving that bearing of excessive pressure. In this instance, the total initial compression of the springs is about 30,000 lbs. With this arrangement that part of the weight of the boiler which is carried by the front system is divided between three supports, namely, the self-adjusting sliding balance valve, located between the third and fourth pair of driving wheels, the spring supported columns and the pair of adjustable hinged bolts which connect the frames of the two systems. The surface of the boiler bearing is located between the second and third pair of driving wheels which are normally not in contact, so that this bearing does not support any weight except under unusual conditions. With this construction the columns are free to sway in any direction, while they support a load equal to the total compression of the four springs. In this case, the total initial compression of the springs is about 30,000 lbs., which amount is taken off the main boiler bearing.

Besides relieving the main boiler bearing of the load which they support, the floating columns throw a certain load on the equalizing bolts in the rear of the frames; since the three supporting points constitute a system of support similar to the balanced beam, with the main boiler bearing as the fulcrum, the loads carried in the supporting columns and the equalizing bolt as the weights applied at either end. Consequently, if the system is in equilibrium, for any load supported by the floating columns, the equalizing beam must receive a load having the same proportion to the other as the respective distances of the floating columns and the equalizing bolts from the main boiler bearing have to each other. As the sum of the loads supported at each of the three points is equal to that part of the weight of the boiler which is carried on the front system, the total amount of the load removed from the main boiler bearing, by the introduction of the floating balance device, is equal to the sum of the load supported by the columns themselves and that thrown on the equalizing bolts.

In this engine, the floating columns are 52 ins. from the main boiler bearing, and the equalizing bolts are 65½ ins., so that with 30,000 lbs. supported by the columns, about 54,000 lbs. are removed from the main boiler bearing. In passing through curves, the horizontal component of the force exerted by the springs tends to counteract the increasing resistance of the centering spring, and thus maintain a practically uniform side resistance on curves of different radii. In engines of the articulated type of ordinary weight, the floating balance device is not necessary, but in designs of such great weight as the engines here illustrated, where the bearing pressure on the boiler support would otherwise be excessive, its distinct advantage is apparent.

The side spring buffers are located in the pocket casting of the articulated connection, one on either side, and as far apart as possible. They are so designed that when the engine is on a tangent the buffers just touch the bumper castings bolted to the cast steel crosstie at the ends of the rear frames. Thus, when the engine enters a curve one or the other of the buffer springs is compressed. When the engine is curving, these buffers serve to direct the pushing force through the center of the wheel base of the front engine instead of through the flange of the outside forward driving wheel as it would be were they not applied. In pushing, the resistance of the head load tends to swing the front system about the center of its wheel base when the engine is passing through a curve, thereby increasing the flange friction of the front driving wheels. The action of the spring buffer is to counteract this side push of the load ahead and thus reduce the resistance.

In cases where the wheel base is comparatively long, as in the present instance, and the engine is engaged in pushing service, these buffers have been found to be very effective.

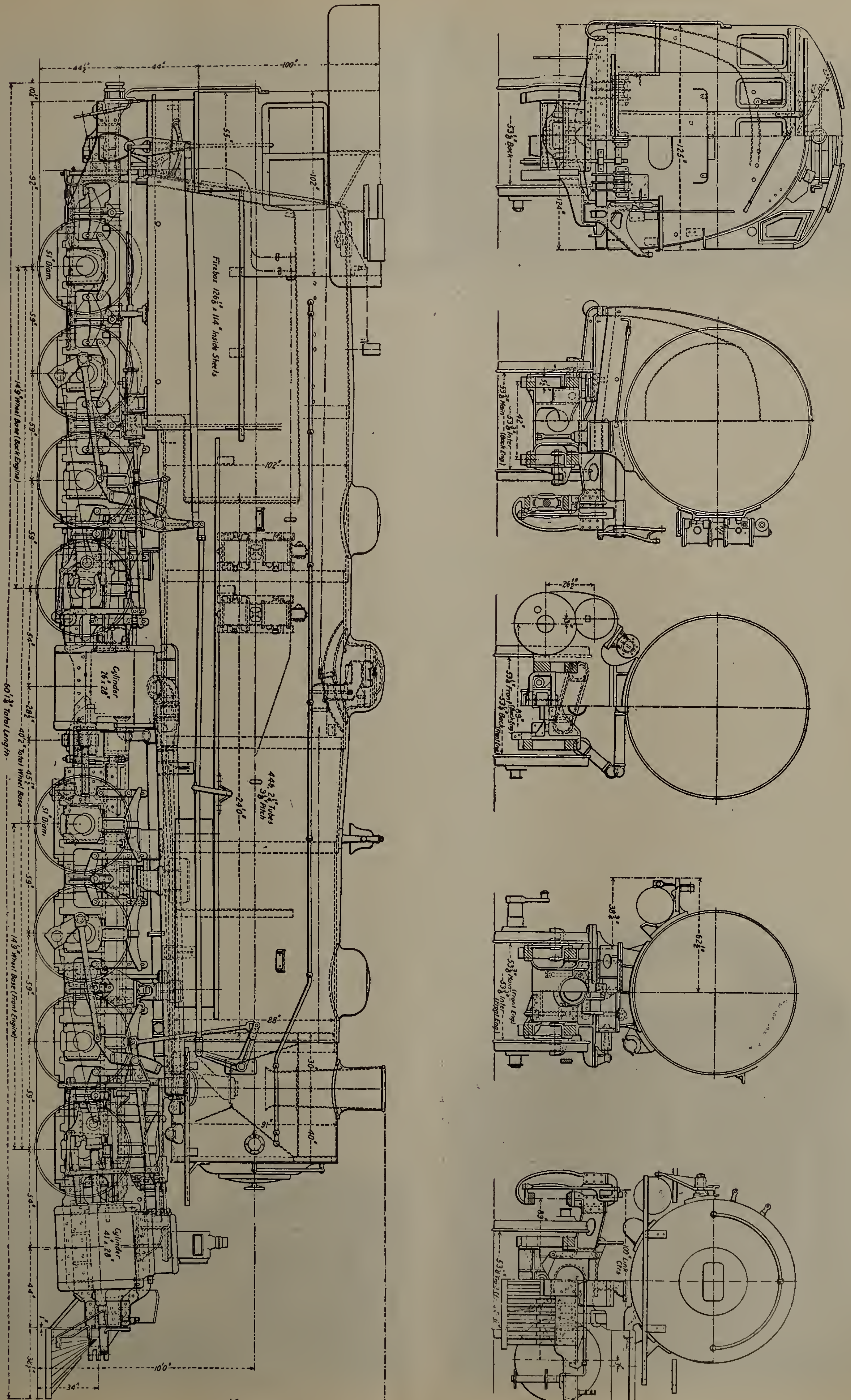
Apart from its size, the boiler is of special interest because of the careful attention with which every detail of the design is worked out, to provide the greatest efficiency. The boiler is of the radial stayed type with conical connection sheet. At the first course the barrel measures 90 ins. in diameter outside, while the outside diameter of the largest course is 102 ins.

The barrel is fitted with 446 tubes, 2¼ ins. in diameter and 24 ft. long. The arrangement of the tubes is clearly shown in the reproduction of the photograph of the front view of the boiler. This latter illustration shows particularly clearly the liberal width of bridges between the tubes, which are spaced 3 1-8 ins. between centers.

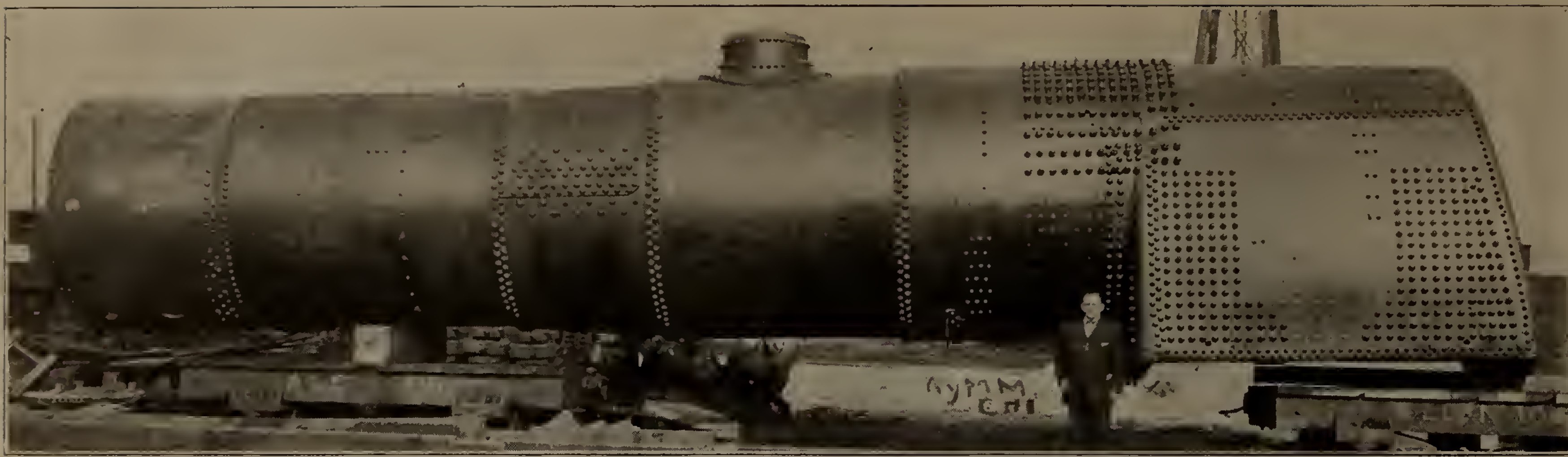
The boiler incorporates a 4-ft. combustion chamber, which is radially stayed to the shell of the boiler. Ample space is allowed between the combustion chamber and the shell of the boiler on all sides to insure good circulation of the water. The width of the water space is not less than 8½ ins. at any point and increases to 11¼ ins. at the bottom. Over the crown of the combustion chamber and down to the second row of staybolts above the center line of the boiler, flexible staybolts are used. All the plates of the boiler shell are, of course, very thick, the heaviest plate being 1 3-16 ins. thick, and the lightest 1 in.

The firebox is 114 ins. wide and 126⅛ ins. long, and provides a grate area of 100 sq. ft. Two Chicago sight feed flange oilers are provided for oiling the flanges of the front and back wheels of each system when the engine is passing through a curve. These are located on the back head of the boiler and oil is fed from them by steam pressure through a pipe line, from which there are leads to the above mentioned wheels. A single firedoor is provided in the firebox, equipped with a Franklin automatic opener.

Iron sliding doors are provided at the back of the cab, which may be closed when the engine is backing. The tender is fitted with a water bottom tank of large capacity. The tank



Sections and Side Elevation of Delaware & Hudson Mallet Locomotive.



Photograph of Finished Boiler, Delaware & Hudson Mallet.

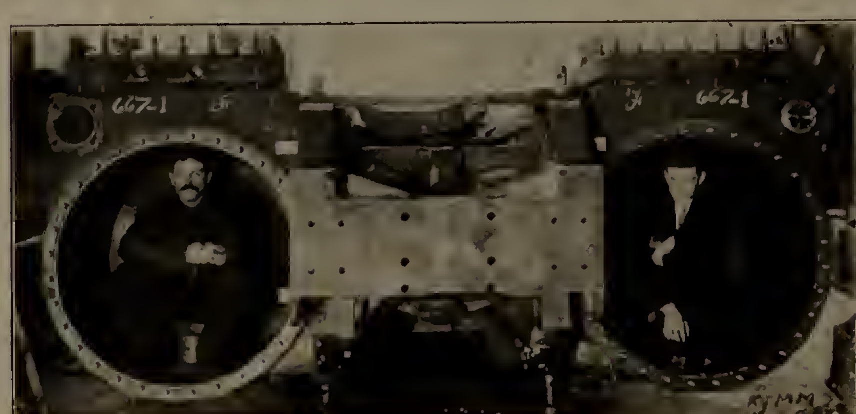
carries 9,000 gallons of water and the coal space holds 14 tons of coal.

In the design of the tender frame special care was taken to provide a strong and rigid construction. The longitudinal sills are constructed of 15 in. steel channels weighing 33 lbs. to the foot, and top and bottom cover plates are used. Both the front and rear bumpers are of cast steel. The tender trucks are of the four-wheel arch bar type, the design following the Delaware & Hudson Co.'s standard practice, and have a carrying capacity of 100,000 lbs. each.

The principal weights and dimensions are as follows:

Cylinder, type	Compound
Cylinder, diameter	26 and 41 ins.
Cylinder, stroke	28 ins.
Track gauge	4 ft. 8½ ins.
Tractive power	105,000 lbs.
Wheel base, driving	14 ft. 9 ins.
Wheel base, rigid	14 ft. 9 ins.
Wheel base, total	40 ft. 2 ins.
Wheel base, total, engine and tender	75 ft. 7¼ ins.
Weight, in working order	445,000 lbs.
Weight, on drivers	445,000 lbs.
Weight, in working order, engine and tender	611,800 lbs.
Heating surface, tubes	6,276 sq. ft.
Heating surface, firebox	353 sq. ft.
Heating surface, total	6,629 sq. ft.
Grate area	100 ft.
Axles, driving journals	Main, 10x12 ins.; others, 10x12 ins.
Axles, tender truck journals	Diam., 5½ ins.; others, 10 ins.
Boiler type	Conical Conn.; O. D. first ring, 90 ins.
Boiler, working pressure	220 lbs.
Fuel	Bituminous coal
Firebox, length	126⅛ ins.
Firebox, width	114 ins.
Firebox, thickness	of crown, ⅜ in.; tube, 9/16 in.; sides, ⅜ in.; back, ⅜ in.
Firebox, water space	Front, 5 ins.; sides, 4 ins.; back, 4⅝ ins.
Crown staying	Radial
Tubes, material	Spellerized steel
Tubes, number	446
Tubes, diameter	2¼ ins.
Tubes, length	24 ft. 0 in.
Tubes, gauge	No. 11 B. W. W.
Boxes, driving	Main, C. S.; others, C. S.
Brake, driver	West. Amer. Comb.
Brake, tender	Westinghouse
Brake, pump	Two 11-in. L. Hand
Exhaust pipe	Single
Exhaust pipe, nozzles	6½-6¾-7
Grate, style	Rocking
Piston rod, diameter	4¼ ins.
Piston packing	Gun iron, ring
Smoke stack, diameter	18 ins.
Smoke stack, top above rail	16 ft. 0 in.
Tender frame	15 in. channels
Tank, style	Water bottom
Tank, capacity	9,000 gallons
Tank, capacity, fuel	14 tons
Valves, type	L. P., Double Ported; H. P., Piston, 1 1/16 ins.
Valves, travel	6 ins.
Valves, steam lamp	L. P., 1 in.
Valves, ex. lap	H. P., 5/16; L. P., 7/16
Setting	3/16 in. lead
Wheels, driving, diameter outside tire	51 ins.
Wheels, driving, centers, diameter	44 ins.
Wheel, material	Cast steel
Wheels, tender truck, diameter	33 in. Schoen rolled steel

Front End of Boiler, D. & H. Mallet.



Low-Pressure Cylinders, D. & H. Mallet.

Handling Locomotives at Terminals*

By Frederic M. Whyte.

Detail methods in the handling of locomotive terminals vary so widely that the scope of this paper has been limited to well established practices along certain definite lines, in the United States and Canada, with some personal suggestions. Steam locomotive terminals alone are sufficiently developed to permit of extended discussion.

Terminals differ very much in importance and the paper will be confined largely to the more important ones, leaving it to the judgment of the reader to decide what parts apply to the smaller terminals. By the designation "important terminals" is meant those caring for about 100 locomotives during each 24 hours.

Starting with a terminal at each end of a railroad the intermediate terminals are located as the topography of the line, the location of important towns, or other factors, may indicate. Some years ago the distance between locomotive terminals was shorter than is considered desirable now, and generally the divisions have been lengthened, so that at the present time they range in length from 100 miles to 200 miles; divisions approximately 150 miles in length are quite common. Frequently there are locomotive terminals between the division extremes, but these are usually for local and suburban runs and are of lesser importance, although a few years ago they were the important terminals.

From the standpoint of operation, the engine house and its accessories at the divisional point should be located close to the freight yard, for freight locomotives, and to the passenger station, for passenger locomotives. This condition is more readily fulfilled for freight than for passenger service. For the latter it is sometimes necessary to place the engine house five to ten miles from the passenger station where the locomotive is detached from the train. This requires the introduction of separate crews for handling the locomotives between the engine house and the station and also necessitates exceptional methods of inspection and reporting and calling the crews and equipping the locomotives for the next trip. Such conditions exist at Buffalo on the New York Central & Hudson River R. R. On the other hand if the station is not a terminal of the road the through trains may be stopped near the engine house and the locomotive detached and attached there; such is the method on the Lake Shore & Michigan Southern Railway at Cleveland.

The route between the train terminal and the engine house should be as direct as possible and independent of all other movements. This is not always possible, however, and in passenger service more particularly, the route is largely made up of main line track. Especially is this true when the locomotive terminal is at some distance from the station.

So far as concerns the mechanical operation of the locomotives, the mechanical department must be responsible. There are two well recognized and quite different forms of railroad organization: the departmental, in which the mechanical department has supervision over the design, maintenance and mechanical operation of the locomotives; and the divisional, in which the mechanical department has supervision over the design, construction and general condition of the locomotives, and the transportation department has supervision over running, maintenance and mechanical operation. In either of these organizations the responsibility for the locomotives must change, so far as individual officials are concerned, at some place adjacent to the engine house. In some organizations this change is made at the turntable, or its equivalent, there are a very limited number of rectangular engine houses, notably at the St. Louis passenger terminal, where a transfer table is used and a turntable is not necessary. In these organizations the official in charge of the engine house, who is a part of the mechanical department, has supervision over the movement of the locomotives between the table and the house and over the locomotives in the house; and the coaling plant, ashpit and other accessories are handled by the transportation department. In other organizations the engine house official has supervision over the entire engine house premises, including the coaling plant, ashpit and all other accessories.

It is not well established which is the better organization, and not only does the organization differ on different roads, but often the same road has changed several times from one arrangement to the other. It is probable, however, that the best arrangement is the one which provides the highest class official nearest to the place to be handled. The best results probably will be obtained from the present tendency to place a master mechanic at each of these important locomotive terminals and assign to him supervision over the entire plant. Such an arrangement will place the line of separation of responsibility for incoming locomotives on the approach to the engine house and outside of the coaling plant; and for outgoing locomotives at the track assigned for locomotives ready for service.

On a division having only one important locomotive terminal it is not necessary to designate where the important repair work will be done, but on many divisions there are two or more engine houses thoroughly equipped for the complete maintenance of a certain number of locomotives, and on these divisions it is necessary to designate those which will be maintained at each house. Each engine house will do the periodic work and the running repair work on the locomotives assigned to it, and the inspection and safety repair work on any locomotive which is run into the engine house. The assignment of the locomotives to the different houses is made by the divisional mechanical officer, usually designated as master mechanic. There is more or less transference of locomotives from one division to another for temporary service, but there are serious objections to this, especially when the periodic work and reports are to be considered, and when the duration of the temporary service is more than a few days. On the large railroad systems it seems quite necessary that an individual locomotive record of periodic inspection and work be kept by the divisions and the transferring of locomotives from one division to another for a week or two results in annoyances, errors and loss of records incident to transferring records when the locomotives are transferred.

Layout of a Locomotive Terminal.

It is not the intention of this paper to cover this item in such detail as would be necessary for the preparation of an ideal layout, but rather to deal in generalities which may be of greater interest in an international discussion. It will be in order to consider, first, the capacity of the various facilities which are to be supplied. It is desirable to rate the capacity on the maximum demand for a comparatively short interval of time, say one hour or two hours, for the coaling, ashplant, turntable, water and sand facilities; and for longer periods of time for other facilities. Some of these ratings may be consistently higher than the sustained rating of 24 hours. There should be considered also, how much of the terminal will become inoperative in case of accident to any one of the important units of the terminal, and the approximate length of time the resulting disorder may continue; and to provide the necessary assurance of continuous operation, by the installation of duplicate units. The water and coal plants and the turntable are the most important units and these will need special study.

*From a paper before the American Society of Mechanical Engineers.

Water columns are usually so well distributed at a division terminal that only a failure of the entire water system need cause much delay, so that the important consideration is convenience of location. The insurance may be taken care of in the general water system. An ample supply of water is also of prime importance.

For insurance of the coaling operation there may be selected one of several schemes, one of which is to place the cars of coal on one, and the locomotives on another of two or more adjacent tracks, transferring the coal from the cars to the tenders by hand or by locomotive crane. Another scheme is to coal the locomotive at the coal-stocking plant, if one is near by; or by other means, none of which seriously affect the general arrangement of the locomotive terminal.

On the contrary, insurance of turntable service will very decidedly affect the general layout of the terminal because the spare table must be capable of serving the whole or a considerable part of the engine house capacity, inasmuch as failure of one table may occur when a large number of the locomotives are in the house served by it. The only way in which more than one turntable can serve one unit of engine house capacity, in a circular engine house, is by dividing the house unit into parts and having a turntable for each part. To accomplish this result it is considered very good practice to limit the size of a separate engine house to approximately a half-circle, and to provide any additional capacity in another half-circle, offset from the first at least enough to permit of a separate turntable for each. The separate turntables should have track connections to the inbound and outbound tracks, and usually have inter-connecting tracks.

For further insurance of uninterrupted turntable operation two motors for revolving each turntable are considered desirable, and even necessary, but both should not be operated from the same power plant. Sometimes two gasoline motors are used, and sometimes one electric motor is provided for general use and a gasoline motor for emergency use.

If the house is made up of parts of two circles, one and of each part will be placed near one end of the other, and the machine shop, storehouse, power house and offices will drop in very naturally between the two. The drop pits, overhead crane, and other special facilities necessary in a limited section of the engine house, will be placed convenient to the shop.

There remain to be located only the coaling plant, ashpit, sand house and water columns, which will be placed primarily for convenience in getting the inbound locomotives to them. There must be ample water facilities on the outgoing tracks and it is desirable to have a small ashpit and a sanding place on these tracks. If provisions are made to get the outgoing locomotives to the coaling plant on special occasions, then a coaling place is not necessary on the outgoing track. Of these facilities on the inbound tracks the ashpit will be nearest the turntable so that the locomotives may be moved the shortest distance when there is little or no fire on the grates. Sometimes it has been thought desirable so to arrange the facilities that coal, water and sand can all be taken at the same time; but if the hostler is to stay in the cab so as to be ready for moving the locomotive promptly, it is probable that the difficulty in arranging these facilities for the various lengths of locomotives will make it desirable to place then somewhat more than a locomotive length apart if the ground space permits. Sometimes a track arrangement is made that permits of advancing one or more locomotives around other locomotives, and when the ground space is available this is a good thing to do. The tracks on which the ash cars are taken to and from the ashpit should be independent of the inbound and outbound locomotive tracks.

The two items which have been given most consideration during the last few years, for houses located in the colder climates, are the heating and the ventilating; they are so closely related that they should be considered together. For low cost of heating, the area of the cross-section should be as small as the locomotives will permit and until recent years it was the practice to follow this principle in the design. Unfortunately, good ventilation, which is equally important, has not been obtained with the small cross-area and as a result the condition of fog and smoke, and principally fog, in these low-roofed houses in cold weather is such, at times, as scarcely to be understood until seen.

A decided improvement in ventilation has resulted from raising part of the roof somewhat higher than the necessary headroom would require, placing the ventilators at the top of this higher portion. The design of these ventilators is undergoing a process of development and at present practically each road has its own preferred design. An advantage of this high roof section is that additional area for windows is given in the enclosing wall, and this additional lighting is important for the wider houses now necessary.

In the effort to reduce to a minimum the fog in the house in cold weather, special efforts are also made to prevent the escape of steam from the locomotives. To this end a pipe line of large diameter is placed around the house, usually above the locomotives, with terminals conveniently arranged for making quickly a pipe connection to a valve in the top of the boiler. To reduce the steam pressure in a boiler the steam is blown through this pipe into the atmosphere, or to water-heating tanks or hot wells.

Pipe lines, including cold-water, hot-water and steam lines, are similarly arranged for washing out boilers, and provision made for mixing the cold water with hot water or steam to get the desired temperature for washing. The same pipe lines, or others, conduct the water from the boiler to storage tanks and reheaters. The smokejacks have elongated bases which cover the safety valves as well as the stack.

The heating is done by one of two methods: by direct radiation from steam pipes placed on the side walls of the pits; or by hot-air blast. Probably the latter is preferable. The place of delivery of the heat is as near the locomotive as possible. The capacity for the steam heating is usually all that can be obtained from two to six 2-in. pipes on each side wall in the pit and some on the outer wall of the house; for the hot-air system the capacity is the volume of the house every ten to fifteen minutes, at a temperature of about 60 deg. fahr. A very important point about heating engine houses is to keep the doors and windows closed and to cover the usual openings at the bottom of the doors. It is desirable also that the roof timbers be so placed as not to interfere with the flow of air upward along the roof to the ventilator outlets.

It is the general practice to provide several tracks in the house with a drop pit into which to drop driving and truck wheels, and to provide in the same section of the house an overhead crane for loading to and unloading from cars these wheels, and for handling air pumps, cabs, boiler fronts and other heavy parts to and from the locomotives. Light portable cranes are provided for lifting steam chest covers, rods, and other heavy parts which do not require high lifts.

There are many smaller details about engine house design and equipment which contribute to the rapid and efficient handling of locomotives, but it will be best not to burden the paper with them.

The Coaling Plant.

The uninterrupted operation of the coaling plant is of prime importance, and with this in mind, that design should be chosen which is least liable to be deranged and which can be repaired most quickly. With sufficient ground space available, these considerations will make the choice a trestle, so that cars of coal can be pushed or hauled up an incline and the coal dumped direct from the cars into the bins from which it slides by gravity into the locomotive tender. This kind of plant reduces to a minimum the breakage of fragile coal, sometimes an important feature. If the incline approach is too steep for steam locomotive operation, the motor and winch should be in duplicate and the motors not dependent upon the same source of power, unless there is little chance of total disability of the source.

When the ground space is limited the mechanical hoisting plant, of the bucket or a similar type, is a necessity, and it has been selected sometimes when the available space would permit of a trestle. There are various forms of the mechanical plant, but it will be unnecessary to consider them in detail. Usually they are placed crosswise of the tracks. Sometimes the same apparatus used to elevate the coal is used to convey ashes from the pits and to deliver them into storage bins or into cars. This combination has the advantage of concentration of facilities when such concentration is necessary, but there are objections to it otherwise. To give the necessary capacity at the coal pockets and ashpits a greater number of tracks are necessary and the risk of personal injury from coal falling from the tender and striking the men who must be about the ashpit is increased. This concentration wil shorten and widen the approach to the engine house.

The Ashpit.

It is desirable to have a pit capacity immediately beneath the locomotives for several hours' busy dumping of pans and grates, whether the ashes are handled by hand or by machinery from the pit to cars. If handled by hand this is to provide for economical time distribution of labor; if handled by machinery, to provide for continuous dumping when the machinery is out of order. The economical transferring of ashes from pit to car by hand requires a lower pit for the ash cars, adjacent to the ashpit, and sometimes conditions do not permit of such an arrangement or of the necessary track approach. If the ash pan and fire cleaners can be used for transferring the ashes from pit to car, at intervals when there are no pans or grates to be cleaned, the manual labor can be most economically distributed. The mechanical plants usually operate crosswise of the pit, limiting the length of pit undesirably, and making necessary several pits side by side or a further mechanical installation for transferring the ashes lengthwise of the pits to the cross conveyor. With each addition to the mechanical devices, complications are multiplied. Water hydrants for hand hose are located conveniently about the ash pits, and shelters are provided near by for the men to occupy when there is a lull in the work.

The Sanding Plant.

The sand-drying plant should be located convenient to the inbound tracks, but not necessarily adjacent to them. Convenience in delivering wet sand to the drying plant is important. As air pressure is use to elevate the dry sand to the storage bin from which it falls by gravity to the locomotive sand box, air pressure can also be used for transferring the dry sand for some distance horizontally, so that the place of delivery for the wet sand may be conveniently located for such delivery. Sometimes the sand is dried on steam-heated tables, but since the temperature cannot be raised high enough for satisfactory drying, the preferred dryer is the stove. The dry sand bin, from which the sand is delivered to the locomotive, is usually located between the coaling plant and the ashpit.

The Organization.

The usual divisional organization places one man, the master mechanic, in charge of the locomotives on the division, both when the locomotives are away from the engine house and when at the engine house. One of the division terminals is under his supervision and his headquarters are generally at that terminal because it is the important point of his jurisdiction. He may have assistants with duties both at terminals and between them, and he always has assistants, called assistant master mechanics, who confine their efforts to the terminal, and others who confine their efforts to the road work. If at the divisional terminals the freight locomotives and the passenger locomotives are separated, as is often the case, one assistant may have supervision over freight locomotives and terminals, another over passenger locomotives and terminals, and a third over the intermediate division engine house, in which both passenger and freight locomotives may be cared for.

The assistants in the operation on the road are usually designated as traveling engineers or road foremen of engines, and traveling firemen. Some are assigned to passenger service and others to freight service, and they report to the master mechanic, or if there are assistant master mechanics, then to the proper assistant master mechanic. Their duties are, nominally, to instruct the engine drivers and the firemen; to report the conditions of the locomotives as delivered from the engine house; to foresee, when possible, and to report work on the locomotives which may require special preparation or special attention for the preparation of material, etc. Too often, and it may be said usually, they are kept busy ascertaining and reporting what has already happened and explaining it, whereas their efforts should be directed to preventing the repetition of undesirable occurrences. It is conceded, however, that a general knowledge of what has happened and the causes is essential for the intelligent direction of means for preventing recurrence.

All of these officials, from master mechanic to traveling firemen, are subject to call at any hour.

The organization at the locomotive terminal will begin with the general foreman, who will have general supervision of the terminal 24 hours a day and seven days in the week. He will have personal supervision in the daytime; the assistant general foreman will report to him and have supervision at night. These two may arrange between themselves, subject to the approval of the master mechanic or the assistant master mechanic, for regular rest days. The division of the 24 hours between these two men means somewhat more than 12 hours a day service for each, that there may be time for the necessary consultation between them. Because of this and the fact that the change in supervision is made in the morning and evening, the busiest hours at most engine houses, and at about the same time the other employees change shifts, there is being considered, and in fact put into operation at a few places, an arrangement for 8-hour shifts, so assigning the terminal men that the entire shift will not change at any time. In such an arrangement the general foreman would be present during a part or the whole of every shift and one of his three assistants would be assigned to each shift. Twenty-four-hour operation is necessary at engine houses and two complete breaks in each 24 hours are not conducive to best results, nor can a man deliver his best efforts for 12 hours a day continuously. Hence the tendency to shorten the hours of daily service and to minimize the effect of each change of shift.

In addition to the assistant general foreman, the storekeeper and chief clerk will also report to the general foreman. To the assistant general foreman in charge of each shift, the yard foreman, the house foreman, the shop foreman, the foreman of laborers, the despatcher and the necessary clerks, will report.

The yard foreman should have complete charge of the locomotives at the terminal and outside of the house. He should take from the house foreman instructions as to the particular stall in which each locomotive is to be placed and report as soon as it is placed; and should take from the despatcher instructions about delivering the locomotives to the transportation department. This arrangement will place under the supervision of the yard foreman the coaling, sanding, watering and ashpit plants, and the turntables; the care of the locomotives which are standing outside of the house; and also the special crews that run the locomotives between the engine house and the train terminal, when such crews are necessary.

The house foreman should have supervision over the workmen in the house, and over the inspectors on the incoming track, if there are such inspectors. The various foremen reporting to him are those in charge of repairs to tenders, boilers, machinery and air brakes, and others similar, depending on how far the work is specialized. In working out the 8-hour shift arrangement, it has been suggested that there be assistant house foremen, each with supervision over certain stalls assigned to him; the special work, however, such as air brake and similar work, to be done by special gangs for all the stalls. The shop foreman will also transfer machinists, boilermakers, etc., from one assistant foreman to another, as conditions may demand. This arrangement of dividing the house into sections, each in charge of an assistant foreman, is being used with satisfactory results. It makes of the assistant foreman a high-class inspector, because it places him in such close touch with the conditions that he can say just what work should be done, and know how thoroughly it is done. This is a most important consideration, because the engine men and inspectors may report a lot of work to be done, partly to clear themselves, as well as to inform the foreman thoroughly. The man who does the inspecting and repairing on a locomotive or on a number of locomotives day after day is well informed on what must be done and how it should be done; which leads to the suggestion of the further step that the maintenance of certain locomotives be assigned to certain gangs. This ought not to be impossible in passenger locomotive terminals.

The importance of the shop foreman depends largely upon the importance of the shop. Sometimes his duties are assumed by the engine house foreman. The tendency seems to be in the direction of providing larger shop facilities, and as these are increased the importance of the shop foreman will increase.

The clerical force perform the usual duties of such employees. There is one clerical position, however, which is growing in importance and the qualifications for the filling of which are becoming more and more exacting; this is the position of work report clerk. He should understand clerical work and know enough about locomotive parts and repairs to make out a satisfactory report of work to be done. He first comes into contact with the arriving engineman, who reports on conditions which can be observed only when the locomotive is in action. Enginemen do not like to write, hence their written reports are short and unsatisfactory. The tendency at present therefore is for the clerk to write these reports for the signature of the engineman and the clerk must understand what work is necessary and report it properly. As the clerk is almost always accessible, the information is thus available in case further explanations are required. This clerk also makes a record of the incidents of the trip as reported by the engineman, so that, in case of inquiry, the desired information is already on file.

The engineman's report of work to be done and the report of the inspector should reach the work report clerk at the same time, that there may be no delay in distributing the work to the respective gangs.

Quite as important as having the work to be done promptly reported to those who are to do it, is the reporting back promptly when the work is completed, and to have this information easily available for those who need to have it. For this purpose various arrangements are provided, the details being worked out to suit the peculiar layout of each house. The essential features are provided by a blackboard located conveniently for those who make the records and for those who must read them. This board is ruled into vertical columns, one for the number of the locomotive, one for the number of the stall in which the locomotive is located, and other columns, depending upon how the work in the house is distributed among the repairmen. For instance, there may be a column headed "air brake," another "boiler," another "machinery." As each class of work is completed each foreman marks on the board in the proper column and opposite the particular locomotive number his "O. K.," indicating that his work on the locomotive has been completed. When all the spaces opposite a locomotive number are marked "O. K.," it is evident that the locomotive is ready for service. The record is erased as soon as the locomotive is taken out of the house. The convenience and dispatch with which these records can be made are important factors.

Contrary to the previous practice of requiring the locomotive crew to do some cleaning, fill oil cups, and in general look after the outfitting of the locomotive, the present tendency, and it is pretty well established, is for the engine house force to outfit each locomotive completely for service on the road. There remains for the crew, of course, the responsibility to know that the necessary repairs and outfitting have been done, even though the locomotive is delivered to them at the station.

It remains for the despatcher to know what locomotives and crews are arriving, and to care for the proper despatching of locomotives and crews.

Pooling.

Some years ago it was the general practice to assign a locomotive to a crew and both crew and locomotive to particular runs, and when the locomotive was taken to the shop for repairs the crew worked in the shop until the repairs were completed, usually devoting much, or all, of its shop time to its locomotive. At that period there were few extra passenger runs and the freight runs were very largely scheduled runs, under which conditions it was easy to assign locomotives to crews and crews to runs, keeping each crew on its particular locomotive and run. As the maximum freight service increased and the fluctuation between maximum and minimum freight service widened, it became necessary to move a large proportion of the freight trains as extras, which made it quite impossible to assign crews and locomotives to runs not scheduled. It was also necessary to increase or to decrease the number of locomotives in proportion to business demands, which could be done only by withdrawing locomotives from service, during which time there would be only the interest and depreciation charges on them.

As a result a plan was developed to increase the service of the locomotives by placing any crew on any locomotive for service, instead of holding it until its assigned crew could obtain the necessary rest. While this prevented the assignment of locomotives to crews it made possible a larger individual locomotive mileage per month or per year. The first experience with this arrangement in freight service seemed so satisfactory that it promised well for passenger service, to which it was extended, so that a locomotive used one day on one train would be used the next day on a different train, permitting the operation of a certain number of trains per day with greater or less number of locomotives than trains. The idea, of course, was to operate a number of trains with a less number of locomotives.

The criticism most generally made upon this system is that the personal interest which the man had originally in his own locomotive is lost. This has been valued very highly by some officials, more particularly those of the motive power department, and less highly by others, usually of the transportation department and more particularly those who are not so well versed with the trials and tribulations of the motive power department. Under the pooling system the effort of the average crew is to get through with the particular locomotive as quickly and as easily as possible and to let the next crew get along as best it can.

Such conditions necessitate careful watching of the reports from the enginemen so that everything that the engine house inspectors cannot well find is included, and also careful inspection and repairing at the engine houses. It may make necessary also an additional expense per locomotive for wear and tear, as some argue, and at the engine houses, as others argue; but whatever the cause or amount, this additional expense is the cost of getting the additional mileage per locomotive per month or per year, and it is a question of whether the cost is more than offset by the gain. The argument that it is as well to get the mileage-life of a locomotive in fifteen years as in ten neglects the fact that possibly 50 per cent more locomotives will be required if it is gotten in fifteen years than if in ten years, with a resulting interest charge.

Possibly, also, those who hearken back to the times of assigned locomotives and crews and picture to themselves the enginemen setting box wedges and rod brasses, adjusting the piston rod packing and doing a long list of other work overlook the difference in the size of the parts of present and past locomotives, and that a crew even if it knew a certain work was required and was willing would be unable to do it, at least alone. Extensive experiments have been made to determine the relative costs of the assigning and the pooling systems and in some of these experiments at least, no material difference in cost has been found. However, there may be, and probably is, some loss in reliability of service in pooling.

The fundamental idea of pooling is to obtain from each locomotive the maximum mileage per month or per year, in other words to keep the locomotive going, and various schemes have been devised to accomplish this and to obtain at the same time any advantages there may be in the personal interest of a crew in its own locomotive. One of these is to assign one locomotive to two or, at times, three crews, each crew making a round trip from terminal to terminal. A variation is to change the crews about midway in the trip; this has some decided advantages, the principal one being that a fresh crew is obtained at the beginning of each quarter of a round trip, or each half of a single trip, and while the rest at each terminal is not of long duration, yet it means much to the crew, especially in hot weather; also, inasmuch as the crew is not at home at the divisional terminal, the men are anxious to start back so that they may reach home. To work out satisfactorily this system of changing crews at the middle of a division, it is necessary that the divisions be so arranged, or of such length, that there shall not be too much constructive mileage for the crew; that is, that the mileage for which the crew is paid shall not be materially less than the actual mileage made by it.

Since it is quite certain that a locomotive in proper condition for service can be used a greater number of miles or hours per week or per month than one crew is able to stand, it would seem to be good policy to get full returns in some way and not limit the output in miles or in hours service to the capacity of the crew; on the other hand, the men must be given proper consideration and be permitted to make fair wages. The pooling of locomotives and of crews in the different kinds of service makes it possible to use each locomotive the maximum number of miles in a certain period of time, which maximum will be about the same as for any other locomotives in the same service, granting, of course, that nothing serious goes wrong with it; it also makes possible maximum and equal earnings by men of physical equality.

The assigning of one locomotive to one crew limits the output obtained from the locomotive during a month or a year to the capacity of the crew; assigning one locomotive in road service to two or more regular crews need not limit the output of the locomotive, but may place the earnings of the crew below its ability and below average earnings for similar work. In yard service it is possible and is the general practice to assign one locomotive to two crews. If in road service one locomotive is assigned to two or more crews, the run should be arranged to permit each crew fair earnings. Another variation of the pooling system is to assign two locomotives to three crews, to which resort may be made when two crews on one locomotive cannot make the average earnings.

It will be noted that the original idea of pooling was to obtain maximum mileage from the locomotives, which resulted, apparently, in taking from the crews and placing upon the engine house a large part of the responsibility of the condition of the locomotives; then appeared variations which had in view this original idea, coupled with the effort to place upon the crews at least a part of the responsibility for the condition of the locomotives taken from them or voluntarily given up by them under the straight pooling system; each arrangement having in mind a fair earnings return to the crews.

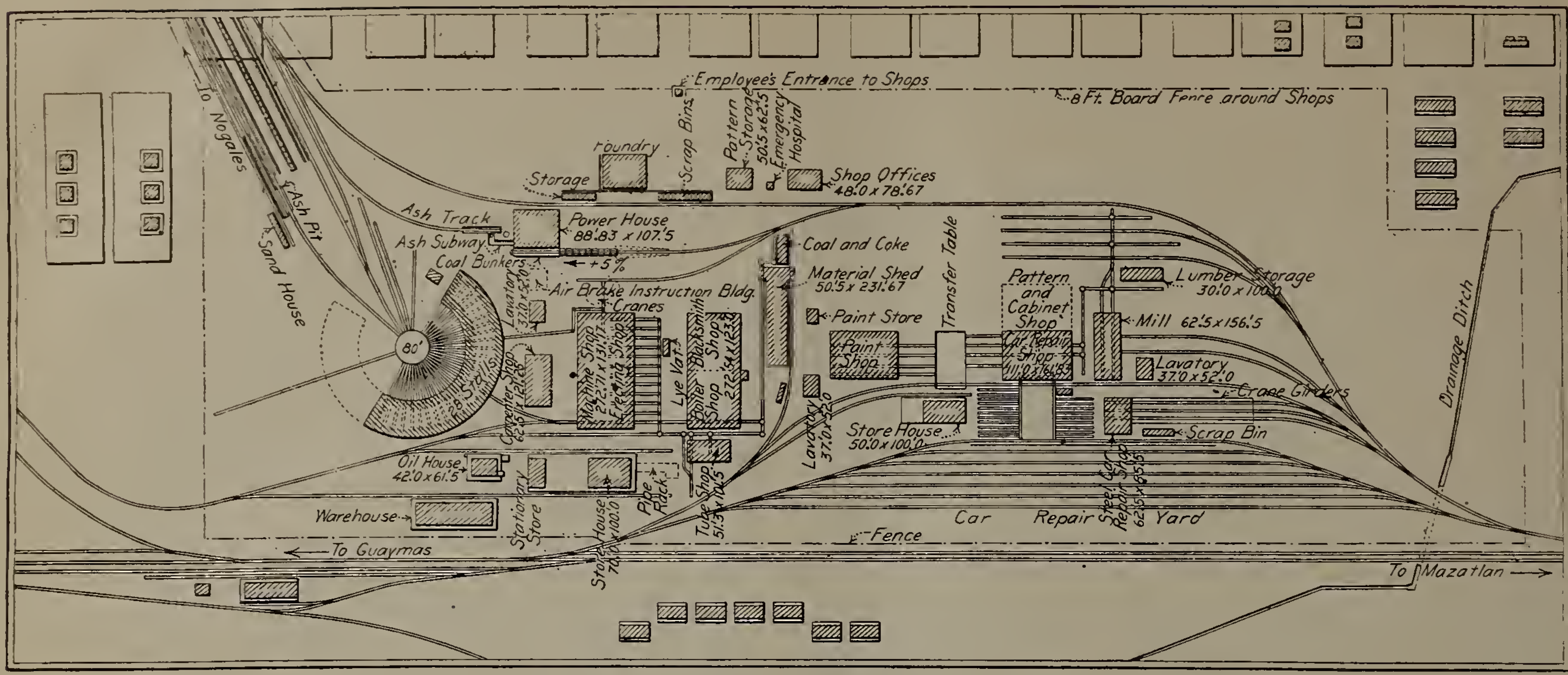
Shops of the Southern Pacific at Empalme, Mex.

The new Empalme car and locomotive shops of the Southern Pacific Co., plans for which were started in 1907, were recently completed. These shops are designed to handle all general repairs for the Southern Pacific R. R. of Mexico and the Sonora Ry., the location of the shops being equally convenient for both Southern Pacific lines. The number of locomotives operated by these two roads totals only about 86 in number, and it will be noted that the capacity of the locomotive repair section of the shops is ample for a considerable growth in motive power.

The accompanying plan shows the purpose of all of the buildings and gives the dimensions of the principal ones. The 28-stall engine house, the machine and erection shop, the boiler and blacksmith shop, the foundry, and all those parts of the plant tributary to locomotive repairs have been grouped close together in the west end of the shop grounds, and convenient to the tracks entering the plant both from Nogales and Guaymas. The buildings which are concerned with car repairs occupy the eastern half of the shops, adjacent to the car repair yard. The plan shows the tracks for communication between all of the buildings.

The first building erected was the roundhouse, which was constructed of stone obtained from the company's quarries 2½ km. from Empalme. This construction indicated that concrete would be more economical than stone and accordingly plans were made for its use in the other buildings. These, in general, have concrete walls with pilasters carrying steel roof trusses, but the largest building, the machine and erecting shop, has a complete steel frame with concrete curtain walls. Factory ribbed glass was used throughout the plant and the roofs were covered with three-ply composition roofing, of saturated felt, asphaltum and gravel.

The machine and erecting shop measures 131.2x272.7 ft. in plan and is divided longitudinally into two bays, the one used



Layout of Empalme Shops, Southern Pacific Co.

by the machine shop measuring 53 ft. 7 ins. in the clear and the one occupied by the erecting shop 63 ft. 4 ins in the clear. The machine shop is commanded by a 15-ton crane, the crane rail along the wall being carried upon an independent line of columns but the other rail upon brackets on the central line of building columns. The erecting shop is commanded by a 100-ton crane carried on two lines of girders supported on columns independent of those of the building frame but connected thereto by diaphragms. Each bay is surmounted by a monitor running its full length.

Previously to starting the construction a test of the soil was made in order to determine the permissible foundation load. This showed that it would be necessary either to put in large spread concrete footings under the piers of the larger buildings having traveling crane loads or to drive concrete piles. The latter plan was adopted because if the former had been used it would have been necessary to carry the spread footings below filled ground, or an average depth of 8 ft. below the finished grade. Sixteen-inch Simplex concrete piles were therefore driven in clusters to an average depth of 16 ft. under the wall and crane columns in the machine and erecting shop and in the boiler and blacksmith shop.

The erecting shop contains 12 concrete engine pits. The machine shop has a shallow basement, for electric wiring in connection with machines, in which the floor is of concrete, the main floor being carried on low concrete piers 13 ft. on centers, in one direction and 14 ft. in the other. These piers support the longitudinal girders consisting of two 8 x 16-in. timbers carrying the 3 x 12-in. joists upon which the 3-in. plank flooring is laid. In order to bring engines into the erecting shop a through track is laid through both shops at the south end.

The steel building and crane columns are spaced 22 ft. on centers longitudinally and all building columns except those in the central row are enclosed in concrete. The concrete curtain walls are 12 in. thick, and where carried over the windows are reinforced with corrugated bars in their lower elements. This building and the boiler and blacksmith shop containing about 750 tons of steel which was fabricated and erected by the Llewellyn Iron Works, of Los Angeles, Cal.

The boiler and blacksmith shop is housed in one building having concrete walls and a steel truss roof, each occupying half of the structure.

The foundry likewise has concrete walls and a roof carried upon steel trusses. It contains a main casting room, measuring 55x 78 ft., a 32 x 55-ft. brass foundry and brass cleaning room, a 19-ft. 10-in. x 27-ft. general cleaning room, a 19-ft. 10-in. x 47-ft. core room and a 19-ft. 10-in. x 24-ft. cupola room. The last three are side by side along one of the walls and are divided from each other and from the casting rooms by 12-in. concrete walls. The main casting room and the brass foundry are divided by a wire fence having a concrete base. The cupola house has three stories, connected by an elevator. The second floor is the fan room and the third the charging floor, the former having a concrete floor, carried by steel I-beams and the latter a checkered steel floor with the same type of support. Provision is made for two cupolas, but only one has now been installed.

The main material shed, besides shelving for storage, contains bolt cutting and similar machines. It is a structural steel frame building with a covering of corrugated iron.

The shop marked in the drawing "carpenter shop" is in reality devoted to a variety of purposes, accommodating the copper, the pipe, the carpenter and the electrical shops.

The oilhouse has a deep basement and a main floor and is surrounded entirely by a 10-ft. platform. The basement contains the oil tanks which can be filled direct from the cars through hose connections outside the building. From these connections pipes are carried to the tanks. The main floor is used for the storage of the higher grade oils and the pumps for the tanks below. Provision is made by means of ventilating flues for removing oil fumes from both floors.

The location of the various buildings of the car repair department is shown on the layout. A yard crane extends out from the steel car repair shop and serves three tracks. The runway is about 300 feet long.

All machines throughout the shop are individually motor driven with the exception of group drives in the tool room.

The shop area is enclosed with an 8-ft. tight board fence with barbed wire at the top. All employees are checked in and out at the same entrance.

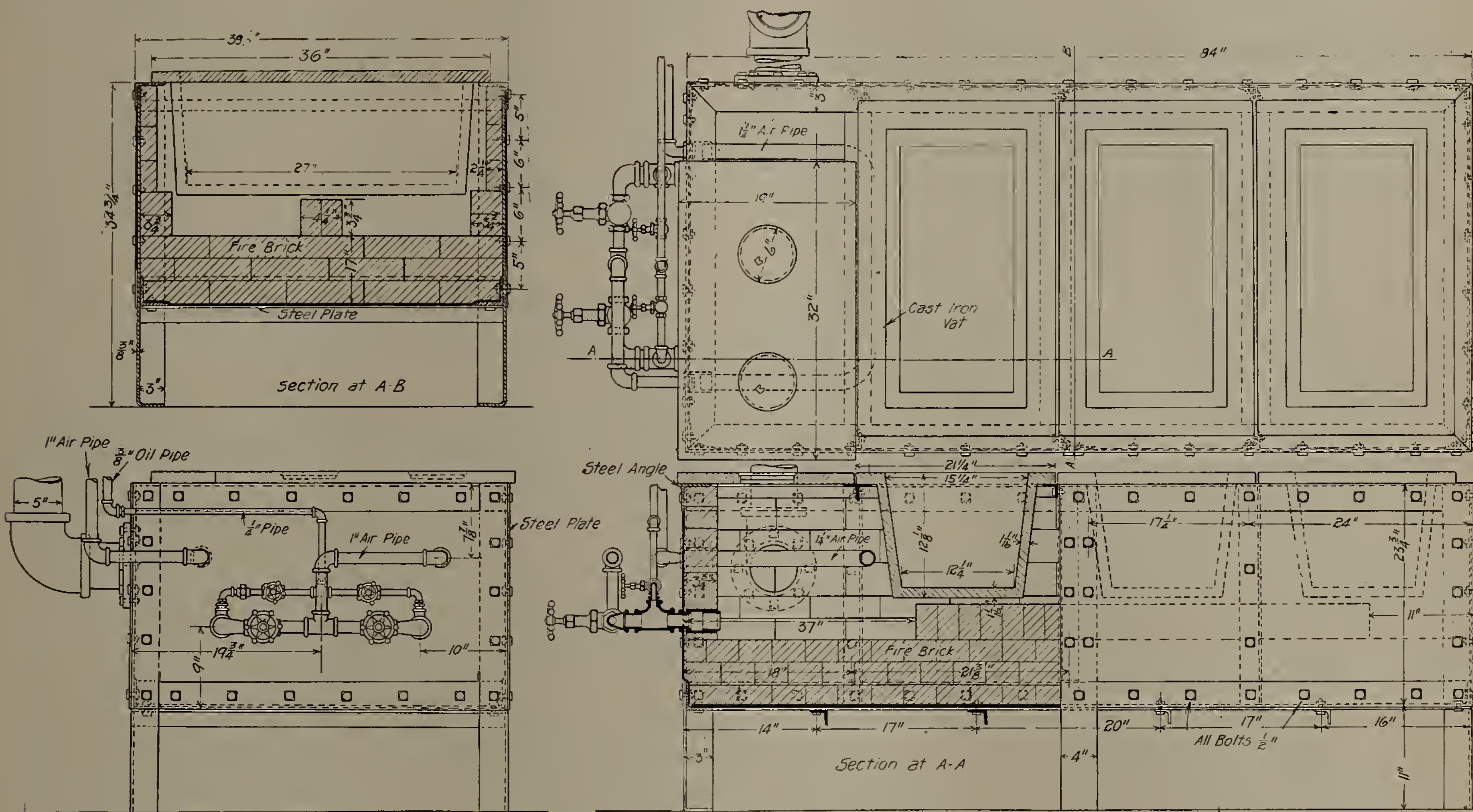
The Fairview & Oklahoma City Ry. Co. has been chartered with $100,000 capital stock, to build a line from Fairview to Rusk, Okla., four and one-half miles. The incorporators are O. E. Snyder, of Oklahoma City, president; H. A. Noah, secretary; M. M. Fulkerson, treasurer, both of Alva; W. D. Bowling, H. A. Bower, H. Clay Willis all of Fairview, vice-presidents; W. B. Noble, Alva, and S. B. Moore, Oklahoma City.

Locomotive Testing Plant Presented to University

Upon the recommendation of Robert Quayle, superintendent of motive power and machinery, and with the approval of W. A. Gardner, vice-president, the locomotive testing plant of the Chicago & North Western Railway has been presented to the University of Illinois. Under the immediate direction of H. T. Bentley, assistant superintendent of motive power and machinery, it has been taken from its foundation, the bearings and other running parts have been put in good order for service, and the plant with all the special patterns used in its construction has been loaded and shipped to the University of Illinois. It is understood that the plant will be held by the University pending the construction of its proposed transportation laboratory.

The plant was designed under the general direction of Mr. Quayle aided by E. M. Herr, now vice-president and general manager of the Westinghouse Electric & Manufacturing Co., but at that time assistant superintendent of motive power and machinery. The drawings were developed under the immediate direction of E. B. Thompson, now superintendent of motive power and machinery of the Chicago, St. Paul, Minneapolis & Omaha Railway, but who at that time was chief draftsman. Mr. Quayle had been made chairman of the Master Mechanics' committee on Exhaust Pipes and Steam Passages, and sometime before while master mechanic at South Kaukauna, Wisconsin, had improvised a testing plant by lengthening out the members of a passenger-car truck to make the wheel spacing agree with that of the drivers of the locomotive he desired to test, and by mounting this truck bottom side up in a pit in such manner that he could run a locomotive upon it. Encouraged by these earlier experiments he later advocated the testing of locomotives at the Fortieth Ave. shops. The result was the plant which is now being sent to the University of Illinois. The proceedings of the Master Car Builders' Association will show that the North Western plant was an important factor in the development of several committee reports dealing with the design of exhaust pipes, steam passages, draft pipes and stacks. The plant was found useful also in working out various other problems of more immediate interest to the Chicago & North Western Railway. In recent years it has been idle.

The plant consists of foundation plates, pedestals and three pairs of axles with their bearings, supporting wheels, friction brakes, etc. It was the first of its kind to be supplied with permanent mounting rails, by use of which a locomotive could be rolled on or off the wheels without resort to temporary blocking. It is announced by Dean Goss of the College of Engineering, that the plant at the University will constitute a portion of the equipment of the School of Railway Engineering and Administration, and that when installed it will be operated under the immediate direction of Professor Edward C. Schmidt, in charge of Railway Engineering.



Soft Metal Furnace, Beech Grove Shops.

Shop Kinks at Beech Grove Shops

Since the publication, in the January and February issues of the Railway Master Mechanic, of the descriptions and drawings of a large number of shop kinks in use at the Beech Grove shops of the Cleveland, Cincinnati, Chicago & St. Louis Ry., Mr. M. J. McCarthy, shop superintendent, has supplied us with the data on several additional devices which are fully as important and valuable as those illustrated heretofore.

One of the accompanying illustrations shows a very efficient furnace for melting soft metals such as babbitt. The furnace consists of three large oblong vats and one heater plate supported by angle iron forming the entire top of furnace. The interior is walled with fire brick and is made with a ridge wall extending through the center lengthwise of furnace, allowing 15-inch space at each end and rising within one inch of the bottom of the vats. A 1½-inch air supply enters the furnace at the heater plate end and passes around that space and comes out at the center of the end of the furnace, then dividing and extending both ways to the operating air valve; ⅜-inch oil lines piped to a "T" and reduced to ¼ inch both ways, enter respective "T's," where hot air and oil mix for furnace heat. Although the furnace has two burners, one only is used for fire, while the other is used for air, to form a resisting current against the opposite burner. By regulating this air valve, combustion can be confined at various points of the furnace where the greatest heat is desired. By just cracking the air valve and giving a greater volume to oil and air valves on opposite side a flame can be made to extend entirely around the furnace, for general heat. This develops a feature not often seen in fuel oil furnaces; that is, the directing of the oil against a volume of air instead of against an obstruction.

The second drawing illustrates a swager for copper ferrules. Its operation and construction are at once evident. It is run on compressed air direct from the shop air lines, of course.

Another drawing illustrates a portable punching and shearing outfit. This device saves the transporting of large quantities of work from different parts of the shop to the stationary punch and shears. It is of sufficient capacity to handle a large part of the small work in the boiler and machine shop. Several of these outfits would be of great value in almost any railroad shop.

Another of the drawings shows plainly a small lathe crane which is of great assistance when mounted on the larger lathes. The drawing shows the crane as used for mounting a heavy chuck on the spindle. Other uses will suggest themselves as occasion demands.

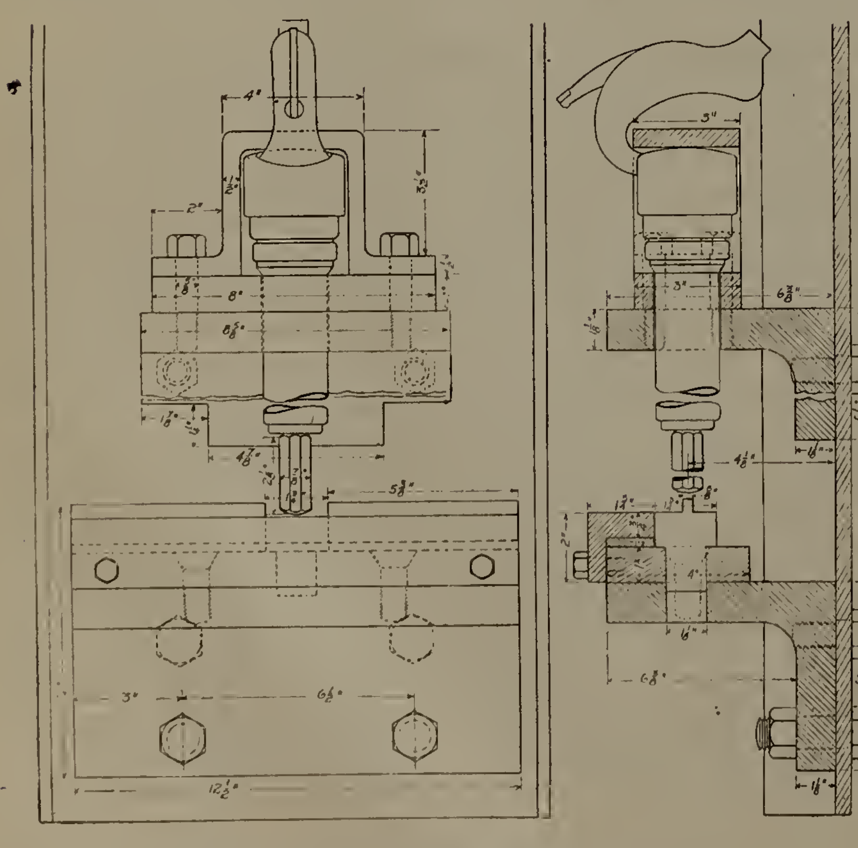
Mechanical Stokers*

In compiling its report on Mechanical Stokers, the committee decided to briefly refer to the progress and development of stokers reported upon by previous committees, and to describe the stokers which have not previously been dealt with in the reports.

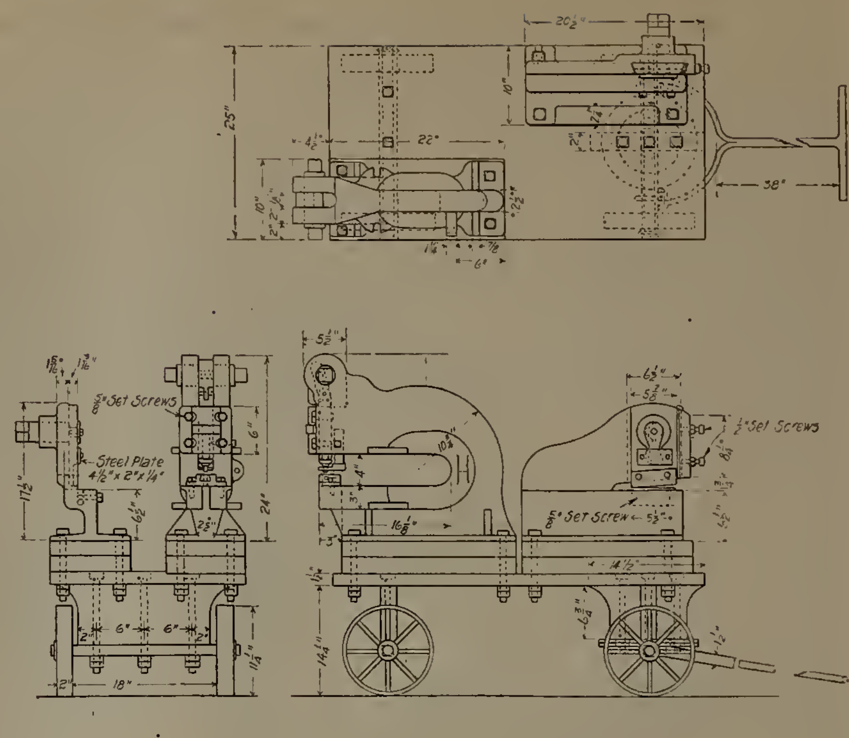
Crawford No. 8 Mechanical Stoker.

The general form of the stoker is shown by accompanying illustrations. All the mechanism of the stoker is operated by a single steam cylinder, including the conveyor from the tender.

*Report of Committee of the American Railway Master Mechanics' Association.



Pneumatic Swedger, Beech Grove Shops.

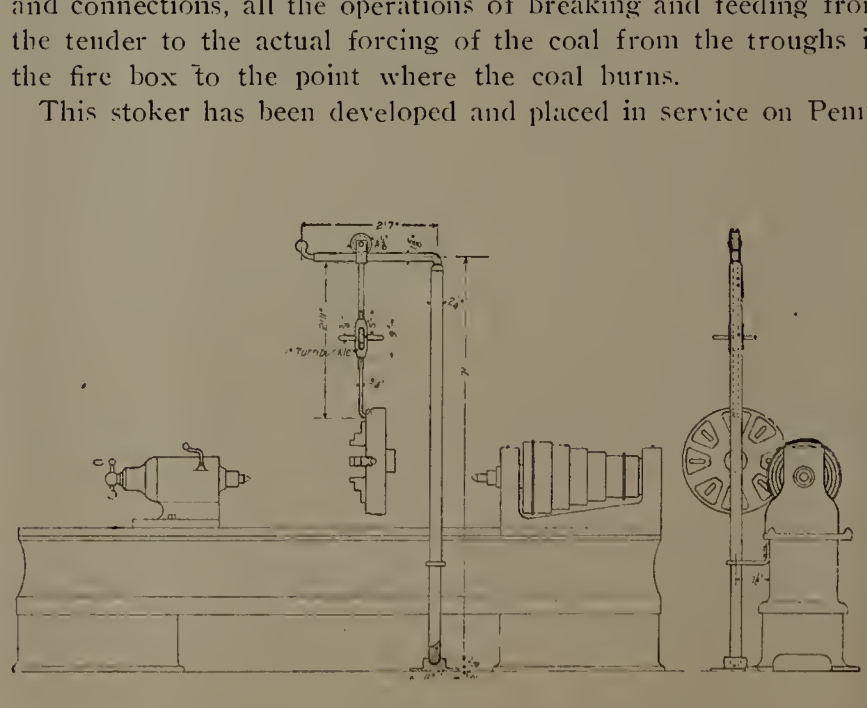


Portable Punch and Shears, Beech Grove Shops.

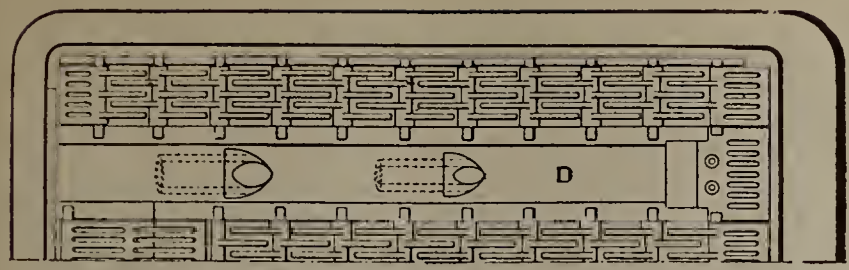
The coal is fed from the tender through an opening in the floor and is then handled by a feeder and breaker sliding backward and forward in the direction of the center line of the tender. This is not a crusher, but has a limited opening, and is provided to prevent large lumps having access to the conveyor beneath.

Inside of the conveyor, and at eleven points, are placed rake fingers operated from a bar above and extending nearly to the bottom of the trough, and having such a movement as to drag over the coal in moving backward and scraping the coal toward the locomotive in its forward movement. From the conveyor the coal is led to a point directly beneath the deck plate of the locomotive back of the boiler and dropped into a space where it is pushed by plungers under the mud ring and into two troughs longitudinal to the fire box and below the surface of the grates. In the bottom of the troughs are additional feeders for conveying the coal to the middle or forward portion of the grate. The plunger or feeder first taking the coal feeds it principally to the back end of the grate, and the additional feeders carry it forward. The arrangement of these feeders is such that their number can be increased so as to get the desired distribution of coal. The operation of the steam cylinder is controlled by a small valve in the cab, which is operated by the fireman. As already stated, one steam cylinder performs, through a system of levers and connections, all the operations of breaking and feeding from the tender to the actual forcing of the coal from the troughs in the fire box to the point where the coal burns.

This stoker has been developed and placed in service on Penn-



Radial Lathe Crane, Beech Grove Shops.



Half Plan of Grates for Crawford Stoker.

sylvania Lines locomotive No. 8592, class "H6b," the principal dimensions of which are as follows:

Diameter of driving wheels	56 inches.
Wheel arrangement	2-8.
General class	Consolidation.
Cylinders, diameter	22 inches.
Cylinders, stroke	28 inches.
Type of boiler	Belpaire wide fire box.
Number of tubes	373.
Outside diameter of tubes	2 inches.
Length between tube sheets	164½ inches.
Great area	49.4 square feet.
Total heating surface of boiler	2,844 square feet.
Steam pressure	205 pounds per square inch.
Weight of engine in working order	202,000 pounds.
Weight on drivers	179,000 pounds.
Weight of tender	143,000 pounds.
Ratio of heating surface to grate area	57.99.
Tractive power with M. E. pressure equal to 80% boiler pressure	39,588 pounds.
Ratio weight on drivers to tractive power	4.51.

There have been about sixty runs made with this locomotive between Columbus and Dennison, Ohio. The coal used is that known as the Panhandle coal, mined west of Pittsburg, and also the Indiana coals have been employed. The distance between the two above-named points is 100 miles, the time of the run varying from four to nine hours.

The steam pressure in all tests was good, being probably about 203 pounds, with a few exceptions, when a slight derangement of the stoker existed. There were, out of these trips, 43 made where there was no hand firing whatever. There has been as much as 5,200 pounds of coal fired per hour, about 17,000 pounds of coal being used on the trips with preference trains.

Smoke from the locomotive has been entirely absent while the stoker was in operation, with the exception that smoke appeared at the stack when the fire was hooked or scraped and when the grates were shaken. The extent of the smoke under these circumstances was about the same as with hand-fired locomotives, but smoke was entirely absent unless this work was being done. After the operation of hooking or shaking the grates the smoke entirely disappeared within a few hundred feet.

The time required to get the fire in condition so that it can be handled by the stoker, before the beginning of the trip, is practically the same as with the hand-fired locomotives. The fire must be started in the usual way and sufficient coal put on the grates by hand while the engine is waiting for its train. As soon as starting with the train, the stoker is put into operation and thereafter handles the fire entirely without the aid of the fireman, except that necessary for occasional hooking or scraping and the shaking of the grates. The control of the fire through the stoker mechanism is absolutely satisfactory, the fireman controlling the movement of the conveyor and stoker through one valve in the cab and allowing the stoker to move as many strokes as the fire indicates, or required to supply the necessary coal. The stoking is intermittent. Each movement of the operating steam cylinder delivers about two shovelfuls of coal to the fire. The blowing of the safety valve during the runs made was not greater than with the hand firing, and, in general, the control of the fire is quite as satisfactory as with hand firing.

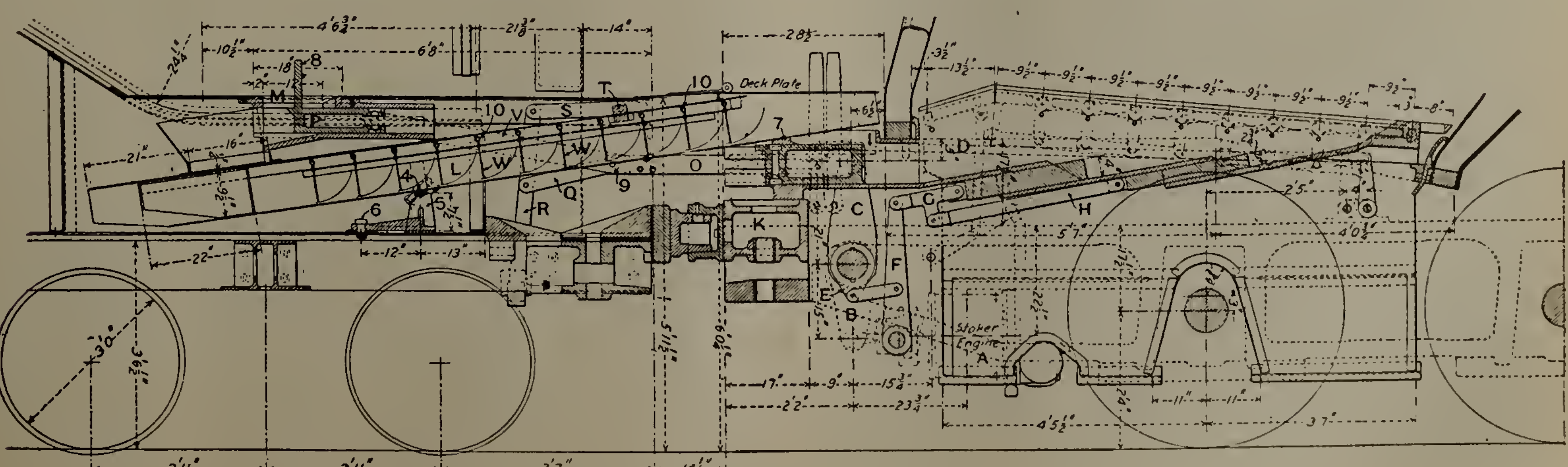
The cleaning of fires at the end of the trip is performed by dropping the back drop grates, and no difficulty is experienced in hauling the fire back and discharging through these openings. The fire is then leveled off and banked in the usual way. As showing the comparative work done in hooking and shaking the grates, a record was kept, showing for one run that the hook was used with any locomotive and with hand firing, 13.8 times over the run, and with the stoker the hook was used 14.2 times. The shaking of the grate with the hand-fired locomotives of the same class and over the same distance occurred 11 times and with the stoker 13 times. As to the coal consumption, no accurate figures have yet been determined in order to compare the performance with average firing.

Barnum Stoker.

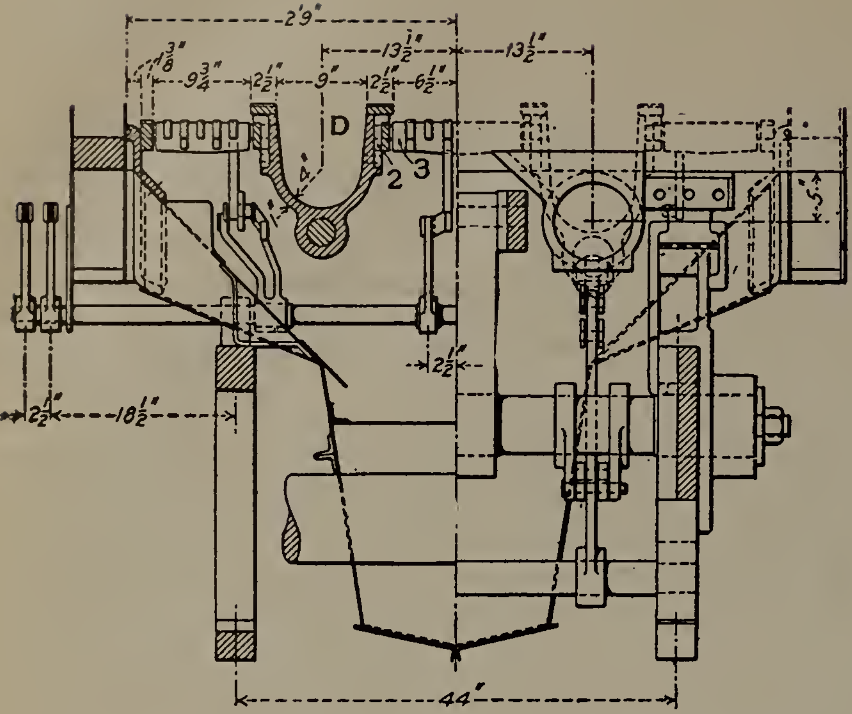
The Barnum stoker being experimented with on the Chicago, Burlington & Quincy Railroad has not yet reached a state of development which would warrant its general application, and your committee has been informed that, on account of increased demands for locomotive service, the stoker was removed from the locomotive during the winter months. Further tests and experiments will be continued during the summer of 1910.

Dodge or Black Stoker.

This stoker, which is under investigation by the Erie Railroad, developed several defects in design, the most important being the heating of the bearings of the distributing blades, which was so severe that lubrication was impossible, resulting in excessive wear. The blades were moved back to overcome this difficulty, but in the new position the effectiveness of the coal-spreading device was greatly impaired, thus necessitating further modification, the results from which are not available for this report.



Crawford Stoker and Coal Conveyor.



Cross Section Showing Application of Crawford Stoker.

Hayden Stoker.

This stoker, in operation on the Erie Railroad upon five locomotives of similar type as the one on which test was made, is, apart from changes to improve effectiveness and reliability, the same as described in your committee's report of 1909. The changes brought about material improvement and the results of test forming part of the report indicate improved efficiency. It will be noticed in the accompanying data that the equivalent evaporation per pound of combustible showed a loss, in comparison to hand firing, of 1.22 per cent east and .89 per cent west. A comparison on the basis of combustible per ton-mile showed 14 per cent less east and a saving of 5.15 per cent on the westbound test, while on a basis of combustible per draw-bar H. P. H. the stoker showed a loss of 5.6 per cent east and 4.6 per cent west. In view of the fact that identical tests will show a variation of this amount, it is taken that the stoker showing is at least hopeful.

Dimensions and Proportions of Locomotive Equipped with Hayden Stoker.

Kind of engine	2-8-0.
Type of boiler	Straight top.
Type of fire box	Wide.
Cylinders	R. 22⅝ inches, piston rod 3 29-32 inches, L. 22 0-16 inches.
Strokes	32 inches.
Grate surface	54 square feet.
Heating surface	3,358 square feet.
Ratio H. S. to G. S.	62.2.
Area exhaust nozzle	15.98 square inches.
Diameter of drivers	62 inches.
Weight on drivers	176,400 pounds.
Weight of tender loaded	137,000 pounds.
Weight of engine	200,700 pounds.
Total weight of engine and tender	337,700 pounds.
No. of flues	380 2 inches by 10 feet 0 inches.
Tractive power 80 per cent B. P.	40,034 pounds.
Kind of valve	Richardson balanced.
Kind of coal	Dagus nut and slack.

The Street Locomotive Stoker.

The Street locomotive stoker, as designed by Mr. Clement F. Street, of Cleveland, Ohio, has been in experimental service on the Lake Shore & Michigan Southern Railroad continuously since the first of May, 1909. The general construction of this device is shown in the accompanying illustrations, in which Fig. 1 is reproduced from a photograph of the rear end of the locomotive, Fig. 2 is a view of the interior of the cab, Fig. 3 a view of the front end of the tender. These illustrations show the stoker as applied to New York Central Lines locomotives Class G046-C, which is of a 2-8-0 type, and of which the following are some of the important dimensions:

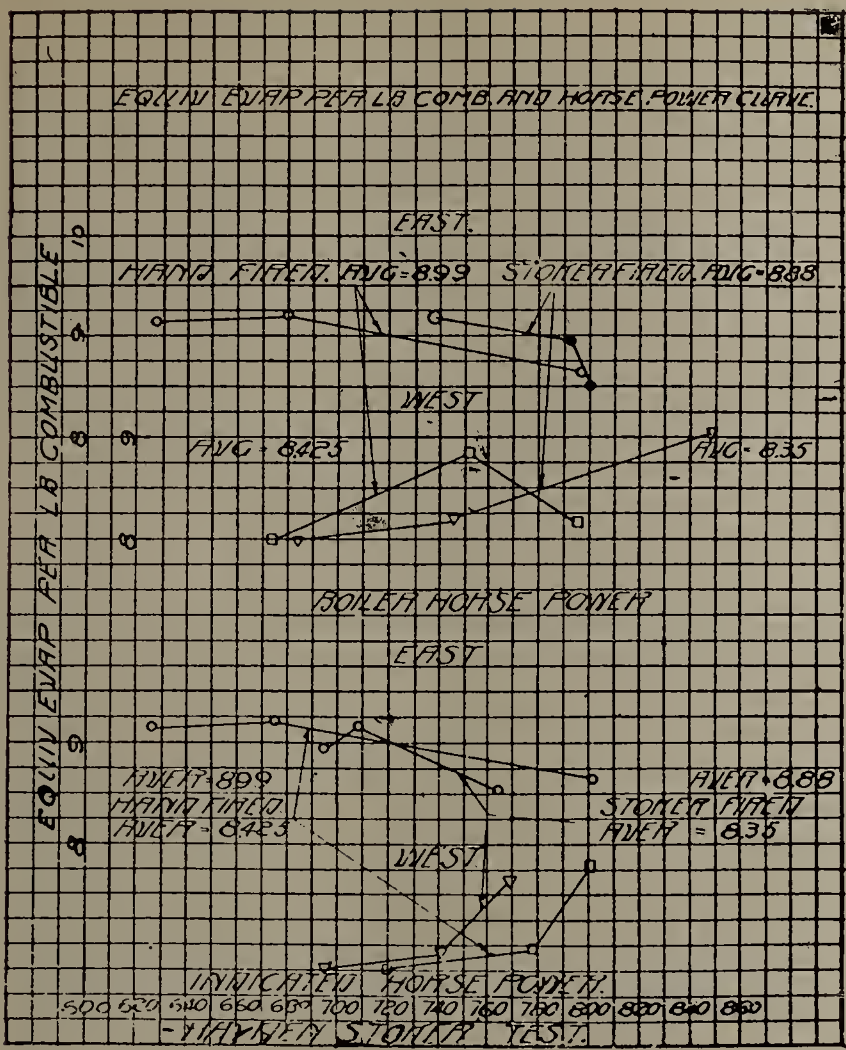
Cylinders	23 by 30 inches.
Fire box	108 by 73 inches.
Grate surface	55 square feet.
Number of tubes	460.
Length of tubes	15 feet 6 inches.
Heating surface total	3,957 square feet.
Heating surface fire box	232 square feet.
Diameter of drivers	57 inches.
Weight of drivers	210,000 pounds.

SUMMARY.

	Hand.	Stoker	Difference in Percent of Hand Firing	Hand.	Stoker.	Difference in Percent of Hand Firing
Average running time	7.8892	7.231	.....	8.855	8.29	.....
Number miles run	135	128	.....	135	135	....
Average ton-miles	316,134	301,160	. .	313,837	306,281	....
Ton-miles per hour	38,466.6	41,780	...	35,390	36,960	.....
Average steam pressure	191.59	192.20	. .	191.68	190	....
Lbs. fuel consumed, dry coal	25,130	24,766	...	306,080	29,143	....
Lbs. water evaporated	163,921	161,280	......	192,306	176,919	....
Lbs. water evaporated per lb. of fuel	6.47	6.52	....	6.195	5.960	.. ..
Weight of ash	3,452	3,286	......	3,504	4,218	...
Percent of ash	13.77	12.82	....	11.54	14.41	......
Lbs. combustible consumed	22,090	21,960	.....	27,396	25,449	.....
Lbs. water evaporated per lb. of combustible	7.44	7.476	.484	7.01	6.96	.713
*Lbs. water from and at 212° F. per lb. combustible	8.99	8.88	1.22	8.425	8.35	.89
Average temperature feed-water	38.4	36.42	....	39.72	37.2	.....
Combustible per square foot heating surface per hour	.8035	.9010	.. ..	.9220	.912	.....
Combustible per square foot grate surface per hour	49.95	55.98	...	57.59	56.7	.....
Equivalent evaporated per square foot heating surface per hour	7.21	7.985	....	7.782	7.61	.....
Lbs. dry coal per ton-mile	.07962	.0826	..	.0993	.0956	.....
Lbs. dry coal per indicated horse-power	4.356	4.716	...	4.51	4.80	.....
Lbs. dry coal per dynamo horse-power hour	5.28	5.538	.....	5.55	5.76	....
Lbs. combustible per ton-mile	.0642	.0732	14	.0875	.0830	5.15
Lbs. combustible per indicated horse-power hour	3.83	4.19	9.4	3.90	4.17	6.9
Lbs. combustible per dynamo horse-power hour	4.99	4.91	5.6	4.79	5.01	4.6
Lbs. equivalent evaporated per ton-mile	.629	.648	..	.737	.699	.....
Lbs. equivalent evaporated per hour per indicated horse-power	34.46	37.12	7.7	33.90	34.8	2.6
Lbs. equivalent evaporated per dynamo horse-power	41.82	43.54	4.15	41.67	41.8	.31

NOTE.—*See curves.

Comparative Performance Test Between Susquehanna and Hornell. Hayden Stoker, Engine 1654.



Curves Showing Results of Tests, Hayden Stoker.

Weight of truck ....30,000 pounds.
Drop bar pull ....49,100 pounds.

This stoker is of the scatter type, in which crushed coal is driven into the fire box by steam jets. It consists essentially of three parts, namely, a crusher, an elevator and a distribution system. The crusher is located on the tender, a small section of the water bottom being cut to accommodate it. It is of the swinging-jaw type, and the opening is on a level with the tank floor so that the coal can be scraped into it without being lifted. The crusher will take "run of mine" coal with lumps up to 8 by 10 inches and reduce them to a size which will pass through a slot about 1½ inches in width. It is driven by a single-acting steam engine bolted rigidly to the crusher and direct connected thereto. The coal, after being crushed, slides by gravity through a boiler-iron trough pivoted to the tender, into a hopper located beneath the deck plate of the locomotive secured thereto and forming the lower end of the elevator casing.

The elevator consists of a double endless chain with drop-forged links, and having malleable-iron buckets riveted thereto. This chain travels in a casing made of gas pipe of standard dimensions. The upper end of this casing is secured firmly to the boiler head and the lower end to the deck plate. At the upper right-hand corner the elevator passes over a steel sprocket wheel which forms the drive. This wheel is, through a worm, driven by a small steam engine bolted to the boiler head.

The coal is discharged from the elevator at a point centrally on the boiler head directly above the fire door. It falls through a distributor hopper into three distributors, one of which is located centrally and each of the other two on the side, and all above the fire door. From these distributors it is, by means of the distribution system, spread over the grates. The distributors are made of cast iron, extending through tubes which are rolled and beaded into the back head of the boiler and the fire-box sheet. Each distributor is fitted with a steam nozzle, through which a blast of steam is admitted intermittently for driving the coal into the fire box. A discharge regulator is provided, which, when moved to the right, will give a heavy fire on the right side of the grate, and, when moved to the left, will give a heavy fire on the left side of the grate. The distributor hopper is provided with a deflector, by movement of which the major proportion of the coal can be fed to the center or the slide distributors as desired.

The experiments have shown that accurate adjustment of the above is not essential. While a considerable change in the position of the reverse lever will affect the distribution, a movement of three or four notches makes no perceptible difference.

The steam engines running at a constant speed are both fitted with shaft governors enclosed in a crank case, and the lower end of the connecting rod and valve rod are the only adjustable bearings. The only attention these engines require is the introduction of a small quantity of oil in the crank case every three or four days. The only other parts of the stoker requiring attention are the three bearing on the crusher and two on the elevator, which require oiling once a day.

It is, of course, desirable to do away with the crusher, and have crushed coal delivered to the tender, as this will reduce the number of working parts of the stoker. The crusher is provided with a relief spring which makes a breakage impossible, and the elevator is made sufficiently strong to stop the engine which drives it without breakage.

With crushed coal on the tender a screw conveyor will be used for carrying it to the locomotive. This conveyor will be protected by a wire netting which will make impossible the introduction of any thing which can not be handled by the elevator and the distributors. The screw conveyor will be driven by the elevator engine, which will be the only engine used with this type of stoker. The claims made for this stoker are, first, its non-interference with the fire door; second, the simplicity of its construction; third, the ease with which it is operated; fourth, the control it gives the fire; fifth, fuel economy.

The fact that this stoker does not in any way interfere with or obstruct the fire door makes is possible for the fireman at any time to inspect his fire, use the hook, or supplement the work of the stoker by hand firing. Should the stoker fail, or

Fig. 1.—Street Stoker in Cab of Locomotive.

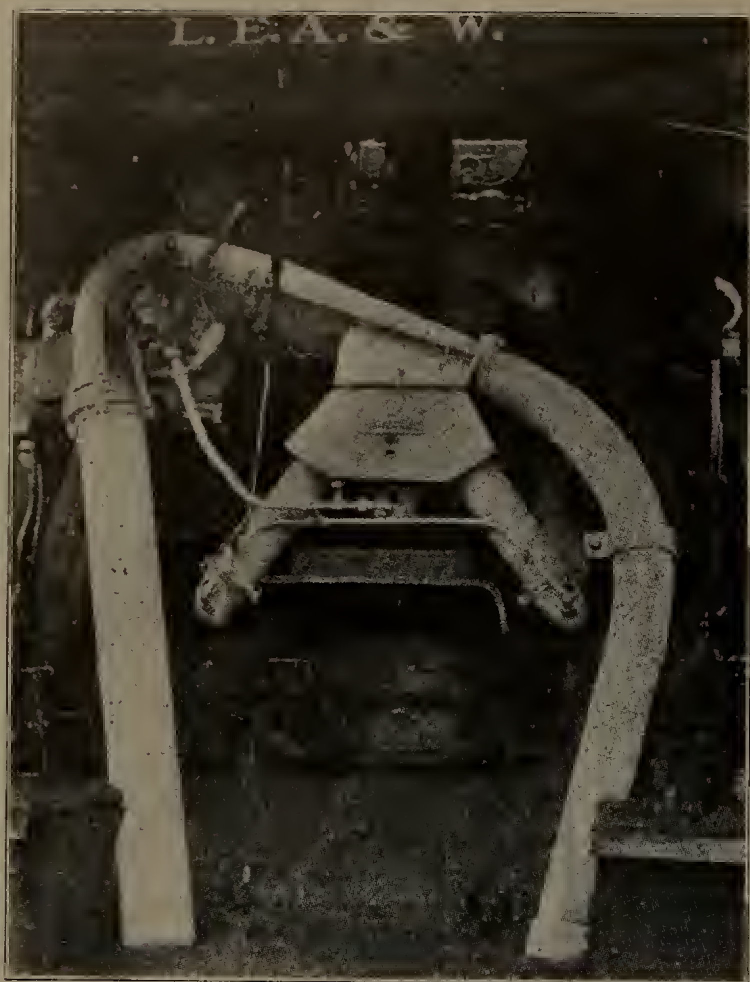


Fig. 2.—Close View of Street Stoker in Cab.

anything go wrong with it, hand firing can be immediately resorted to, and a stoker failure will not result in a locomotive failure. It has been found, however, during a long series of experimental runs, that it is seldom necessary to open the door at all, and complete round trips over a division of over one hundred miles have been made without the door being opened.

The construction of the engines for operating the mechanism is quite simple. Their protective casings make it unnecessary for the fireman to do anything to them except lubricate, and the same is true of all the other parts of the machine. It requires only a few seconds to place the stoker in operation, and, after it has been adjusted, which also requires only a few minutes, it needs no attention of the fireman other than the operation of the mechanism.

It is claimed that this stoker gives a much better control of the fire than is possible by hand firing. In regular service, the steam pressure has been allowed to fall off from 40 to 30 pounds and restored to a maximum within two and a half minutes while the locomotive was working at full capacity with the injector on. The results of tests seem to indicate that the even distribution in thin layers of coal prevents the formation of clinkers. Under ordinary condition the cleaning of the fire is not found necessary.

Strouse Stoker.

This stoker, as mentioned in the report of your committee of 1909, is manufactured by the American Stoker Company, of Milwaukee, and is being experimented with on the Iowa Central, Minneapolis & St. Louis and Chicago & Alton Railways.

During time of comparative tests on the Iowa Central the performance was very satisfactory. During the period of this test the engine was in charge of a regular assigned crew. After the test was completed, engine was assigned to regular chain-gang or pooled service, after which time various failures were experienced, due to different parts of the machine breaking. These failures resulted in the stoker being out of commission a good portion of the time, for the reason that a stock of repairs was not carried. Therefore, when any part failed it was necessary to order same from the manufacturers. This did not, to any great extent, lay up the engine, as when the stoker would fail, either at terminal or on the road, it would be removed, which would require about twenty minutes, and hand-firing would be carried on in the usual manner It is generally regarded that the failures experienced were largely due to the enginemen being inexperienced in operating the machine.

Our experience has developed that the stoker is not mechanically perfect. Therefore, it requires considerable skill and care on the part of the enginemen to avoid failures. The stoker company have made several improvements in the design of the machine in the past year, and, in view of the improvements that have been made that have so materially improved its performance, it is reasonable to assume that this machine will yet prove a successful device for automatic firing of locomotives.

Summary.

It could hardly be expected that mechanical stokers at the present stage of development could show an economy over hand firing by an expert fireman, but it is considered that, if economy is expected, it must be looked for in the comparison with the average of all grades of firemen in regular service. Designers of the present day are more interested in effecting practicability and security against failure rather than the promoting efficiency by its use, as this effect is more or less taken for granted with any properly designed and thoroughly practical stoker. The main defect of the present stokers seems to be, to a very great extent, with the coal-conveying apparatus, and it is the failure of this particular feature which usually makes the stokers of to-day somewhat unreliable. Your committee considers the progress and the development of the mechanical stokers during the past years as indicative of a determined effort to build stokers which will be in every way a success, and is convinced that the mechanical stoker is destined to be a very important factor in the operation of heavy locomotives in the not very distant future.

Committee.

T. Rumney, Chairman.
E. D. Nelson,
C. E. Gossett,
J. A. Carney,
Geo. Hodgins,

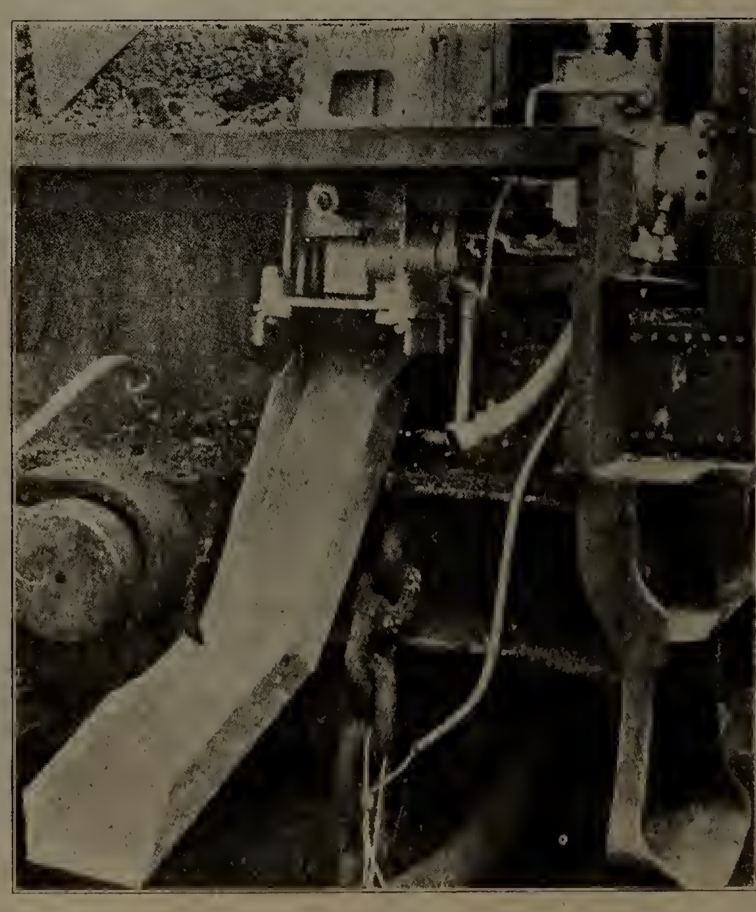


Fig. 3.—Front End of Tender Showing Conveyor for Street Stoker.

Responsibility for Preventable Railway Accidents

By W. H. Sheasby, Transportation Expert, Berkeley, Cal.

In the earlier period of railroading, every thing had to be learned. A new force, awful in its possibilities for death and injury, was suddenly placed in the hands of men lacking guidance and control, ludicrous in the light of modern development, left a wide margin for chance. The public contemplated the frequent lists of casualities with the mental reservation that some way would have to be devised for replacing the steady toll of life and limb with a guarantee of safety. Any hypothesis of a lack of grasp by employees of a keen sense of responsibility was untenable since the best of American manhood entered the service, choosing the calling for a life work with promotion as an incentive, while every plan and calculation for home building hinged on perpetuity of position, and where life and limb are ever in the balance any hypothesis of deliberate violation of first principles of safety would appear unthinkable, yet the elusive ideal remained unrealized.

Study of, what may be termed, evolution in railroading reveals in a measure the magnitude of the responsibility resting on the shoulders of operating officials, which involves final settlement of a series of problems challenging the best constructive ability for harmonizing conflicting currents of thought and theory, and bringing a million men more or less highly skilled in their respective lines to think and act as one mind. Abundant evidence of the sincerity of effort by the managements is found in the millions expended for installation of safety devices with the hope that intelligent blending of the inanimate, or mechanical, with the human equation, would secure the ideal. Half a century of evolution has developed the phenomena of two separate schools, viz, the practical and the theoretical, and has also demonstrated that it is as impossible for either school alone to secure the ideal, as for a man to walk normally on one leg and a crutch, results must leave much to be desired. Drastic experience in which both schools have been discredited in turn has given us a third type, known as the practically theoretical school and the task of final settlement rests wholly with the latter, and its activities will secure the ideal in exact ratio to the harmonizing of the first and second into the third for ultimate standardization.

The purely practical man is the product of a period spent in securing results by application of past experiences, each year adding to his value as an element of safety and, being honest, he profits by his experience and errors, even though each error in the case of the railroad man may cost a human life, and so far as his individual initiative is a factor the diagrammatic lines taken on an indicator card for measuring his performance might tend toward the 100 per cent and up to the first introduction of the automatic block system, the safety of the public was measured by the per cent of this class in the service. His quick grasp and correct judgment in emergency has often been the line dividing life and death of several hundred passengers. He developed a pride in personal achievement, bordering on the aristocratic and took unkindly to the suggestion from the theoretical school that the service was entitled to a still higher guarantee than a rope of sand composed of human units yielding a per cent of performance ranging any where from 10 per cent to 100 per cent. The managements challenged the assumed infallibility of the human equation and insisted that the only solution of the problem was systematic standardization of methods which would guarantee the full 100 per cent performance, which they recognized as the public's right, from the 50 per cent employee without depending on a list of dead and injured as the only means for raising his percentage, for while the 100 per cent is possible from the individual, the 100 per cent aggregate under any system of disconnected personal responsibility is a delusion and a myth.

The introduction of the mechanical block and other safety devices was received with some prejudice by the self sufficient 100 per cent operative and mistakenly viewed by him in some instances as a theoretical discounting of his personality, and he withheld that degree of hearty co-operation which is necessary to best results, thus depriving the service of a valuable asset through a lack of right theory on the part of the practical man, and the 50 per cent employee, quick to take his cue from a recognized expert, fumbled the ball and caused a wreck, which was pointed to by the critic of modern methods as evidence of their failure to make good.

No mechanical equation can fulfill its purpose without the co-operation of the efficient and ever alert human factor held up to its work through right methods of supervision and strict military discipline, and the radical theorist postpones final settlement by claiming that the mechanical embraces all there is to the problem of railroad safety, and he thus deprives the service of another valuable asset through lack of practical grasp on the part of the theoretical man.

What the managements are aiming to secure is a guarantee that the train which is safely handled today by the 100 per cent man will be equally safe tomorrow in the hands of the possible 50 per cent man; there is no other possible basis of settlement of the problem.

Evolution of the block system has introduced new problems into the manipulation of men and material in railroad operation. It placed in the hands of an army of men a new and untried instrument whose object was the securing of the full 100 per cent as the normal condition and their attitude towards it has been an interesting study. Some chose the lines of least resistance, shirking their own responsibility and producing a result lower than they would have achieved without it, thus defeating the aim of the managements, while others held it in contempt as a theoretical invasion of their mythical dignity of caste, and the millions spent so liberally for safety machinery and the hard work of formulating fixed standards and rules of procedure were not yielding anticipated returns. The self-sufficient practical man was overlooking the fact that his own expert activities were being taken as copy and a basis of standardization, a sort of conservation of the only guarantee which the service and the public had thus far known, while going still further and endeavoring to establish the 100 per cent where heretofore the 50 per cent man had caused a wreck. The American Railway Association had sought to establish the only possible nucleus of the 100 per cent as a fixed mode of procedure in every one of a million instances.

It was the highest compliment which the theoretical school could pay the practical, that of guaranteeing that each of a million repetitions should conform to the fixed standards of the other school without regard to the personality of the operative, instead of the haphazard rag-time which might yield 100 per cent today and a possible 10 per cent tomorrow. There is a type of born railroad man whose keen sense of loyalty and readiness to make personal sacrifice in the interest of the service, often meaning deliberate sacrifice of his own life to save others, constitutes an asset which has always made for the full 100 per cent and the real function of administration is to conserve and make this the pacemaker in all standarization measures.

When it was found that certain of the rank and file were withholding necessary co-operation and substituting their own self sufficiency, thus nullifying expected results a system of surprise checking was inaugurated. It was what might be termed in military tactics, determining to the general's satisfaction whether his sentries were in the habit of sleeping at the post, and the revelations showed that breaking away from old idols was proving no easy task, and convinced the managements that their work was not yet finished, and the leading American lines, at great expense, inaugurated systematic measures to have every man in the service, not only understand every rule, but also the reasons for its existence so that reasons for the application of penalties for non-performance may be intelligently understood by each employee with a view to securing strict conformity with what the concrete wisdom of the best railroad experts have decided as correct means for securing the full 100 per cent aggregate and thus pass railroad wrecks into history. Passenger cars are being equipped with a complete system of charts, models, diagrams and stereopticon outfits for displaying exact track conditions as they appear to the engineer in the cab of the fast train, together with comprehensive diagrammatic instruction class work and every one of the army of men in transportation service are required to pass a rigid examination in order that the management may be sure that before disciplining for non-performance, it has rendered the full 100 per cent to the employee in the way of full opportunity for thorough information.

As evidence of the purpose of the managements to set an example of the 100 per cent performance it may be said they have spent several years in instruction and interpreting the rules and standards before beginning to apply penalties for failure, for the average employee in railroad service is ambitious to deliver the 100 per cent and they recognize in this modern method of coaching and instruction the only logical means for standardization which can alone secure their ideal.

It is evidently the purpose of the railroads to assure to the public the full 100 per cent in the interest of the two dominant factors viz., money and humanity and the different boards of examiners intersperse their routine with short talks and bits of lectures on the strict interpretation of the moral obligation which always forms the basis of contracts between employer and employee that the attitude of the employee in exchange for the money remuneration shall always be the same as though every dollar invested was his own, and being an active factor in a thousand ways in creating sentiment for or against the railroad employing him, he unconsciously creates property or destroys it, since the good will of the public is property and any disturbance through the indifference or deliberate act of the employee is not only violation of duty but is an invasion of property rights, and just to the extent that the employee as an individual and through his labor organization exhausts every means for rendering a liberal 100 per cent which he owes to his employer, to the stockholder and to the public, just to that extent will he free himself from the indictment which is plainly written by every railroad disaster brought about through his neglect or indifference to the strenuous efforts being made by the managements to secure automatic conformity and standardization.

Nor can the public in the exercise of its clamor for what is termed its rights escape its share of the many sided responsibility for success or failure by the railroads to deliver this 100 per cent. The complex ramifications of this issue invite study of the homogeneous relationship between the man who pays his fare or freight, and the man who accepts it in the name of the railroad. If we may accept as correct the hypothesis of a low grade result from the man whose standard of living is held below the normal by a low scale of wages, with its train of narrowing tendencies, and if it is likewise true that a high type of manhood is essential to a liberal 100 per cent result from the railroad employee, the truth of which we emphatically subscribe to, whose work is not subject to the minute supervision of the gang boss or floorwalker, does it not follow that the desired 100 per cent, which is the only possible guarantee of safety, will largely depend on the ability of the railroad to maintain a standard of remuneration from the public to itself and from itself to the employee, which will enable each to avoid any lowering of standards, that of service on the part of the roads and of living on the part of the employee?

It should not be forgotten that a shading downward from the 100 per cent by the employee of mine or factory can at most mean but a slight money loss while on the part of the railroad operative it contains the possibilities for the coronor and undertaker.

A very large part of the clamor which is mistaken for a public conscience and pretends to see grave danger in every effort of the railroads to secure a slight increase in rates in order to counterbalance the steady increase in the costs of every item which enters into maintenance and operation including labor, would cease if an honest effort were made to study from its many angles this stupenduous question of transportation, and if the same degree of commercial rectitude, the same righteous standard of intercourse between employer and employee, the same freedom from sham and deception and double dealing, the same deep-seated purpose to render a liberal 100 per cent could be established as the standards for all other commercial activities which are known to actuate the managements of our railways, then the necessity for rate increases would immediately disappear and a return to sane prices and costs of living and a nearer approach to the eternal fitness could be realized. It is this strange contradiction in this thing called public conscience which calmly submits to the unrestrained profit raising and price jugglery, which makes repeated readjustments of accounting necessary by the railroads and their employees, all through our fabric of commercial activity, yet pretends to feel a thrill of danger when the railroads find it necessary in order to meet this conscienceless tribute levied by this system of brigandage, to increase their rates which seems to be setting up a false philosophy and if the railway employee imbibes the teachings of these false prophets and thereby gains a false understanding of the true aim and purpose of the managements employing him, and is thus led to relax that hearty co-operation referred to, thus lowering his per cent, it can not be viewed in any other light than a reaping by the public in exact accordance as it has planted.

His Vision Blinded.

Superheaters*

Your committee submits herewith its report on locomotive superheaters. We have been in communication with motive power officials all over the world, but from the replies received to our correspondence it is evident that at present the superheater has not found its way on to locomotives beyond Europe and North America, although interest in the question is manifest in many quarters.

In 1901 the Canadian Pacific Ry., under the pioneer leadership of Mr. Roger Atkinson, of the Canadian Locomotive Works, introduced the use of superheated steam on locomotives in America. A few years later Mr. H. H. Vaughan extended the use, and the success of the superheater is due in a great measure to his push and energy. Today we have reports from twenty American roads which have more or less engines equipped.

The circulars asked for answers based on comparative tests made as to certain particulars. However, the circulars requested that the data as to costs, etc., for superheater and nonsuperheater locomotives be taken from regular service records covering a considerable period of time.

Superheaters are reported on American roads as follows:

A., T. & S. F.	168
Boston & Maine	1
C. & N. W.	1
Canadian Pacific	487
C., B. & Q.	5
Central of Georgia	1
C., R. I. & P.	9
Erie	1
Great Northern	61
M., St. P. & S. S. M.	1
National Rys. of Mexico	1
Northern Pacific	36
N. Y. Cent. (L. S. & M. S.)	2
Oregon Short Line	2
Pennsylvania	1
Pittsburg, Shawmut & Northern	1
Southern Pacific	2
St. L. & S. F.	21
W. & L. E.	1
Union Pacific	3
Total	805

Superheaters which are considered and number of engines reported are as follows:

Type of Superheaters.	Number of Railroads.	Number of Engines.
Baldwin	12	79
Churchward (England)	1	61
Cole	6	13
Emerson	2	59
Jacobs	1	104
Schmidt	3	58
Union Pacific	1	1
Vaughan-Horsey	5	491

Schmidt superheaters are used on 130 railroads in Europe, and in service, or in course of construction, on over 5,000 locomotives.

Baldwin Superheater.

The Baldwin superheater is of the smoke-box type, and in effect is the usual steam pipe transformed into a superheater by increasing the area and splitting it up into a number of small tubes. The steam pipe is extended on either side of the smoke-box into headers at the top and bottom, and between them are placed from 150 to 200 1¼-in. tubes, bent into a quarter circle to conform to the shape of the smoke-box shell. The tubes are expanded into tube plates and these plates are bolted to the cast portion of the headers, copper gaskets being inserted between to make the joint steam-tight. The headers and tubes are divided into three vertical sections, so that the steam first passes into the top headers, then downward through the first section of tubes, then forward in bottom header, then upward through the second section of tubes, then forward in top headers, then downward in third section of tubes and to the steam chest.

Cole Superheater.

The Cole superheater is of the smoke-tube type. This consists of a system of small return tubes arranged within fire tubes of large diameter. The large fire tubes are about 5 in. in diameter and are arranged to take the place of the central and upper regular fire tubes. Each large tube contains two loops of 1¼-in. superheater pipes, threaded at the back ends and screwed into steel return bends. The front ends are fastened to vertical headers by the usual method of expanding with a roller, the roller in this case being inserted in a hole at the front of the header, which is afterwards closed with a screw plug.

The steam from the dry pipe enters a header placed crosswise in the smoke-box, which is divided into a saturated steam compartment and a superheated steam compartment. Bolted to this header are vertical sectional headers, each of which is also divided into a saturated steam space and a superheated steam space. Each vertical sectional header serves four large tubes placed in one vertical row. When the throttle is opened, steam enters the upper horizontal header and passes into the forward vertical headers, thence through the small tubes and return bends to the rear vertical sectional header, and through this to the lower or superheated steam crosswise header and thence through ordinary steam pipes to the steam chest.

The flow of heat through the large tubes is controlled by a damper hinged below the steam headers in the smoke-box. The damper is opened by a steam-actuated cylinder when the throttle is opened, and being closed by a coil spring when the throttle is shut. More recent designs show the steam headers on either side of the smoke-box. Each header is divided into two compartments, one for saturated steam and one for superheated steam. The superheater tubes are connected to the header by means of ball-and-socket joints, arranged in pairs. In case a tube is ruptured it can be easily removed and a pair of dummy joints inserted.

Emerson Superheater.

The Emerson superheater is of the smoke-tube type. It consists of a system of small return tubes arranged within fire tubes of larger diameter. The large fire tubes are about 5 in. in diameter and are distributed over the entire flue-sheet space. Each large tube contains four superheater pipes arranged in the shape of an elongated coil made up by screwing into steel return bends, forming a continuous double-looped tube. The front ends are fastened to headers by the usual method of expanding with rollers, the roller in this case being inserted in a hole at the front of the header, which is afterward closed with a screw plug.

The steam from the dry pipe enters headers which, in general form and position, are similar to the usual steam pipes. Each header is divided vertically into two compartments, forming the front compartment for saturated steam and the rear compartment for superheated steam. Hollow lugs are cast on either side of the headers and the superheater tubes fastened to these. When the throttle is opened steam enters the front header and passes through the small tubes and return bends to the rear or superheated steam header, and thence to the steam chests.

Jacobs Superheater.

The Jacobs superheater is of the smoke-box fire-tube type.

*Report of committee before the American Railway Master Mechanics' Convention.

and of such design that its application can be readily made to locomotives of the usual type without radical changes to the boiler or front end. The principal feature in its operation is the utilization of waste heat in the combustion gases without a sacrifice of effective heating surface in the boiler.

In its present form and construction, the Jacobs superheater consists of two steel drums, fitted with a series of horizontal fire tubes between the heads and with steam-pipe connections. The rear drum is made oval in cross section to provide room for passage of dry-pipe extension to the front drum and is placed directly before the front flue sheet of the boiler. The forward drum of the superheater is circular in cross-section and placed just ahead of the exhaust pipe. For facilitating repair work on boiler tubes, the rear drum is placed about 24 in. ahead of the front flue sheet, and a manhole, provided in the bottom of the smoke box, gives access to a boilermaker. A 20-in. return flue in the front drum and a 6-in. central flue in the rear drum are lined up so that leaky or defective flues may be cut out of the boiler and removed through the front end without the necessity of taking out the superheaters. The tubes in the rear drum of the superheater are inserted without copper ferrules, then rolled and expanded, after which they are welded at both ends by either the autogenous or electric method. The tubes in the front drum are merely rolled, expanded and beaded, similar to common practice with boiler flues. The drums are held in place by Z-shaped brackets. When the throttle is opened steam passes from the dry pipe to the rear head of the front superheater, where baffle plates of thin steel are arranged to direct the steam in a somewhat spiral course over all the tubes, thence to the rear superheater, which is arranged with baffle plates similar to the front superheater, and out of the drum through steam-pipe connection to the steam chests.

Type of Superheater.	Railroad.	Does the superheater give you any trouble on the road or in the roundhouse? (Please give as many details as possible and say what has been done to overcome or minimize them.)
BALDWIN	A. T. & S. F.	Some trouble with steam-pipe joints leaking; front end fills up
	C. B. & Q.	No trouble
	Central of Georgia	No. This engine has record of not having a single failure in making 30,595 miles
	Erie	Front end fills up with cinders. Cinders also ruptured several superheater pipes so they had to be plugged
	Nat'l. Rys. of Mexico	Front end fills up with cinders. No remedy at present — experimenting
	Oregon Short Line	No trouble. Twelve months' service
	Pennsylvania	No trouble
	Pittsburg, Shawmut & Nor.	Front end fills up
	Rock Island	Cinders cut superheater tubes due to sand-blast action. Front end filled up with cinders and engine does not make steam
	Southern Pacific	No trouble
	Union Pacific	No data
CHURCHWARD	Gt. Western (England)	Ends of tubes have blown in several cases, but this failure has now ceased
COLE	C. & N. W.	Very little
	Boston & Maine	Superheater flues at firebox and expanded and beaded instead of screwed. Gaskets leaked between headers and T-head; improved design has obviated this trouble. Superheater flues have given trouble by filling up; blower applied and works fairly well. Other small defects, for instance, leaks at junction of the superheater pipes and return bends ascribed to defects of material rather than of design
	New York Central	A little trouble in roundhouse on account of keeping joints tight; not serious, however
	Northern Pacific	Cinders in passing through tubes wear out return bends. Gaskets at connection between small superheater pipes and main header give same trouble
	Rock Island	Had trouble with Field tubes stopping up. Changed to return-tube system and had no trouble. Had trouble with joints and fastenings. Recent designs obviate this trouble
	Wheeling & Lake Erie	No
EMERSON	Great Northern	Threaded pipes in return bends break off. Now welding pipe into the return bend
JACOBS	A. T. & S. F.	Occasional leaks in steam-pipe joints. Recent designs have joints on the outside
SCHMIDT	C. B. & Q.	Leaks in front end overcome by providing more secure fastening for the blocks connecting superheater pipes to the header and by bracing the header to smoke arch. Clinkers formed on back end of superheater pipes; cleaned off every trip
	European Railways	So far as we know, neither the superheater itself nor the large smoke tubes have given any trouble in European practice. In a few isolated cases, the large smoke tubes have begun to leak at the fire-box side; in such cases, investigation has shown that the tubes were not properly expanded in the tube sheets, nor according to our recommendations. These defects have been easily remedied, after which no further difficulty was experienced. No difficulty has been experienced in European practice in keeping the joints of the superheater elements tight. An essential requirement, however, is that the bottom facing of the collector casting shall be properly machined and that the right kind of copper-asbestos gaskets shall be used for these joints; and, further, that the bolts shall be taken up after the engine has been for the first time under steam. In most cases the large smoke tubes have to be blown out every day to avoid clogging. But there are railroads, as for instance the Belgian State Railways, which blow the tubes out only every three days on the average. This largely depends upon the kind of fuel used
	Great Northern	Yes. Gaskets leak, also threaded pipes in return bend break off. Now welding the pipe into return bend
	Northern Pacific	Cinders wear out return bends. Gaskets at connection between small superheater pipes and main header give same trouble
UNION PACIFIC	Union Pacific	No
VAUGHAN-HORSEY	Canadian Pacific	Originally gave trouble, due to unsuitable gaskets between superheater pipe and header fittings. Since remedied by using stronger style of gaskets. Nuts connecting pipes to fittings originally made of brass, found to corrode, were replaced by cast steel, and later by drop-forged nuts, which has overcome the trouble. Nuts slacked off remedied by using special nutlocks and by making closer fit of the threads. Cast-iron headers cracked, caused by faulty construction; has been remedied by improved design. The tubes blocked at the return bends; has been overcome by systematic inspection and using proper appliances for cleaning and blowing out tubes
	C. B. & Q.	No more trouble than other engines
	New York Central	Practically no trouble. Old design of holder broke once or twice, but new design gives no trouble
	Northern Pacific	Cinders in passing through tubes wear out the return bends. Gaskets at connection between small superheater pipes and main connection give same trouble
	Union Pacific	No trouble

COST OF COAL PER 100-TON MILE
OR
PER PASSENGER CAR MILE

Road.	Superheater.	Non-Superheater.	Per Cent Saving of Superheater Over Non-Superheater.	Per Cent Increased Cost of Superheater Over Non-Superheater.
Baldwin Superheater				
C. B. & Q..................	.0114	.0122	6.5	....
	.0106	.0122	13.1	....
Oregon Short Line.........	.200	.230	13 0	....
Southern Pacific...........	.0135	.0135	....	....
Cole Superheater				
Wheeling & Lake Erie.....	.0169	.0191	11.5	....
Jacobs Superheater				
A. T. & S. F.	.0116	.0170	31.8	....
Schmidt Superheater				
C. B. & Q..................	.0105	.0130	19.2	....
	.0109	.0133	18.0	....
Great Northern (Pass.)....	.0195	.0208	6.2	....
	.0207	.0248	16.5	....
Vaughan-Horsey Superheater				
Canadian Pac.. Freight...	.148	.153	3.3	....
	.219	.298	26.5	....
Canadian Pac.. Passenger	.0115	.0199	42 2	....
	.0187	.0194	3.6	....
C. B. & Q......	.0098	.0120	18.3	....

In all types of Jacobs superheaters the flue gases pass from the boiler flues through the tubes of the rear superheater. This is accomplished by deflector plates placed around the back end of the rear drum and front end of the forward drum of the superheater, except for a space of 18 in. at the bottom. These plates extend from the outer shell of the superheater drums to the smoke-box shell. Upon leaving the rear drum the gases in the central and top flues are deflected around the petticoat pipe and elbow, which serves to connect the large cylindrical flue in the forward drum to the petticoat pipe. The exhaust nozzle extends through this elbow and the exhaust steam travels up and out of the stack through the petticoat pipe without circulating through the smoke box or coming in contact with the superheater drums. After the gases pass through the rear drum and are partially deflected as above described, they travel forward through the tubes of the front drum and are drawn back through central return flue in front drum to the petticoat pipe and out of the stack. With this design of superheater any desired degree of superheat may be obtained by setting the front flue sheet back farther in the boiler and this space utilized for superheating surface.

Schmidt Superheater.

There are two distinct patterns of the Schmidt superheater as applied to locomotives, namely, the smoke-box type and the smoke-tube type. As the smoke-box type does not appear in the replies to the circular letter, no description need be given. The Schmidt superheater under consideration is of the smoke-tube type. Among the men who have devoted a considerable amount of time and engineering skill to furthering the solution of the problem of superheated steam, Dr. Wilhelm Schmidt, of Wilhelmshöhe, Germany, must admittedly be accorded the foremost place. About twenty years ago Dr. Schmidt was employed in perfecting a type of engine using a mixture of hot air and steam, by the use of which he expected to obtain a vast improvement over the ordinary steam engine. The tests convinced him of the feasibility of using temperatures up to 660 degrees, and he also came to the conclusion that highly superheated steam was the one agent which would obviate all the losses due to condensation. From the time referred to down to the present day, Dr. Schmidt has made the development of the superheated steam engine his life-work. He has designed several types of superheaters, all of which are capable of producing a high degree of superheat. To Dr. Schmidt is due the credit of having introduced the use of highly superheated steam on a thoroughly practical and extended scale in Europe.

In the smoke-tube type the upper part of the boiler is fitted with from two to four rows of large smoke tubes, which are expanded into the fire-box and smoke-box sheets in a special manner. These tubes are about 5 inches in diameter, except near the fire-box ends (where the diameter is somewhat reduced), and inserted in each is a superheater element or section, consisting of two sets of pipes bent in the form of a "U" and connected at the smoke-box end to a header, thus forming a continuous double-looped tube. The steam has to traverse each element to and fro. The connections between the tubes on the fire-box end are made either by return bends of cast steel or by welding. The open ends of each element extend into the smoke box, where they are bent slightly upward and expanded into a common flange, which is secured to the face of the steam collector or header by a single central bolt. The flow of heat through the large tubes is controlled by dampers of different designs hinged or pivoted below the steam header in the smoke box. These dampers are automatic in action, opening by a steam-actuated cylinder when the throttle is opened, and being closed by a counterweight, or spring, when the throttle is shut.

Union Pacific Superheater.

The Union Pacific Superheater is of the smoke-box type, and in effect is the usual steam pipe transformed into a superheater by increasing the area and splitting it up into a number of small tubes. The steam-pipe forms vertical headers of a crescent shape at the front and rear of the smoke box, and between them are placed 108 2-inch tubes, arranged horizontally. The ends of the tubes are fastened to the headers by the usual method of expanding with a roller, the roller being inserted in a hole in the header opposite the tube, which is afterwards closed with a screw plug. The steam passes into the top of the rear headers, thence forward through the tubes to the front headers, thence downward to steam-pipe connection to the steam chest.

COST OF VALVE OIL PER MILE

Road.	Superheater.	Non-Superheater.	Per Cent. Saving of Superheater Over Non-Superheater.	Per Cent. Increased Cost of Superheater Over Non-Superheater.
Baldwin Superheater				
Oregon Short Line.........	.00123	.00103	....	19.0
Southern Pacific...........	.00137	.00118	....	16 0
Cole Superheater				
Wheeling & Lake Er'e	.00118	.00059	....	100.0
Schmidt Superheater				
Great Northern (Pass.)	.00175	.00137	....	27.7
	.00254	.00132	....	92 5
Vaughan-Horsey Superheater				
Canadian Pac.. Freight...	.0110	.0077	....	43.0
	.0074	.0061	....	21 3
Canadian Pac.. Passenger	.0067	.0069	2.9	....
	.1162	.0064	3.1	....

Vaughan-Horsey Superheater.

The Vaughan-Horsey superheater is of the smoke-tube type. This consists of a system of small return tubes arranged within fire tubes of large diameter. The large fire tubes are about 5 inches in diameter and are arranged to take the place of the upper regular fire tubes. Each large tube contains two loops of 1¼-inch superheater pipes. The Vaughan-Horsey superheater differs from the other types particularly in the peculiar form and arrangement of the steam headers. The headers are placed crosswise in the smoke box, each having fingerlike projections; one header is for saturated steam and is situated in the upper part of the smoke box with its fingers extending downward; the other header is for superheated steam and is located just below

COST OF RUNNING REPAIRS PER 100-TON MILES
OR
PER PASSENGER CAR MILE.

Road	Superheater.	Non-Superheater.	Per Cent. Saving of Superheater Over Non-Superheater	Per Cent. Increased Cost of Superheater Over Non-Superheater.
Baldwin Superheater.				
A. T. & S. F.	Comparisons not available, as superheater and non-superheater engines do not run on same district.			
Central of Georgia	.038	.046	17.4	......
C. B. & Q.	.018	.026	30.8	......
	.024	.026	7.7	......
Oregon Short Line	.0234	.0225	......	4 0
Southern Pacific	.059	.050	......	18.0
Cole Superheater.				
Boston & Maine (Pass.)	.0725	.0641	......	13.1
Wheeling & Lake Erie	.0366	.0342	......	7.0
Jacobs Superheater.				
A. T. & S. F.	.124	.161	23.0	......
Schmidt Superheater.				
C. B. & Q.	.031	.027	......	14.8
	.030	.027	......	11.1
Great Northern (Pass.)	.0403	.0807	50.0	......
	.193	.092	......	110.0
Vaughan-Horsey Superheater.				
Canadian Pac. — Freight	.024	.0408	41.1	......
	.0415	.0477	13.0	......
Canadian Pac. — Passenger	.0306	.0376	18.6	......
	.0290	.0287	......	1.0
C. B. & Q.	.0150	.0270	44.5	......

the center of the smoke box and has fingers extending upward; these fingers being interposed with the fingers of the opposite header.

The superheating tubes at the fire-box end are connected in pairs by means of return bends. The opposite ends are connected to the front of the headers by means of special "cross" castings, each one serving four of the superheating tubes.

When the throttle is opened the steam enters the upper header and down each of the fingers out into the "cross" casting, thence through the four openings into the small superheater tubes, around the bends and back through the opposite "cross" connection into the lower or superheated steam header and thence through steam pipes to the steam chests. The flow of the heat through the large tubes is controlled by a damper hinged below the steam headers in the smoke box. The damper is opened by a steam-actuated cylinder when the throttle is opened, and is closed by a counterweight when the throttle is shut, thus preventing the passage of hot gases through the large tubes when the superheater tubes are empty.

Reduction of Boiler Pressure.

The answers show that the general practice is to reduce the boiler pressure when superheater is applied; at the same time, where there is a considerable reduction made, the diameter of the steam cylinders is increased. On the A. T. & S. F., tandem compound engines have had the high-pressure cylinder removed when superheater was applied, and the boiler pressure reduced from 220 to 160 pounds. Where reduction of boiler pressure is made the general result shows a reduction of boiler repairs.

Superheater Troubles.

The troubles arising from superheaters are given on the chart herewith in detail.

Lubrication of Slide-valve Engines.

With the Baldwin superheater, four roads report slide valves on superheater engines as having no trouble in lubricating with superheat from 11 to 44 degrees. With the Schmidt superheater, Dr. Schmidt reports European practice: "Slide valves have been tried in a few instances on superheated-steam locomotives and to our knowledge they could be worked with a fair measure of satisfaction up to a steam temperature of about 450° F. The trouble experienced with higher degrees of superheated steam on slide valve engines is due, in our opinion, not so much to the difficulty of lubrication as to valve warping at higher temperature and seizing on its flat seat." With the Vaughan-Horsey superheater the Canadian Pacific reports that it is impossible to lubricate slide valves above 190 degrees superheat. A heavier valve oil is used on superheater engines than on nonsuperheater engines. The Union Pacific has one slide-valve engine equipped with Vaughan-Horsey superheater, and has had trouble in lubricating with superheat of from 160 degrees to 219 degrees.

Lubrication.

Forced lubrication is found to be unnecessary with low and moderate degrees of superheat. Different kinds of pumps have been used on some roads when first installing superheaters and later on abandoned for the ordinary sight-feed lubricator. Of course, it is natural that superheater engines should show a little increase in the cost of cylinder lubrication over the non-superheater, but you can buy several pints of valve oil for the price of a ton of coal. In Europe, where a high degree of superheat is the practice, it is found that forced lubrication is necessary.

Piston and Valve Rings.

The result from the majority of railroads indicates that it is unnecessary to use a special mixture in casting piston and valve rings. The New York Central, with the Cole and Vaughan-Horsey superheaters, uses a mixture containing more copper. The Canadian Pacific, with the Vaughan-Horsey superheater, reports "had difficulty at first; have made progress and are still experimenting." The St. Louis & San Francisco report that they recently received twenty Pacific-type engines with the Emerson superheater. The cylinder packing that came with these engines gave out in about 1,500 miles. They are now using a special metal. The Union Pacific, with Vaughan-Horsey superheater on a slide-valve engine, found it necessary to apply a bronze false valve seat. The Canadian Pacific gave results as to life of cylinder and valve-packing rings for the year ending October, 1909. In freight service, packing rings on engines without superheater ran from two to three times as long as the rings on the superheater engines. In passenger service the difference was not so great. In one case the life was the same, while in another case the life of rings on the nonsuperheater engines was nearly double that of the superheater engines.

Superheated Steam on Compound Engines.

The Jacobs superheater on the Santa Fe is the only superheater reported which superheats the steam between the high and low pressure cylinders on compound engines. These superheaters are now in service on tandem, balanced and Mallet compounds. Tests on this road prove that greater efficiency can be obtained from a superheater giving superheat between the high and low pressure cylinders, than from superheater giving superheat to high-pressure cylinders only.

Dampers.

The Baldwin, Emerson, Union Pacific and Jacobs superheaters have no dampers and experience no trouble from pipes burning out.

The Cole, Schmidt and Vaughan-Horsey superheaters have dampers on all roads reported, except the Great Northern (Schmidt superheater), where the damper interfered with the drafting and was taken out. The dampers are automatic in action, opening and closing as the throttle is opened or closed. They experienced no trouble from pipes burning out.

Do Boiler Tubes on Engines Equipped with Superheaters Give Trouble?

All reports show that boiler tubes on engines equipped with superheater give no more trouble than engines not equipped with superheater.

Packing on Piston and Valve Rods.

The roads using Baldwin and Jacobs superheaters report that it is not necessary to use any special kind of packing on piston and valve rods. The New York Central (Cole superheater) reports a packing used with a higher melting point. The Great Northern (Emerson and Schmidt superheaters) use a special metal for rod packing when the temperature in the steam chest is above 600 degrees. The Canadian Pacific and New York Central (Vaughan-Horsey superheater) use a special kind of packing on outside admission valves.

Boiler Repairs.

The Canadian Pacific (Vaughan-Horsey superheater) was the only road from which were received figures showing cost of boiler repairs.

Cost Per Engine Mile.

Class of Engine	Superheater.	Nonsuperheater.
4-6-0—D 6	.19 cents	.91 cents
2-8-0—M 4	.33 cents	.30 cents
4-6-0—E 5	.65 cents	.46 cents
4-6-0—E 5	.47 cents	.31 cents

Tests.

Tests have been made on the Central of Georgia with Baldwin superheater; Sante Fe, with the Jacobs superheater; Southern Pacific, with the Baldwin superheater; Union Pacific, with Vaughan-Horsey and Union Pacific superheaters; Northern Pacific, with Cole, Schmidt and Vaughan-Horsey superheaters, and are presented in somewhat condensed form.

Central of Georgia Railway Co.

Engine Test—Southwestern Division Freight Service, July, 1909. Same fifteen carloads of coal hauled in each test; same engineer and fireman each test.

Average or Total for Two Trips.	Engine 1224. Baldwin Superheater. 2-8-0 Type. Cylinders, 22 by 28 in. Weight on Drivers, 143,290 lbs. Boiler Pressure, 160 lbs.	Engine 1222. 2-8-0 Type. Cylinders, 22 by 28 in. Weight on Drivers, 143,290 lbs. Boiler Pressure, 200 lbs.
Time on road.....	6 hrs. 45 mins.	6 hrs. 48 mins.
Ton-mile	205,740	205,740
Total coal consumed, lbs.	24,200	23,700
Coal per 100 ton-miles	11.8	11.5
Total water consumed, lbs.	168,866	166,100
Water per lb. of coal	6.98	7.01
Miles run to one ton of coal......	16.5	16.9

The results from the Baldwin superheater on the Central of Georgia show no advantage of the superheater engine over the nonsuperheater engine. The Santa Fe has made a test of the Jacobs high and low pressure superheater on a tandem compound engine versus a similar engine without superheater.

ATCHISON, TOPEKA & SANTA FE RY.

Test of Jacobs High and Low Pressure Superheater on Tandem Compound Engine versus Same Class of Engine Without Superheater.

	Engine 901. 2-10-2 Type. Jacobs Superheater Cylinders, 19x32x32 in. Weight on Drivers, 234,600 lbs. Superheating Surface, 1,868 sq. ft. Boiler Pressure, 220 lbs.	Engine 923. 2-10-2 Type. Nonsuperheater. Cylinders, 19x32x32 in. Weight on Drivers, 234,600 lbs. Boiler Pressure, 220 lbs.
Speed, miles per hour	14.05	13.03
Tonnage	1,332	1,221
Lbs. of coal per 100 ton-miles	24.4	30.4
Saving in coal.....	19.6%	
Dry coal per 1 H.-P. hour	3.43	4.10
Decrease per 1 H. P.	16.3%	
Equivalent evaporation of water.....	8.10	7.81
Saving in water....	3.7%	
Superheat:		
High pressure..	19.3° average	
Low pressure...	95.0° average	

The superheat in high-pressure superheater averaged 19.3 degrees and in low-pressure superheater averaged 95 degrees. The relative performance of superheated engine over non-superheated engine is as follows:

Equivalent evaporation per lb. of coal............... 3.7% gain.
Coal per 100 ton-miles ....19.6% gain.
Coal per 1 H.-P. hour ....16.3% gain.

The Southern Pacific has made a test of the Baldwin superheater versus a similar engine without superheater. The superheat averaged 23.2 degrees. The relative performance of superheated engine over non-superheated engine is as follows:

Equivalent evaporation per lb. of fuel ....3.37% loss.
Ton-miles per lb. of fuel ....1.35% loss.
Ton-miles per gal. of water ....3.32% gain

The Union Pacific test of the Vaughan-Horsey superheater shows the superheat obtained at varying conditions of speed and cut-off. The maximum superheat is 219 degrees. With an average superheat of 185 degrees.

The Union Pacific test of the Union Pacific type of superheater shows the superheat obtained at varying conditions of speed and cut-off. The maximum superheat is 61.9 degrees, with an average superheat of 48.6 degrees.

The test on the Northern Pacific gave the following results from the Cole, Schmidt and Vaughan-Horsey superheaters:

NORTHERN PACIFIC RY.

Test of Cole Superheater versus Same Class of Engine Withouc Superheater.

	Engine 2137. Cole Superheater. Cylinders, 22 by 26 in. Weight on Drivers, 146,300 lbs. Superheating Surface, 341 sq. ft. Boiler Pressure, 200 lbs.	Engine 2136. Nonsuperheater. Cylinders, 22 by 26 in. Weight on Drivers, 146,300 lbs. Boiler Pressure, 200 lbs.
Speed, miles per hour	30.26	28.56
Tonnage	556.	599.
Lbs. coal per 100 ton-miles	16.2	20.6
Decrease	21.4%	
Coal per draw-bar horse-power hour.	4.91	6.54
Decrease	25.0%	
Equivalent evaporation of water.....	10.06	9.94
Saving in water....	1.2%	
Superheat	147°	

The relative performance of superheated engine over non-superheated engine is as follows:

Equivalent evaporation	1.2% gain.
Coal per draw-bar horse-power	25.0% gain.
Coal per 100 ton-miles	21.4% gain.
Superheat (average)	147 degrees

NORTHERN PACIFIC RY.

Test of Schmidt Superheater versus Same Class of Engine Without Superheater.

	Engine 2137. Schmidt Superheater. Cylinders, 21 by 28 in. Weight on Drivers, 153,504 lbs. Superheating Surface, 248 sq. ft. Boiler Pressure, 200 lbs.	Engine 2136. Cylinders, 21 by 28 in. Weight on Drivers, 153,500 lbs. Boiler Pressure, 200 lbs.
Speed, miles per hour	15.74	15.00
Tonnage	2,437	2,429
Lbs. coal per 100 ton-miles	4.98	5.92
Decrease	15.8%	
Coal per draw-bar horse-power hour.	4.55	5.64
Decrease	19.3%	
Equivalent evaporation of water	9.04	9.13
Saving in water		1.0%
Superheat	147°	

The relative performance of superheated engine over non-superheated engine is as follows:

Equivalent evaporation	1.0% loss.
Coal per draw-bar horse-power	19.3% gain.
Coal per 100 ton-miles	15.8% gain.
Superheat (average)	147 degrees.

NORTHERN PACIFIC RY.

Test of Vaughan-Horsey Superheater versus Same Class of Engine Without Superheater.

	Engine 1609. Vaughan-Horsey Superheater. Cylinders, 24 by 30 in. Weight on Drivers, 261,500 lbs. Superheating Surface, 326 sq. ft. Boiler Pressure, 200 lbs.	Engine 1561. Cylinders, 24 by 30 in. Weight on Drivers, 201,500 lbs. Boiler Pressure, 200 lbs.
Speed, miles per hour	10.50	11.77
Tonnage	2,073	2,034
Lbs. coal per 100 ton-miles	13.1	16.2
Decrease	19.1%	
Coal per draw-bar horse-power hour.	5.41	6.54
Decrease	17.3%	
Equivalent evaporation of water	6.87	6.87
Saving in water	——	——
Superheat	121°	

The relative performance of superheated engine over non-superheated engine is as follows:

Equivalent evaporation	Equal.
Coal per draw-bar horse-power	17.3% gain.
Coal per 100 ton-miles	19.1% gain.
Superheat (average)	121 degrees.

RECOMMENDATIONS.

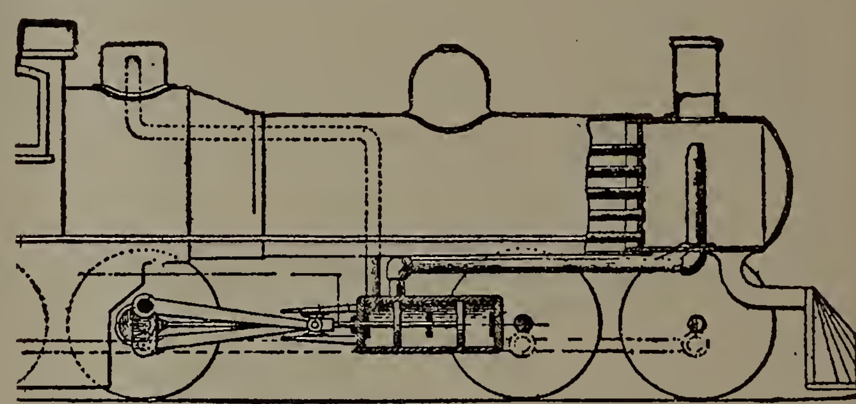
The experiences gained by various railroads with superheated steam, which have been reported to your committee, indicate that the use of superheated steam on locomotives is both economical and practical. Many types of superheaters with varying degrees of superheat have been used to advantage in railroad service. In the United States there are about 60,000 locomotives, and from reports received there are 317 locomotives equipped with superheaters, or approximately five-tenths of one per cent. This is such a small proportion that it is evident that the use of superheaters is as yet in its infancy in this country. With this in view, the committee feels that recommendations as to type of superheater or degree of superheat are not warranted at this time. The committee feels that this is a most important subject, and one that is worthy of much more time and consideration.

The unanimous opinion of motive power and transportation officials is that the superheater engine gets its load over the division in far better form and in better time than the non-superheater, or, as one superintendent of motive power put it, "'Tis a more snappy machine all around."

Committee: Lacey R. Johnson, chairman, F. F. Gaines, R. D. Hawkins, H. W. Jacobs and W. J. Tollerton.

Unique Locomotive Crank and Cylinder Design

The accompanying drawings taken from a daily newspaper, show an arrangement of double pistons and cranks for locomotives invented by F. Hennebohle, of South Chicago, Ill. The account does not state whether this feature has ever been tried out in service.

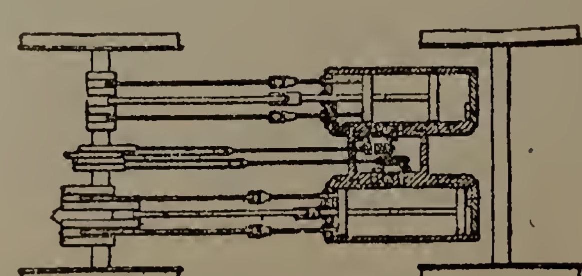


Unique Two-Cylinder Balanced Locomotive.

The account as published is somewhat mixed in technical terms it runs as follows:

"Briefly, his idea has been to connect two cylinders in pairs, with the steam chest serving both of them lying between the two. Then in each of these cylinders he provided two cylinder heads to driving rods, the steam valve at each end of the twin cylinders driving the piston heads together, then a corresponding jet in the center driving the piston heads apart.

"This gives him the balanced piston movement, where with the single cylinder the tendency is to force the one piston to the far cylinder head, afterward pulling it backward, giving to either the motive or stationary engine that jerkiness of motion which marks the running of machinery having only the one cylinder stroke. In operation the crankshaft of the new type is pushed over and down, while at the other end the crank is pulled up and over, effecting a complementary action keeping the whole machinery in balance. Also it is asserted by the inventor that the use of the central valve in forcing the pistons apart may serve to give one-third to one-half more power to any cylinder using the old single piston stroke.



Plan of Balanced Two-Cylinder Locomotive.

"Adapting the balanced pistons to the locomotive, the inventor arranges his twin cylinders underneath the boiler, which with two pistons to each cylinder serve four drive wheels on a side. The driving rods are on the outside of the drivers, drivers one and three and two and four working in pairs on each side. When one pair of drivers in each set has the crank pin thrown forward the other set, by means of the cylinder heads thrown away from the centers of the cylinders, is pulling over the cranks on the other set.

"Less length of engine, lighter framework, lighter rails, and greater, safer speed is promised, with decreased consumption of coal."

Sheasby and Neal Air Brake

2246 San Pablo Avenue, Berkeley, Cal
June 9th, 1910.

Editor, Railway Master Mechanic—Referring to the following brief description of the Sheasby and Neal Air Brake, which will have patents issued from Washington now within a few days I am giving the readers of the Railway Master Mechanic a few of the fundamental characteristics. You will observe this is not the half-hearted attempt at adding something to the system of air brakes now in use, but a distinct individuality, separate and apart in every detail and fundamental. Mr. Neal, my co-inventor, is the son of a former Santa Fe master mechanic, and while but 26 years old is about the best logical inventor west of the Mississippi. Personally, I have had 35 years practical experience in transportation service, in train and official departments, and we have created our brake with a full knowledge of the actual needs of the service.

We are presuming to enter the power brake field, with a full sense of the obligation we undertake to make good before the court of final appeal composed of leading critics on mechanical safe-guards in modern transportation, and frankly challenge any system of power brake which employs the unit storage principle for regular service requirements, embracing periodical abandonment of control pending restoration of depleted pressure on grades.

Our system of straight and automatic air in one train line, whereby we apply straight air by making a reduction embraces every advantage and guarantee of automatic action and establishes absolute continuity of supply, thus eliminating any need of retaining devices or the use of hand brakes on grades. We secure full normal performance of each braking unit in a train of any length through perfect co-operation with other co-relative working parts of each unit; as for example, the piston with abnormal travel performs its work equally with the normally adjusted travel, and the leaky brake cylinder is held to its normal braking duty regardless of such leak. Thus we secure full normal action by each braking unit, eliminating imposition of abnormal service on certain faithful units by reason of the abnormal conditions above cited. We build up the pressure from zero to required amount and maintain such speed on grades as may be called for by adding to or taking from pressure and by securing full service from each unit we eliminate excessive heating of wheels under abnormally braked units.

We believe in eliminating as far as possible the human factor other than the engineer. Assuming that trainmen always prove faithful under adverse conditions, experience points to the fact that hand brakes frequently are found inoperative, while others are frequently inaccessable by reason of the physical make up of trains, making progress from car to car, not only difficult but extremely hazardous and often impossible.

In detail and assembling of parts our system is simplified, securing the ideal by employment of parts in comparison with other systems in a ratio of one to four and in some instances one to eleven in our favor. Realizing that our statements may incline the air expert to suggest our examination by a lunacy commission, we suggest that complete mastery of other systems will be of no assistance in the study of ours, since we have not patterned or copied in a single feature but have created along entirely new and distinct lines which spell air evolution according to a new hypothesis with theory and practice so correctly blended and poised as to secure what may be termed the fourth dimension in the air brake. We challenge the best air experts to point to a single flaw in its foundation.

In our system all such engineering difficulties as, "stated volume in auxiliaries, the condition of it, the time it takes to make reductions, and the time it takes to restore it" have all passed into air brake history; since we never draw on our auxiliary supply except in rare emergencies, but carry it in full reserve maintaining its maximum force unimpaired thus guaranteeing the full 100% results when required by train parting or when used by the conductor. We have avoided delicate and intricate adjustment pregnant with failure under adverse conditions and the air under each separate operation is so sealed that the mischief of leaking on or off is eliminated, as is also the braking shock with all its train of vexing results. Under extreme emergency conditions we maintain a large reserve energy impossible of exhaustion thus guaranteeing complete mastery by the engineer under all possible conditions, and if it should be possible to exhaust the supply in main reservoir by reason of both pumps going out of commission at once, the engineer can turn the full maximum auxiliary supply in to brake cylinders in addition to the straight air already there, with a possible result of nearly 100 pounds on the brakes, or more if higher train line pressure be carried.

We have harnessed up this natural law in a manner that is startling in its simplicity and its interchange feature is one of its many charms since we can equip any car with our system by simply removing the triple valve already there and replacing our own, using the same bolts and same nuts, and we can bring trains to a stand by service application in the same time and distance required now by emergency brake action. Our triple valve is constructed without either spring or slide valve, and dirty triples or crazy valves, or "Dynamiters" will accompany the retainer and hand brake in to the realms of memory. Any car equipped with our air may be picked up by a train equipped with other systems and it will work in perfect harmony regardless of the kind of engineer's valve in use.

When reduction is made, but a small portion of the air is wasted, as the major portion of it goes to brake cylinder for service and by each train unit making its own reduction we secure instantaneous action on entire train thus eliminating premature setting on head end or hanging on rear end. In our patent work we secured 95% of all claims submitted.

(Signed) W. H. Sheasby.

TECHNICAL DESCRIPTION.

This braking system enables the engineer to employ either straight or automatic air through a single train pipe, as he may elect, and also provides for emergency application of brakes by conductor or train men and in case of the train parting.

The objects and advantages are secured by providing an improved triple valve controlled by variations of train pipe pressure and brake cylinder pressure acting in harmony against the auxiliary pressure.

Referring to the accompanying drawings which illustrate the invention,—Figure 1 is a side elevational view of a braking equipment provided with fluid-controlling means constructed according to the principles of this invention, and adapted for mounting on a locomotive. The detached right hand portion of this view illustrates a continuation of the train line, and the braking apparatus thereof may be regarded as showing either the braking equipment of the tender of the engine or the equipment of a car. This figure is somewhat diagrammatic, some of the parts being shown out of true position. Fig. 2 is a fragmental plan section on line x^2 of Fig. 3. Fig. 3 is a longitudinal mid-section of the engineer's brake valve on line x^3 of Fig. 4. Fig. 4 is a side elevation of said valve partly sectioned on line x^4 of Fig. 3. Fig. 5 is a plan section looking up from line x^5 of Figs. 3 and 4. Fig. 6 is a plan view of the indicator of the engineer's brake valve.

In Fig. 1 is included the piping and chambers of a well-known braking system. In the drawing, 1 designates the train pipe, 2 the main supply reservoir supplied from the pump P, 3 the truck brake cylinder of an engine, 4 its driver brake cylinder and 5 its tender brake cylinder. 6 is the auxiliary reservoir of the engine proper and 7 the auxiliary reservoir on the tender. A branch 8 of the train pipe supplies air from said pipe to the braking equipment of the engine and a branch 9 supplies air to the braking equipment of the tender. Brake cylinders 3 and 4 are connected by a pipe 10 which establishes free communication between said brake cylinders.

The triple valve to which this invention more particularly relates is shown in two places in Fig. 1, being there shown applied to the braking apparatus of the engine proper and also applied to the braking apparatus of the tender.

11 in a general way designates the triple valve where it is shown applied to the engine proper and 12 designates a valve likewise constructed and applied to the braking apparatus of the tender; or the valve designated 12 may be considered as being shown in connection with the brakes of a car of the train, the tender equipment and equipment of a car being the same.

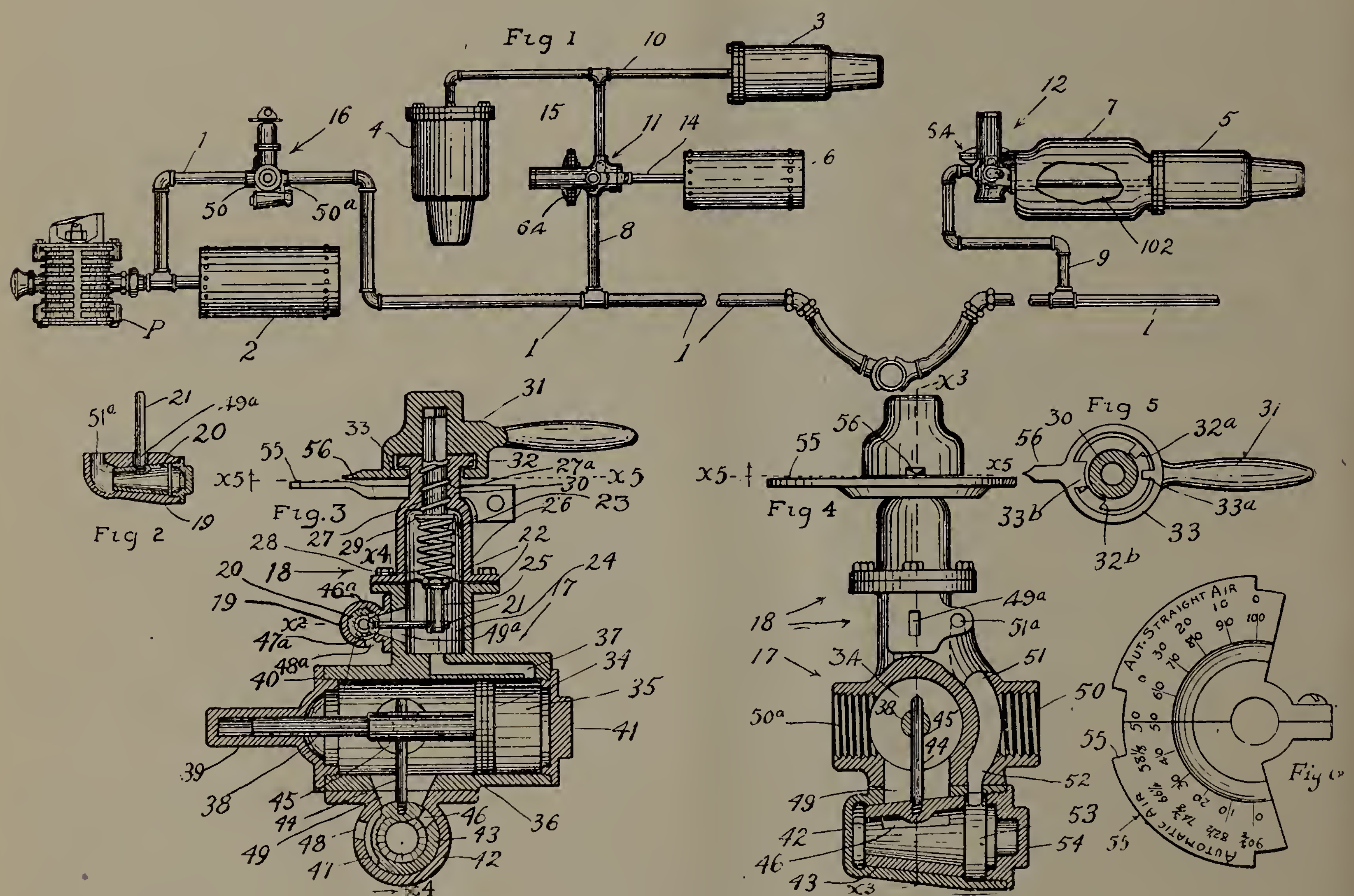
The valve 11 communicates with the train pipe through pipe 8 already referred to, with the auxiliary reservoir 6 through a pipe 14, and by a pipe 15 with the supply pipe 10 of brake cylinders 3 and 4.

16 in a general way designates the engineer's brake valve. Referring to Figs. 3 and 4 for a clearer understanding of this brake valve 16,—17 designates the lower portion of the valve which constitutes the valve proper, and 18 the upper portion of said valve which constitutes a pilot valve for operating the same. The pilot valve 18 comprises a casing 19 inclosing a plug 20 provided with a radial operating arm 21. Said pilot valve also comprises a diaphragm 22 which separates an upper chamber 23 from a lower chamber 24, the casings of said chambers 23 and 24 being preferably flanged at their contiguous ends and united together by bolts which form an air-tight fitting and clamp the diaphragm in place.

25 designates a pendent stem which extends through and is fastened to a diaphragm 22 by a nut 26 in a well-known manner. Pendent stem 25 is slotted at its lower end as shown in section in Fig. 3 to receive the end of valve arm 21 and form an operative connection therewith.

27 is an externally threaded compression stem terminating within and just below the top of spring 28, said stem being provided with a collar 29 which seats upon said spring to compress the latter.

30 is a tubular standard having internal threads to cooperate with the external threads 27^a of stem 27. Said stem 27 is angular at its upper end to fit the operating handle 31. The stem may slide with respect to said handle but cannot rotate therein. Standard 30 is provided at its top with a collar 32, having a small notch 32^a and a large notch 32^b cut therein, and handle 31 is provided with a depending rim 33 having a narrow lug 33^a and a wide lug 33^b adapted to slide through said notches and take under the collar to hold the



Sheasby and Neal Brake, Figs. 1, 2, 3, 4 and 5.

handle in operative position. This construction of notches and lugs is provided to render the handle non-detachable and operative during nearly a complete revolution.

The lower portion 17, which forms the valve proper of the engineer's brake valve, is provided with a piston head 34 which divides the piston chamber thereby forming the operating chamber 35 and the equalizing chamber 36.

37 designates a passage at all times affording communication between chamber 24 of the pilot valve and operating chamber 35 of the valve proper.

Piston-rod 38 is carried at its right end by piston head 34 and is guided at its left end by a hollow extension 39 which is formed on the cap 40 that forms the closure for the left end of the chamber 36.

41 is a cap closing the right end of the chamber 35.

Within a valve casing 42 is a valve plug 43 which is operated by a radial arm 44 projected through a hole or short slot 45 through piston-rod 38 thus forming an operative connection between said rod and arm. Plug 43 is provided with a supply port 46 and release groove 47, said groove co-operating with a casing port 48.

49 designates an operating slot along which arm 44 operates, said slot also forming a supply and release port which co-operates with port 46 and groove 47.

Valve plugs 43 and 20 and their adjacent parts are desirably identical in form and arrangement of ports, said plugs being shown as differing only in size, except that the air is admitted to the small instead of the large end of the pilot valve plug as shown in Fig. 2 where 51^a designates the inlet to the pilot valve. The parts designated 46, 47, 48 and 49 where they appear in the valve proper, are respectively designated 46^a, 47^a, 48^a, and 49^a, in the pilot valve.

50 is a supply inlet (see Fig. 4) for the braking valve 16, said inlet receiving the air as it enters from the supply reservoir 2 through the portion of the train pipe 1 shown in Fig. 1 at the left of said brake valve 16. Said inlet has an upper branch 51 which admits air to the interior of the pilot valve plug 20, and a lower branch 52 which admits air to supply chamber 53 with which the open end of plug 43 communicates.

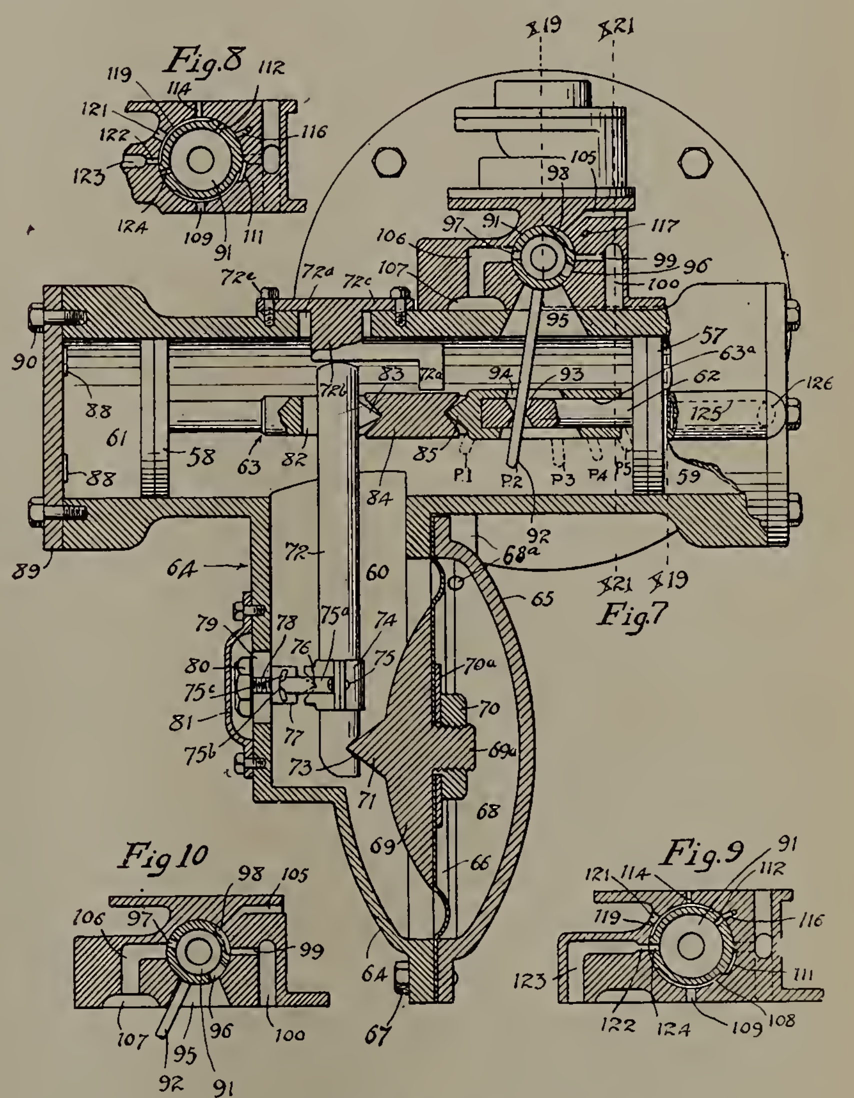
54 designates a cap closing the valve casing at the right of chamber 53.

50^a is an outlet leading to the section of train pipe 1 on the farther side of the braking valve.

By rotating handle 31 of the brake valve in one direction the threaded stem 27 will be depressed thereby compressing spring 28 and applying more pressure to the top of diaphragm 22, which pressure, if more than sufficient to oppose the resistance of the air in chamber 24, will depress the diaphragm and the pendent stem attached thereto thus also depressing valve arm 21 and rotating plug 20 of the pilot valve. Rotating the handle 31 in the reverse direction will produce opposite results.

To illustrate the manner in which the engineer's brake valve when properly adjusted automatically maintains the desired pressure in the train pipe line, let it be supposed that handle 31 of the pilot valve has been rotated sufficiently to so operate plug 20 of the pilot valve as to allow air from supply channel 51 (see Fig. 4) to enter chamber 24 and pass therefrom through channel 37 into chamber 35, and that the piston head 34 is therefore moved toward the left together with the piston rod 38 until the left end of said piston rod 38 strikes against the end of guide 39 maintaining port 46 of plug 43 in fully opened position. After the end of extension 39 limits the left hand movement of piston head 34 the pressure is confined against further expansion in chamber 35 and consequently increases in said chamber and also increases in chamber 34 of the pilot valve until said pressure operates with sufficient force against the lower side of diaphragm 22 to cause said diaphragm to yield upwardly against the set compression of spring 28 until the valve plug 20 moves to lap position shown in Fig. 3 thus maintaining constant the pressure which exists in chambers 24 and 35. It will be seen that the pressure in chamber 24 is now greater than it was before handle 31 was so rotated as to compress spring 28, because the rotation of said arm has further compressed spring 28 thus augmenting the pressure of diaphragh 19 so that a greater pressure under said diaphragm is necessary to bring it back to its original position.

While read 34 is in the left hand position and port 46 is consequently open to chamber 36 the pressure in the train pipe 1 and in chamber 36 will continue to increase until the pressure on the left hand side of piston head 34 begins to exceed that on the right hand side thereof. Said piston head 34 will then begin to move toward the right thus pro-



Sheasby and Neal Brake, Figs. 7, 8, 9 and 10.

ducing a greater pressure under diaphragm 22 and consequently rotating plug 20 to a position allowing air to gradually escape from chambers 35 and 24 through the groove 47^a and port 48^a. Piston head 34 will continue to move toward the right rotating plug 43 until said plug is brought to lap position cutting off further supply from main supply pipe 50 and channel 52, and stopping further compression of air in chambers 35 and 24, whereupon valve 20 comes to lap position automatically cutting off further escape of air from chambers 24 and 35 thus maintaining constant the amount of pressure for which spring 28 is set.

The degree of pressure attained in chamber 36 before plug 43 is brought to lap position will depend upon the degree of pressure maintained in chambers 24 and 35, being necessarily nearly as high as the pressure in said chambers, the friction of head 34 causing but a slight difference between the pressure on the right hand and left hand side thereof. Therefore, since by rotating arm 31 in a clockwise direction greater pressure is maintained in chambers 24 and 35, it necessarily follows that such operation of handle 31 results in causing and maintaining a corresponding increase of pressure in chamber 36 and in the train pipe line leading therefrom. Conversely, rotating handle 31 in an anti-clockwise direction will cause a reverse operation of the parts from that just described resulting in the escape of air from chamber 24 through groove 47ª and port 48ª thus lessening the pressure in chambers 24 and 35 causing piston head 34 to move toward the right and allowing air to escape from chamber 36 through groove 47 and release port 48, thus lessening the pressure in the train pipe until the pressure in said chamber 36 has decreased slightly below that in chamber 35, with the result that the pressure in chamber 35 moves piston head 34 toward the left and brings the valve to a lap position shown in Fig. 3 thus stopping further reduction of the train pipe pressure.

It will now be readily understood that a leakage from the train pipe will cause a reverse operation to that just described, automatically causing air to enter chamber 36 through ports 46 and 49 until the train pipe is supplied with a pressure sufficient to carry piston 34 back toward its original or lap position, thus cutting off further increase of pressure in the train pipe. If there is a steady leak from the train pipe the port 46 will remain opened wide enough to supply the amount of the leak.

55 designates a dial, and 56 a pointer carried by the handle-rim 33 to co-operate with said dial to indicate to the engineer the amount of pressure both in the train pipe and in the brake cylinders. The pressure in the train pipe and the brake cylinders may also be directly indicated to the engineer by means of the usual gages, not shown.

Referring to Fig. 6, the upper half of the dial indicates approximately the air pressures in the train pipe and brake cylinders during straight air application of the brakes; the figures on the lower half of said dial indicating such pressures during automatic application. On each half of the dial the inner figures indicate approximately the train pipe pressure, and the outer figures indicate brake cylinder pressure when the handle is so moved as to bring the pointer to the figures indicating the desired pressure.

Having now described the means for maintaining the desired pressure in the train pipe, means will next be described for building up and automatically maintaining pressure in the brake cylinders as desired by supplying them with air from the train pipe, this operation being accomplished by reduction of the train pipe pressure by operation of the engineer's brake valve, which may be continued until the pressures in the brake cylinders and train pipe approach and finally equal each other; and, after brake cylinder and train pipe pressure have thus been brought to an equality, means will be described for further increasing brake cylinder pressure by utilizing a still further reduction of train pipe pressure in a manner to cause auxiliary reservoir pressure to pass to the brake cylinders. The means for performing these operations by a reduction of train pipe pressure, is adapted to utilize an increase of such pressure in a manner to charge the auxiliary reservoirs from the train pipe. These operations are accomplished by providing a triple valve 12 on each car of the train to direct and control the air currents in the necessary manner.

Referring to Fig. 7 the triple valves may each be constructed as a hollow casting provided with a cylindrical portion forming a piston chamber for piston heads 57 and 58, said piston heads dividing the piston chamber so as to form a train pipe chamber 59, a central or equalizing chamber 60, and a full release chamber 61. Piston head 57 is provided with an extensible stem 62 which slidably engages within a socket 63ª with which the right end of a piston rod 63 is provided. The left end of said piston rod is fastened to piston head 58.

Equalizing chamber 60 extends down into a hollow projection 64 with which the triple valve is provided. This projection is formed as a casting open at one side, the opening being covered by a flanged cap 65, a diaphragm 66 being interposed between said cap and the casting and clamped between said parts by means of bolts 67, thus forming a diaphragm chamber 68, whence passages 68ª and 151 lead to the auxiliary reservoir.

69 is preferably a plano-convex casting to reinforce the diaphragm. 69ª is a threaded boss projecting from the flat side of said casting through a central opening in diaphragm 66 and held thereto by a nut 70 screwing onto said boss, and against a washer 70ª. Said casting 69 is provided on the convex side thereof with a wedge-shaped projection 71 which forms a pivotal joint between casting 69 and the lower end of upright lever 72, said lever having a notch 73 to receive said projection 71. Said upright lever is provided with a fulcrum-collar 74 preferably formed in two flanged pieces united by screws 75 as shown in Figs. 17 and 18. Said collar is provided with a fulcrum-notch 76 which engages a fulcrum-block 77. Said block 77 is furnished with a threaded extension 78 which extends through a vertical slot 79 through the wall of the casting and is held in vertical adjustment in said slot by nut 80. 81 is a closure cap bolted over the slot to form an air-tight closure thereover.

Screws 75 hold in place L-shaped leaf springs 75ª, said springs bearing inwardly against the sides of the fulcrum-point of block 77. Said springs have inbent terminal portions 75ᵇ which enter grooves 75ᶜ in the sides of the fulcrum-joint and thus prevent the parts of the joint from becoming disengaged.

The upper end of lever 72 extends into a slot 82 with which piston rod 63 is provided and said lever is provided with a laterally projecting wedge-point 83.

84 is a joint-piece which extends longitudinally with respect to slot 82 and has a working fit therein. Said joint-piece is notched at each end, one notch engaging wedge-point 83, and the other notch engaging a point 85 which is formed in that end of slot 82.

To limit the movement of upright lever 72 toward the train pipe chamber, a stop member 72ª is provided, as best shown in Fig. 7. Said member is desirably a casting formed with a stop portion 72ᵇ against which the top of upright lever 72 strikes, to prevent head 57 from taking automatic positions except when train-pipe pressure is lower than brake cylinder pressure, as hereinafter described. Said member is also furnished with a flanged head 72ᶜ which is fastened within an opening 72ᵈ by means of cap-screws 72ᵉ.

The outward movement of piston-head 57 may be limited by providing the cylinder head 86 with inwardly projecting lugs 87. 88 are similar lugs formed on the cylinder head 89 to stop piston-head 58. The construction just described or some equivalent arrangement should be provided to prevent the piston-heads from seating on the heads of the cylinder and thus diminish or cut off the area exposed to pressure in chambers 59 and 61. 90 are cap-screws for holding on the cylinder-heads.

Plug 91 of the distributing valve is provided with a radial arm 92 which extends downwardly through a slot 93 in stem 62 within which it has a working fit as shown in Fig. 7. The socketed portion of piston-rod 63 also has a double slot 94 extending therethrough through which the valve arm 92 extends, said last mentioned slot being of sufficient length to allow the valve arm considerable play with relation to the piston-rod. 95 designates an operating slot adjacent plug 91. Said operating slot affords an opening to receive the valve arm 92 and also serves as a port which co-operates with plug port 96. Plug 91 is also provided on the same transverse plane with the operating slot and port just mentioned, with a port 97 and a groove 98. Plug port 96 co-operates with casing port 99, said casing port leading to a larger passage 100 which leads around through the wall of the triple valve to channel 101, thence by pipe 102 through the auxiliary reservoir to the brake cylinder.

Plug groove 98, already referred to, opens and closes communication between casing port 99 and casing release port 105, said release port 105 leading directly to the atmosphere.

Plug port 97 establishes and cuts off communication between supply port 106 and the interior of the valve plug. Said port 106 leads to a larger passage 107 which extends along the cylinder casing to branch 8 of the train pipe (see Fig. 21). Fig. 20 illustrates the ports of the valve casing just described.

In the embodiment of the invention illustrated in the drawings, each triple valve comprises, in addition to the distributing valve and means for operating valve arm .02 thereof, a secondary valve designated in a general way as 115. A plug port 112 moves into and out of register with a casing port 114, thus establishing and cutting off communication between said secondary valve. This port 112 also remains in communication with a charging port 116 whenever it is necessary to maintain communication between the interior of the valve plug and the auxiliary reservoir. Said charging port 116 leads by way of channel 117 to the discharge passage of the secondary valve 115, thence to the auxiliary reservoir.

There are two release positions of the triple valve, one, shown in Figs. 9 and 10, when a full release of brakes is effected with train line pressure above brake cylinder pressure; and the other release position known as automatic or preliminary release is assumed when the train line pressure is below the brake cylinder pressure at the time of release, and can only be continued until the decreasing brake cylinder pressure and increasing train pipe pressure meet and equalize, after which triple valve will immediately assume full release or straight air release as in Figs. 9 and 10. That is to say, when the train-pipe pressure is considerably below brake cylinder pressure, an increase of the train-pipe pressure will (if such increased pressure still remain below brake cylinder pressure) cause a release of air from the brake cylinder into the train-pipe. A release of the brakes of this character is termed "preliminary" because if the train-pipe pressure is further increased the valve will upon another increase of train-pipe pressure be made assume the position shown in Figs. 9 and 10, thus releasing the brake cylinder pressure to the atmosphere.

There is at no time direct communication between the train pipe chamber 59 and the central chamber 60. The train pipe, however, feeds both the central chamber 60 and the train pipe chamber 59, being in constant communication with the train pipe chamber and only intermittently in communication with the central chamber. The train pipe chamber 59 is always in communication with the train pipe through port 126 and channel 125 which leads to branch pipe 8 or 9, as shown in Fig. 1. The central chamber 60 is maintained in communication with the train pipe only during full release of the brakes, communication at such time being from branch pipe 8 or 9 through channel 107.

Assume the parts to be in the full release position first mentioned, shown in Figs. 9 and 10, the valve arm being in position p^1 (see dotted lines of Fig. 7) and the train line pressure one hundred pounds per square inch. In such case, this pressure of one hundred pounds will always exist in chambers 59, 60, 61 and 68, and also in the auxiliary reservoir, which is in communication with diaphragm chamber 68 at all times. When the pressure is the same in said diaphragm chamber as in train line chamber 59, the pressures in these chambers, considered by themselves, counterbalance each other because of the length of the arms of upright lever 72 on either side of its fulcrum being so proportioned to the areas of the pistons and diaphragm as to produce this result. To make a service application of the brakes under these circumstances, a reduction may be made in the train line pressure as in present systems of, for instance, ten pounds, with the result that the opposition of the air in chamber 59 to the piston head 57 is lessened, allowing the air in chambers 61 and 68 to move the valve arm from the first toward the second position p^2. This movement may perhaps be aided by reason of the pressure being lowered in chamber 59 more quickly than in chamber 60 on account of the smallness of the opening between ports 96 and 95 when the valve is in the position shown in Fig. 10 causing the pressure in chamber 60 to reduce more slowly than that in chamber 59, so that the pressure in chamber 60 will be somewhat greater than that in chamber 59 while the reduction is being made. This state of facts may cause a temporary extension of the stem 62 from its socket, but as soon as the right end of groove 108 (see Figs. 8 and 9) has come into communication with equalizing groove 111, the air in central chamber 60 will be released to the brake cylinder thus bringing the pressure in chamber 60 down to nearly zero, and allowing expansion of the air in diaphragm chamber 68 to move the valve arm to position p^3, opening a free communication between the train line and the brake cylinder.

Ports 123 and 124 are only in communication in full release position. It will be noticed that in service application air is released from chamber 61 (which said ports supply) thus allowing piston 57 and diaphragm 66 to equalize with each other with the aid of the brake cylinder pressure as described. But assuming the parts to be in full release position (see Figs. 9 and 10) the pressure will then be the same in all chambers of the triple valve which would be maximum train line pressure. It will be seen that by reducing the train line pressure the pressure in chamber 57 will also be reduced allowing the pressure in chamber 61 (which is now the greater pressure) to move piston rod 63 to the right. Extensible stem 62 will also aid in this operation as the lesser pressure on the right side of piston 57 will not resist that on the left side thereof which will cause a temporary extension of stem 62 which will rotate valve 91 and cause the triple valve to operate, thus reducing the train line pressure a predetermined number of pounds increasing by the same number of pounds the air pressure existing in the brake cylinder.

When the engineer has reduced train pipe pressure sufficiently to cause release of air from the train pipe to the brake cylinder as just described, the immediate effect of such release will be to further reduce the train pipe pressure by causing each distributing valve to aid in making a reduction of the train pipe pressure thus making a quicker and more uniform application of the brakes and causing a greater portion of the air which escapes from the train pipe to be put to useful work.

The operation will be readily understood when it is noted that the reduction of pressure on the inner side of one piston head offsets that on the inner side of the other, so that, by reducing the pressure in the central chamber, no movement of the piston-rod 63 is caused except that resulting from the expansion of the air in diaphragm chamber 68 and in the auxiliary reservoir connected therewith.

Personals

Ira G. Rawn, president of the Chicago, Indianapolis & Louisville, died from a bullet wound early in the morning of July 20. The shooting occurred in his country home under mysterious circumstances, which may never be solved. Mr. Rawn had been president of the "Monon" road since October 9, 1909. He had been in the railway business from the time he was 22 years old. He was born in the little town of Delaware, Ohio, and educated in the public schools there. At the age of 15 he learned telegraphy. Two years later he was an operator. At the age of 19 he got his first position. Three years later he had a railroad position. His advancement was rapid. He graduated from the position of telegraph operator to train dispatcher and trainmaster. It was not long before he was holding more important positions. Through devotion and industry he gained the confidence of the men for whom he worked. He was advanced through various positions in the Kentucky Central, the Chesapeake & Ohio, and the Baltimore & Ohio Southwestern, until in 1902 he was made general superintendent of the Baltimore & Ohio. A year later he became associated with the Illinois Central as assistant to J. T. Harahan and was quickly advanced through the positions of general superintendent of transportation and general manager until he was vice president, a position he held when called on to accept the place of president of the Monon.

T. H. Goodnow has been returned to Englewood, Chicago, as master car builder for the New York Central Lines. Mr. Goodnow has for the past few weeks held the position of assistant master mechanic at Elkhart, Ind.

J. L. Fagen succeeds C. M. Hoffman as master mechanic of the Denver & Rio Grande at Grand Jct., Colo.

R. Q. Prendergast succeeds R. B. Stout as master mechanic of the Denver & Rio Grande at Pueblo, Colo.

W. R. Wood has been appointed engineer of tests of the Great Northern, with office at St. Paul, Minn.

J. W. Austin has been appointed master mechanic of the Jonesboro, Lake City & Eastern, with office at Jonesboro, Ark.

A. Johnson succeeds W. W. Scott as master mechanic of the Kalamazoo, Lake Shore & Chicago, with office at Paw Paw, Mich.

J. W. Senger has been appointed superintendent of materials of the Lake Shore & Michigan Southern at Cleveland.

S. B. Burdell has been appointed assistant mechanical superintendent of National Rys. of Mexico, with office at San Luis Potosi.

Among the Manufacturers

NEW LOCOMOTIVE THROTTLE VALVE.

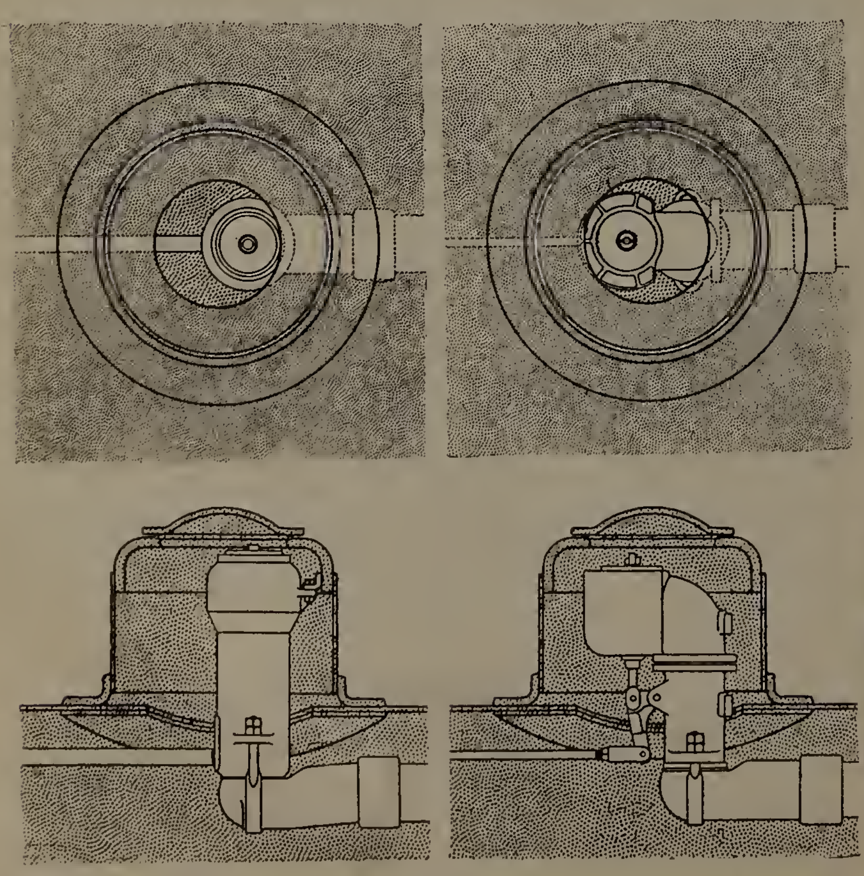
The locomotive throttle valve here illustrated was invented by J. S. Chambers, superintendent of motive power of the Atlantic Coast Line, and has now had service tests of over three years, during which time the results are said to have been highly satisfactory. The apparatus combines throttle valve, throttle box and stand pipe, and is unique in many ways.

The stand pipe where the throttle stem enters above the center line of the dry pipe fits onto the elbow on the end of the dry pipe as shown. If the throttle stem must enter below the center line of the dry pipe, the elbow is cast as part of the stand pipe.

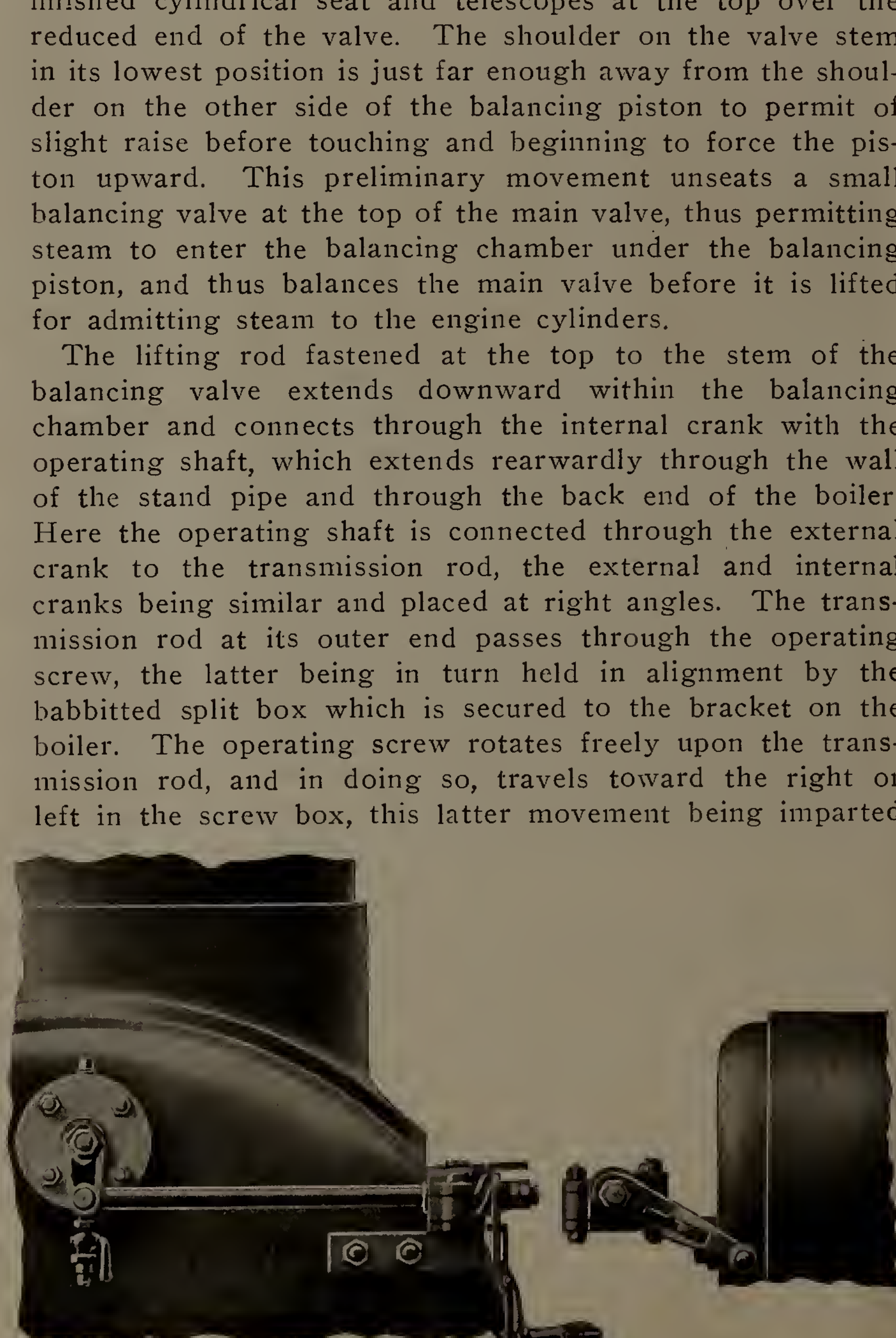
In the type shown, no opening in the wall of the steam dome is required for operating the throttle valve proper, but if in replacing another type of valve on a locomotive already in service or for other reasons it is desirable to bring the operating shaft through the wall of the steam dome, the valve is made to meet this requirement. The stand pipe is held rigidly in the steam dome at the top by some form of bolted connection and at the bottom is clamped to the dry pipe by a U-strap bolt, or by two hook straps.

The throttle valve proper is a single balanced disc resting on top of the stand pipe. The valve is unseated by the upward movement of the balancing piston which slides in a finished cylindrical seat and telescopes at the top over the reduced end of the valve. The shoulder on the valve stem in its lowest position is just far enough away from the shoulder on the other side of the balancing piston to permit of slight raise before touching and beginning to force the piston upward. This preliminary movement unseats a small balancing valve at the top of the main valve, thus permitting steam to enter the balancing chamber under the balancing piston, and thus balances the main valve before it is lifted for admitting steam to the engine cylinders.

The lifting rod fastened at the top to the stem of the balancing valve extends downward within the balancing chamber and connects through the internal crank with the operating shaft, which extends rearwardly through the wall of the stand pipe and through the back end of the boiler. Here the operating shaft is connected through the external crank to the transmission rod, the external and internal cranks being similar and placed at right angles. The transmission rod at its outer end passes through the operating screw, the latter being in turn held in alignment by the babbitted split box which is secured to the bracket on the boiler. The operating screw rotates freely upon the transmission rod, and in doing so, travels toward the right or left in the screw box, this latter movement being imparted



Position of Chambers Throttle Valve in Dome Compared with That of Another Type in General Use.



View of Controlling Mechanism, Chambers Throttle.

to the transmission rod. The screw and operating handle are riveted together and travel sidewise as one solid piece, engaging on one side, a shoulder on the transmission rod and on the other washers so adjusted on the outer end of the rod that there is no lost motion, the washers being locked into place by the jamb nut.

The handle in normal position for closed throttle extends away from the operator and is latched to prevent accidental opening. Turning the handle downward and backward draws the transmission rod to the right, rotates the operating shaft and thus opens successively the balancing valve and throttle. The amount of throttle opening is indicated by the position of the handle and is limited by a stop which limits the travel of the handle. The length of the handle is such as to give practically the same forward and backward travel for any ordinary opening as with the ordinary throttle lever.

The part of the operating shaft within the boiler is surrounded by a pipe casing which is threaded on the inner end into a steam-tight bushing in the stand pipe wall, and on the outer end into a sleeve that in turn is packed into the stuffing box with metallic packing to take up unequal expansion. It will thus be seen that with closed throttle the operating shaft is entirely unaffected by boiler pressure. The inner end of the operating shaft and the annular space between shaft and casing are therefore free from steam pressure while the throttle is closed, unless there is leakage at the throttle valve, balancing valve, or some interior connection of the stand pipe. Such leakage admits steam to the balancing chamber and builds pressure in the annular space around the shaft and in the drain chamber between stuffing box and packing gland. This leakage can be detected by opening the test and drain cock. This cock may also be utilized for blowing steam through occasionally to remove any mud that may get into the pipe.

As the balancing valve opens and pressure builds in the balancing chamber, the outward end thrust upon the end of the operating shaft is distributed upon a number of annular bearing shoulders turned on the operating shaft and working against a babbitted bearing in the packing gland. This babbitted packing also prevents the escape of any steam or condensation that works its way into the back end of the operating shaft casing while the throttle is open. The stuffing box is bolted into place in the usual manner and fitted with a ground ball joint which conforms to any slope of the boiler head.

Unintentional interior disconnections are prevented in a Chambers valve by the absence of loose pins from its operating mechanism. The only pins used are on the ends of the lifting rod and these are countersunk at their heads and riveted over on the outer ends. No pin is used at all to connect the operating shaft and internal crank, as the end of the operating shaft centers itself in a square tapered socket in the internal crank.

The construction has been simplified throughout with a view to minimizing inspection and repair expenses. The operating levers being entirely within the stand pipe, and the stand pipe set far toward the side of the dome enables an inspector to enter the dome or make repairs without meeting obstructions or having to break steam joints.

View of Chambers Throttle Valve in Position in Locomotive Dome.

No clearance is needed on top of the throttle valve save that required for the lift. The valve may therefore be placed high in the dome and deliver steam into the dry pipe with minimum moisture. As the steam passes through only one valve, there is little countercurrent or obstruction to impede its flow, the object of this being to secure more useful work and thus get the most from the steam.

The main valve, being single seated, does not require regrinding frequently as unequal expansion is never a factor in its operation. The pressure on the upper side further tends to keep the valve seated and the movement imparted by the steam flow makes this valve to a large extent self-grinding.

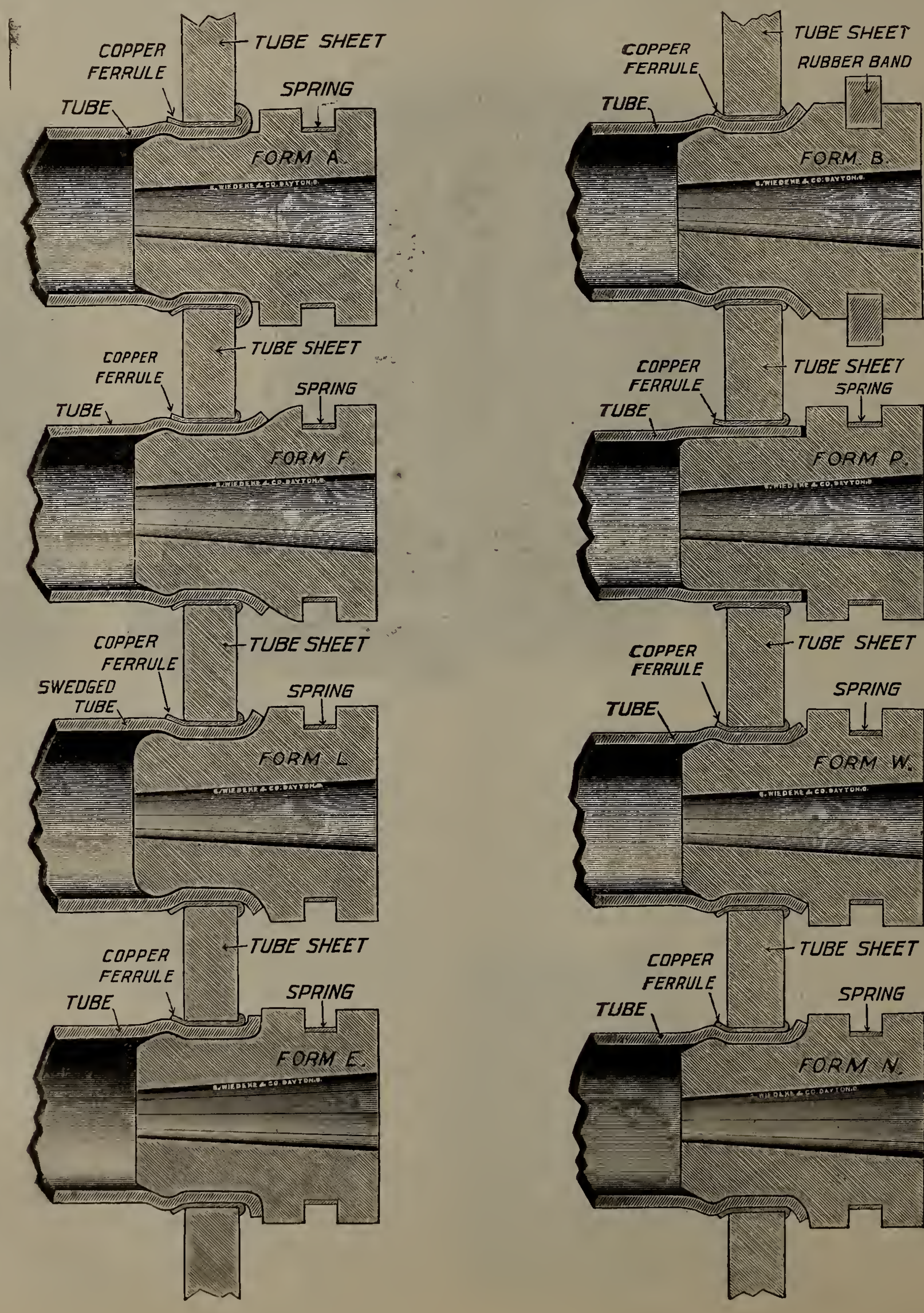
The main valve is readily accessible upon removal of the steam dome cap and regrinding can usually be effected without removing valve or seat. If, however, the combined balancing ring and seat is to be machined, it may be taken out of the stand pipe upon the removal of three screw bolts.

The Chambers valve is not subject to the troubles that are found on account of an unbalanced condition of the valve for the main valve does not open until almost exactly balanced by the steam pressure under the balancing piston. It is evident, too, that end thrust on the operating shaft cannot influence the valve opening. The throttle handle can therefore be moved by a light pull and as no other force tends to displace the valve further, the engineer has easy, complete and quick control of steam admission.

The regulation of a Chambers valve is said to be so close that no special drifting valve is necessary in mountainous sections. Maintenance of an opening as small as $\frac{1}{64}$ inch is said to be practical so that the engineer can admit the requisite small amount of steam to properly lubricate the cylinders and exactly balance the reciprocating parts while drifting down long hills.

The substitution of the rotary for a reciprocating operating shaft overcomes the tendency to push the steam outward and open the valve unduly. With the Chambers valve there can be no end thrust on the operating shaft while the throttle is open, although a slight outward movement of the operating shaft could not influence the regulating movement. The regulation remains under control without the necessity of locking the throttle handle into fixed position.

Neither the metallic packing on the end of the shaft casing nor the babbitted shaft bearing are subjected to frictional contact as a means of holding the operating parts. The former merely provides for unequal expansion of shaft and casing and the construction is such that blowout is impossible. The small duty on the metallic and babbitt packing is evidenced by the fact that on a locomotive in three



Recognized Standard Forms of Sectional Tube Expanders.

years' constant service these packings did not have to be touched.

The babbitt in the packing gland is not under pressure while the throttle is closed, but is in steam tight contact with the bearing shoulders on the operating shaft. This contact is maintained by an adjustable friction ring on the outer end of the shaft. End thrust on the operating shaft while the throttle is open jambs the bearing shoulders and babbitt closer together, thus tightening the seat and lessening the possibilities of steam escape. It is evident that with closed throttle, the removal and replacement of gland and shaft for adjustment or inspection are possible under steam pressure.

The Chambers valve is manufactured by the Watson-Stillman Co., 50 Church St., New York.

SECTIONAL TUBE EXPANDERS.

In the accompanying illustration are shown eight recognized standard forms for sectional tube expanders. These drawings are interesting in that every form illustrates the personal preference of a large number of mechanical men. There are of course many methods of expanding tubes into their sheets which differ materially from any of those shown, but their use is not general enough to be called standard practice.

Gustav Wiedeke & Co., Dayton, O., by whose courtesy the drawings are published, are among the foremost in the manufacture of tube expanders.

NEW LITERATURE.

In a booklet recently issued, the Flower Waste & Packing Co., of New York, gives considerable information regarding good and bad waste and the packing of journal boxes with the same. A number of drawings are shown in connection with journal box packing.

* * *

One of the noteworthy features in a recent bulletin of Gustav Wiedeke & Co., Dayton, Ohio, is a page of drawings showing the various standard forms of sectional expanders in use in this country. On the following pages is shown a complete line of tube expanders.

* * *

The Ingersoll-Rand Co., of New York, has issued two bulletins devoted to "Crown" sand rammers and duplex Corliss steam-driven air compressors. They are arranged in neat form for insertion in a binder.

* * *

"The Boilermaker" of New York has published a very neat 3x5 booklet entitled "Where to Buy Boiler Shop Equipment and Supplies," being a classified directory of firms supplying this equipment.

* * *

The Pennsylvania Flexible Metallic Tubing Co., Cleveland, Ohio, has issued an attractive booklet descriptive of Pennsylvania interlocking metal hose for railroad service.

* * *

New developments in valve gear motions are always of interest and in a recent pamphlet Pilliod Brothers, of Toledo, O., describe their new gear, which differs considerably from others now in use. The new gear is manufactured either for cross-head connection or for cross-head crank connection.

* * *

The American Blower Co., of Detroit, Mich., has published a booklet dealing with blower equipment for the modern foundry. A number of pages devoted to "Heating and Ventilating the Foundry" are of especial interest.

* * *

The Carnegie Steel Co., of Pittsburg, has just gotten out a pamphlet on steel derricks and drilling machines for oil, gas and salt wells, which contains much matter of interest for those connected with this work.

* * *

In a neat booklet lately issued by the Durbin Automatic Safety Car Coupler Co., of Ft. Scott, Kan., there is described the new safety coupler made by this company. It is noteworthy for its simplicity and is said to obviate all Interstate Commerce Commission difficulties on the coupler question.

* * *

Catalogue 22 of the Mulconroy Co., of Philadelphia, shows very completely the line of rubber goods made by them, which includes hose, boots, belting, rubber coats, sheet and piston packing.

* * *

The Contractors' Supply & Equipment Co., of Denver, Colo., in their latest catalogue, shows a complete line of contractors' equipment, together with prices.

* * *

The Markel removable driving box brasses, which it is claimed are more simple and less expensive than the ordinary brasses, are set forth in detail in a pamphlet recently issued by the Locomotive Improvement Co., of Clinton, Ia.

* * *

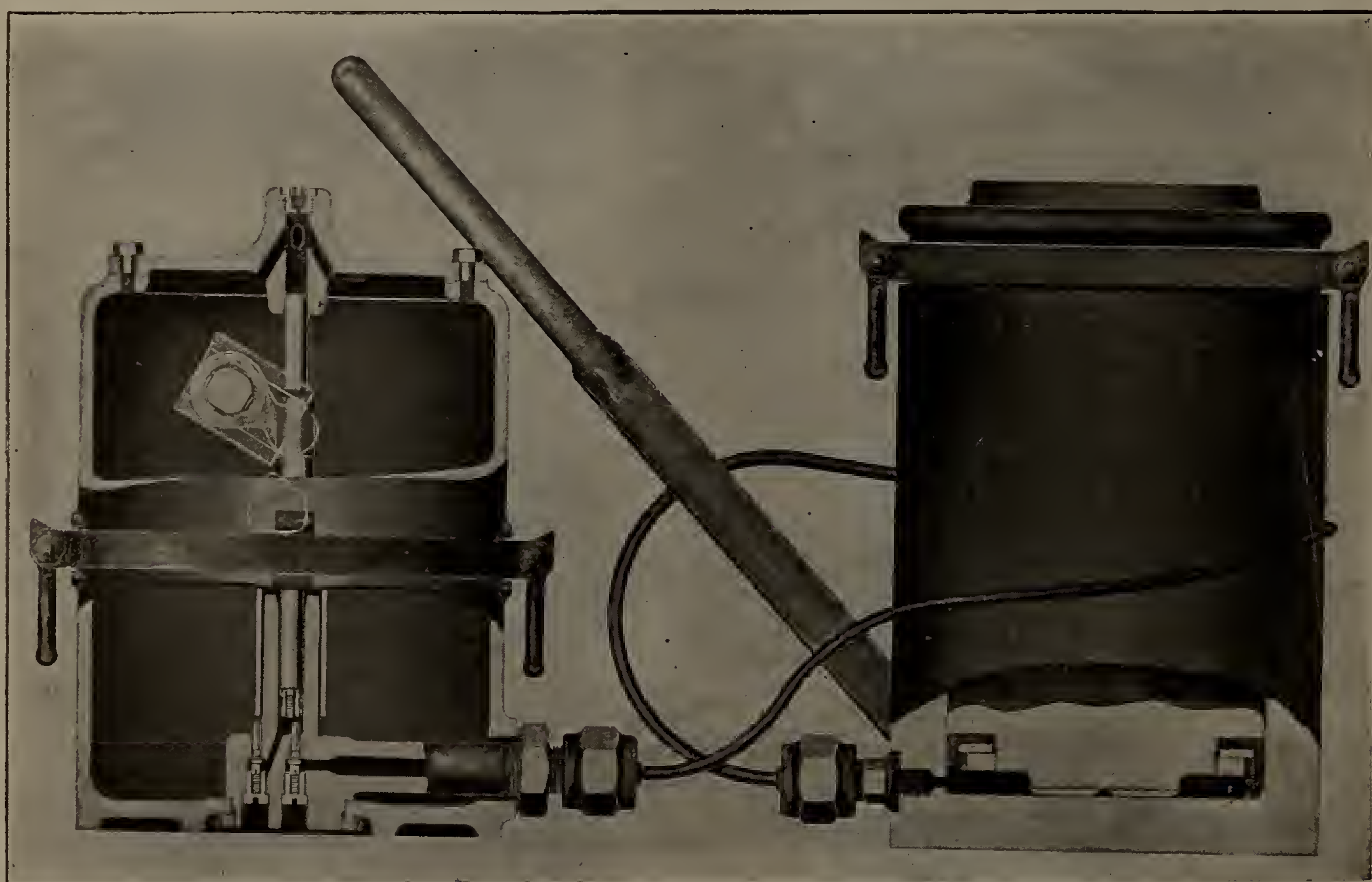
The Commonwealth Steel Co., of St. Louis, has issued a very attractive and handy booklet showing the various products handled by this company, which include trucks, underframes, bolsters and draft gear.

DUFF-BETHLEHEM INDEPENDENT HYDRAULIC JACK.

Something new in hydraulic lifting jacks is to be found in a design recently put upon the market by The Duff Manufacturing Co., Pittsburg, Pa. This jack is a powerful tool with lifting capacities ranging from 100 to 500 tons and a raise from 6 to 12 inches. It is intended for use wherever it is convenient to operate an ordinary jack, and is, therefore, coming into quite general use in ship-building, bridge construction, machine shops, etc. The novel construction of this jack is clearly shown in the illustration. Forged steel is used throughout and the design is simple and compact. It consists of two main parts. The water reservoir with its pump chambers and the ram or lifting mechanism. These two parts are separate and distinct except for the flexible copper tubing which connects them. This arrangement allows the ram to be placed in any spot where there is sufficient room for it to rest securely while the pump can be placed anywhere or at any distance permitted by the length of the tube, where it can be conveniently operated. Since the jack can be placed at any angle, it is of great service. With small modifications in the frame construction this tool can be put to many uses for which an hydraulic press is employed.

The details of the construction of this jack present many interesting mechanical features. On the left in the illustration is the pump and reservoir cross sectioned in part, to show the valve construction. The pump is double acting with a working or pumping stroke on both upward and downward motion of the piston. There are two pump chambers, the upper having about five times the capacity of the lower. The valves in the pump chambers are so arranged that on light loads the larger volume of water in the upper chamber is forced under the bottom of the same, causing it to rise through larger units of space than on heavy loads or overloads, when the smaller volume of water in the lower chamber is utilized. This speed adjustment is secured by means of an automatic by-pass valve in the diaphragm between the upper and lower reservoirs, which acts against a spring which can be adjusted so as to allow the water in the upper pump chamber to escape at predetermined loads. This setting is generally at 25 per cent of the total capacity of jack which corresponds to the lifting power which can be exerted by one man on large pump chamber. To trip the load the operating lever is reversed so that the lug on the side projects upward, allowing the lever to be pressed further down, causing the trip sleeve and pump piston to bear directly on the suction and discharge valves respectively, thus allowing the liquid to pass back from the ram cylinder to the reservoir. The load may be lowered as slowly as desired or stopped at will by varying the pressure or lifting up on the lever.

Since the weight lifted by the jack is inversely proportional to the speed of ram travel the arrangement just described automatically adjusts the speed to the varying conditions of usage. The valve action is positive and there are no refinements of construction to cause trouble in a tool that is sure to receive rough usage. The tube which leads from the pump to the ram cylinder is as already stated, made of flexible copper and is guaranteed by the manufacturers to withstand a pressure of 10,000 pounds per square inch. This tube is about eight feet long. In the construction of the cylinder there are several features which make for unusual efficiency and economy of maintenance. This cylinder is a solid steel forging, there being no joint at its base as in other makes. This design gives greater stiffness and strength with minimum weight and what is more important, obviates the necessity of having a packed joint at the body of the cylinder. This joint is a fruitful source of leakage and is the hardest joint to make water-tight since it is the one subjected to the greatest pressure. This pressure varies, of course, directly with the load and with the distance through which the load is lifted, being greatest when the load is at rest at the extreme limit of travel of the ram. The only packed joint in this type of jack is between the ram and cylinder walls, where packing is easy and leakage less likely to occur owing to pressure being less direct and decreasing as the ram rises being inconsiderable when the load is at rest at the end of the lift. The advantages outlined above will be recognized by all users of jacks. The valve and cylinder construction in the independent pump jack is not, however, peculiar to it, but is characteristic of all the hydraulic jacks made by The Duff Manufacturing Co.



Duff-Bethlehem Independent Pneumatic Jack.

INDUSTRIAL NOTES.

A 70-ft. gasoline motor car, built by the McKeen Motor Car Company, Omaha, Nebraska, for the Atchison, Topeka & Santa Fe, left Omaha July 29th. The car was sent south for service in Texas.

The Chickamauga Steel & Iron Co. has been incorporated with a capital of $5,000,000. The principal office of the company is in Jersey City, N. J. The incorporators are George W. Adams, Montclair, N. J.; Robert W. Pollock, New York City, and Francis Van Winkle, Brooklyn, N. Y. The company was organized for the purpose of engaging in the business of manufacturing steel and iron.

The Linde Air Products Co., Buffalo, N. Y., is building a one-story brick and steel addition to its plant at Chandler street and Manton place.

The Isthmian Canal Commission will receive bids until September 16 to furnish and erect machinery to operate the Stoney gate valves for controlling the main culverts, and machinery to operate the cylindrical valves for controlling the lateral culverts of the upper lock and the Pedro Miguel lock (Circular No. 596); until August 15 for water meters and steel billets (Circular No. 597); until August 19 for steel castings, manganese steel bushings, steel, iron, brass condenser tubes, cast iron pipe, sluice gate, valves, pumps, etc. (Circular No. 598.)

W. M. Chamberlin, manager promotion department of the Detroit Lubricator Company, Detroit, Mich., has resigned, effective August 1, to become manager of a bureau of general service of The American Supply & Machinery Manufacturers' Association, to be located at Detroit. The establishment of this bureau is in line with the inauguration of an aggressive campaign by this association for the furtherance of the mutual interests of its members. G. K. MacEdward will succeed Mr. Chamberlin as manager of the promotion department of the Detroit Lubricator Company. He has been associated with the Gray Motor Company.

The American Water Softener Company, of Philadelphia, Pa., has recently received orders for fifteen water softening plants from the Norfolk & Western, ranging in capacity from 12,500 to 18,000 gallons per hour, and also an installation of similar design for the Toronto, Hamilton & Buffalo at Hamilton, Ont. The business in the filter department is equally good and includes recent orders from the Salisbury Water Works, Salisbury, N. C.; Town of Weston, Ont.; Decatur Water Works Co., Decatur, Ala.; Philadelphia Paper Mfg. Co., Philadelphia, Pa.; Merchantville Water Co., Merchantville, N. J., and the Midvale Steel Co., Philadelphia, Pa.

The Whipple Supply Company has taken larger quarters at 50 Church street, New York, rooms 2065 and 2066. On June 1 it established western offices in the First National Bank building, Chicago, in charge of H. F. Keegan, western manager of sales.

Winthrop B. Lillis, general foreman of the Illinois Central shops at Waterloo, Iowa, has resigned to accept a position as superintendent of the Greenlee Brothers Company, Rockford, Ill.

The American Spark Arrester Co., Indianapolis, Ind., has been incorporated with a capital of $100,000. The incorporators are: T. A. Van Horn, C. A. McCotter, H. N. Knight, C. F. Remy, J. W. Sale, E. E. Perry and V. E. Butler.

The motive power department of the Chilian Transandine Railway, Ltd., wants catalogues of all kinds of locomotive equipment and supplies, and machinery and supplies for railway shops. These catalogues should be addressed as follows: Locomotive Superintendent, Transandine Railway Company, Ltd., Los Angeles, Chile, S. A.

Mr. L. R. Pomeroy, assistant to the president of the Safety Car Heating & Lighting Co., has resigned to take a position with the engineering and contracting firm of J. G. White & Co.

The Orenstein-Arthur Koppel Company, manufacturers of portable and industrial railways and steel cars, paid a dividend for the year 1909 of 13 per cent of their capital of $6,500,000. The surplus fund of this company amounts to $1,800,000.

John F. Schurch, chief clerk to the president of the Minneapolis, St. Paul & Sault Ste. Marie, has been elected treasurer of the Railway Materials Co., with office in the Old Colony building, Chicago.

The Pullman Co. has declared a quarterly dividend of two dollars per share from net earnings to be paid August 15 to stockholders of record on July.

The Railway Supply Manufacturers' Association has moved its offices from 313 Sixth avenue, Pittsburg, Pa., to room 2135, Oliver building.

Mrs. A. Fenton Walker, U. S. representative, The Railway & Marine World, Toronto Canada, and Directory Publishing Co., Ltd., London, England, has moved her office from 143 to 140 Liberty St. New York.

The United States Lighting & Heating Company, of New York, expects to have the new plant that it is now constructing at Niagara Falls, N. Y., completed by fall. A main building, 200 x 400 ft., is about finished, and other structures are being erected. The company has 18 acres of land at Niagara Falls, and the plant will be devoted to the manufacture of electrical appliances, chiefly lighting systems for railroad trains.

The Union Machine Co., Inc., 164 University Ave., St. Paul, Minn., has been appointed general manufacturing and sales agent for the products of the Plunger Plastic Packing Co., Inc. of St Paul. The products of the Plunger Plastic Packing Co., include—the D & L throttle rod, stuffing box, and Plunger Plastic Packing.

The Southern Railway Equipment Co., St. Louis, Mo., entered its new building, 113 North Second street, on July 1. This company has secured the direct agency for that territory for the Anchor Packing Co.. and D. J. Murray, the local representative of that company has taken charge of the packing department of the Southern Railway Supply Co. M. E. Towner, whose resignation as purchasing agent of the St. Louis & San Francisco has been announced in these columns, has been elected president of the company, Mr. Bartman becoming secretary.

At a meeting of the board of directors of the Petroleum Iron Works Co., Sharon, Pa., on July 11, 1910, C. H. Todd, of Washington, Pa., was elected president to succeed E. G. Wright, resigned. Mr. Todd, who was one of the founders of the Petroleum Iron Works Co., and who will be in active charge of the company's affairs, is well and favorably known, especially in the eastern and southwestern oil fields. The directors reported the plant as running at full capacity, with sufficient orders booked to insure a steady run for several months, and the financial position of the company as unusually strong.

Dexter L. Phipps, general manager of the Chicago Refrigerator Car Co., has resigned to become president and director of the Chicago Car & Equipment Co., Clearing, Ill. Mr. Phipps has been engaged in the car building business for the past 20 years and is thoroughly experienced in this line. The Chicago Car & Equipment Co. has been in business during the past year, its work being largely in the line of car and locomotive repairs. The company expects to open offices and headquarters in Chicago in a short time.

Arrangements have been made by the C. W. Hunt Company, New York, builders of coal handling, conveying and hoisting machinery; by which their business on the Pacific coast will be handled by the San Francisco Bridge Co., with offices at 865 Monadnock Building, San Francisco. The company has just completed a naval coaling station in San Francisco Bay for the Government.

C. A. Tupper, who has been in charge of the publicity department of the Allis-Chalmers Co. for several years, was given a farewell dinner at the Gargoyle in Milwaukee on June 30, by a number of his friends. Mr. Tupper resigned his position with the Allis-Chalmers Co. to become manager of the Reliance Engineering & Equipment Co., which he organized.

The Delaware, Lackawanna & Western R. R. has ordered from the Allis-Chalmers Company six 200 k. w., 3-phase; three 200 k. w., single-phase; two 150 k. w., three-phase, and one 100 k. w. single-phase, oil-filled, self-cooled transformers. These will be installed in collieries and washeries at Scranton, Nauticoke and Taylor, Pa.

The Pittsburg Machinery & Equipment Co., Pittsburg, Pa., has been appointed agent for that territory for the Davenport Locomotive Works, of Davenport, Iowa.

H. W. Marsh has been appointed general manager of the Milwaukee Car Manufacturing Co. of Milwaukee, Wis., to succeed Mr. T. F. Howe, who resigned recently.

H. S. White has been appointed sales manager of the Detroit Seamless Steel Tube Co., of Detroit, Mich.

The Refrigerator Car Accessories Company, of New York, has been incorporated to manufacture all kinds of refrigerator cars and accessories, etc. The incorporators are, Edward H. B. Noetzli, 50 White street, New York, and Anthony Watson, and Barnard J. Reitze, of Jersey City, N. J. Capital, $1,000.

The annual convention of the Association of Railway Electrical Engineers will be held in the La Salle hotel, Chicago. September 27-30. The entire seventeenth floor of the hotel has been reserved for the convention. All of the exhibits will be located in the large ball room, which affords ample accommodation and a beautiful setting for the convention exhibits. All matters pertaining to the various applications of electricity in railway operation, aside from telegraphy and signaling, will be considered at this convention and it is anticipatied that a large number of ralroad men will be in attendance.

Railway Mechanical Patents Issued During July

Box car, 962,425—William E. Fowler, Montreal, Quebec, Canada.

Car wheel, 962,456—William McConway, Pittsburg, Pa.

Concrete car, 962,465—John B. Quinn, Chicago, Ill.

Locomotive headlight, 962,469—Mark A. Ross, Chicago, Ill.

Car ventilator, 962,476—Frederick W. Simson, Winthrop, Mass.

Dust guard for car journals, 962,480—John P. Thomas, Chicago, Ill.

Air brake, 962,517—James F. McElroy, Albany, N. Y.

Air brake apparatus, 962,546—Henry F. Bickel, New York, N. Y.

Air brake apparatus, 962,547—John W. Bingley, Watertown, N. Y.

Dump car and cart, 962,593—John Bell Shelton, Detroit, Mich.

Auxiliary coupling hook, 962,634—David T. Goodman, Altoona, Pa.

Nut lock, 962,642—Basel D. Kemp, Gracemont, Okla.

Hand brake for railway cars, 962,693—Robert T. Burdette, Los Angeles, Cal.

Straight air brake attachment for automatic systems, 962,696—Willard R. Chandler, Branchville, S. C.

Automatic car step, 962,832—William Millard Hamilton, West-plains, Mo.

Uncoupling lever, 962,912—Walter P. Murphy, St. Louis, Mo.

Snow machine, 962,917—Christopher Reynolds, Carlock, Ill.

Car truck, 962,937—John C. Barber, Chicago, Ill.

Car retarder or chock, 962,967—Robert M. Lindsay, Oliver Springs, Tenn.

Automatic air brake coupling, 962,980—Forrest H. Roe, Batesville, Ohio.

Friction draft rigging, 962,993—Clinton A. Tower, Cleveland, Ohio.

Tank car, 963,025—William M. Krickbaum, Cleveland, Ohio.

Draft and buffing mechanism, 963,158—Harry T. Krakau, Cleveland, Ohio.

Dumping car, 963,282—Ralph Davenport, Chicago, Ill.

Car wheel, 963,289—Andrew Sigfrid Gustafson, Chattanooga, Tenn.

Grain door for cars, 963,290—John Henry, Grand Forks, N. D.

Safety attachment for cars, 963,396—Benjamin F. Rogers, Fairmont, W. Va.

Automatic railway air-brake, 963,465—William K. Omick, Detroit, Mich.

Combined automatic and straight-air brake apparatus, 963,487—Walter V. Turner, Edgewood, Pa.

Railway track car, 963,576—Merrill L. Jenkins, Harvey, Ill.

Train-pipe coupling, 963,599—Albert L. Lindh, Irwin, Pa.

Firebox for boilers, 963,627—James M. McClellon, Everett, Mass.

Brake shoe, 963,640—Joseph Alexander Panton, Waterloo, near Liverpool, England.

Brake shoe, 963,771—Harry Jones, Suffern, N. Y.

Interlocking brake shoe, 963,772—Harry Jones, Suffern, N. Y.

Brake for railway cars, 963,861—Argyle Campbell, Chicago, Ill.

Hopper dump car, 963,862—Argyle Campbell, Chicago, Ill.

Gravel dump car, 963,863—Argyle Campbell, Chicago, Ill.

Underframe for railway cars, 963,891—Harry S. Hart, Chicago, Ill.

Brake rigging, 963,947—William H. Sauvage, New York, N. Y.

Brake for railway cars, 963,961—George C. Thompson, Philadelphia, Pa.

Car truck, 963,978—John C. Barber, Chicago, Ill.

Air brake hose, 964,004—Charles T. Driggs, Erie, Pa.

Freight car door, 964,020—Taylor W. Heintzelman, Sacramento, Cal.

Nut lock, 964,062—George Farquharson, Seddon, Holborn, London, England.

Stay bolt breaker, 964,129—Alfred Sterner, Chicago, Ill.

Control device for air brake mechanism, 964,168—Camille Lang, Wilmington, Del.

Combined friction and spring draft rigging, 964,173—William D. Lowry, St. Louis, Mo.

Passenger car, 964,269—Pearl N. Jones, Pittsburg, Pa.

Car ventilator, 964,373—Alfred Best, Salt Lake City, Utah.

Nut locking tool, 964,393—Russell A. Clark, Pittsburg, Pa.

Sleeping car, 964,539—Herman H. Niemeyer, Arthur E. Lehmann and Adolph Sinskey, St. Charles, Mo.

Sleeping car, 964,540—Herman H. Niemeyer, Arthur E. Lehmann, and Adolf Sinskey, St. Charles, Mo.

Metallic car construction, 964,541—Henry H. Niemeyer, Arthur E. Lehmann, and Adolph Sinskey, St. Charles, Mo.

Smoke consumer, 964,662—Louis Limoges, Montreal, Quebec, Canada.

Auxiliary car coupling, 964,713—Joseph E Ulsh and David T. Goodman, Altoona, Pa.

Dump car, 964,749—Argyle Campbell, Chicago, Ill.

Nut lock, 964,813—Oliver C. Roedler, St. Louis, Mo.

Swing motion truck for cars, 964,834—Charles Duncanson Young, Columbus, Ohio.

Street or station indicator, 964,835—Herman Alwies, St. Louis, Mo.

Locomotive pedestal grinder, 964,884—Wilfried Salmon, Minneapolis, Minn.

Car fender, 964,887—Albert J. Thornley, Pawtucket, R. I.

Box car door, 964,899—Frank Vanoy Carman, Oakland, Cal.

Freight car door operator, 964,934—James A. Pickett, Pulaski, Va.

Ice protector for sand spouts, 964,985—Benjamin C. Loring, Edgewood, R. I.

Fire box door closer, 965,009—Richard A. Philbrick, Coffeyville, Kans.

Dump door operating mechanism, 965,023—Frederick Seaberg, Chicago, Ill.

Manufacture of wheels, 965,032—Edwin E. Slick, Pittsburg, Pa.

Method of making wheels or circular bodies having peripheral treads, 965,033—Edwin E. Slick, Pittsburg, Pa.

Rotary shears, 965,034—Edwin E. Slick, Pittsburg, Pa.

Manufacture of wheels, 965,035—Edwin E. Slick, Pittsburg, Pa.

Method of and apparatus for forging metal, 965,036—Edwin E. Slick, Pittsburg, Pa.

Rotary shears, 965,037—Edwin E. Slick, Pittsburg, Pa.

Method of and apparatus for rolling hollow metal bodies, 965,038—Edwin E. Slick, Pittsburg, Pa.

Method of forming flanged metal wheels, 965,039—Edwin E. Slick, Pittsburg, Pa.

Forged metal car wheel, 965,040—Edwin E. Slick, Pittsburg, Pa.

Method of forming flanged metal wheels, 965,041—Edwin E. Slick, Pittsburg, Pa.

Car replacer, 965,085—Joseph Clement, Proctor, Minn.

Safety appliance for car couplings, 965,107—Patrick J. Harrigan, McKeesport, Pa.

Draft rigging, 965,126—James Timms, Columbus, Ohio.

RAILWAY MASTER MECHANIC

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THE DEVELOPMENT OF TOOL STEEL.

One of the factors which has aided greatly in the increase of production and efficiency has been the development in high-speed tool-steels, and this has been particularly rapid during the past ten years. Up to about 1860 carbon tool steel, which as its name indicates is an alloy of iron and carbon with some impurities such as phosphorus, sulphur and manganese, was the only tool steel used and its cutting speed was from 5 to 30 feet per minute. In the early sixties Robert Mushet found that by the addition of tungsten and chromium instead of manganese, the tool was ready to grind after forging. This steel was costly, however, and did not come into common use until about 1894, when it was found upon test that this steel would do from 50 to 80 per cent more work than the carbon steel, whereupon it began to be used commercially. The real development of our high-speed steels began in 1898 when Taylor and White discovered in experiments being carried on for the Bethlehem Steel Works that after passing the "breaking down" stage, these steels again regained their hardness at about 1700° F., and retained it at temperatures of 2200° F. Heretofore it had been supposed that steel was ruined if heated beyond the "breaking down" point, which was about 1550° F. This was the beginning of a large number of experiments in which tungsten and chromium were used in varying amounts and other metals such as molybdenum, vanadium and nickel were tried, the result being our present high-speed steel. Although tool steel is now developed to a high degree compared to its state ten years ago, experiments are still being carried on and various manufacturers use chromium, tungsten and vanadium in varying amounts. The addition of chromium and tungsten tends to prevent the disintegration of the carbon, which makes the tool harder under high temperatures. Vanadium, a more expensive element, is substituted for chromium, with good results, and it is found to a limited degree in many of our tool steels. Molybdenum, also an expensive element, gives much the same results as tungsten with the use of one-quarter of the amount.

The development which has taken place in this field has caused many changes. Machines have had to be redesigned in order to withstand the added strains to which they are subjected, but their output has been increased, consequently fewer machines are required and the efficiency of those in use is greater than before. The new tools do not require rehardening and sharpening as frequently as the old, resulting in a saving of the machinist's time, which also promotes his efficiency. High speed drills and files have been used to a limited extent and have effected a saving where used on certain classes of work. We believe that the next few years will see still further developments in the field of high-speed steels, together with wider applications for their use.

THE CARE OF PNEUMATIC TOOLS.

The pneumatic hammer and pneumatic drill are the most useful and efficient tools about a shop, especially when kept in good working order, but ordinarily they are given no more care than a wrench or hammer, for being small and light they are regarded as being in the same class with a simple tool. An air drill, or a hammer, especially, will be thrown down and allowed to kick around in any old place, with the result that dirt works inside to cut and clog the finely made pistons and valves. Particularly is this true in foundries, where a few particles of sand may ruin one of these little high speed machines in a short time. The neglect of oiling and cleaning air tools shortens their life by about a half and a large percentage of repairs is due to this lack of attention. At a recent meeting of Railway Tool Foremen's Association, Mr. J. H. Simons, of the Ingersoll-Rand Co., recommended the cleaning of pneumatic tools every day by pouring kerosene or benzine in freely at the throttle handle, thus cutting out the thick oil and dirt, blowing out the same with air and lubricating with a light body oil such as sewing machine oil. He also brought out another abuse of pneumatic riveting hammers which is prevalent in structural steel shops and where a lower class of labor is employed. The workmen have found that by using a shorter piston, the number of blows per minute will be increased and thus their work will be facilitated, consequently old standard pistons are ground down and inserted, and in doing so the hardening in them is removed to a large degree. Hammers are designed with the parts properly proportioned for the class of work to which they are adapted and treatment of this sort results in cracked cylinders and broken handles. Mr. Simons also recommended the use of the best quality of air hose, easily cleaned filters in the pipe-line and an air pressure of between 90 and 100 pounds.

HONESTY STILL THE BEST POLICY.

Recent developments in the Illinois Central car repair scandal have convinced those most conservative in judgment that somebody on the railway side has, to say the least, seriously erred. The charge of incompetency is as shameful a one in some cases as is that of the willful misappropriation of funds for personal gain. It is regretable that the name of one man, against whose character during life nothing is charged, should of necessity be dragged through the mire of a criminal investigation after death.

On the other side,—that of the repair companies involved,—there is little of favorable nature to be said by the most generous. Theirs is not only a crime against the railway to which they owe, in several cases, their mushroom growth, but an injury of more or less serious nature has been rendered their contemporaries who have been attempting by means of honest competition to secure a fair share of the business.

A great many, not well informed, will look upon the disclosures of the Illinois Central as perhaps representative instances of what is going on continually in that line of business industry. That, of course, is neither the correct nor logical conclusion. The contrary is proven to the thinking ones when it is considered that this, one of the strongest possible of conspiracies, has been unable to conceal from or withstand the onslaughts of the investigators. That honesty is still the best policy is mutely testified by the ruined men left in the wake of the graft investigation.

SHALL THE MASTER CAR BUILDERS' AND MASTER MECHANICS' ASSOCIATIONS CONSOLIDATE?

Editor Railway Master Mechanic:

At the next meeting of the Railway Mechanical Associations, in June of next year, the question of consolidation of the two societies will be up for decision. In the handling of this question we must lay aside all sentiment and look at it from the standpoint of what will be the most benefit to the railroads represented, both in time saved and in the efficiency of the organization, or organizations. We must also consider the probable effect on the exhibitors in case of a change, and so arrange the time of meetings as to give ample opportunity both to participate in the proceedings and to inspect the exhibits.

There is no question that the railroads obtain valuable returns for the time spent on the exhibits, and to curtail the time now available will be to curtail the value of the association by an equal amount.

Since the founding of the Master Car Builders' Association there has been considerable change in its membership. A majority, or at least a large number of its members are also members of the Master Mechanics' Association. This has been caused by the change in organization of the railroads, due to the car and locomotive departments coming under one mechanical department chief. While the subjects to be handled will continue to be apportioned to both car and locomotive departments, and while only a part of the membership is interested in both, yet they have many things in common, and frequently committees in both associations are working on the same subject.

With consolidation, and one organization, considerable time now duplicated could be saved. The one organization would be stronger, and its standards and rulings have more weight, not only with the public, but also with our superior officers. On the whole it would seem as if there was much to be gained and nothing lost by combination.

As to time of meeting, the arrangement proposed last year, i. e.—of holding a continuous session for six days,—is impracticable and undesirable. No set of officers would be equal to continuous service for six days without overworking. There would also be little time for exhibits. A much better arrangement would be to have the session open on Wednesday, devote Wednesday, Thursday and Friday to car matters, interchange rules, etc; allow a recess for Saturday and Sunday, as at present; and apportion Monday, Tuesday and Wednesday to locomotive matters. Car department members could attend the first part of the convention and return home, and those interested only in the locomotive department need only take the time for the latter part of the session.

As desirable as consolidation seems, however, unless some arrangement of meeting as outlined above is contemplated, it is better to go on as we are.

In case of consolidation, the new organization should consider the absorption of the minor associations, such as the Traveling Engineers', Air Brake, General Foremen's, etc. This would save further duplication of committee work, and allow of assigning committee work to better advantage. In the event of the latter it would probably be advisable to have the minor associations meet at different times, as at present, but their working committees should be appointed by the executive committee of the main association, and all of their reports and proceedings subject to the executive committee's approval.

A plan of consolidation along these lines would make a strong Railway Mechanical Association, with increased capabilities of usefulness and more effective time at its disposal. It is to be hoped that the matter will be thoroughly investigated from all standpoints, and opinions on the matter crystalized by the time of the June, 1911, meeting.

S. M. P.

New Locomotives for the Carolina, Clinchfield & Ohio Ry.

The Carolina, Clinchfield and Ohio Ry. is conspicuous as a new road, built to a high standard throughout, and presenting a maximum grade, against loaded traffic, of only 0.5 per cent. The sharpest curves on the main line are of 8 degrees. The principal source of traffic is coal, and the conditions are thus favorable to handling the heaviest class of tonnage trains.

In 1909 this road received from the Baldwin Locomotive Works, an experimental Mallet locomotive of the 2-6-6-2 type. This engine weighs 342,000 pounds and carries 300,000 pounds on driving wheels, and is rated at 4,000 tons of cars and lading on 0.5 per cent. compensated grades. In view of its satisfactory performance, the road ordered ten additional Mallet locomotives of greater power, from the Baldwin Locomotive Works. These have recently been delivered, together with three passenger locomotives of the Pacific type. The two designs will be separately considered.

Mallet Locomotives.

These engines are designated as class M-2, and are of high capacity for road service. The tractive force exerted is 77,500 pounds. The design is similar in many respects, to that of the experimental engine, the details having been revised and improved where possible. With the limited space available in this case, a boiler of the ordinary type, without a separable point and feed water heater, is preferably used; the tube length being 21 feet. The shell diameter (86 ins.) is unusually large, and with wide water legs, liberal tube spacing and ample heating surface and grate area, free steaming should result. The fire-box staying is radial, and 404 flexible stays are applied. These are grouped in the outside rows in the sides and back; in the upper corners of the sides, and in two triangular areas located on either side in the throat. Firing is accomplished through two oval fire-doors, placed 44 inches apart transversely.

The boiler barrel is composed of three rings, and the dome is placed on the second ring, immediately above the high pressure cylinders. The arrangement of the steam piping is similar to that used on the consolidation Mallet locomotives built for the Southern Pacific Company. The high pressure exhaust is conveyed forward, through external horizontal pipes, to a Baldwin reheater placed in the smoke-box. The steam distribution is controlled throughout by 15 inch piston valves, which are duplicates of one another. This high pressure valves provide inside admission and the low pressure outside admission, the ports and bushings being modified to suit. The valves are all set with a lead of ¼ in.; the steam lap is 1⅛ in., and the exhaust clearance ¼ in. The by-pass consist of flat plates, which normally cover the relief ports; this arrangement being in accordance with the usual practice of the builders for piston valve locomotives. Walschaerts motion is used throughout, and the gears are controlled simultaneously by the Baldwin power reverse mechanism.

The frames are of cast steel, 5 inches in width. The articulated connection is affected by a single radius bar, and the frame construction throughout is in accordance with the well-known practice of the builders for engines of this size. The boiler is supported on the front frames, by a single bearer placed between the second and third pairs of driving-wheels. The front bearer carries the controlling springs, and normally has a clearance of ½ in. between the upper and lower castings.

The arrangement of the trucks and running gear calls for no special comment. The practical value of these trucks is proved by their continued use on the part of roads which, like the Clinchfield, have had experience with engines so equipped.

Pacific Locomotives.

These are powerful locomotives for passenger service, as they develop a tractive force of 37,000 lbs. The cylinder volume is 14.4 cubic feet. The following ratios should be noted:—

Grate Area to heating surface, 1 to 76.

Cylinder volume (cubic feet) to heating surface (square feet) 1 to 284.

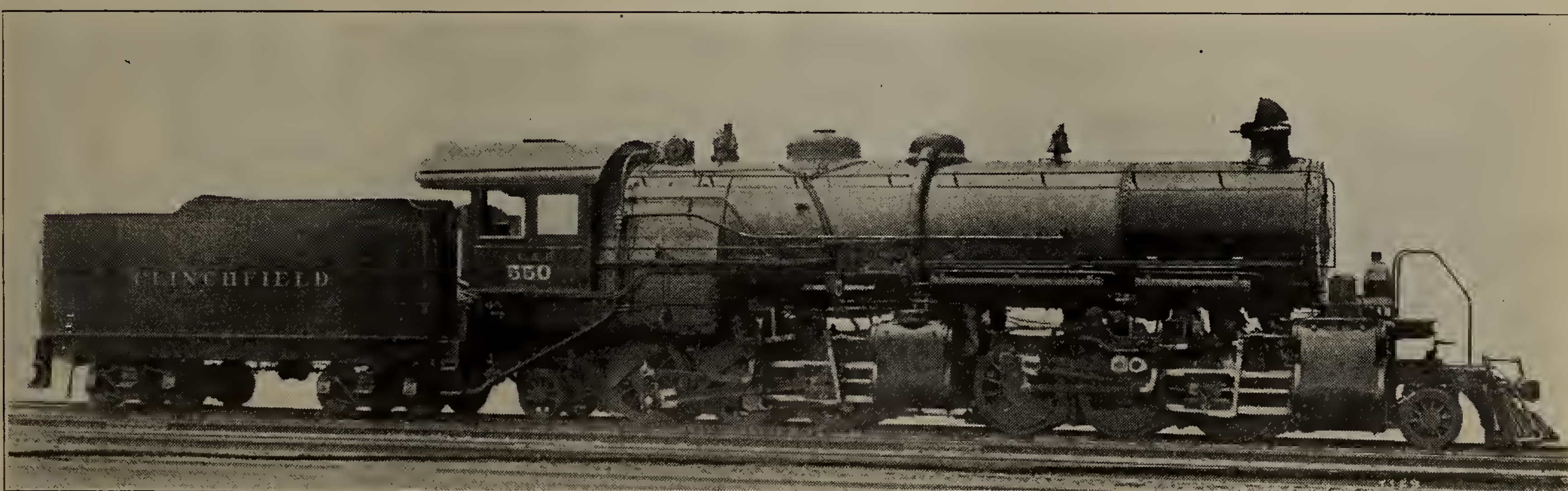
Ratio of adhesion, 4.13.

These ratios indicate a locomotive well adapted to handling heavy trains on long grades. With 23x32 in. cylinders and 69 in. wheels, the tractive force per pound mean effective pressure is 230 pounds, which is high for a passenger locomotive.

The boiler used in this design is of the extended wagon top type, 74 inches in diameter at the front ring and 83½ ins. on the wagon top. The fire-box staying is similar to that of the Mallet type, the flexible stays numbering 386. The fire-doors are two in number, and they are placed 28 ins. between centers, the width of the grate being 71¾ ins. The tubes are set with ⅞ in. bridges.

The stack is of cast iron, with a wide mouthed internal extension, and measures 21½ inches in diameter at the choke. The Master Mechanics style of front end is used, with an adjustable diaphragm plate in front of the nozzle. No cinder pocket is provided with this arrangement.

The main frames are of cast steel, 5 ins. in width, and in one piece with the rear sections. The front rails are single, and of forged iron. Each rail is hooked and double keyed to its corresponding main frame, and is held in place by four vertical bolts, 1½ ins. in diameter. At the point of its con-



New Mallet Locomotive, Carolina, Clinchfield & Ohio Ry.

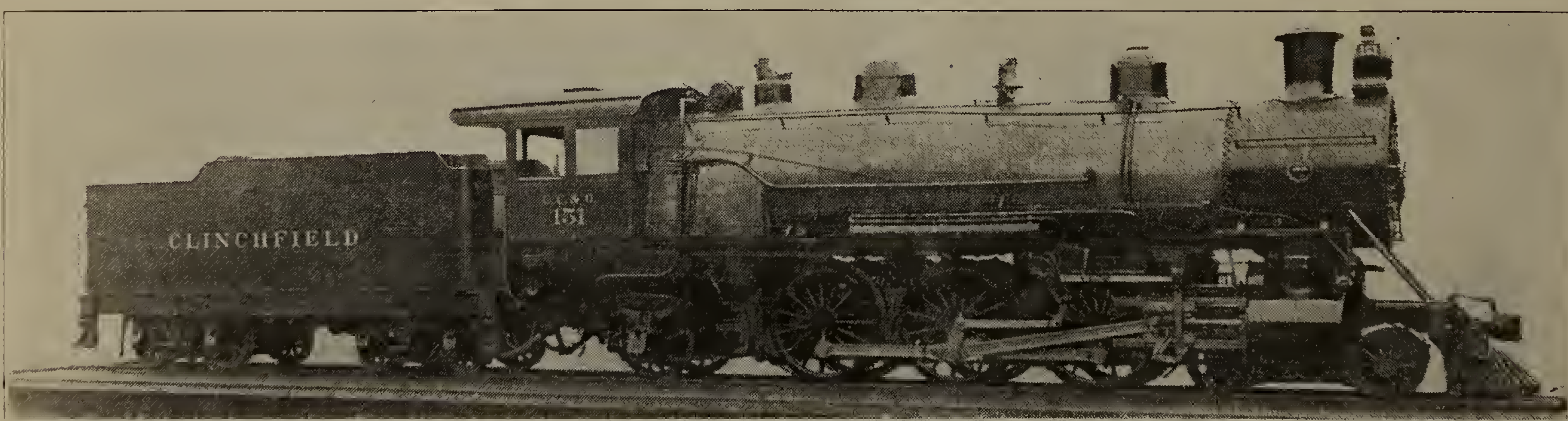
nection with the cylinder saddle, the frame measures 4½ ins. wide by 7 ins. deep.

The front truck is of the swing bolster type, and is fitted with a cast steel saddle and three point suspension swing links of the same material. The wheels are steel tired, with cast iron centers. The rear truck is of the radial type, with outside journals. The side swing is taken by the spring links, which are seated at each end, on flat keys, and so arranged that they have a limited amount of fore and aft, as well as transverse, swing. This form of truck is simple in construction, and has been applied by the Baldwin Locomotive Works to a large number of locomotives.

The cylinders are lined with bushings ⅝ inch thick, and are placed 87 inches between centers, while the steam chest centers are 49 inches apart. The valves are duplicates of those used on the Mallet engines. They are arranged for inside admission, and are set with a lead of ¼ in. The by-pass valves are also similar to those of the Mallet locomotives. The location of the steam chests on the Pacific type engines simplifies the arrangement of the steam and exhaust passages, but necessitates using rockers in connection with the Walschaerts valve gear. The rocker boxes are bolted to the guide yoke, and the links are carried on longitudinal bearers outside the leading driving wheels.

The tenders of both classes are similar in construction, although those for the freight engines have a greater fuel and water capacity than the tenders used with the passenger locomotives. The frames are composed of 12 in. channels, the center sills weighing 40 pounds per foot and the side sills 25 pounds. The tanks are of the water-bottom type. Arch bar trucks are used, those under the passenger tenders being fitted with steel tired wheels, while the freight tenders are carried on solid rolled steel wheels. All truck wheels under the locomotives and tenders were supplied by the Standard Steel Works Co.

These engines, apart from their construction details, are of interest as representing the motive power policy of a new line, already prominent among the railways of the south. The principal dimensions of both classes of locomotives are given in the accompanying tables.



New Pacific Locomotive, Carolina, Clinchfield & Ohio Ry.

MALLET LOCOMOTIVES.

Gauge,	4 ft. 8½ ins.
Cylinders,	24 ins. & 37 ins. x 32 ins.
Valves,	Balanced Piston.
Boiler	
Type,	Straight
Material	Steel
Diameter,	86 ins.
Thickness of sheets,	⅞ ins.
Working Pressure,	200 lbs.
Fuel,	Soft Coal
Staying,	Radial
Fire Box.	
Material,	Steel
Length,	117 ins.
Width,	96 ins.
Depth, front,	79½ ins.
Depth, back,	76 ins.
Thickness of sheets, sides,	⅜ ins.
Thickness of sheets, back,	⅜ ins.
Thickness of sheets, crown,	⅜ ins.
Thickness of sheets, tube,	½ ins.
Water Space.	
Front,	6 ins.
Sides,	5 ins.
Back,	5 ins.
Tubes	
Material	Steel
Thickness	0.11 ins.
Number	448
Diameter	2¼ ins.
Length	21 ft. 0 ins.
Heating Surface.	
Fire box	233 sq. ft.
Tubes	5519 sq. ft.
Total	5752 sq. ft.
Grate area	78 sq. ft.
Driving Wheels	
Diameter, outside	57 ins.
Diameter, center	50 ins.
Journals, main	11x13 ins.
Journals, others	10x13 ins.
Engine Truck Wheels	
Diameter, front	33 ins.
Journals	6½x12 ins.
Diameter, back	33 ins.
Journals	6½x12 ins.
Wheel Base	
Driving	31 ft. 0 ins.
Rigid	10 ft. 8 ins.
Total engine	46 ft. 6 ins.
Total engine and tender	74 ft. 11 ins.
Weight.	
On driving wheels	325,850 lbs.
On truck, front	24,600 lbs.
On truck, back	28,200 lbs.
Total engine	378,650 lbs.
Total engine and tender, about	550,000 lbs.
Tender.	
Wheels, number	8
Wheels, diameter	33 ins.
Journals	6x11 ins.
Tank capacity	10,000 gals.
Fuel capacity	15 tons
Service	freight

PACIFIC LOCOMOTIVES.

Gauge	4 ft. 8½ ins.
Cylinders	23x30 ins.

Valves	Balanced piston

Boiler.

Type	Wagon top
Material	Steel
Diameter	74 ins.
Thickness of sheets	$\frac{13}{16}$ and $\frac{7}{8}$ ins.
Working pressure	190 lbs.
Fuel	Soft coal
Staying	Radial

Fire Box.

Material	Steel
Length	108⅛ ins.
Width	71¾ ins.
Depth, front	76 ins.
Depth, back	63 ins.
Thickness of sheets, sides	⅜ ins.
Thickness of sheets, back	$\frac{5}{16}$ in.
Thickness of sheets, crown	⅜ ins.
Thickness of sheets, tube	½ ins.

Water Space.

Front	5 ins.
Sides	4 ins.
Back	4 ins.

Tubes.

Material	Steel
Thickness	0.11 ins.
Number	317
Diameter	2¼ ins.
Length	21 ft. 0 ins.

Heating Surface.

Fire box	192 sq. ft.
Tubes	3,903 sq. ft.
Total	4,095 sq. ft.
Grate area	54 sq. ft.

Driving Wheels.

Diameter, outside	69 ins.
Diameter, center	62 ins.
Journals, main	10x13 ins.
Journals, others	9x13 ins.

Engine Truck Wheels.

Diameter, front	33 ins.
Journals	6½x12 ins.
Diameter, back	45 ins.
Journals	8x14 ins.

Wheel Base.

Driving	13 ft. 0 ins.
Rigid	13 ft. 0 ins.
Total engine	34 ft. 0 ins.
Total engine and tender	65 ft. 10 ins.

Weight.

On driving wheels	152,900 lbs.
On truck front	42,750 lbs.
On truck back	37,400 lbs.
Total engine	233,050 lbs.
Total engine and tender, about	385,000 lbs.

Tender.

Wheels, number	8
Wheels, diameter	36 ins.
Journals	5½ ins. x 10 ft.
Tank capacity	8,000 gals.
Fuel capacity	14 tons
Service	Passenger

The Traveling Engineers' Convention.

The annual meeting of the Traveling Engineers' Association was held this year at the Clifton Hotel, Niagara Falls, Ontario, on August 16, 17, 18 and 19, and it proved to be the most pleasant and profitable convention which this rapidly growing association has yet held. The convention was opened on Tuesday with prayer by the Rev. Houston and a welcome by Mayor O. E. Dores of Niagara Falls, after which the opportunities and duties of the traveling engineer were well brought out in the president's address by Mr. C. F. Richardson, assistant to the general superintendent of motive power of the Rock Island lines. He said in part:

"At the present time all railroads are facing an unusual condition. The increased cost of operation, brought about by increased cost of material and labor, makes it necessary to practice the strictest economy, and I believe one of the greatest opportunities for the Traveling Engineers to assist in reducing the cost of operation lies in fuel economy. This question has a special interest for us, as it comes directly under the supervision of the Traveling Engineer, and the possibilities of economy in fuel consumption, together with the question of how to educate the engineer and fireman to the highest efficiency in the work, are questions demanding serious consideration by the members of this association. Also the waste of coal through other sources should be carefully looked into by every Traveling Engineer on his division.

"The saving that can be brought about by using low-grade coal in many places where high-grade coal has been used, will cause your general manager to wonder why it was not done before. If you will study the situation and make a recommendation showing what can be saved by making the change, it will be worth while. The traveling engineers should be able to give better information on these savings than any one else, and we cannot afford to overlook any opportunity to reduce the cost of operation of the road we represent. Most railroad managers are looking for subordinates who can work out plans to reduce the cost of pulling a ton of freight one mile, and how much we can do towards this depends entirely upon our own efforts, and the more we accomplish makes each and every traveling engineer a more valuable official to his company.

"Another important matter is to systematize our work, and I think we should keep certain records that we may work intelligently. I believe every traveling engineer should have a record of the draft arrangement in the front end of every engine on his division. By having this record, he will be able to regulate the drafting of the engines to reduce fuel consumption.

"I am assuming that the traveling engineer receives proper support from the master mechanic in not allowing the roundhouse people to change the drafting appliances after they have been properly adjusted. It has been my observation that more fuel is wasted by reducing nozzle tips to overcome poor operation of a locomotive and neglected work in the roundhouse, in not keeping flues bored out, grates in good condition, valves squared, front ends tightened and packing in good order, than can possibly be saved by the traveling engineer. When an engine is once properly adjusted to steam and be economical in coal, if she fails for steam, the real cause of the failure should be located instead of reducing nozzle tips to overcome stopped up flues, defective grates, valves out of square, leaky front ends and worn out packing, and when the traveling engineer can get the proper support from his master mechanic to have the draft appliances let alone after they are rightly adjusted, it will increase the efficiency of the traveling engineer by allowing him more time to ride with and instruct such engine crews as are not 100 per cent in efficiency.

"Too much can hardly be said on this subject, and I regret that I am unable to devote more time to it. Many railroads fail to get the best results of the work of the traveling engineer, the organization being such that he has no authority over the men. He is expected to instruct and direct. An organization of this kind I consider sadly defective, and I am unable to understand why it should be allowed to continue. The traveling engineer should be a man capable of instructing and directing the men under him, and, if he is not, a change should be made at once. The engine crews must understand that the traveling engineer is responsible for the successful operation of the locomotives on the road, and that they are operating them under his supervision, and, when their attention is called to irregular or improper handling of engines, the instructions of the traveling engineer must be obeyed, and not referred to the master mechanic one hundred miles away."

The secretary's and treasurer's reports which followed showed the association to be in excellent condition both as to membership and finances, the membership now being 770, a gain of 12½ per cent over last year.

The first paper by the committee on "Superheat as Applied to Locomotives," took up the reasons and advantages of using superheated steam, the various types of superheaters and results obtained on different roads through the use of the same. In the discussion of the paper Mr. Simon Hoffman of the Locomotive Superheater Co. favored superheaters which gave 500° to 600° of superheat, stating that such a superheater would pay for itself within a year. He brought out the fact that a series of tests on the roads of Belgium showed that a superheat of 60° was of value only in that it insured dry steam on the cylinders. The difficulty of proper lubrication with high superheat was also gone into.

The other paper taken up on the opening day of the convention was: "How can the traveling engineer best educate the present day fireman to become a successful engineer of the future," and among the ideas suggested to accomplish this end were, a good library of railway textbooks and periodicals, class room meetings over which the traveling engineer should preside and a series of examinations culminating a final examination for promotion. In line with these suggestions was a device for class room use described by M. H. Haig, mechanical engineer of the Santa Fe. The device shows the position of the water upon the crown sheet on ascending and descending grades and consists of a mounted drawing of a boiler in section, across the face of which is placed a string to show the water level. By means of a graduated scale the drawing may be tilted to represent any desired grade and the string in front shows the position of the water on the crown sheet.

The second day of the convention was opened by the committee report on "Latest developments in air brake equipment and their effect on train handling," which was read by E. F. Wentworth, chairman. The discussion which followed was very general and was taken part in by W. U. Turner, of the Westinghouse Air Brake Co., T. F. Lyons, air brake inspector, New York Central, and others. Mr. Turner said that the braking power is sometimes seven times as great in front as it is in the rear and that unless the engineer makes an allowance for the time element, he is bound to have trouble. He gave it as his opinion that wheel sliding is not caused by any braking power in use today—no wheel ever slides under an emergency application—it is the long drawn out stop which causes it. During the discussion of this paper a strong talk was given by F. W. Brazier, superintendent of rolling stock of the New York Central, and he expressed the spirit of his remarks in a current phrase: "If you can't pull, push; if you can't push, get out of the way." The other paper discussed at this session was on "Reducing the cost of locomotive lubrication. Is it advisable to place this item entirely under the control of the traveling engineer." This gave rise to some discussion of the relative merits of oil and grease. With regard to the second part of the subject the report says: "We believe there should be some one higher in authority than the Traveling Engineer having general supervision. To our minds a great deal of the progress has been made under the direct supervision of the Road Foreman or Traveling Engineer, and we do not believe there is any one in a better position to know what should be done in the way of lubricating a locomotive; but as this item of expense is handled in some instances by the Mechanical Department and in others by the Store Department, we do not believe it would be practicable to place it under the direct control of the Road Foreman or Traveling Engineer."

One of the best and most comprehensive reports delivered befor the convention was that on "Fuel Economy," which we publish elsewhere. A vote of thanks was extended to this committee by the association. In the discussion of the paper the matter of economy was considered from the time the coal was purchased until it had been converted into energy, with especial reference to the loss of coal from the tender. The question of cheap fuel and low heat value or higher-priced fuel with a higher heat value provoked considerable discussion and the opinion seemed to be in general that if all delays and engine failures due to cheap coal were charged up to it, the higher-priced coal would be found the more economical. However, in some classes of service, involving many stops, where the engine was worked up to its maximum capacity for only a small portion of the time, it was believed that the cheaper coal might be the more economical. The brick arch came in for a large share of the discussion of this paper and among its enthusiastic supporters was D. R. MacBain, superintendent of motive power on the Lake Shore. It is the custom of the association to appoint the past president as its delegate to the Master Mechanics Association, and following the above discussion the convention listened to the report of Master Mechanics' convention by J. A. Talty.

Friday morning was devoted to a paper on "New valve gears as compared with the Stephenson or link motion, referring particularly to economy of operation and maintenance, and also necessary procedure in case of breakdowns." The subject was handled very thoroughly. Following came the election of officers for the coming year, who are as follows: President, F. C. Thayer, Southern Ry., Atlanta, Ga.; first vice president, W. C. Hayes, Erie R. R., New York; second vice president, W. H. Corbett, Michigan Central R. R., Jackson, Mich.; third vice president, F. P. Roesch, El Paso & Southwestern, Douglas, Ariz.; secretary, W. O. Thompson, New York Central, East Buffalo, N. Y.; treasurer, C. B. Conger, Grand Rapids, Mich.

The exhibit of the Traveling Engineers' Supply Men's Association in one of the large halls on the first floor of the hotel was one of the popular meeting places of the convention. Among the firms which exhibited were: Strong-Carlisle & Hammond, Pilliod Brothers, C. M. Goodrich, Franklin Railway Supply Co., Watson-Stillman Co., Commercial Acetylene Co., Ford & Johnson Co., The Pilliod Co., American Arch Co., The Leslie Co. and the Detroit Lubricator Co.

The locality at the Falls afforded abundant opportunity for sight seeing and visitors and guests made the trip on the "Maid of the Mist" and also down the gorge route, while automobile trips were also provided for the ladies. On Wednesday evening a ball was given at the Clifton Hotel and the closing entertainment was given Thursday evening by a New York vaudeville troupe.

THE SANTA FE-ARMOUR SCHOLARSHIP.

The Armour Institute of Technology, located in Chicago, has given to Albert MacRae, managing editor of the Santa Fe Employes' Magazine, a scholarship to be conferred upon the apprentice who makes the best record for combined class-room and shop work during his apprenticeship to the Atchison, Topeka & Santa Fe Ry.

One scholarship will be awarded in 1910 and another in 1911, with the understanding that, if the arrangement proves to be perfectly satisfactory to the Armour Institute, the Santa Fe and the apprentices, a yearly scholarship will be established. The only condition imposed by Armour Institute is that the apprentice must be able to pass its regular entrance examination.

The Santa Fe will require the apprentices to have served at least three years and six months of their apprenticeship, and no apprentice who will be out of his time prior to May 1 will be eligible to the scholarship the following September. The successful candidate will be entitled to four years' free tuition and may select any course offered by the institute, viz., civil engineering, mechanical engineering, electrical engineering, chemical engineering, architecture, or fire protection engineering. The Armour Institute of Technology was founded in 1892 by P. D. Armour and today stands in the front rank, with a world-wide reputation for the thoroughness of its instruction and the efficiency of its graduates.

English Engine House Practice.

At the joint meeting of the Institution of Mechanical Engineers and the American Society of Mechanical Engineers at Birmingham, England, July 26, 1910, C. W. Paget, general superintendent of the Midland Ry., read an interesting paper on "English Engine House Practice" which is published in part below. The illustrations are taken from "Engineering" of London:

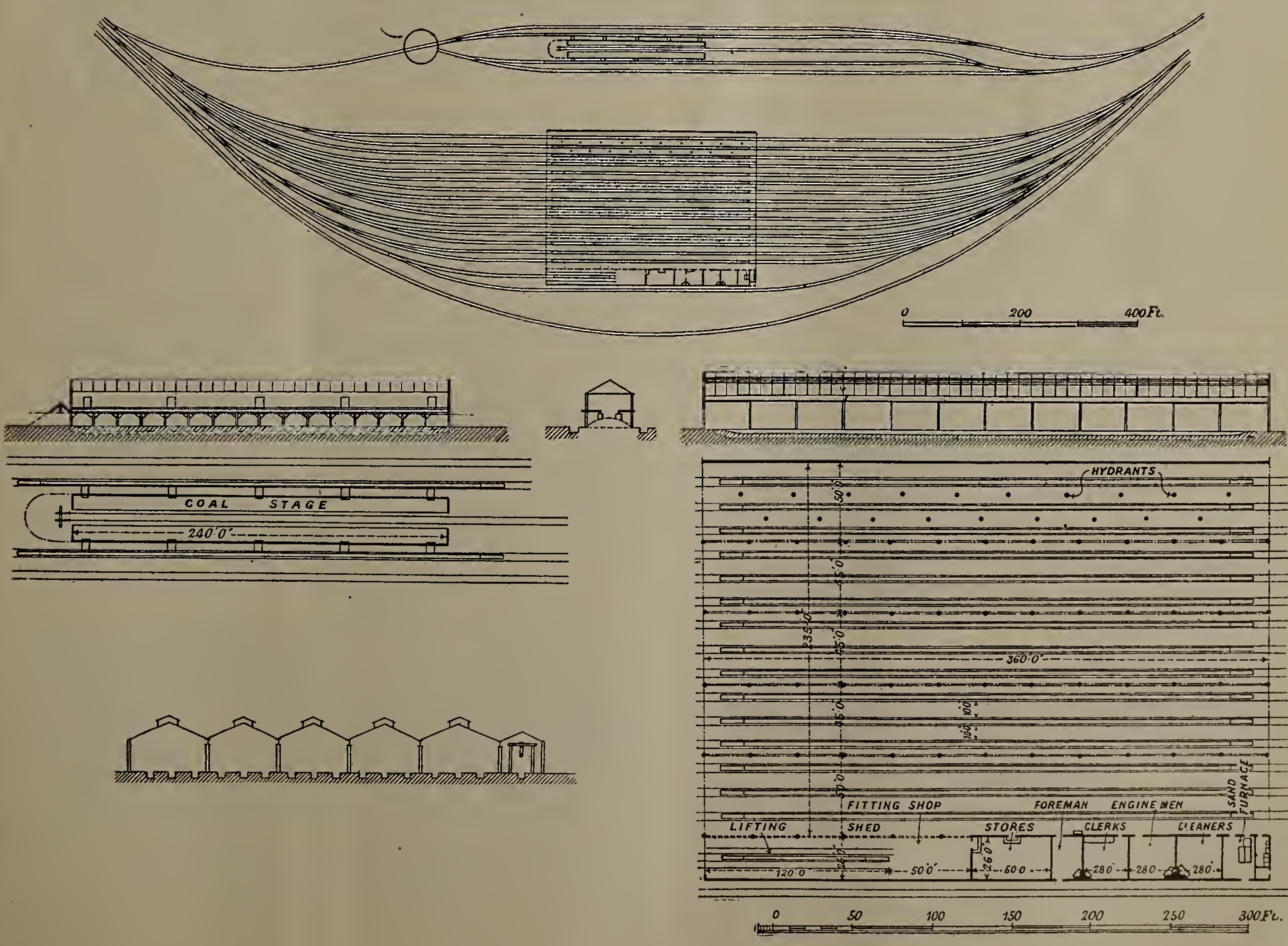
The running-sheds in England are of two types:

1. Those in which the roads are laid parallel, usually called straight sheds.

2. Those in which the roads radiate from a centre turntable, called round sheds.

The straight sheds are economical in first cost and maintenance, but unless they are of the type known as "through sheds" they are awkward to work; the latter class are necessarily draughty.

The centre-turntable type, though more expensive to build, possesses considerable advantages of working, because engines can be easily got in and out without moving others. The radial arrangement of the pits also lends itself better to lighting and convenience of getting about. There is plenty of room towards the end of the pits for fitters to work at the bench between two engines, and the work of washing out boilers, swilling out pits, and general cleaning can be done without inconvenience. To set against these advantages there is the objection that, when the turntable requires lifting for repairs, it throws the whole of the pits served by it out of use while the repairs are going on.



An Engine House of the "Through Straight" Type, with Coaling Plant, London & S. W. Ry.

The illustrations herewith are of the more recent installations on English railways.

The necessary offices, stores, mess-rooms, and lavatories should be conveniently placed, and reference to the plans will show their arrangement in the two sheds referred to, which may be taken as examples of the latest British practice.

Shear-Legs and Fitters' Appliances.

Attached to every shed of any size are shear-legs capable of lifting one end of an engine so that the wheels and axle-boxes may be removed for examination or repairs. These legs were made almost universally at one time of wood, and of the tripod type, the single leg on one side of the rails being of extra strength and carrying the lifting-gear. The disadvantage of this type, of which many are still in existence, is that since so many engines have now extended cabs, the legs have to be of great height in order to allow the trailing wheels to be taken out, as the cab top has not room to rise between the frame of the legs. This difficulty was sometimes overcome by forming the top of the legs of bow-shaped iron castings, whilst two wooden struts were placed on each side. The most modern construction is, however, to use a framework of steel joists, with top cross-girders and gussets leaving sufficient head-room for any contingency. To some modern examples is attached a small jib-crane, which is of use in taking off the bogie-frame for examination, loading wheels, etc. A capacity of 15 tons used to be looked upon as amply sufficient, but the large increase in the weight of engines in recent years has led to stronger legs being required, and the more modern ones are capable of raising 35 to 40 tons. The load is usually lifted by hand by means of a crab or train of wheels operating a chain or wire rope which works round a sheave or set of blocks. In some cases where hydraulic power is available it is employed, but the more modern method, where current can be obtained, is to use an electric motor.

The position of the shear-legs relative to the shed depends largely upon local circumstances, but in sheds where the pits radiate from the table, and the building is a square one, a set of legs is usually fixed on one of the longer roads, that is, one of the roads leading to the corners of the shed, because better work and more care are probable where men can work without being exposed to the weather. In all cases, whether outside or indoor, the legs are placed over a pit, which is usually 2 ft. 10 in. deep below rail-level.

Very little tackle of a special nature is required by shed fitters, but amongst those things which must be always at hand are jacks—hydraulic and bottle—for lifting engines to change bearing-springs, etc., lever and stands to allow of axle-boxes being tried up the horn-plates, wood blocks to act as temporary axle-boxes, clamps to draw engine and tender together, and to facilitate uncoupling, iron lorries to put under the engine when the bogie has been removed, wood blocks to pack engine on, etc., as well as a good supply of ordinary shop-tools. If not attached to the shear-legs a small crane is useful to lift a bogie-frame off the axles when required, whilst a pair of two-hundreweight pulley-blocks are often employed to allow of the boxes being tried on the axles.

Where engine and tender-springs stand above the platform of the framing, a claw spanner, about 8 ft. long, with one jaw much longer than the other, is often employed to allow of changing the springs without lifting.

Fitter's Stores.

The stock of materials and fittings necessary to repair or keep an engine in service should be kept as low as possible consistent with efficiency. The card system with a maximum and minimum for each article is quite commonly in use, and enables a check to be kept on stock in hand and on the time in which deliveries are effected. The amount of the stock depends largely upon an efficient system of supply. It is very easy to have large sums of money lying idle, unless a very close watch is kept upon this section.

The Lancashire and Yorkshire Railway Company distribute stores to the sheds on their system by vans, of which three are sent out daily. The vans are designed for dealing conveniently with stores, and are fitted with swing-jibs and pulley-blocks for handling the heavier articles. The system works very satisfactorily, and quick delivery is ensured, material ordered overnight being delivered the next morning at 8:30. The vans are worked on passenger trains and have resulted in freeing the passenger-station platforms, whilst the expense of delivering stores has been materially reduced.

Lighting of Locomotive Sheds.

As the greater part of the cleaning of locomotives has to be performed during the night, the question of the lighting of locomotive sheds has received considerable attention on many railways. In the majority of cases, where gas is available, it is employed, because electric light, until the recent development of metallic filament lamps, has only been economical where arc-lamps were used, and such large units of light are not required. In properly lighted sheds incandescent gas is usually employed, and this allows of adequate illumination at reasonable cost at the points required. Two considerations chiefly govern the successful lighting of a shed, these being that the boilers of the engines should be well lighted, and also that sufficient illumination should be shown on the motion work, the latter object being the more difficult to achieve.

With straight sheds the position of the lights is naturally restricted, as the lamps have to be placed in rows between the engines; if they contain two mantles, each consuming 3 cubic feet of gas per hour, and are spaced 35 ft. apart and 11 ft. high, the result will be satisfactory, although as the length of the engines stabled will differ, the best light is not always at the point required.

With round (turntable) sheds a different arrangement is required, as the table has to be lighted separately, usually by four lamps placed so that they will not be affected by the exhaust of the engines running on and off the pits. The lighting of the sides and motions of the engines is a simpler matter than with straight sheds, as the smoke-box end of the locomotive always faces the table, and the motion is always about the same distance from the centre. Lamps can alternately be placed so as to throw their light in the motion on one side, and opposite the cab on the other. Long roads which hold two engines, it will be seen, require two lamps. In some cases the employment of high-pressure gas (10 in. of water) is found to be advantageous, as a light of about 500 candles is obtained with a consumption of 20 cubic feet of gas. The result of this type of lighting is particularly good, as will be seen from a photograph of a shed lighted in this way, reproduced herewith. In many cases fittings are provided in the shed-pits to afford a movable light, or allow of flexible connections being used for a portable light.

Arrangements for Washing Out.

Washing out is usually done inside the shed with cold water, the mains with a good head of water are laid, having hydrants at convenient places. Washing out with hot water, though very desirable, is not at present in general use, but in view of the importance of the matter, it has been thought that a description of the apparatus erected by the North-Eastern Railway at Gateshead would prove interesting.

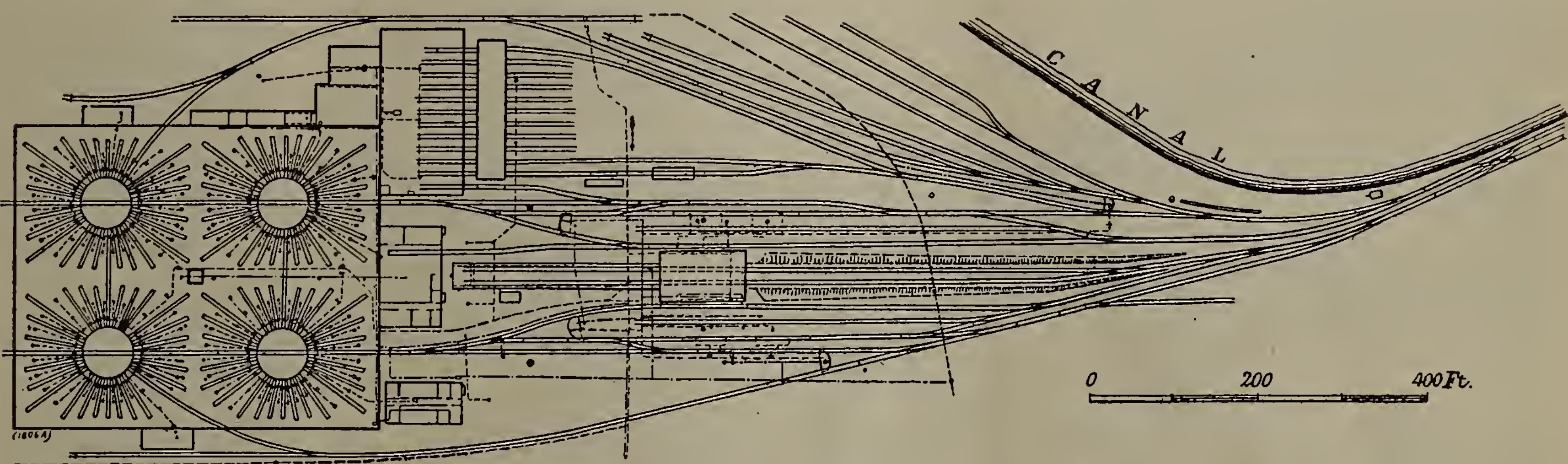
An engine is brought in with about 60 lb. of steam still in the boiler, and by means of a flexible metallic hose-pipe a connection is made betwen the blow-off cock on the engine and the blow-off line of piping to the tanks which contain the hot water for washing out and filling. The engine is then blown off, and the water and steam pass away to a separator on the top of the tank containing the washing-out water. The water falls down through a coke filter-bed (which arrests any scale) into the tank, and the steam passes away through a pipe to a chamber on the top of the tank which contains the filling water, where it meets pure cold water from the main water supply. This water is heated up by the steam and falls into the tank.

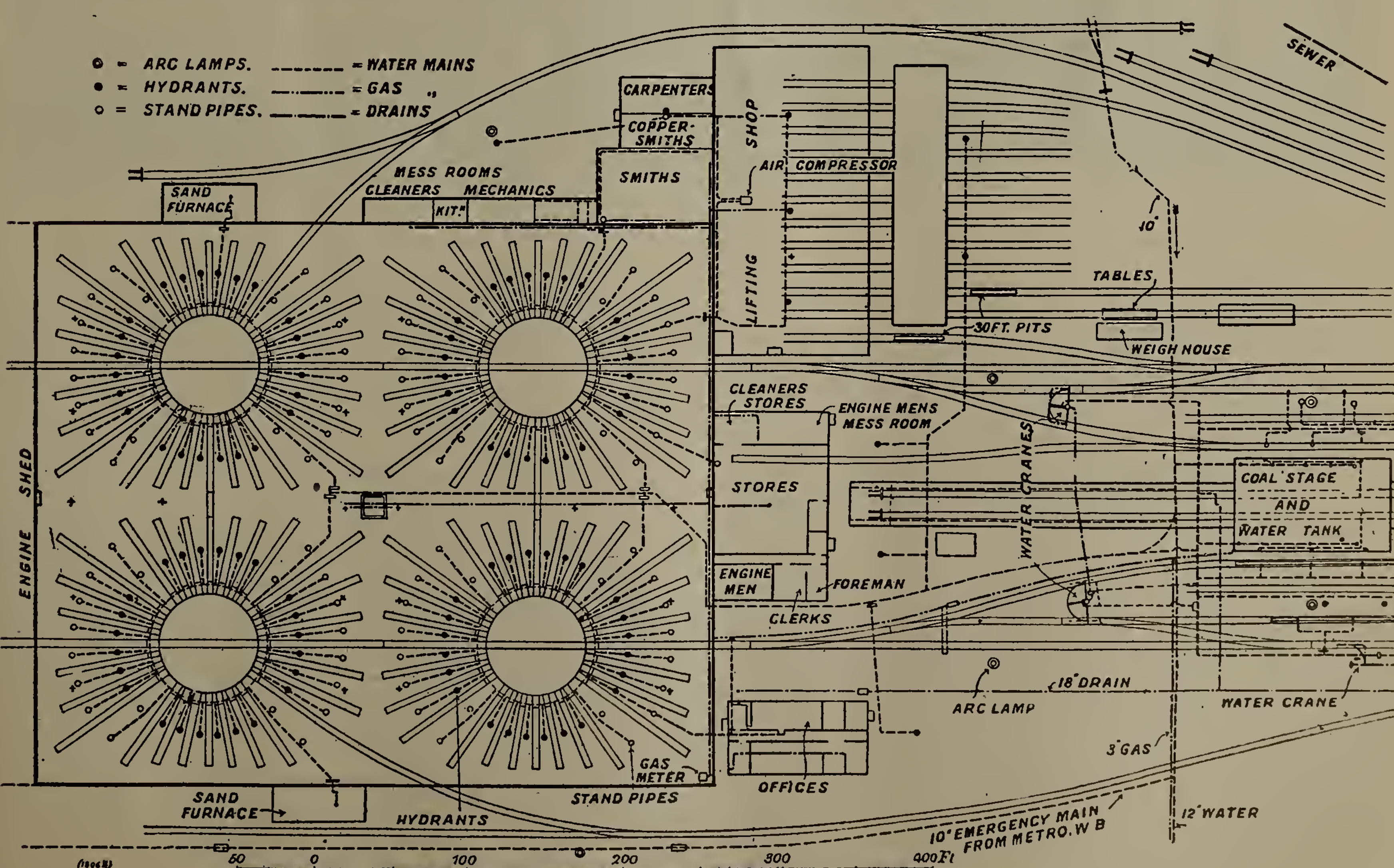
When the engine has been fully blown off, which occupies from 10 to 20 minutes, according to the size of the boiler, the blow-off hose is disconnected and an armoured hose wash-out pipe is connected to another line of piping through which the water from the wash-out tank is pumped and the engine is washed out in the usual manner. A duplex Worthington pump, capable of delivering 450 gallons per minute, is used for pumping the wash-out water, and this is automatically controlled so as to give a pressure of 60 lbs. per square inch. By means of the thermostatic valve the temperature of the wash-out water is maintained at 140 deg. Fahr., which is as high a temperature as can be conveniently handled by the men.

When the washing-out has been completed, and all the plugs and mud-hole doors have been put back, the hose is shifted on to another line of piping, and the boiler filled up from the filling-tank with water at not less than 180 deg. Fahr. This is pumped from the filling tank by a duplex pump similar to the one mentioned above. A thermostatic valve automatically opens a valve to supply live steam for heating purposes to the filling-tank when the temperature of the water in its falls below 180 deg. Fahr., and shuts off the supply of steam on that temperature being reached. The waste steam from the engines that are blown off is, however, usually sufficient to give the required heat to the water in the filling-tank, and it is rarely necessary to use live steam for this purpose. The filling and wash-out tanks hold 6,000 gallons of water each, and several engines can be blown off, washed out, or filled up, at the same time. With the hot-water washing and filling system, an engine can be blown off, washed out, filled up, and in steam about two hours from the commencement of the operation without the boiler plates, etc., having been subjected to detrimental changes of temperature.

Methods of Coaling.

The general method is to push the coal in wagons up an inclined road to a stage where it is unloaded into small "tubs" on wheels. The stage is of such a height that when





Terminal Yards and Engine Houses of the Great Western Ry., Oak Common, England.

the tubs are run out on to a small tipping stage projecting from the main stage they are over the tender, which is alongside, to be coaled. The small stages are hinged and weighted so that their normal position is clear of the loading-gauge. In some cases power-cranes are used, but the method described above is the most general.

Sand-Furnaces.

Sand furnaces are provided in connection with every running-shed, because it is important that the sand used should be dry: quite equal to this in importance is the necessity for its being thoroughly sieved, so that no lumps can be present which might render the steam sanders ineffective.

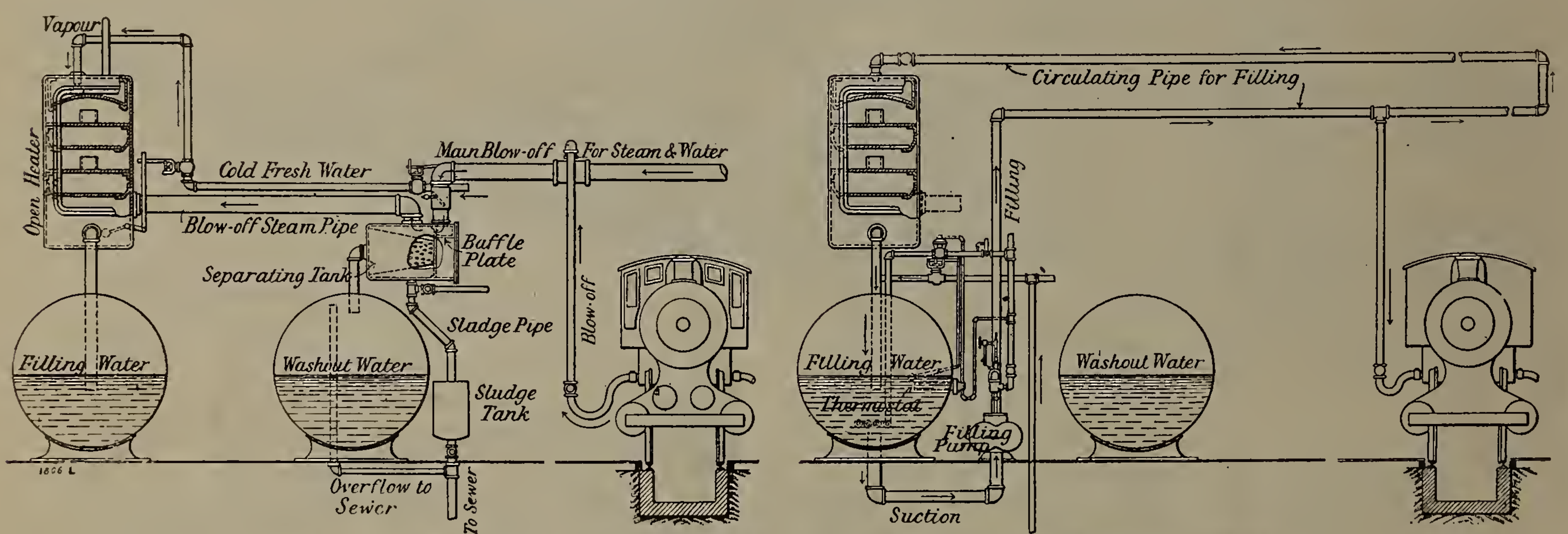
Ash-Pits.

Ash-pits are provided in suitable positions so that engines may be placed over them on their way back to the shed. The fire is raked into the pit and quenched. The ashes and clinkers are afterwards thrown out and the pit kept clean, so that the drivers can move about in it freely to examine their engines. A path about 3 ft. wide is kept swept at each side of the pit for the same purpose. The ashes are thrown on to plates beyond these paths and loaded up by the engineer's ballast gangs daily.

Water-Softening.

Few English railways have adopted water-softening extensively, though several use it on a limited scale. The softeners in use may be divided into two groups—namely, continuous-flow softeners, represented by the Desrumaux, Kennicott, Pulsometer, Reisert, Porter-Clark, and other types; and intermittent-type softeners, represented by the original Clark process and the Archbutt-Deeley plant. In all softeners the chemical treatment is the same. The water is treated with a caustic alkali, usually milk of lime or lime-water, which, by combining with the free and half-combined carbonic acid and decomposing magnesium salts, precipitates the calcium carbonate and magnesia; by the further addition of soda-ash the remaining calcium salts are decomposed and the removal of the scale-forming matter is completed. In the continuous-flow plants the chemicals are added to the water during its flow through the softener, and the precipitate is either collected on sloping plates arranged so as to divide the water into a series of shallow layers in which settlement takes place rapidly, or a filter-press may be used, as in Porter's arrangement. These plants occupy the least ground space, and the water loses very little head; they are best suited for waters which do not vary much in composition, such as those derived from deep wells or springs. In the intermittent-type plants the chemical treatment takes place in tanks in which a large volume of water is thoroughly mixed with the chemicals and allowed to remain quiescent until the precipitate has settled and clear water can be drawn off, a continuous supply being obtained by using two or more tanks. In Clark's process very large tanks were needed owing to the slow rate of settling; but in the Archbutt-Deeley system the rate of settling is accelerated by stirring up the old precipitate, and much smaller tanks are needed; this type of softener is specially adapted for the treatment of waters which are variable in composition.

There are certain inconveniences connected with the use of softened waters, because, if the soluble salts reach from 150 to 300 grains per gallon, priming will take place. This will more readily occur when sodium salts are present, owing to the use of soda-ash to decompose the sulphates and chlorides. If, owing to the impurities, it is necessary to soften the water with soda-ash, arrangements must be made to prevent trouble arising from concentration of salts in the boiler. This may be done either by changing the water, or by the use of blow-off or scum cocks, but neither method is at present extensively used in England. This is probably largely due to the fact that, taken as a whole, the waters used for locomotive purposes in this country are of fairly good quality. Owing to the comparative smallness of the boilers, engines are, however, liable to work with steam in which there is an excess of water, and the avoidable coal consumption due to this cause may be high, although water may not be present in the steam to such an extent as to constitute priming. Experience shows that where softening has been resorted to with a bad water, considerable saving is effected in the cost of boiler repairs and renewals.



The Blow-Off and Filling Piping of the Hot Water Washout System at Gateshead.

ENGINE HOUSE WORK.

In order that the earning capacity of the locomotive stock may be as high as possible, it is the aim of the management to get as much work out of the engines as is consistent with safety. To do this, they must be kept in an efficient state, because, apart from considerations of safety, which hold the first place, failures on the road are very expensive.

Examinations.

The period between the examinations of the various parts of engines is fixed either on a time or mileage basis. On the Midland Railway the method employed depends upon the parts to be examined, fire-boxes and boiler fittings being examined on a time basis, and working parts on a mileage basis. In the periods, as in the mileages, there is a fair working margin between the time when an engine enters the period or mileage at which it is due for examination and the time or mileage at which it must be examined. This margin is given to enable all examinations to be done together as far as possible, and prevent an engine being put out of service several times for examinations of different parts.

In order to enable the examinations to be regularly carried out when engines, owing to the demands of the traffic, are working for any length of time away from the owning station, each engine carries in the cab a card, upon which are recorded the dates of the last examinations and wash-out, and if the inspection of this card shows an examination or wash-out to be due, the work is carried out and an entry made on the card to that effect.

In addition to the prescribed periodical examinations, each driver, when giving up his engine, examines it and reports on repairs that are required. It is the practice in a good many sheds also to employ examining fitters for the purpose of examining engines when they are put in the shed after work.

Running Repairs.

As a result of the examination and the reports of the drivers and examining fitters, the necessary small repairs and adjustments are done by the running-shed fitting staff. On the Midland Railway the books into which drivers and fitters used to enter their reports have been replaced by cards, which, on being entered up, are dropped into a locked box. In the case of no repairs being required a "nil" card is put in. By this method the foreman fitter is able to arrange his work better. He has before him in a convenient form the amount of repairs of various kinds that require to be done, and by associating this information with the train-board he can tell by what time the work must be done and is able to arrange his men accordingly.

Washing Out.

Owing to the use of different qualities of water, the periodic washing out of boilers varies considerably. The general practice is to wash out passenger engines after 500 miles' work, and freight engines after 800 to 900 miles' work. At busy times there is no doubt that the time allowed for engines to cool is frequently not as long as it should be, and, with the object of avoiding the damage to boilers caused by too rapid cooling, and obtaining additional work from the engine by reducing the time of standing, the introduction of the practice of washing out with hot water is being considered on several railways.

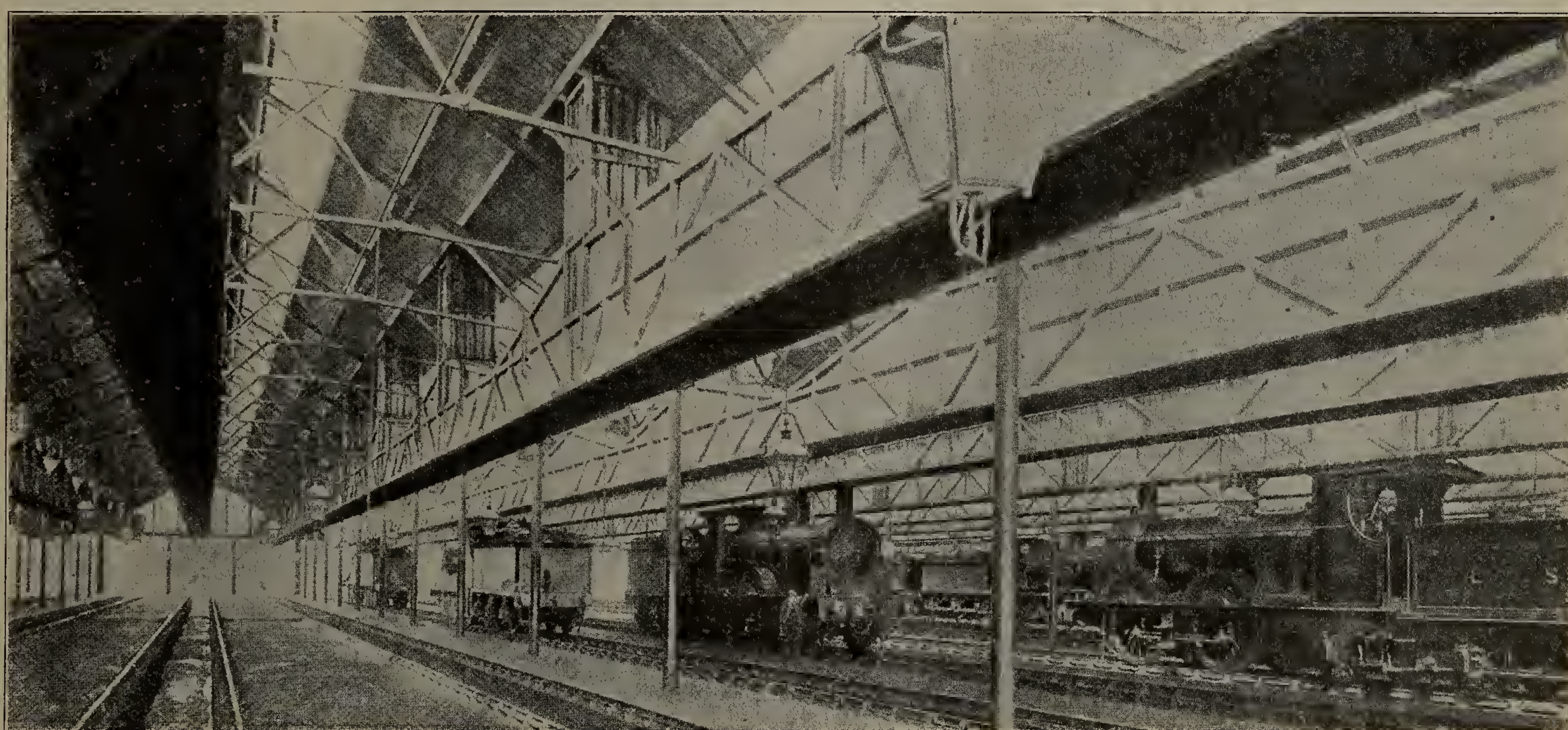
Casualty Office.

A notable feature in connection with the running department is the "casualty" office. Under the charge of a trained engineer the function of this department is to collect reports from the running-shed staff of all engine failures, a failure or casualty being any defect in the working of an engine which causes it to lose time on the journey or to be late in passing to its train from the shed. The head of the casualty office arranges for the proper classification of every case of failure, and directs the investigation into each case. After careful inquiry the cause of the failures can be brought to the notice of those responsible for design, materials, workmanship, operation, or purchase of coal, oil, and other stores, the object always being to promote efficiency in construction and improvement in operation rather than the discovery of an offender. A good moral effect, however, is created by thus constantly reminding all concerned of their individual responsibility.

The summarized statements periodically made to the general manager and directors of all failures by which delay is caused to trains form a fair guide to the efficiency of the locomotives on the road.

Engine Cleaning.

In order that the examinations previously referred to can be properly carried out, engines must be kept as clean as possible at a moderate cost. On English railways the general practice as regards engine cleaning is to employ boys from fourteen to nineteen years of age, who are afterwards promoted to firemen.



Interior View of the Straight Type Engine House at Eastleigh, L. & S. W. Ry.

The method of payment for cleaning varies on different railways, day-work, piece-work, and premium being employed, but day work is the most general. The piece-work system of cleaning was introduced some years ago on the Midland Railway, and was satisfactory until ten years ago, when the larger types of engines began to make their appearance; the work of cleaning an engine then had to be divided, and this gradually led to cleaning by gangs on piece-work.

Piece-work gangs being unsatisfactory and difficult to handle, a system of cleaning engines on Rowan's premium system was introduced about four years ago at most of the large depots on the Midland Railway, and is still in operation, although principally confined to the passenger engines. This system provides for a more methodical and thorough means of supervision, since each part of an engine, no matter how small, can be taken separately, and, if passed, paid for on its merits without reference to other parts. The premium system has been satisfactorily applied by working the men in groups of four, each man being responsible for particular parts of the engine, as set out on his job ticket. The premium earned by the man in cleaning those parts goes to his account, and has nothing to do with the earnings of the other men, thus preventing indifferent workers reaping the benefit of the industry of others in the group.

The premium system is successful, inasmuch as it introduces a strong incentive to do more than had been considered a day's work under other conditions. Cleaners working on premium are able to supplement their weekly rate to the extent of from 20 to 40 per cent. The arrangement of working the men in groups of four as a rule ensures engines being ready for service as soon as they are required. Should the engine require cleaning in a shorter time than usual, more men are put on, each man having his work detailed on a job ticket, and there is no fear of the work being scamped. Under the piece-work arrangement this was not easy to avoid.

Shopping of Engines.

The engines are turned over by the running department to the repairing engines department for heavy repairs, as a result of the condition of the various parts revealed at the periodical examinations in the shed, but mainly as the result of the periodical examination of boilers. The repairs to the boilers, as a general rule, take longer than those to other parts, and the order of putting work through the shops is dependent on the time taken to repair the boiler. By making other repairs subservient to it, the engine is likely to be out of service for the least possible time. In selecting engines for repairs, consideration is given to the probable demands of traffic working, the heavy repairs to passenger engines being undertaken in the winter months, and to freight engines in the summer. Roughly speaking, it is the practice on the Midland Railway to overhaul in the repairing shops each passenger engine every twelve to fifteen months, and each freight engine every eighteen to twenty months.

The means described for examination, shed repairs and shopping, are those taken to ensure the efficient working of the locomotive stock. On the Midland Railway this efficiency is secured by the withdrawal from service of about 25 per cent of the total stock. The actual percentages work out at:

	Passenger per cent.	Freight per cent.	Total per cent.
In repairing-shops	15.77	13.03	13.9
Under examination	1.36	0.95	1.08
Stopped for various repairs	8.57	7.55	8.08
Engines not available for work	25.70	21.53	23.06

These figures may be taken as fairly representative of British practice. Having about 75 per cent of the total stock available for work, its earning capacity, so far as it is controlled by the running department, lies mainly in the efficiency of the train arrangements.

Arrangement of Engine Workings.

It is usual for the traffic department to provide in convenient form a statement of the train service for which motive power is required. The graphic form of the time-table is very suitable for this purpose, as by its use it is easier to arrange economically the outward and return workings, and at the same time make provision for the most convenient places to change engines and ensure intervals during which the men can get their meals and attend to engine duties.

Passenger Trains.

Several English railways divide their passenger train working into two classes: The first, generally the most important express trains, being paid on a basis of mileage, and the second being paid by the day.

Links.

Suitable workings are grouped together in numbers varying from 3 or 4 to as high as 20, and the corresponding number of men necessary to work them are employed in rotation on each working. These groups are called links. Such grouping has the effect of dividing up the trains into two or three classes, which vary in their demands for power and correspondingly call for the use of different classes of engines. The grouping of workings is arranged in such a manner that the most powerful engines are kept as far as possible on trains where they are not extravagantly employed.

One of the main objects in the preparation of train arrangements before they are sent to the locomotive depots is to see that the maximum amount of the drivers' time is occupied in charge of the engines, and to reduct as far as possible the time during which the men are unemployed or engaged in miscellaneous duties. On several railways charts are exhibited at each depot periodically, giving the classification of the drivers' time and how employed. These charts act as a very good check on the foremen's arrangement of the men's work, as it enables him to see at a glance whether the percentage of time in charge of his engine is on the increase or decrease. It is advisable to have a link of such a size that it is large enough not to limit the drivers' knowledge to a particular road, but not so large that the knowledge gained of the various roads would be forgotten owing to the infrequent occasions the men work over the line.

In arranging links, due regard is paid to day and night work, and an effort is made to regulate the work so that a man is not continuously on one or the other. The men in each link work all the trains in it in turn, and any slight advantage in a particular week's work is, therefore, shared by all the men. When the links are arranged they are posted, for the guidance of the men, in a case at the engine shed, together with a complete list of the booked engine workings.

Special Trains.

Special passenger trains are provided for in the weekly excursion time-table. Arrangements are made at headquarters for the various depots to work such trains, those having an outward and homeward trip being generally worked by the depot from which the train starts, but in the case of additional or duplicate trains an endeavor is made to balance the mileage by utilizing an engine in one direction to work an additional train that may be required in the opposite direction, or when duplicates are necessary over the same section from opposite ends about the same time, they are dovetailed in with the ordinary booked trains. The timings of these special trains are supplied in a convenient form to the drivers working the trains. Such trains are worked by spare men or men whose time is not fully occupied.

From the train arrangement sheets the "working engines board," fixed in a convenient place on the shed wall, is arranged daily by the foreman in charge on the day or night shift, the trains being shown in the order of running, and the engines allotted to work them, together with the information as to where the engines can be found—that is, the shed or sidings where they may be standing. It usually shows also all the engines due for examination or washing out.

Engines and Men.

As far as possible, engines are allotted to and kept for the same drivers, and this is almost universally the rule in the case of passenger engines on most English railways, but it has not been attained as regards the freight engines at present (except with the more important goods trains) owing to the uncertainty as to when the engines of the ordinary goods and mineral trains will come into the sheds.

It would appear that the majority of the locomotive superintendents in England are of opinion that where first-class express work has to be done it is a distinct advantage to book an engine regularly to the same driver. This practice extends on some lines to fast fitted goods-trains, which require nearly as much working as an express. The experience on the Midland is that casualties are lessened owing to the greater care taken by the driver in working the engine and in properly reporting defects; and as a result the coal consumption is generally less.

Working Results.

The necessary statistics for criticizing the results of working of the various sheds are obtained in the following manner. Each engine-driver, at the end of his day's work, makes out a journal on which he enters in detail all trains worked by him, time occupied in doing so, the route and description of train, and the material used during the day's work. These journals are handed into the time-office, and the mileage is then entered to each trip, and the weight of coal, oil, etc., is checked with the coal-man and storekeeper's records in order to see that the entries made by the driver agree with what has actually been issued to him. From these journals the following statistics are compiled:

Engine hours..........Passenger trains.
Engine hours..........Goods and mineral trains.
Engine hours..........Shunting.
Engine hours..........Assisting, piloting, ballasting, etc.
Ordinary passenger train miles.
Special passenger train miles.
Assisting passenger train miles.
Passenger shunting performed (calculated at 6 miles an hour.
Ordinary goods and mineral train miles.
Special goods and mineral train miles.
Assisting goods and mineral train miles.
Goods and mineral shunting performed (calculated at 6 miles an hour).
Detentions to engines.
Consumption of coal, oil, and other stores by each individual engine.

The time of engines employed exclusively for shunting purposes is calculated at 6 miles an hour, from the time they leave the locomotive yard to the time they again reach the ash-pit—with a minimum debit of 10 hours.

Ballasting is calculated at the rate of 8 miles an hour, but only the actual time occupied is brought to debit.

Engines standing as pilot, that is, to assist or work duplicate trains as required, are charged at the rate of 6 miles an hour for the actual time they are standing. A statement of mileage, wages, coal, oil, and stores consumed is compiled for comparing one depot with another. The compilation of these figures involves an immense amount of routine work; recognizing this the Lancashire and Yorkshire Company have adopted the "Hollerith Tabulating Machine" for the purpose, by means of which the following data are obtained:

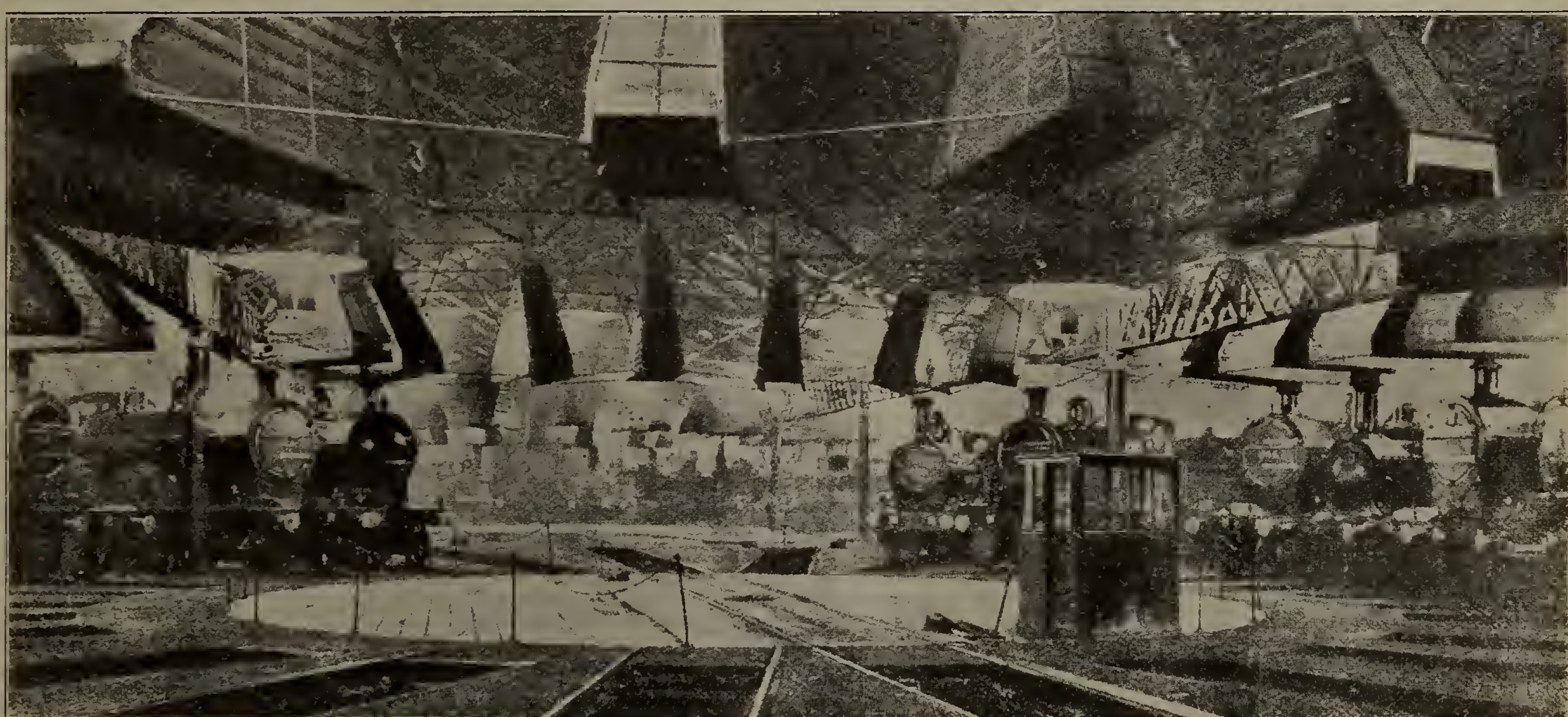
Date.
Shed where driver is stationed.
Class of engine.
Engine number.
Shed where engine is stationed.
Driver's number.
Description of mileage.
Miles run.
Shed where coal is received.
Weight of coal supplied.
Description of lubricant.
Quantity of lubricant supplied.
Description of time.
Time worked in hours and minutes.

By means of the punched holes denoting the description, the same cards will show:

Number of train-miles run.	Passenger, freight, mineral.
Number of train-miles run. Assisting.	Ditto.
Number of light-engine miles run.	Ditto

Number of locomotive shunting miles.
Number of traffic shunting miles.
Number of empty carriage miles run.
Quantity of locomotive oil supplied.
Quantity of cylinder oil supplied.
Quantity of tallow supplied.
Length of time men were in charge of engine.
Length of time men were traveling before or after being relieved.
Length of time men were engaged conducting, waiting orders, etc.
Length of time trains were detained by signals, etc.

These cards can be conveniently assembled to show cost of operating the various sheds, classes of engines, classes of mileage, etc.



Turntable Engine House at Oak Common, Great Western Ry.

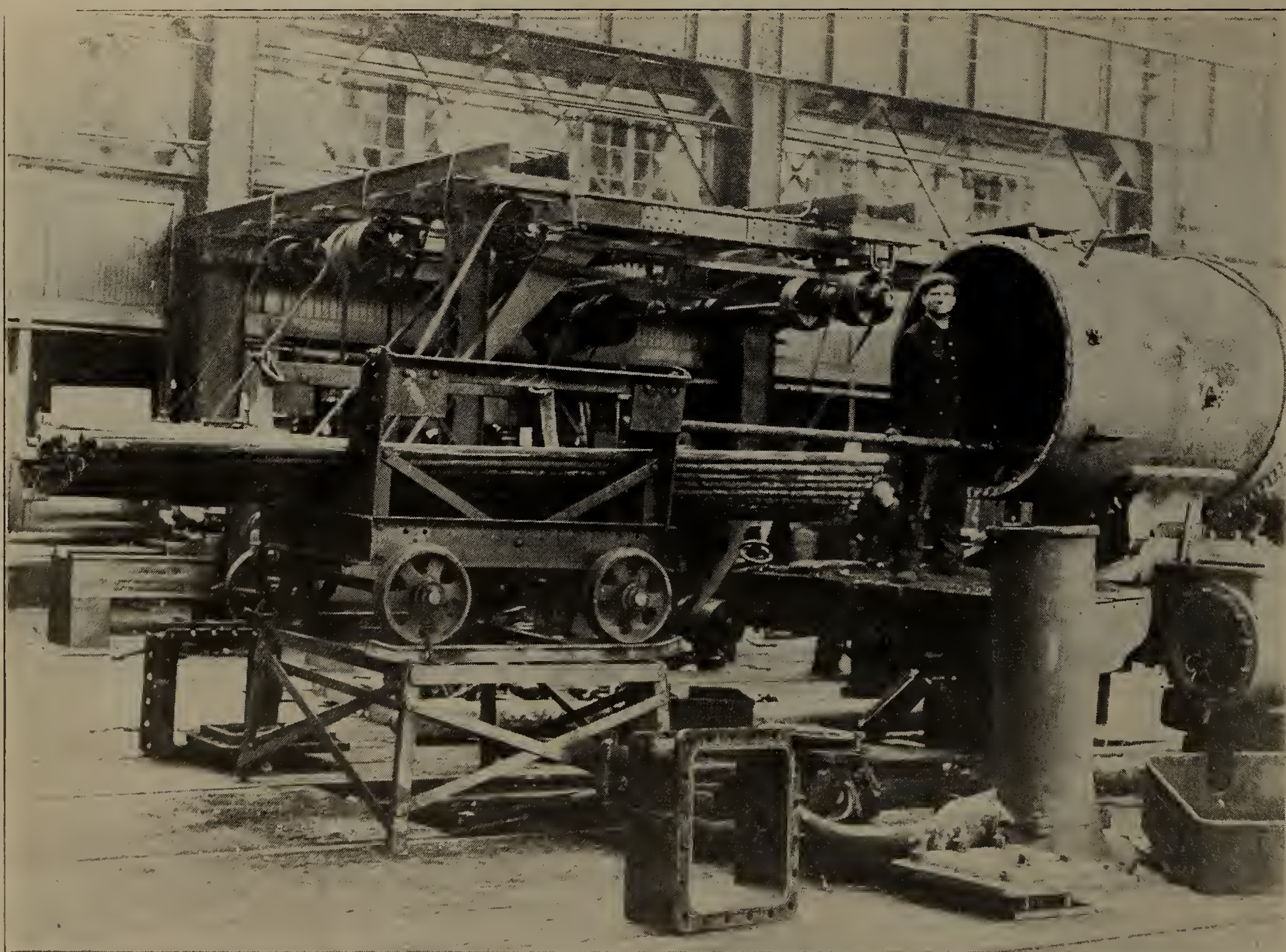
Shop Kinks at Angus Shops, Canadian Pacific Ry.

We are indebted to Mr. Lacey R. Johnson, assistant superintendent of motive power of the Canadian Pacific Ry., for the following valuable shop kinks.

Method of Handling Boiler Tubes.

The photographs illustrate a method which was developed with the idea of minimizing the individual handling of the flues so as to handle them only during the welding operations. Figure 1 shows the method of placing them in a special truck which is carried by the overhead traveller to the tube shop and placed on the storage ground as shown in Figure 2. It will be noted that the trucks are so designed that they can be placed on top of one another. The usual practice being to have three trucks placed together in this manner. The storage space is sufficiently large to accommodate eighteen trucks. Figure 3 shows the tubes in the flue cleaner. This is the Ryerson chain cleaner and the tubes are taken out and replaced in the trucks after cleaning, through mechanical means entirely.

After cleaning, the tubes are passed through the welding machine, cut to lengths, etc., and finally laced back in the truck as shown in Figure 4, after which there is no more handling until they are put back into the boiler. This method has proved very effective, reducing the cost of handling this work considerably and has the further advantage that the amount of room required for storage is comparatively small and the appearance of the shop is neat and orderly.


Handling Boiler Tubes, Angus Shops, C. P. R., Fig. 1.

Portable Hydraulic Press.

This press was designed for the purpose of forcing in valve bushes in piston valve cylinders and is used in connection with a portable hydraulic pump that gives a pressure of fifteen hundred pounds to the square inch. The two bushes are entered into the cylinder and the press then put into position, operating on both bushes.

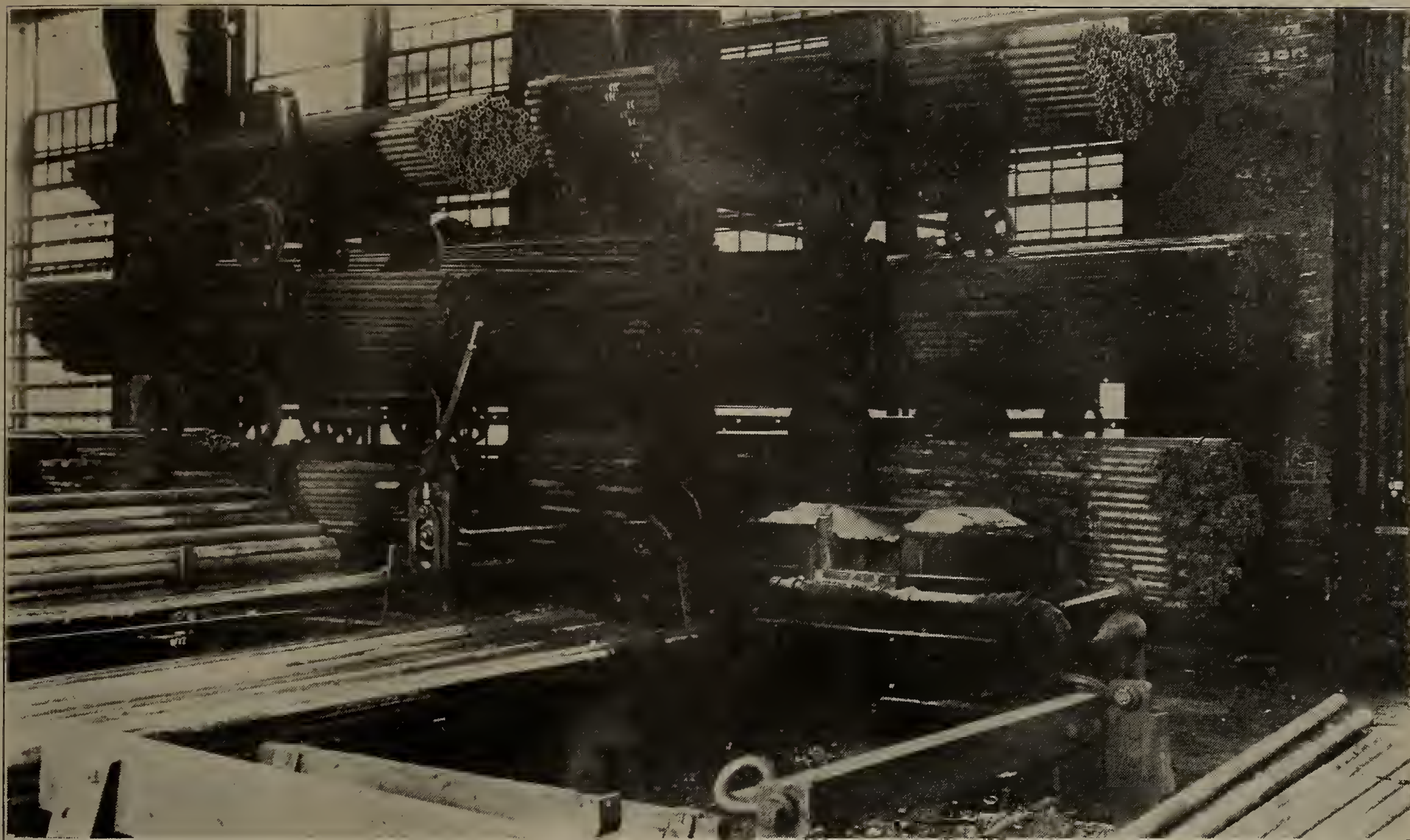
It was deemed advisable to make the maximum stroke with a limit of 9 inches in order not to make the machine too unweildy, and it is, therefore, necessary to return the piston to its starting point and follow up with the nut on the end of the rod.

The pump has been made up of an 8-inch Westinghouse pump with a small bore water end, the whole mounted on a truck, which also carries a water tank. It is operated with compressed air.

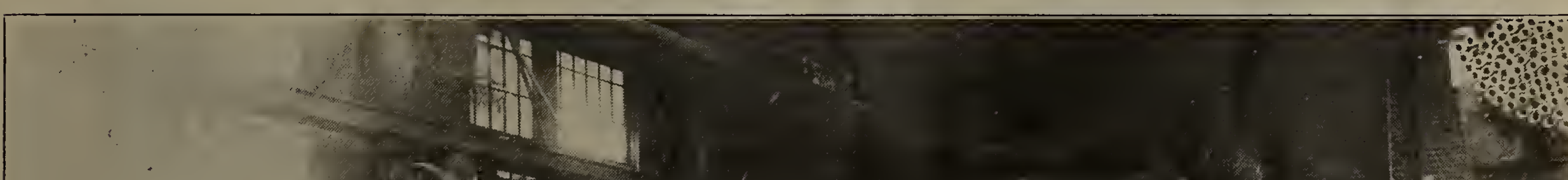
Centre Square and Level for Testing the Quartering of Locomotive Wheels.

As shown in the illustration, this tool consists of a centre square "A" on which a sliding head "B" has been mounted, and at point "C" a block carrying two levels "D" and "E." set at exactly ninety degrees to each other. The block has been carefully located and dowelled to the square. The method of application of this tool is as follows:

The forked end of the square is applied against the crankpin and the movable slide "B" adjusted to the center of the axle. The wheels are then wedged up until the level "D" shows a true vertical position. After this the square



Handling Boiler Tubes, Angus Shops, Fig. 2.



Handling Boiler Tubes, Angus Shops, Fig. 4.

Handling Boiler Tubes, Fig. 3.

is applied to the opposite wheel and through level "E" will indicate whether there is any error in the quartering or difference in the throw of the two pins.

Combined Tube Sheet Drill and Reamer.

This tool is made of high speed steel screwed into a carbon steel shank, and has proved to be a very effective tool, producing a smooth hole running at the maximum speed and feeds that the steel will stand.

Handling Material Through Shops.

The photographic reproduction illustrates what has proved to be an excellent method for the handling of material in a shop where it is necessary to bring it in from one end of the building and distribute it to the various departments.

A double narrow gauge track has been laid, the outer rails of each track being the standard 4 ft. 8½ in. gauge, thus allowing in exceptional cases to bring in loaded cars.

The trucks have been made with an overhang on one side of about one foot, the other side being even with the ends of the axles. This allows two trucks to pass each other, and also gives sufficient space to load up heavy castings and forgings. Instructions have been issued as to the loading of the trucks and the direction of the traffic on the two tracks, and this is followed, with the result that everything moves smoothly.

At certain intervals throughout the shop, turntable and cross tracks have been provided, where the loading and unloading takes place whenever possible.

Fuel Economy.*

The subject of fuel economy is to be presented under the following heads:

(A) Value of present draft appliances. Can they be improved to effect fuel economy.

(B Firing practices, including the prevention of black smoke.

(C) Roundhouse practices, whether it is more economical to knock or bank fires at terminals.

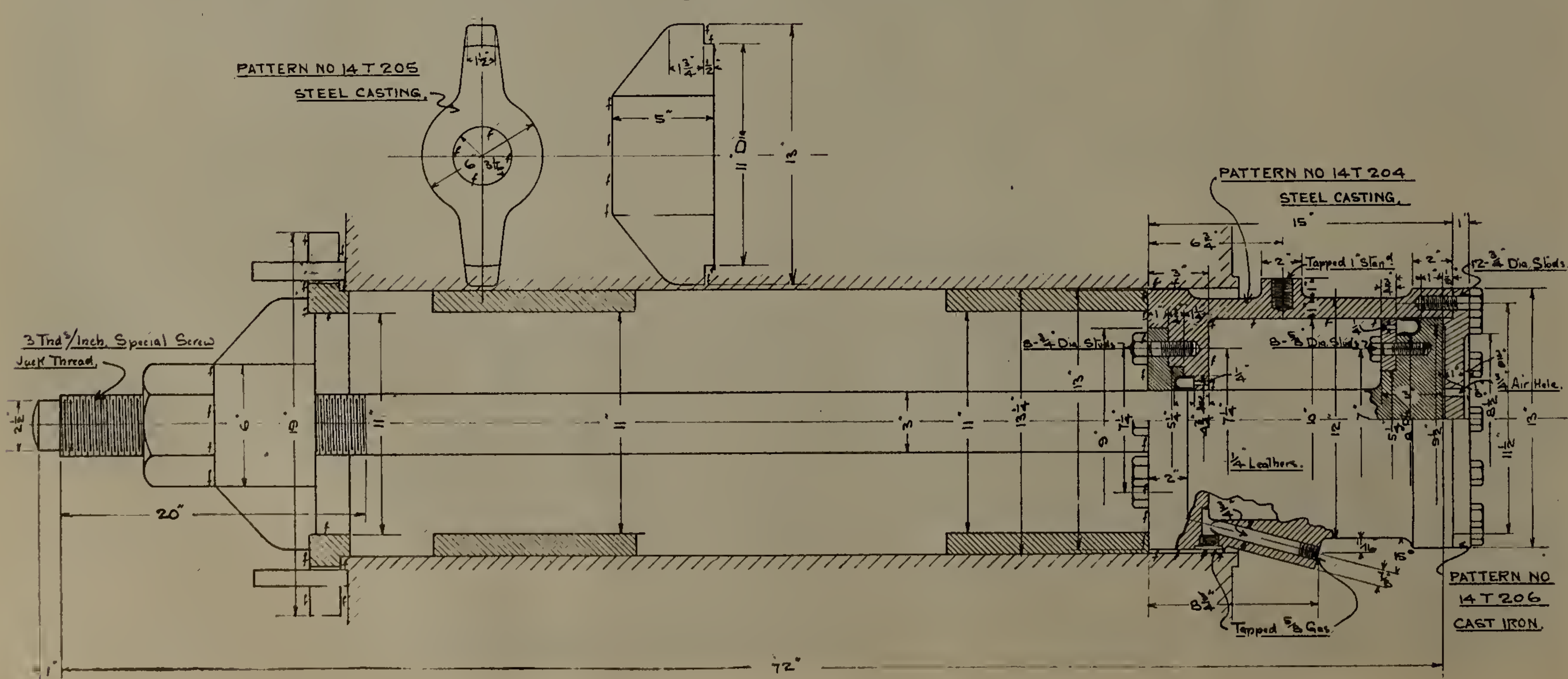
(D Whether it is more economical to buy cheap fuel of a low heat value or a higher price fuel of a greater heat value.

(E) Devices and appliances for use on engines and tenders to prevent waste en route, etc.

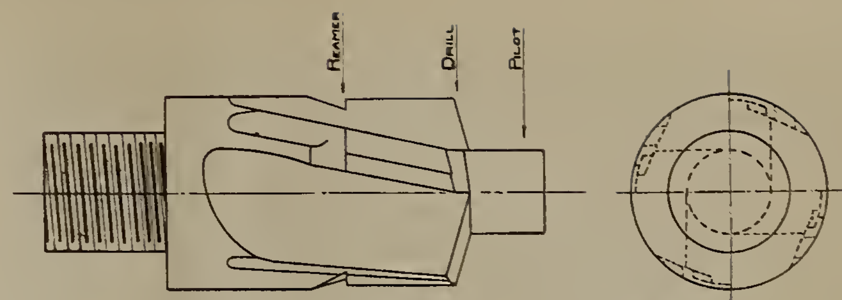
In answer to the first question—"Value of present draft appliances; can they be improved to effect fuel economy?"—we say that with the different kinds of fuel used for locomotives there is without doubt a large field to work in for drafting engines to obtain fuel economy. We believe that the first consideration should be given to the service required, next to the quality of coal furnished, and then the engine should be drafted to use the minimum amount of coal for furnishing the necessary amount of steam.

There are so many conditions which enter into the proper drafting of the locomotive, to be economical in fuel consumption, that in treating this subject we must assume that the following items are given consideration and proper attention:

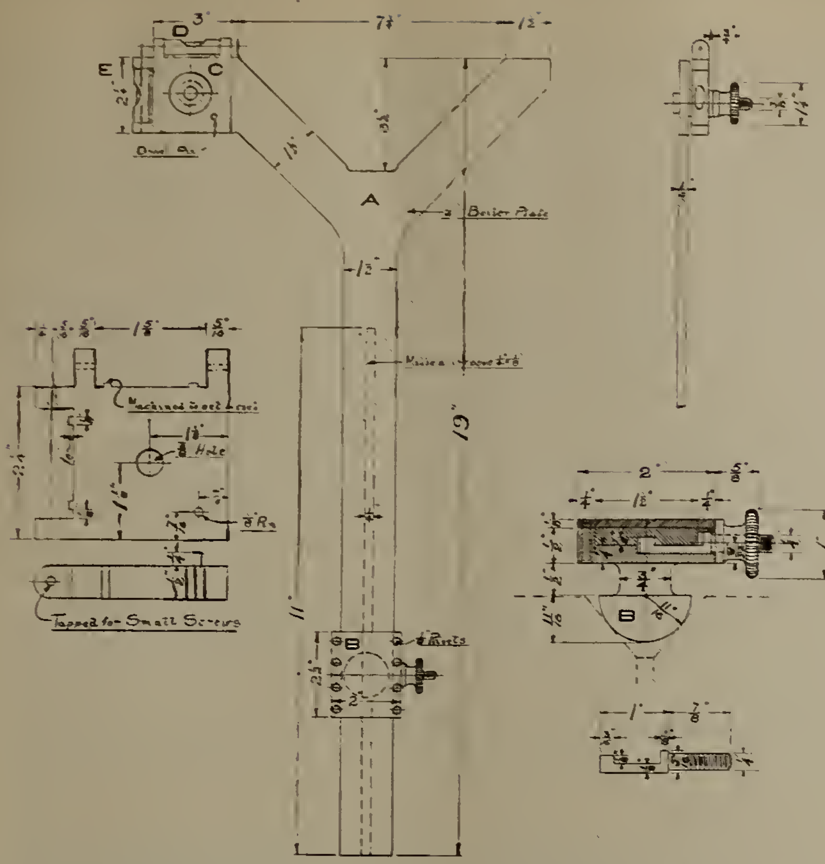
*From a committee report at the Traveling Engineers' convention.



Hydraulic Press for Valve Bushings, Angus Shops.



Combined Tube Sheet Drill and Reamer.



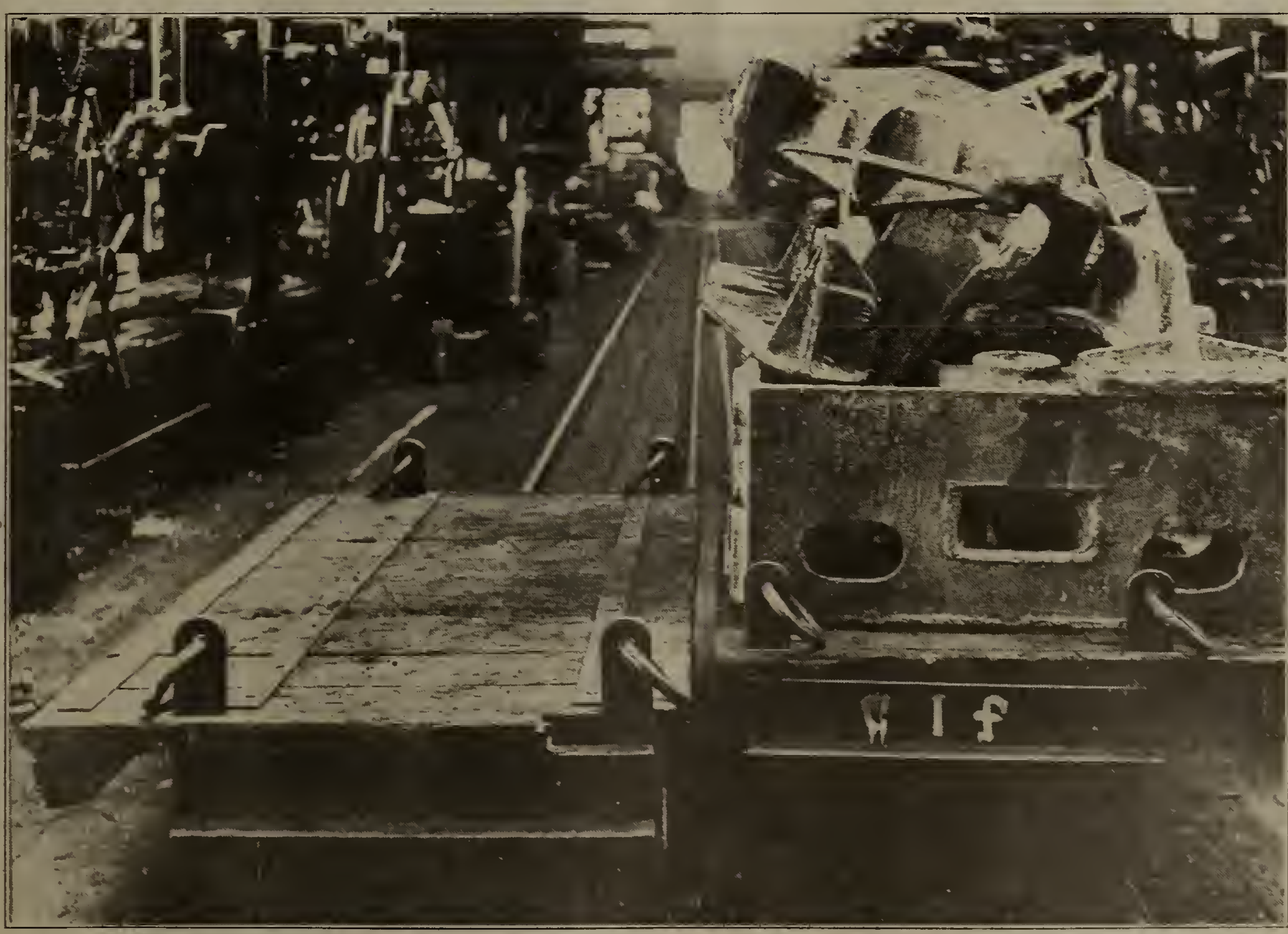
Center Square and Levels for Testing Locomotive Wheel Quartering.

The boiler must be kept free from mud and scale and leaks, the crown and flue-sheets should be kept free from honeycomb, and the grates must have the proper opening. The lost motion in the grate rigging should be kept up so that the grates can be properly operated. The ash-pan should have the necessary number of openings to admit air for perfect combustion. The steam pipe joints, nozzle base and tip joints, the cinder chute and handhold plate joints, smoke-box ring and door joints should be kept tight to prevent any irregularities in the draft. The cylinder packing, valves, piston rod and valve rod packing should be kept free from leaks. The valves should be adjusted for an equal distribution of the steam in the cylinders, and the engine must have the proper cylinder clearance.

With these items properly cared for and the valves and cylinders receiving proper lubrication, you are then in position to adjust the draft appliances in the front end of a locomotive to burn the least amount of coal possible, if properly handled; to do the required amount of work expected of the engine. But in ordinary locomotive practice we find many of the above mentioned items neglected, which affect the steaming of an engine, and after a locomotive has been properly drafted in a majority of cases the first thing done in the roundhouse is to reduce the size of the exhaust nozzle by bushing or bridging, in order to overcome the defects in some other part of the engine, and in consequence of this practice the draft appliances, which have been thoroughly demonstrated to be all right, have been given a backset.

On one of the large eastern systems the former practice of bridging and bushing the nozzles to make engines steam freely has been discontinued and greater attention is given to the other items which will cause an engine to fail for steam, with the result that engines were made to steam freely without the use of a bridge or bushing and they are more economical on fuel.

Prof. W. F. M. Goss, giving results of his test, estimates that of the 90,000,000 tons of coal consumed by the 51,000 locomotives in the United States in 1906, 720,000 tons were



Trucking Material in Erecting Shop, Angus Shops.

lost through incomplete combustion of the gases; 10,080,000 tons were lost through heat of gases discharged through the stack; 8,640,000 tons were lost through cinders and sparks, and 2,880,000 tons were lost through unconsumed fuel in the ashes. These figures indicate that there is considerable room for improvement in our present draft appliances.

While our present draft appliances are good, still a number of roads are experimenting with different draft appliances, and there is no doubt but what they can and will be greatly improved.

It has been the experience of the committee that where the grate area and netting was increased fuel conomy has resulted, and we believe that there is room for further economy along these lines.

(B) Firing practices, including the prevention of black smoke. In order to prevent black smoke and form the habit of proper firing, it is necessary when employing the fireman to instruct him of the importance of learning to fire light and even, scattering the coal as thinly over the grate surface as possible, opening and closing the door between each scoopful of coal and allowing sufficient time between each shovelful of coal for the gases to be expelled and consumed. Explain to him that black smoke is unconsumed gas and a waste of fuel.

In addition to this he should also be notified of the importance of seeing that the fire is properly prepared before starting with a train, to have tools and appliances to care for the fire and to see that the grates are in proper working order, also that the grates must not be shaken too soon after leaving the terminal or too much or too violently at a time. After receiving these instructions, the fireman should be required to make his student or learning trips with a fireman whose practice is light and careful firing and kept with him until he is O. K.'d by both engineer and fireman; then before being allowed to enter the service he should be asked what practice he has followed while making his learning trips, and again impress him with the importance of being always careful to fire lightly, carefully and regularly, for the prevention of black smoke, economy of fuel, maintaining an even temperature in the fire-box, preventing clinkered and dirty fires, and avoiding the annoyance to patrons of the road and the public.

Many devices have been introduced for the prevention of black smoke, such as air and steam jets, but it is the opinion of many that these devices simply overcome the shortcomings of poor firemen and are wasteful of fuel, and that if the firemen are properly instructed and their interest kept stimulated the black smoke can be prevented to a large extent without these devices.

The brick arch, when heated to a high temperature, has given good results in preventing black smoke and in saving fuel, but by many mechanical men it is not considered economical on account of the expense of its application, cost of maintenance and prevention of easy access to the flues.

The use of the blower with the fire-box door slightly open, when the engine is standing or drifting, is successful in preventing black smoke to a large extent, and in this connection it is important that the blower valves be placed handy where the fireman can operate them, also that the blower pipe be large enough and properly located in the smoke-box to have a good action on the fire.

A very important thing in the prevention of black smoke is to have the engine free from leaks in the fire-box and smoke-box, the boiler cleaned, all flues open, grates working properly, ash-pan with sufficient openings for the proper admission of air, and the pistons and valves not blowing.

With the engine free from leaks and blows and properly drafted for free steaming, there is no good reason why the smoke cannot be reduced to a minimum.

Another thing essential in reducing black smoke, as well as to secure fuel economy, is to have the engine crew working in harmony and co-operation with each other at all times. Impress upon the engineer that good results in the prevention of black smoke cannot be obtained unless he properly supplies the boiler with water and works the engine as economically as possible; he should keep the fireman fully informed of all moves that are to be made.

We believe that the best results can be obtained by teaching the fireman the constituents of coal and the principles of combustion; then supervise his work closely, to see that the above mentioned practices are followed as outlined.

Your committee also finds it necessary that the roundhouse forces should lend their best efforts in keeping engines in proper working condition, if results in the prevention of black smoke and economizing of fuel are to be obtained.

Referring to the third heading of the subject—"(C) Roundhouse practices, whether it is more economical to knock or bank fires at terminals"—your committee will state that the many replies received from the members of this Association in different parts of the country show a difference of opinion on this subject, and it is difficult to state which practice is the best to follow.

We believe that this matter is best governed by local conditions. For instance, where boiler troubles prevail, due to bad water and inferior coal, it has not been found practicable to bank fires; however, in some sections of the country it has been found very economical to do so.

A number of tests were made by one member of the commitee on a road having about 1,000 engines in daily service, 75 per cent of which had banked fires at terminals for twelve hours. It was found that there was a saving in fuel of about $700 per day, or $200,000 per year by banking the fires.

A tabulated form of this test and kind of fuel used is shown below:

Class Engine	Grate Surface Sq. Ft.	Total Heat Sur. Sq. Ft.	Coal Used New F. Pounds	Coal Used Bank F. Pounds	Hours Layover	Cost Coal	Cost F. Oil	Remarks Save
4-6-2	54	3,923	2,500	.....	12	$3.75	$0.10	.....
4-6-2	54	3,923	......	1,800	12	2.70	...	$1.15
4-6-0	34.6	2,665	2,000	.....	12	2.85	.08	.....
4-6-0	34.6	2,665	.....	1,200	12	1.71	...	1.22
4-4-0	18.7	1,360	1,200	.....	12	1.71	.06	.....
4-4-0	18.7	1,360	......	700	12	1.00	...	.77

An analysis of coal used during the test is shown below. On 4-6-2 engines see first line; 4-6-0 and 4-4-0 see last line.

Fixed Carbon	Volatile Matter	Ash	Sulphur	Moisture	B. T. U.
55.88	33.36	10.15	1.57	.61	12.935
57.34	32.02	10.20	4.37	.44	13,247

It is claimed by others that the disadvantage of bank fires is that it prevents the examination of grates and grate rigging and the cleaning of flues, which may result in the engines not steaming freely on the road, causing greater and more rapid variations of temperature than would be caused by knocking the fire, also resulting in more coal being used by the engine crew in their anxiety to keep even steam pressure.

It is advocated by many that if an engine is to be placed into service within twelve hours it is better to leave the fire undisturbed until one hour before the engine is to be used, as there is always sufficient fire in the fire-box when the trip is completed to keep for several hours by adding a few shovelfuls of coal, and no cold air will strike the flues as it does when the fire is banked.

It is our conclusion that the length of time the engine is out of service and the local conditions governing on each division will determine which method is the most economical to pursue.

(D) Whether it is more economical to buy cheap fuel of a low heat value or a higher price fuel of a greater heat value.

As to this question, the answer will depend upon locality, length of time the engines are under steam, using fuel and not performing work, class of service to be handled and purchase price of coal.

As to location, if the characteristics of the road are such that the engine is required to work at maximum capacity the greater part of the time, it may be cheaper to buy a higher priced coal of a greater heat value.

The length of time engines are under steam, using fuel and not performing work, will average on some roads 50 or 60 per cent, due to engines being fired up, waiting call, delays at terminals and on the line waiting for trains and after arrival at terminals, before fire is knocked, due to inadequate terminal facilities. Where a large amount of coal is used while the engine is idle, it is evident that the cheapest fuel, so long as it has the steaming qualities, is the best fuel to use.

In cases where the class of freight to be handled is high and the competition for passenger traffic keen, it is necessary to use coal of sufficient heat value to prevent detentions, even though the cost of fuel may exceed that which would give satisfaction under ordinary conditions.

The purchase price of coal has considerable to do with the kind of coal used. A number of roads use coal that is mined on their own lines, and while this coal may not compare favorably with coal from nearby coal fields, the cost of transporting the other coal prohibits its use; but when the before mentioned conditions are not of great concern, we believe it is more economical for any railway company to use the cheapest grade of fuel they can get along with and keep the delays on the line down to a minimum.

It is more economical to have an occasional engine failure on account of poor coal than it is to pay $75 to $100 a day more for coal on one division.

On the average division from 600 to 1,000 tons of coal are consumed per day. If the price of coal is advanced 10 cents a ton, the cost is increased from $75 to $100 per day. Therefore it is a question of how many engine failures a road can afford to have for $75 to $100 a day, due to burning an inferior grade of coal.

An average freight engine does not work to its full capacity more than 25 per cent of the time on an average division, and if the grade of coal is good enough to maintain the maximum steam pressure during this time we believe the right grade of coal has been selected in the way of economy.

If the better grade of coal is selected at the higher price, there will be 75 per cent. of the time when this coal would not be needed and a great deal of it is wasted through the pop valve and in other ways, which demonstrates that the cheaper grade of coal that will get the train over the maximum grade is the most economical to be used.

In this connection we believe that considerable coal could be saved with either kind of fuel used if it were put on the tender as near to uniform size as possible, so that very little of it would have to be cracked by the fireman.

Several roads have installed mechanical crushers in their docks for this purpose, while others have rails or bars put over the dock pits, where the lumps are broken by hand before being loaded.

(E) Devices and appliances for use on engines and tenders to prevent waste enroute, etc.

There are quite a number of devices and appliances used on engines and tenders to prevent waste enroute, such as shields over tank valves, side boards and racks. One of the best devices which we have seen of this kind is a hood extending about twenty-four inches toward the center of the tender; however, these are not advocated for tenders in passenger service, as it is claimed they make the tender top-heavy. We believe that one of the best methods of preventing waste of coal is to have the coal docks spaced so that there will be no occasion for overloading the tenders in order to make coal stations.

Considerable attention should be given to the lost motion between engine and tender. This lost motion should be kept up so coal will not be jarred off while running. The springs and tender trucks should also receive careful attention to make the tender as easy riding as possible and to prevent coal being jarred off.

An angle plate placed at the right side of tender at the gangeway prevents coal from working out of the gangway.

We also recommend that the openings in the coal gates should not be so large that they will allow coal to sift down and work out of the gangway.

Methods of Air Pump Piping.

The following is taken from a committee report presented before the seventeenth annual convention of the Air Brake Association:

Dealing with the first of the three air pump pipe connections, the steam supply, with standard size of iron pipe, this pipe should in no wise be obstructed or the flow of steam restricted either carelessly or intentionally. While many air brake men have in times past favored the use of a gasket with a restricted opening in the air pump steam pipe for the purpose of preventing the pump from being run at an excessive rate of speed, your committee believes the time has arrived when it is no longer good policy, or even reasonable to sacrifice an advantageous point, or any good feature of the brake equipment, in order to compensate for any carelessness or lack of training upon the part of the individuals who operate and maintain the brake.

On railroads where traffic is heavy, train crews are daily confronted with situations, both on level track and mountain grades, in which the time element is the prominent factor, and the charge or recharge of train brakes is of supreme importance. At such a time an obstruction means more than a mere annoyance and waste of time. It is safe to say that the capacity of the standard 9½ in. air pump is insufficient to meet the demands made upon it by the brake pipe on modern trains; however, two 9½ in. air pumps are often used in preference to a pump of larger capacity.

Relative to standard methods of air pump piping, Fig. 1 shows size of piping by which, with 200 lbs. steam pressure and an unrestricted flow of steam through the 1 in. governor, a speed of 175 strokes per minute has been obtained while working against a constant air pressure of 120 lbs. per square inch. The capacity of the 9½ in. pump was at this time 46 cu. ft. of free air per minute, and the back pressure into exhaust pipe 6 ins. from pump was 10 lbs. At a recommended speed of 120 strokes, or 60 cycles, a fall in back pressure in the exhaust pipe to a minimum of 6 lbs. per square inch was observed. The exhaust pipe was 22 ft. long, containing one elbow, and as the record was obtained from shop test, exhaust pipe was open to atmosphere. The indicator card, Fig. 2, was obtained from this arrangement, the indicator being attached to the exhaust pipe 6 ins. from the 9½ in. pump operating at a speed of 158 single strokes per minute against a main reservoir pressure of 120 lbs. The card shows exhaust pipe pressure throughout the stroke, and a minimum back pressure of 9 lbs.

Fig. 3 shows an arrangement of two pumps per locomotive with one pump on right, and other on left side of locomotive boiler, pumps controlled by one regulating and two steam portions of 1 in. governor. In this installation with 1 in. branch pipes to each pump and no globe valves in branch pipes, and with 200 lbs. steam pressure and pumps working against 120 main reservoir pressure, a piston speed of 117 strokes per minute from each pump was obtained, which resulted in a compression of 62 cu.

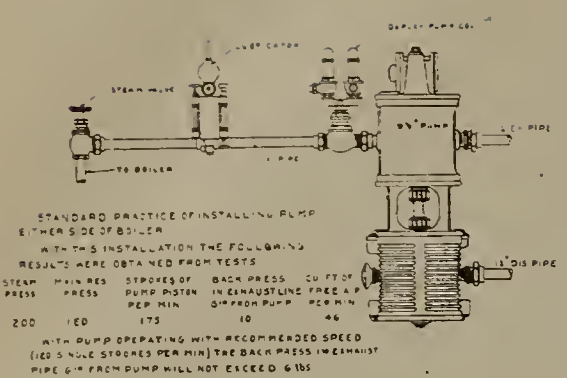


Fig. 1.

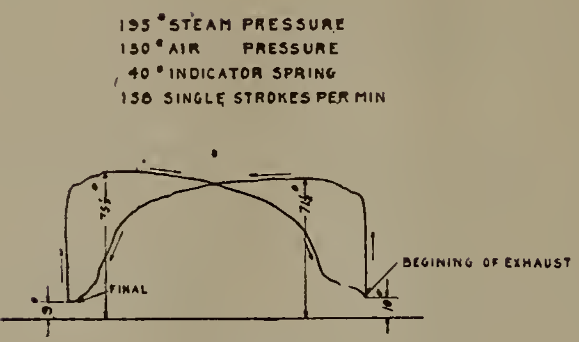


Fig. 2.

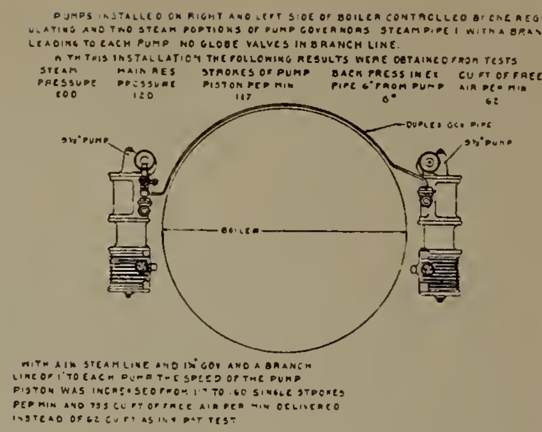


Fig. 3.

ft. of free air per minute. During this test the back pressure in exhaust pipe 6 ins. from pump was 6 lbs. With a 1¼ in. steam line and a 1¼ in. governor with 1 in. branch pipes leading to each pump, an increase of piston speed from 117 strokes to 160 strokes was obtained. This naturally resulted in an increase in the volume of air compressed from 62 cu. ft. per minute to 75.5 cu. ft.

To secure an equal distribution of oil with this method of installation, it is obvious that the steam line must join the branch lines directly on top of the boiler.

Fig. 4 shows standard method of piping when two 9½ in. pumps are located on same side of locomotive boiler, with the only difference that globe valves are shown in the branch pipes. With this arrangement the same results of tests were obtained as when piping is arranged and pumps located as shown in Fig. 3; that is, with same steam pressure and working against same air pressure, the use of 1¼ steam line to branch lines results in an increase of piston speed from 117 to 160 strokes per pump and an increase of volume of air compressed from 62 to 75.5 cu. ft. per minute. While noting that the 9½ in. pump was enabled to compress 46 cu. ft. of free air per minute when driven against 120 lbs. air pressure at a speed of 175 strokes per minute, it will be remembered that such a piston speed is unreasonable and that the pump should not be run beyond a recommended maximum speed except in cases of emergency. At 120 strokes per minute the pump will compress from 28 to 30 cu. ft. of free air per minute.

If piping to two pumps located on the same side of the boiler is installed as shown in sketch Fig. 5, with steam and branch pipes on a horizontal line with each other, with steam line directly above branch lines, it is evident that pump No. 2 receives the major portion, in fact, practically all of the lubrication. This is no doubt due to the oil being conducted along the bottom of the pipe as shown by dots. The same difficulty in oil distribution is encountered where steam line joins branch lines by means of a Y fitting as shown in sketch Fig. 6, when line is directly above, or very nearly above, the branch lines. Any difficulty whatever in steam or oil distribution is avoided by adhering to standard installation as shown in Fig. 4, or its equivalent,which would be that the tee join the branch lines about the same, or at nearly the same distance above the pumps that the steam line happens to be. This necessitates a horizontal turn at right angles in the main steam line and permits of practically an equal distribution of oil.

Fig. 7 shows the ¼ in. steam pipe arrangement referred to in Fig. 3. It will be noticed that the main exhaust pipe is 2 ins. in diameter.

Fig. 8 shows the location of indicator and length of exhaust pipe from which card shown in Fig. 2 was obtained. The same results obtained from several different piping arrangements serves in a measure to check the accuracy of the results observed, and in this specific instance permits of submitting the information derived in the more compact form shown in Fig. 3.

Fig. 9 shows size of piping and performance of the 11 in. pump with a 1 in. steam line. The result is shown on the sheet and it will be noted that when operating with recommended speed, the back pressure will not exceed 7 lbs., and the pump's capacity at such time is 45 cu. ft. of free air per minute.

Fig. 10 shows the possibilities in rapid air compression with the latest type of compressor used on locomotives. It will be observed that this pump can compress 130 cu. ft. of free air per minute, and at the recommended piston speed of 100 single strokes, the pump will compress approximately 100 cu. ft. of air.

Up to the present time we have endeavored to show the capacity of the 9½ in. pumps under different steam pipe arrangements, and have observed the back pressure encountered in the exhaust pipe and noted in this connection as a convenient reference while the exhaust pipe and exhaust steam is being considered. The back pressure referred to at this time in connection with pump capacity, is the result of pipe friction alone and is equivalent to an exhaust into the cylinder saddle of the locomotive when at rest, or to an exhaust into atmospheric pressure in the engine stack. It is manifest that the back pressure, due to pipe friction alone, is not excessive when standard methods of installation are observed.

The single expansion or direct acting air pump is anything but economical in steam consumption, as it permits or no early cut off, uses live steam throughout the entire stroke of the piston and does practically all of its work at the extreme end of its stroke. Excessive back pressure on the air pump piston affects the speed of the pump, reduces its capacity and very materially increases the steam consumption. This back pressure in effect on the exhaust side of the steam piston not

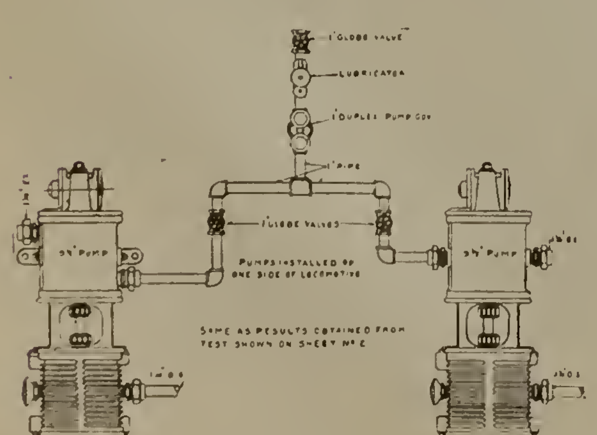


Fig. 4.

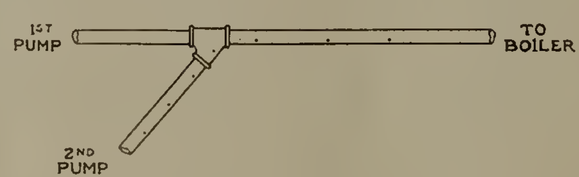


Fig. 6.

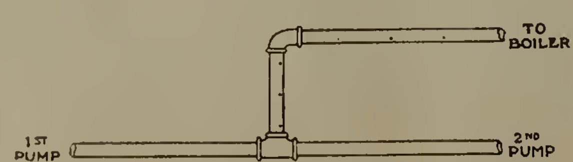


Fig. 5.

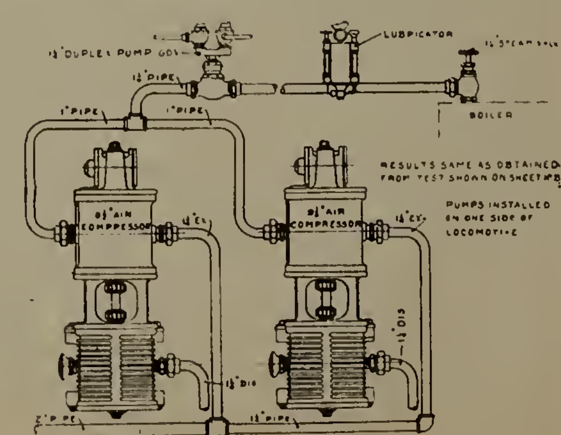


Fig. 7.

only results in a more expansive use of steam but in combination with scant lubrication well worn or slightly defective valve mechanism is no doubt frequently responsible for the pumps stopping in service.

As the results of the tests submitted show that with properly arranged piping of the correct size, excessive back pressure, due to pipe friction will not be encountered, it is therefore apparent that in the event of excessive back pressure occurring with standard installation, it must be due to the disposition of exhaust steam. This disposition of exhaust steam from the air pump has been given considerable attention in order to determine what is the best practice, some roads piping this exhaust steam directly into the front end of the locomotive, and turning the pipe upward to the stack where the exhaust becomes to a certain extent a blower on the fire. This practice results, of course, in fanning the fire to a considerable extent, particularly so when descending grades call the air pump into rapid operation and gives the heavy draft on the fire, where it is least desirable and does not appear to your committee to be economical or the best practice.

Another disposition of the exhaust steam is to pipe it into the exhaust passage of the engine cylinders in the cylinder saddle, and while this does not result in creating the heavy draft on the fire, there is, under working conditions, a back pressure on the pump, particularly so when the engine is being worked hard. Another method of disposing of this exhaust allowing the pump to operate under practically the same conditions as though all the exhaust were allowed free escape. Tests of this device in service show no appreciable difference in the speed of the pump whether the exhaust is used for heating purposes or not. Indicator cards taken from pumps with this valve attached show no material difference in the final back pressure on the exhaust side of piston, and separation tests to determine the division of exhaust steam under road conditions, show from 70 to 85 per cent of the total exhaust steam as being diverted into the heating system.

By disposing of the exhaust steam from the air pump by piping it into the engine stack, it is evident that there could be no material difference here in back pressure on the air pump piston whether the locomotive is working steam or is at rest. In the second case, however, when the pump exhaust is piped into the exhaust cavity of the engine cylinders a back pressure in addition to that resulting from pipe friction does occur while the engine is working steam, which is due to the volume and pressure of the engine exhaust, obstructing or choking the exhaust of air pump steam. In an endeavor to determine to just what extent this back pressure effects the air pump in road service, a gauge was attached to the exhaust pipe 6 ins. from the pump, on an engine using high-speed brake in heavy passenger service. This gage showed a back pressure of 10 lbs. while the locomotive was at rest, and as high a back pressure as 30 lbs. when the locomotive was being worked hard.

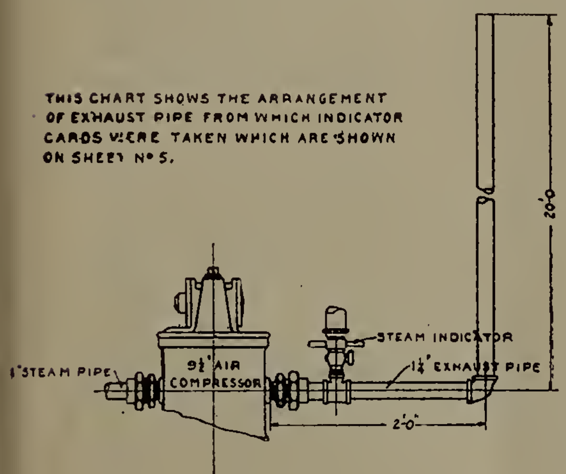


Fig. 8.

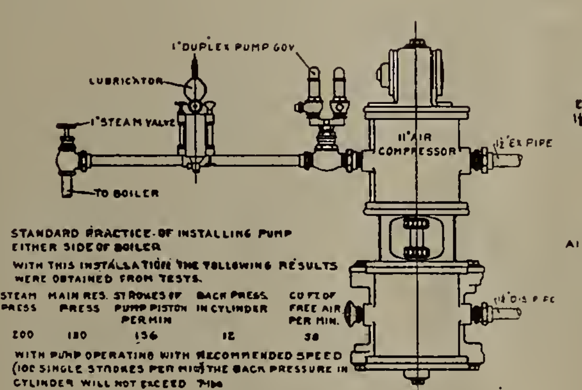


Fig. 9.

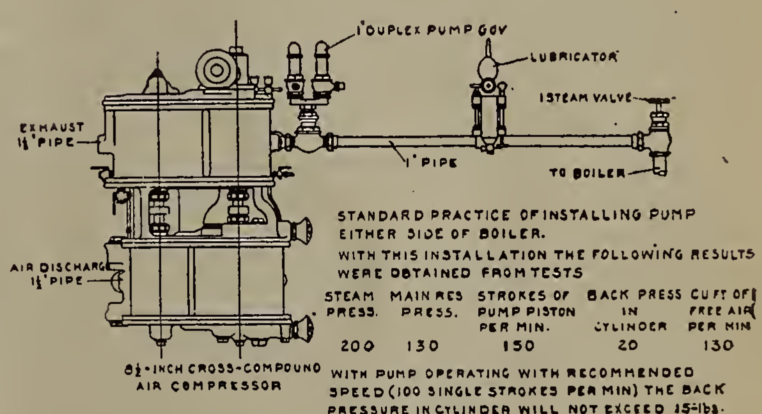


Fig. 10.

steam has been to turn the exhaust pipe into the water tank, for the purpose of raising the temperature of the feed water before it enters the boiler. Still another method which has been used to a great extent consists of utilizing the exhaust steam for car heating purposes, and is as present in use on a large number of roads. One of the latest methods of disposing of the exhaust is to pipe it into the front end of the locomotive along the outside of the extension and stack, exhausting the steam to the atmosphere at the top of the engine stack.

The method of piping air pump exhaust into the cylinder saddle is by far the most prevalent practice, and utilizing the exhaust steam for car heating by diverting the entire exhaust into a storage reservoir creates a back pressure equal to the pressure carried in the steam heat pipes in addition to that resulting from pipe friction. This system cannot be regarded favorably; however, your committee can find no serious objection to using exhaust steam for car heating if the steam is procured by means of a by-pass valve the purpose of which is to entirely avoid the back pressure incident to the employment of the first mentioned system. This valve accomplishes its purpose by allowing the first part of each exhaust to be diverted into the heating system of the train, and when the piston of the air pump has partially completed each stroke and before much air pressure has been built up in the air cylinder, the valve opens an exit for the remainder of the exhaust in the steam cylinder to escape to the stack or front end, thus

The back pressure when the engine was at rest was of course due to pipe friction.

In freight service, an engine hauling a heavy train was selected, and a gage attached to the air pump exhaust pipe 12 ins. from pump and one 24 ins. from the cylinder saddle. The exhaust pipe of this 9½ in. pump used was 21 ft. in length, of 1¼ in. pipe, and with pump working against 100 lbs. air pressure, the gage located 24 ins. from the cylinder saddle registered a constant pressure of 23 lbs., and the gage near the pump vibrated from 30 to 100 lbs. while this engine was hauling a heavy train at 18 miles per hour. While the engine was being worked to its full capacity at a speed of 20 miles per hour, the gage in the exhaust pipe 24 ins. from cylinder saddle registered 40 lbs., and at a time when the engine slipped on the rail a pressure of 50 lbs. was observed and the vibration of the gage 12 ins. from the pump was from 10 to 120 lbs. While hauling another heavy train on an ascending grade the gage near cylinder saddle reigstered pressure of 20 lbs. at 8 miles per hour and 37 lbs. at 18 miles per hour, the back pressure being greatest at such time when the engine was worked at full throttle and running at a speed of 18 miles per hour.

Believing that the method of pipe into the cylinder saddle increases the steam consumption of the 9½ in. pump about 25 per cent, and that the pump's efficiency was considerably reduced by the back pressure acting on the piston at the time it is nearing the completion of its stroke, a member of your committee has designed an air pump exhaust nozzle, the use of which with the size of piping specified will eliminate what may be termed the final back pressure on the pump exhaust, or by its use back pressure will be reduced to the minimum This nozzle is in the form of a casting which encircles the engine exhaust nozzle in the front end, having a 1½ in. pipe connection and a 2 in. exhaust pipe outside of front and was used in tests. With this arrangement the exhaust from the engine cylinders tends to create a vacuum in the air pump exhaust pipe and while the locomotive is at rest the pump exhaust creates no noticeable draft on the fire. The use of the nozzle has no detrimental effect upon the steaming qualities of the locomotive and it also eliminates the thumping sound of the pump exhaust by means of the cavity in the nozzle in combination with the large exhaust pipe acting as a muffler.

This nozzle was tested in freight service under the same conditions as the first mentioned freight test to determine back pressure in exhast pipe, and under the conditions when gage located 24 ins. from cylinder saddle showed from 20 to 23 lbs., this nozzle in connection with the larger pipe prevented the accumulation of sufficient pressure to register on a gage attached at this point, 24 ins. from the saddle. In another demonstration while the engine was pulling a train of cars, the gage located 24 ins. from cylinder saddle registered no pressure while connected with this nozzle. After connecting the exhaust pipe to the cylinder saddle in the standard way and proceeding at the same rate of speed a back pressure of 16 lbs. on this gage was observed.

In this paper we have endeavored to submit for your consideration, that which our investigations have disclosed relative to standard methods of air pump piping, the resultant back pressure, pump capacity, and particularly the disposition of exhaust steam. We feel confident that the information derived justifies the following recommendations concerning air pump piping:

1. That, unless a further reduction in the back pressure is desired, standard methods of piping as shown be adhered to.

2. That a 1¼ in. steam-pipe, 1¼ governor and 1¼ steam valve be used when two pumps are applied to a locomotive whether they are 9½ or 11 in. in size.

3. That the piping be installed with a view of obtaining equal distribution of oil.

4. That in the event of two pumps per locomotive, globe valves as shown in Fig. 4 should be used in branch pipes.

5. That there be no restriction in the flow of steam through the steam pipe.

6. That back pressure on the pump may be kept to the minimum, there should be no undue resistance to the escape of exhaust steam.

7. That the use of pipe that has been flattened by bending, or the use of union fittings whose inside diameter is less than that of the pipe be discouraged.

8. That air pump exhaust nozzle as described herein be used.

9. That the practice of piping the pump exhaust into the cylinder saddle be discontinued.

10. In preference to exhausting into the engine stack, an exhaust pipe running along the outside of the engine stack is favored.

11. That the main exhaust pipe should be no less than 2 ins. in diameter when two 9½ in. pumps are used.

12. That 2½ in. exhaust pipe should be used with two 11 in. pumps.

13. Your committee finds no objection to the use of exhaust steam for train heating purposes if steam is obtained by method herein set forth.

14. Finally we would call attention to and emphasize the importance of dispensing with elbows in exhaust pipes, using instead bends as easy as practicable to make them.

United Kingdom Locomotive Notes.

By Thomas Reece.

The echoes of the discussion in England on compounding and superheating for locomotives are dying down. It will be remembered that the discussion arose upon the paper read by chief mechanical engineer George Hughes of the Lancashire and Yorkshire Railway, and was continued at successive engineers' meetings. There are several fresh points of interest to be recorded for the "Railway Master Mechanic" arising out of this discussion.

When the late Mr. Webb was rapidly turning out his three-cylindered passenger compounds, and, having built thirty of the Experiment class, was busy with forty of the Dreadnought class, very considerable criticism of these engines was given vent in both the engineering and railway papers. None of the hundred three-cylindered passenger compounds had coupled driving wheels, and while the single low-pressure cylinder drove upon the first pair of driving wheels, the two high-pressure cylinders drove upon the second or rear pair of wheels. Mr. Webb at the time stated that he was thus able to do away with side rods and get a freer running engine by "coupling through the cylinders."

The theory may have been attractive, but in practice the high-pressure wheels and the low-pressure wheels frequently "got out of step" with one another, which not only tended to increase back pressure, but also the sluggishness which was especially shown at times in starting running. Some critics suggested that the cylinder arrangement was wrong, that there should have been a single inside high-pressure cylinder and two outside low-pressure cylinders, with the driving wheels coupled, and this idea is incorporated in the Smith system, as used in the successful compounds on the Midland railway.

When Mr. Webb found that the non-coupled theory was a mistake, he built the four-cylindered Jubilee coupled express compounds, substituting two smaller inside low-pressure cylinders for the single one of large dimensions, and in this case, as in the Midland engines, all the cylinders drove on to the leading pair of coupled wheels. But before finally building these engines he built a four-cylindered high-pressure engine, to test against the first of the four-cylindered compounds. As the boiler power was insufficient for the simple engine the test was not successful, and one of the faults of the first four-cylindered compounds was also a barely sufficient amount of boiler power. Forty of these engines were built, but though more successful than the three-cylindered compounds they were apt to lose time and were not so economical in other respects, one reason being the attempt to make one set of motion do for both the high and low pressure cylinders. The second batch of 40 of these engines had larger boilers, and Mr. Whale greatly improved them by fitting a duplex valve gear to them, thereby enabling the driver to regulate the cut-off economically in both sets of cylinders, but the first forty are still running as built, and have been delegated to ordinary passenger train work.

Mr. Whale, however, altered one of the batch to a simple two-cylindered engine by taking away the two outside high-pressure cylinders, lining up the two inside low-pressure cylinders from 20½ in. to 18½ in., and running the engine as a high-pressure one, thus making it a smaller Precursor. Mr. Bowen-Cooke is now converting a number of these engines in this way. He stated that unaltered they could not make time with the Birmingham to Broad street express, whereas when altered they had the work well in hand. He further showed that, making equal tests between Euston and Crewe of two different classes of compounds and a Precursor, the simple easily beat the compound with heavier trains, and that in their first six years the Precursor had only cost in repairs about 16.114 cents per 100 miles as against 20.252 cents per 100 miles for the first six years of the four-cylindered compounds. Mr. Fowler, speaking afterwards, recorded the success of the three-cylindered Midland compounds, which, of course, are different from those of the London and Northwestern, but nevertheless both Mr. Johnson, their originator, and Mr. Deeley, his successor, having longer experience than Mr. Fowler, both continued to build 4-4-0 simple engines; in fact, Mr. Deeley ceased building compounds, and built a new class of four-coupled simple engines.

As regards superheating on the London and North-Western, Mr. Bowen-Cooke, is building twenty of the large 4-4-2 Precursor tank engines, fitted with superheaters, and 5 ft. 6 in. coupled wheels. There is a rumor also that an Atlantic type of engine may be built for the London and North-Western, but this has quite likely arisen merely from the fact of the Great Northern Atlantic engine running last year on the line, and a possible confusion of the wheel arrangement of the above tanks, 4-4(T)-2, with the Atlantic 4-4-2 tender engine.

The five large 4-8-2 locomotives built here for the Natal Government Railways have now been put through their preliminary trials with satisfactory results, and are in active service. This type of engine is particularly heavy for the 3 ft. 6 in. gauge, although it has been actually surpassed in weight by certain Mallet compounds and others recently introduced for South African railroads. The engine is an eight-coupled locomotive with leading four-wheeled bogie and trailing two-wheeled truck, while it has a large boiler, with Belpaire fire-box. A deep fire-box has been provided, and for this to be possible it has been necessary to make arrangements on lines now not uncommon, of terminating the main frames just ahead of the fire-box in a steel transverse casting, to which the outside trailing frames are attached. The distance apart of the main frames is 2 ft. 10¾ in., but at the fire-box the space between the frames is 6 ft. The cylinders are placed outside the frames, and are 21 in. in diameter, with 24 in. stroke. They are bolted to the frames, while a saddle-casting, containing the passages to the blast-pipe, extends between the frames. The steam connections to the cylinders are made by means of short elbow-pipes, with ground joints. The valves are of gun metal and are balanced. The pistons are fitted with tail-rods. The valve-gear adopted is the Walschaert type. Steam reversing gear is fitted on the left side of the engine. In this gear there are two cylinders, one a steam-cylinder, 5½ in. in diameter, and the other a cataract cylinder 5 in. in diameter. This gear is worked by hand-lever and rod connection from the cab.

The coupled wheels are 3 ft. 9½ in. in diameter, the second pair being the main drivers. The leading pair of coupled wheels have flangeless tyres. The trailing wheels are 2 ft. 6 in. in diameter on tread, and the bogie-wheels 2 ft. 4½ in. The bogie is fitted with spring and lever control-gear. The two-wheeled truck is also fitted with spring control.

The boiler barrel has an internal diameter for the first ring of 5 ft. 7½ in., while the length inside the barrel is 18 ft. 1½ in. The barrel-plates are 11/16 in. thick. The smoke-box tube-plate is 1 in. thick. It is set back in the barrel, while the fire-box is sloped forward, thus giving a tube length of 18 ft. 6 in. between plates. The fire-box shell has a length of 7 ft. 8 in., and a width of 5 ft. 10½ in. The depth of the box at the front, below the boiler center line is 5 ft. 5 in. The thickness of the wrapper and back plates is ⅝ in., and of the throat-plate 11/16 in. The fire-box is of copper. The fire-box tube-plate is 1 in. thick over the tube area; the other fire-box plates are 9/16 in. in thickness. The tubes, 237 in number, are steel, solid drawn, 2¼ in. in diameter. The grate is of the rocking-finger type. The working pressure is 200 lbs. per square inch. Two Ramsbottom safety-valves are provided, the four valves being 3½ in. in diameter. Two Gresham and Craven's No. 9 self-acting injectors are provided, and a 40-millimetre combination ejector for the vacuum brake. The engine is braked by a 10-in. steam cylinder, and the tender by a 21-in. vacuum cylinder and hand-brake. A Pyle National electric headlight is mounted on the smoke-box front.

The total weight of the locomotive in working order is 179,452 lbs., and of the tender, 90,832 lbs., giving a total weight for engine and tender of 270,284 lbs. The tender fuel capacity is 240 cubic feet and the water capacity 3,500 gallons. The total wheel base of engine and tender is 55 ft. 6¾ in.

These engines are to be employed on the upper sections of the system, between Ladysmith and Charlestown, in working the heavy coal and fast perishable goods traffic. They have been tested on the lower sections on the heavy gradients of 1 in 30 with curves of 300 ft. radius, and have quite come up to expectations, easily handling loads of 225 tons behind the tender.

The Tientsin-Pukow Railway, which recently had delivered to it some six-coupled locomotives from the Baldwin works at Philadelphia has also been buying engines from the North British Locomotive Company of Glasgow. The comparison of the two types is of considerable interest, as the engines were built, I understand, to the same specification, and therefore represent to some extent the difference in the manner of working out locomotive design between British builders and American, as represented by the Baldwin Works.

The Tientsin-Pukow Railway, for which these locomotives were constructed, is the Chinese line in which British and German interests were the subject of a compromise which awarded the Northern, or Shantung, section to Germany, and the Southern, or Yangtse, section to Great Britain.

The type of locomotive is one which has proved very suitable for Chinese railway conditions. The type was introduced on the Imperial Railways of North China about twenty years ago. Design has undergone some development, of course, since then, the present engines being much more powerful than their forerunners. The specifications for these engines was drawn up by Mr. John Alston, the present locomotive superintendent of the Tientsin-Pukow Railway.

The engines have driving-wheels 5 ft. in diameter, cylinders 19 in. by 24 in., and a boiler pressure of 180 lbs. per square inch. With a mean effective pressure taken as 75 per cent of the boiler pressure, the tractive force works out at 19,494 lbs. The boiler is of the Belpaire type, with copper fire-box. The valve-gear is of the Walschaerts type. The engines were constructed in accordance with the requirements of the British Standard specifications. The Westinghouse brake is fitted on both engine and tender. The following are the chief particulars of the engines:

Locomotive:

Cylinders, diameter	19 in.
Cylinders, stroke	24 in.
Wheels, diameter, driving	5 ft.
Wheels, diameter, bogie	3 ft.
Wheel-base, rigid	15 ft.
Wheel-base, total	23 ft. 3 in.
Heating surface—tubes	1,465 sq. ft.
Heating surface—fire-box	146 sq. ft.
Heating surface—Total	1,611 sq. ft.
Grate area	240 sq. ft.
Working pressure	180 lbs. per sq. in.
Weight in working order	131,376 lbs.

Tender:

Tank capacity	4,000 gals.
Fuel capacity	337.5 cu. ft.
Weight, full	103,376 lbs.

The total wheel-base of locomotive and tender is 46 ft. 9 in., and the total weight in working order is 234,752 lbs.

The Norfolk & Western has begun the erection of an addition to its round house at Bluefield, W. Va., consisting of a 29-foot addition around the entire building to give engines 93 feet under roof. The cost will be about $36,000. An addition to the division offices at the same place will also be made at a cost of $9,000.

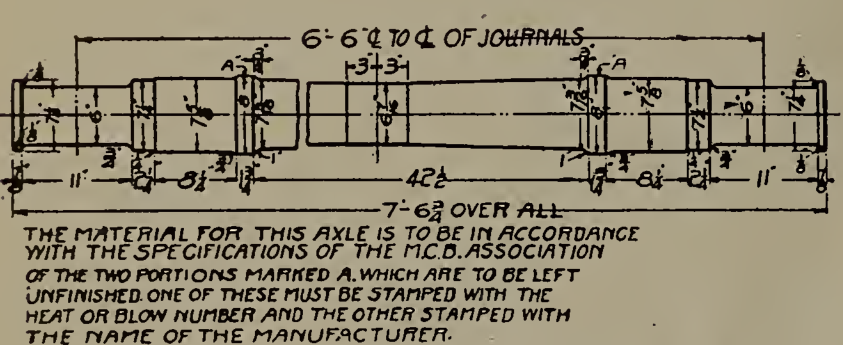
Car Axle to Carry 50,000 Lbs.*

By E. D. Nelson, Engineer of Tests, Penna. R. R.

During the past year at least four railroad companies, represented in the Master Car Builders' Association, have had under consideration a car axle of a larger capacity than the Standard "D" axle of this Association. As a matter of fact, there have been designs made of axles of larger capacity, and naturally these differ somewhat in detail.

The importance of eliminating variations in design is apparent, and I have, therefore, considered it advisable to present a design of axle having a capacity of 50,000 pounds, with a view to its consideration at the present convention.

If the Association would, after consideration, recommend that the adoption of this design as Recommended Practice for one year be submitted to letter ballot, it would give an opportunity to establish a design which could be followed by any railroad company during the coming year and prevent axles of larger capacity than the "D" axle, varying in detail, getting into service.



Dimensions for M. C. B. Axle of 50,000-lbs. Capacity.

In submitting this design of axle, the method outlined in the report of the Committee on Axle, Journal Box, Bearing and Wedge, made to the convention of 1896, has been followed. The method outlined at that time is applicable to axles of any capacity, so far as our present knowledge is concerned. The assumed data is as follows:

Weight of body and trucks...	55,580 pounds	
Weight of lading..............	140,000 "	
10 per cent additional lading.	14,000 "	
Total		209,580 pounds.
Deduct weight of 8 33-inch forged steel wheels........	5,720 "	
Deduct weight of 4 axles......	3,860 "	
Total		9,580 "
Total weight on four axles..................		200,000 "
Total weight on one axle.....................		50,000 "

Assuming for this load that the journal should be 11 in. long its diameter should be, according to (Formula 5) page 152, and by substitution in (Formula 12), page 153, M. C. B. Proceedings of 1896, 5.38 in. Taking the nearest ⅛ in. above this makes the diameter 5½ in., and an allowance of ½ in. diameter for wear brings the diameter of the journal when new, to 6 in.

Assuming, then, that the journal is 6 in. in diameter by 11 in. long, the consideration, so far as friction and lubrication are concerned, would be, quoting the figures from page 169 of the Proceedings of the Association of 1896, as follows:

4¼ by 8-in. journal, new, pressure per sq. in.......449 lbs.
5 by 9-in. journal, new, pressure per sq. in.......469 lbs.
5½ by 10-in. journal, new, pressure per sq. in.......470 lbs.
6 by 11-in. journal, new, pressure per sq. in.......503 lbs.
4¼ by 8-in. journal, old, pressure per sq. in........533 lbs.
5 by 9-in. journal, old, pressure per sq. in........525 lbs.
5½ by 10-in. journal, old, pressure per sq. in........516 lbs.
6 by 11-in. journal, old, pressure per sq. in........549 lbs.

These figures indicate that from the standpoint of friction and lubrication, satisfactory service may be expected from these journals.

Concerning the diameters of the axle at the wheel seat and center (Formula 10), page 152, and (Formula 12), page 153, of the Proceedings of 1896, give the following diameters:

Wheel seat ....7.40 in.
Center ....6.30 in.

For the wheel seat it has been customary to add ¼ in. to the calculated diameter, which would make the diameter at the wheel seat, when new, 7.650 in. It has been customary, however, to keep the diameters at the wheel seat to the nearest ⅛ in., and by making the diameter 7⅝ in., ¼ of an inch diameter can be secured above the calculated diameter within 2½ one-hundredths of an inch. To the calculated diameter at the center, an allowance must be made for the cylindrical portion of the axle, so that this portion does not change abruptly at its intersection with the taper portions of the axle. Taking the diameter to the nearest 1-16 in. would make the diameter at the center 6 7-16 in. The principal dimensions, with the axle new, will, therefore, be as follows:

Journal, diameter ....6 in.
Journal, length ....11 in.
Wheel seat, diameter.......................7⅝ in.
Center, diameter ....6 7-16 in.

The satisfactory results which have been obtained with former designs of axles of the M. C. B. Association, based on the formula as given in the report of 1896, seem to warrant the use of a fibre stress of 22,000 pounds per square inch as used for all of the previous M. C. B. axles, and this figure has been taken in the formulas in order to arrive at the diameters which have been given.

The drawing shows all the dimensions of the proposed axle. It has been designated in accordance with the former practice of the Association as Axle "E" and the quality of the material is to be the same as that required by the present M. C. B. Specifications.

Attention should be called to the fact that the distance between the dust-guard seats is 62½ in., while in all of the other designs of axles of the Association it is 63 in. In the design submitted, this ½ in. was taken off in order to get more clearance back of the journal box, and this will necessitate ¼ in. more dish in the wheels mounted on this design. While at first thought this may apparently indicate inability to interchange wheels between axles, it should be stated that the forged wheels with outside hub diameters suitable for the No. "D" axle, can probably not be bored out so as to fit the present design of axle and leave sufficient material in the hub. It will, therefore, mean that for the axle herewith submitted a special design of wheel will be required.

It is only necessary to add finally that, while the axle herewith submitted is nominally for a car having a capacity of 140,000 pounds, it must be understood that the axle is designed to carry a given load and the capacity of the car is only incidental. If a car body weighing less than that assumed above can be constructed, the decrease in the light weight can, of course, be added to the capacity. The point which should be emphasized is that the axle is designed to carry a load of 50,000 pounds and is not necessarily an axle suitable for a car of 140,000 pounds capacity, regardless of the weight of the car body on the trucks.

*From a paper presented at the Master Car Builders' Convention.

Car Shops of the North Eastern Ry., York, England.

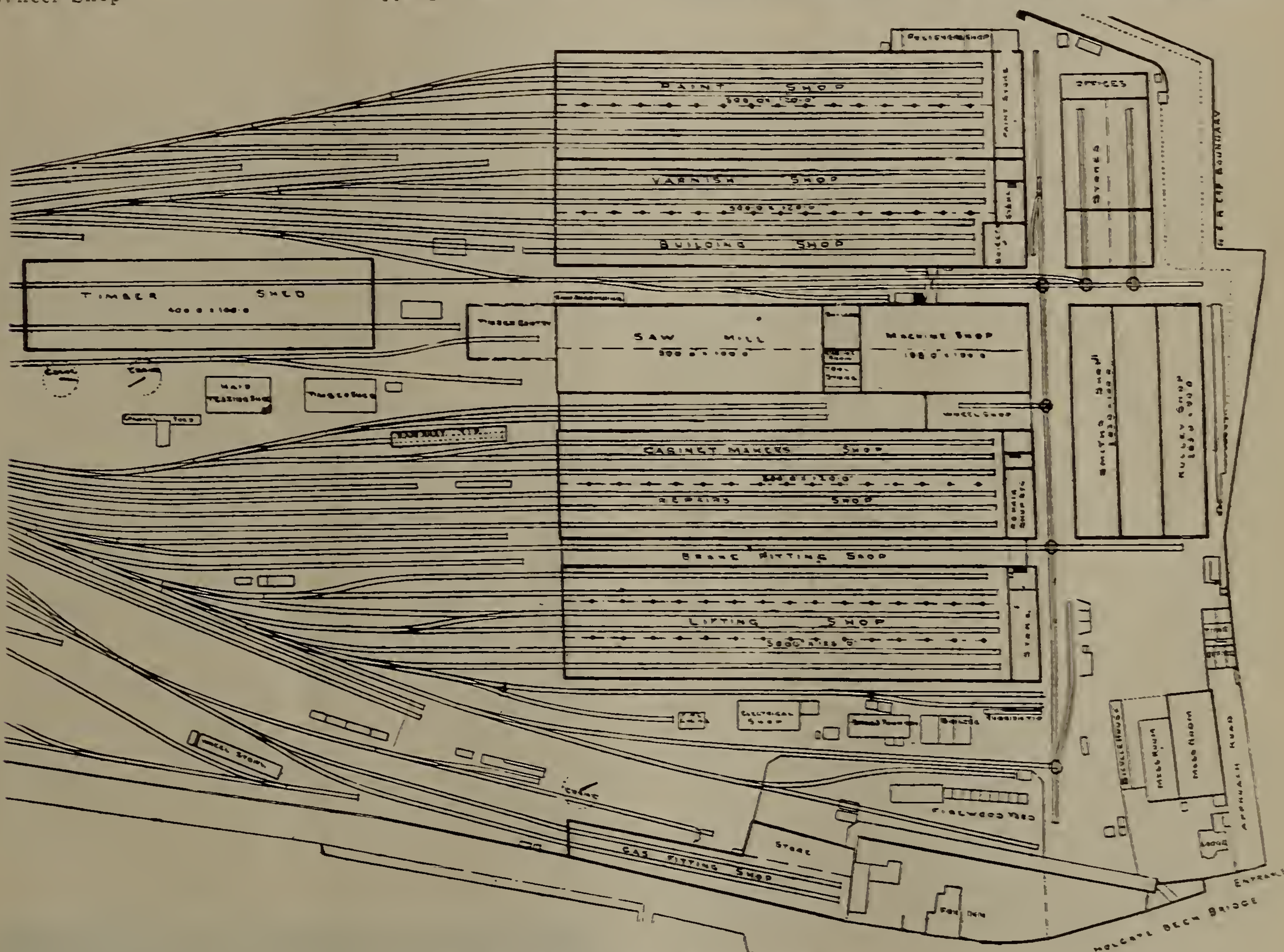
The car shops of the North-Eastern Ry. of England are located at York and while the railway has other car repairing facilities, the York shops are the most extensive. Although the plant is some twenty-five years old the layout is still a representative one and the plan herewith which is taken from the Railway and Travel monthly, should be of interest to American car men.

The shops occupy a total of forty-five acres, the buildings being as follows:

General Stores	occupying 2,111 sq. yds.
Smiths' Shop	occupying 2,922 sq. yds.
Machine Shop	occupying 2,090 sq. yds.
Tool Store	occupying 115 sq. yds.
Wheel Shop	occupying 524 sq. yds.
Gas Fitting Store	occupying 488 sq. yds.
Rulley Shop	occupying 1,461 sq. yds.
Standing Shed	occupying 6,099 sq. yds.
Washing Shed	occupying 1,265 sq. yds.
Breaking-up Shed	occupying 1,166 sq. yds.

In addition to purely North-Eastern Railway stock—the whole of which is constructed at York Works—a certain proportion of the East Coast Joint stock, so called from its joint ownership by the Great Northern, North-Eastern and North British Railways, is built here, as is also a proportion of the rolling stock jointly owned by the two first mentioned railways.

Construction of course varies from year to year, according to requirements laid down in carefully considered



Plan of York Car Shops, Northeastern Ry.

Frame Shop	occupying 1,862 sq. yds.
Small Timber Shed	occupying 327 sq. yds.
Hair Teazing Shed	occupying 333 sq. yds.
Timber Shed	occupying 8,889 sq. yds.
Saw Mill	occupying 3,333 sq. yds.
Building Shop	occupying 3,333 sq. yds.
Varnishing Shop	occupying 3,333 sq. yds.
Painting Shop	occupying 6,666 sq. yds.
Polishing Shop	occupying 304 sq. yds.
Paint Store	occupying 415 sq. yds.
Carving Shop	occupying 284 sq. yds.
Cabinet, Repair and Pattern Shop	occupying 6,666 sq. yds.
Brake Shop	occupying 751 sq. yds.
Gas Fitting Shop	occupying 1,580 sq. yds.

building programmes. But in 1909 the output comprised 113 passenger vehicles of various descriptions and 13 horse boxes and carriage trucks, whilst during the same period a total of 2,921 cars passed through the works to undergo repairs.

A considerable amount of electric power is used generally in the works, the current being generated at the North-Eastern Railway's own power station, which is about a mile distant in Leeman Road. The power is transmitted on the three-wire system, continuous current, the voltage used being 400 or 200.

The machine shop contains a rope-power jib walking crane, single and multiple drilling machines, wheel lathes, automatic bolt turning lathes, axle journal burnishers, oil separator, and tapping and screwing machines. Driving

Erecting Dept., York Shops.

from steam-driven line shafting is being superseded by electricity.

The boiler house, engine room and tool store are clearly indicated on the plan, and the plant in the first named consists of one Cornish and three Lancashire boilers, with a working pressure of 150 lbs. per square inch. The stoking is done by hand, but a mechanical ash elevator and Green's fuel economizer form part of the equipment. The Cornish boiler is used for burning refuse wood from the saw mill.

The engine room contains a single-cylinder high pressure horizontal engine, by Tannet, Walker & Co., Leeds, and also an Ingersoll Sargeant duplex steam-driven air compressing engine of the two-stage type, that is, air is compressed from its free state to 45 lbs. per square inch in one cylinder, then, passing through the cooler, is compressed at from 50 to 100 lbs. per square inch in the other cylinder before being turned through the reservoir on to mains laid through the works, where it is used for various purposes, among which are the working of cranes, lifts for machinery, and pneumatic drilling, riveting and chipping machines.

Since the introduction of cars of 49 ft., 52 ft., and much greater length, the old-fashioned wooden frames of the 32 ft. vehicles which formerly constituted the standard type of passenger stock have become obsolete, having been superseded by under-frames of steel; so that the frame shop is equipped with stamping press, pneumatic hammers, drills and chippers, besides buffing and polishing machines for brass work.

The timber drying shed and wood yard deserve more than cursory attention. At York the natural drying process is followed, and owing to its necessarily slow character it will be at once perceived that the constant presence of large stocks of various timbers is a matter of paramount importance in order that the requirements of the works may be fully served.

As will be observed, from the table, the carriage building shop is of great extent, covering an area of 30,000 sq. ft., and in it the whole process of building any type of cars is carried on. For lifting purposes its equipment consists of electric cranes with a capacity of 15 tons each.

The varnishing shop is of equal area, and here the newly-painted cars are transferred for varnishing, each vehicle receiving five coats. We have now arrived at the painting shop, which covers double the area of the last named, and in which, after being constructed, each coach receives thirteen coats before reaching the varnishing stage. At the northeast side of this building is the polishing shop, where both male and female workers are employed, and in immediate proximity is the paint store, with its complement of grinding and mixing machinery and varnish tanks.

In the southeast corner is another boiler-house, containing three Lancashire boilers with coal elevator and mechanical stokers. Steam for working the hammers in the smiths' shop and also for heating purposes is generated here. In the lifting shop, with its four 15-ton electric cranes, heavy car bodies can be lifted from their trucks and traversed in either direction.

Stresses Developed by Collisions of Freight Cars.*

By Col. B. W. Dunn

The subject of this paper ought to arouse the interest of several classes of railway officials, including those who design freight cars, who maintain equipment, who superintend the loading and staying of packages, and who pass on claims for damaged freight.

It is comparatively easy to deal with static stresses and to provide adequate resistances for them. We can duplicate them, keep them in action and under observation as long as may be necessary to check the accuracy of our conclusions. This is not true of stresses due to impact. Their duration is too short to permit measuring their varying intensities by static testing machines. The fundamental relations between velocity, momentum, path, intensity and work, are simple and well established, but it is difficult to secure an accurate time record of the path traversed by a moving body under the retarding, or accelerating action of an unknown force. Without this record, we cannot measure the varying intensity of the force, and without this intensity we cannot provide intelligently and accurately the resistances needed to protect our material from injury.

We do know, from observation, that the destructive effects of car collisions increase very rapidly with speed and that the rules for coupling cars have been framed with a view to keeping this speed down to the lowest practicable limit. We also know that our train crews exceed more frequently than they observe the limit generally prescribed, of two miles per hour; that if they did observe strictly this limit, their work would be delayed in classification yards; that the automotic couplers and the "humps" are modern necessities and furnish an apparently unavoidable combination tending, in a busy yard, to cause violations of the coupling speed rule.

Many yardmasters are prone to consider as permissable any coupling speed that does not cause a visible injury to the car, and the modern car will stand impacts that wrecked older models. Freight claim agents and auditors know that while the car has been strengthened, little has been done to protect its lading against these increasingly severe coupling shocks. Unless packages are ruptured and their contents visibly leaking

*From a paper read before the New York Railroad Club.

View of Paint Shop, York Shops.

or escaping, the sealed cars will go on to their destination and no subsequent tracer of the car's movement has yet been able to develop an acknowledgment of "rough treatment."

To change the velocity of a body we must apply a force and the product of this force by the path over which it operates gives us the work accomplished. If the force is variable we must obtain this product by integration. When two modern cars collide, the variable resistance of the friction draft gear is first brought into play. The total path for the two gears in contact is about 4.8 inches. If this gear acts in service, and under shock, exactly as it does under laboratory testing conditions the diagram published in the pamphlets describing these gears will tell us the total force exerted on each car at each point in this path. The area under the curve, limited by any two values of the force, is the integral that represents the work accomplished.

An algebraic expression for this work, W, is

$$W = \frac{w\ (V^2 - v^2)}{2\ g} \quad \text{in which}$$

w is the weight of the car, g the acceleration due to gravity, V and v the velocities of the car corresponding to the two points considered. Assuming a solid bumping block to which a draft gear is attached, the total work corresponding to complete compression of the gears under laboratory conditions is about 36,000 foot pounds. If the work is just able to stop a car weighing 150,000 pounds, we find by solution of (1) for V, ($v = o$), V = 3.93 feet per second = 2.68 miles per hour.

It appears therefore, that our rule limiting the coupling speed to two miles per hour does not provide any excessive factor of safety.

When our assumed car has more energy than can be absorbed by the friction draft gear, the excess must be dissipated by elastic or permanent deformation of the car itself. The path available for elastic movement is very limited, and the force must be correspondingly high to absorb an appreciable amount of energy. If our assumed car has, for example, a speed of 5 miles per hour, it will still be moving at a speed of 2.88 miles per hour, or 4.23 feet per second, and its kinetic energy will be 90,300 foot pounds, when the friction draft gears are solid. Even if we could assume a harmless elastic compression of the car frame of one inch, the average force required to absorb this energy over this path would be 1,083,600 pounds, or about 7.2 pounds per pound of weight of car and lading. The maximum force would be about twice the average, or 14.4 pounds per pound of weight. If the elastic compression should be limited to one-half inch, instead of one inch, these values would be doubled.

Any movement permitted of the lading along the floor of the car would tend to prevent the application of these high pressures to the lading but cases may well occur in which the advantage of this movement is apparent only.

A thousand pound package, for example, rigidly attached to the car, moving at a speed of 5 miles per hour, would receive a maximum pressure of, say, 1,000x14.4 = 14,400 pounds. If it is free to slide along the floor, the force of friction (assuming coefficient of friction = 0.4) would be about 400 pounds and the energy of the package would be absorbed by a sliding of 2.1 feet. So far, the advantage of permitting it to slide is pronounced, the maximum force being reduced from 14,400 pounds to 400 pounds. Suppose, however, that after sliding one foot it comes into contact with a solid part of the car and that while the package is sliding this distance of one foot the car has moved over its permitted path of 4.8 inches, and has not only been brought to rest but has acquired some velocity of rebound. The package, with a remaining relative velocity of at least 5.31 feet per second will then collide with a solid obstruction in the car. It will receive a maximum pressure per pound of its weight much greater, probably, than it would have received if it had been rigidly attached to the car and the chances in favor of crushing it will be correspondingly increased.

The necessity for a thorough investigation of car impact stresses is apparent. The ordinary slidometer results are misleading for the reason that the sliding mass in the testing instrument is not restricted to the path of the car. The energy of this sliding mass at the instant of impact can be obtained from the slidometer record together with the maximum force (compression of slidometer spring) required to stop it. The maximum force applied to the car, and to its rigidly attached lading, especially after solidification of friction draft gears, is not measured; and this, unfortunately, is the force that is responsible for the damage we would like to avoid.

Dynamic Measure of Impact Stresses.

An accurate time-space record of the motion of the car after impact would enable us to calculate the forces developed at any instant. This record can be obtained best by the trace of a tuning fork. The fork could be attached to the car and made to trace its record on a stationary surface, or the surface could be attached to the car while the fork is stationary. Another method, and probably the most convenient one, would be to mount both the surface and the fork in the car, one rigidly attached to the car and the other free to continue its unretarded motion for a sufficient distance. The maximum of accuracy in tests of this nature results from the use of photography to record the trace of a fork of high frequency on the sensitized surface of a cylinder revolving uniformly and independently.

Assuming that an accurate time-space record for the car has been obtained, it will furnish, or enable us to construct to a suitable scale, a curve, whose ordinates represent compressions of the draft gear, or motion of the car after impact, and whose abscissas represent time of duration of this motion. The successive differences of ordinates separated by small and equal intervals of time, divided by the time interval, give us the successive velocities of the car and enable us to construct a second curve to show this velocity as a function of time. The first differences of ordinates of the velocity curve divided by the uniform time interval give us the successive decelerations of the car, and the product of these by the mass of the car and its lading give us the force exerted at any instant to stop the car. The method described amounts to a graphical differentiation of the time-space curve and is necessary since the equation of this curve is not known.

Tests at Altoona.

To have investigated this problem by the scientifically accurate method described above would have cost more than was thought advisable for a preliminary investigation. The officials of the Pennsylvania Railroad very kindly offered to assist the Bureau of Explosives with any testing facilities available at Altoona and to construct any simple apparatus that could be devised for the purpose. Under the supervision of Mr. E. D. Nelson, Engineer of Tests, Mr. A. H. Elliott was placed in direct charge and these gentlemen consulted the writer from time to time.

Apparatus No. 1.—A strong cylinder, 14¾ inches long, inside, and 14 inches inside diameter, was bolted securely to the steel underframe of P. R. R. box car 18079, whose weight empty was 45,300 pounds. One end of the horizontal cylinder was closed by a steel diaphragm 0.03 thick and through the rigid end a hole was threaded so that a plug could be inserted with a water tight joint to vary the interior volume of the cylinder. A steam indicator gauge with a carefully calibrated spring was connected at the top and the cylinder filled with water. By forcing in the screw plug water was displaced and a slight outward deflection of the diaphragm produced. A solid metal cylinder 5 inches in diameter and weighing 100 pounds was suspended by chains from the ridge pole of the car and its face adjusted to bear lightly against the center of the diaphragm. On impact, this weight was retarded by pressure from the confined liquid and the gauge was relied on to register this pressure. The mass producing the pressure was the 100 pound weight plus the small weight of a column of water of diameter equal to the gauge piston and of length equal to the distance from the diaphragm to the piston. To calibrate this apparatus, the cylinder was mounted vertically and the gauge readings noted for various weights resting on the diaphragm. The calibration curve was found to be a right line.

The essential point in any such apparatus is to restrict the test weight as rigidly as possible to the path of the car during the work of absorbing their respective energies. In theory, the only increase in path for the weight in this case was that due to the slight escape of water from the cylinder, to follow the movement of the gauge piston, and this corresponded to only about one thousandth of an inch inward deflection of the diaphragm. Means were provided to rotate the gauge cylinder to make the record of pressure a curve, but the amount of this rotation did not represent the path of the car after impact. It did furnish the basis for a rough measure of the duration of impact, since the rotation was due to the otherwise free motion of a pendulum weight having the velocity of the car at impact. When the impact speed was about 5 miles per hour the maximum pressure due to impact was produced in less than one hundredth of a second.

Apparatus No. 2.—A strong 3 inch pipe about 30 feet long, completely filled with water after excluding all air, was bolted securely to the steel underframe of the car with an indicator gauge attached to the impact end. The testing mass in this case was that of a column of water with inside length of pipe to gauge connection and diameter of the gauge piston, weight about 6¾ pounds. Its increase of path over that of the car was due solely to the change in length of the 3-in. column of water corresponding to the small movement of the piston.

Apparatus No. 3.—A small metal cylinder weighing 6¾ pounds, the weight of the active column of water in the second apparatus, was flexibly mounted in a horizontal position with one face in light contact with a steam indicator gauge piston. This amounted, practically, to the ordinary slidometer arrangement and was subject to the objection that the testing weight still had only a partially compressed spring opposing its motion when the friction draft gears were solid. For this reason we should expect its recorded maximum pressures to be less than those given by the hydraulic apparatus and the difference to increase with the speed at impact.

The speeds at impact were obtained by allowing the test car to run down a grade under gravity and they were measured in miles per hour by a reliable electrical apparatus constructed for the purpose. For tests with apparatus No. 1, the moving car was allowed to collide with a draft of from 7 to 11 empty steel cars with their hand and air brakes set. For tests with the other forms of apparatus, from 4 to 6 loaded cars were used. These cars weighed 39,100 pounds empty, and about 150,000 pounds each when loaded with coal.

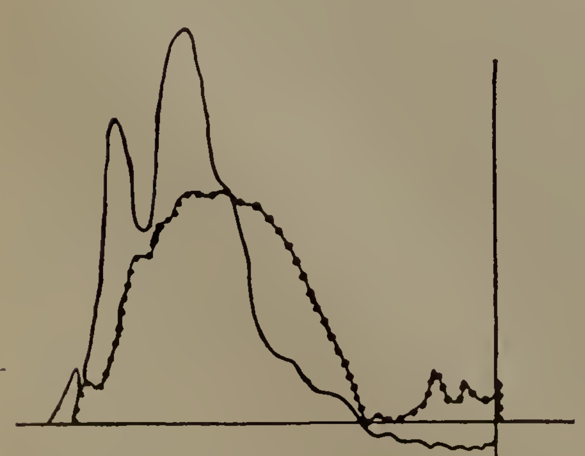
It is unfortunate that accurate observations were not made on the movements of these cars and of their draft gears as a result of the impacts. If further tests are made, and it is important that they should be made, a solid bumping block should be used first that would restrict the path positively to compression of one pair of gears, and the effect of passing from this to various service conditions should then be determined. The substitution of a draft of loaded for a draft of empty cars increased very materially the severity of the conditions in these tests.

Results of Tests.

The first important fact noted was that the gauge records showed several alternations of pressure due apparently to wave motions in the liquid. The first pronounced maximum in the curve was accepted as the maximum pressure, although in some cases subsequent registrations were higher. Efforts were made to remove, or reduce, these alternations of pressure by using Apparatus No. 1 without the suspended 100 pound weight and depending entirely on the mass of the liquid to affect the gauge. The flexible diaphragm was also replaced by a solid head for the cylinder and, in another plan, cotton waste was packed into the cylinder with the water for the same purpose. The gauge continued to show alternations of pressure, and it is now thought possible that this was due to the successively developed resistances of individual cars in the draft and that accurate observations would have shown small movements of these cars.

The gauge pressures recorded were divided by the weight whose decelerations caused the pressures and the results, pounds of pressure per pound of weight, were plotted as a function of the speed at impact in miles per hour. From the average curves constructed in this way, the following table was prepared. It includes data for the three forms of testing apparatus described and for Apparatus No. 3 when the draft gears were blocked to prevent their normal operation in cushioning the blow.

Table of Condensed Results.



Enlarged Gauge Record, Buffing Stresses.

Speed of Car at Impact Miles per Hr.	Maximum Pounds of Pressure Per Pound of Weight			
	Draft of Empty Cars	Draft of Loaded Cars		
	Apparatus No. 1	Apparatus No. 2	Apparatus No. 3	
	Draft Gears Normal	Draft Gears Normal	Draft Gears Normal	Draft Gears Blocked
2	1.6	2.8	2.3	7.0
3	2.8	4.6	3.6	11.4
4	4.1	7.0	5.0	18.0
5	5.8	10 6	6.6	....
6	7.9	18.0	8.5	....

Table of Results, Buffing Stresses.

Discussion by S. P. Bush.

Col. Dunn apprehends that his results are too high. I am led to believe, however, that he is not very far out of the way, for recently on some tests made on a railroad of which I happened to have some knowledge, three 60-ton capacity cars and a dynamometer car attached to an engine, backing up to couple on to a train at a speed of six miles per hour, gave a record on the dynamometer of nearly 1,000,000 pounds; the cars all being equipped with friction draft gears. I had hoped to be able to present a considerable amount of data on this point, but the source from which I expected the information has failed to get them to me in time.

We know, however, in a general way, that the stresses to which cars are subjected have been constantly increasing, and I do not think it will be surprising if in checking up Col. Dunn's results they should be found to be approximately correct. The destruction that takes place from day to day in car equipment is evidence of a general character that such is the case, and that stresses of the magnitude that he suggests are not unusual but frequent and are conditions that prevail many times every day.

I have personally spent a great deal of time on freight trains while in transit and also in yards observing switching operations. My business and my interests for many years have made this essential, and I believe that when I say there is very much carelessness in the handling of freight trains and cars that might be eliminated, I am not stretching the truth.

The first object, therefore, of Col. Dunn's paper, as I have said, is to point out that the prevention of heavy shocks is the first and most important remedy to apply.

Being engaged in the manufacture of articles that go into freight car construction, practically all of which articles are subjected to the impact of service, which element constitutes a very important one in the design of these parts, and often called upon to guarantee the service which they shall render (a request, by the way, in many cases inconsistent), we have in some cases, been at a loss to know what to do. The worst conditions appear in the draft and buffing appliances, where limitations of dimensions have been placed by the standards of the Master Car Builders Association. This applies particularly in case of the car coupler and other parts of the draft gear.

Originally the question of the automatic car coupler was one simply of locking and unlocking and of interchangeability. The element of strength was not an important detail, because at that time there was ample opportunity to make it strong enough. Later, however, when the steel coupler came into existence, the question of strength became more important, and to-day it would appear that strength is the paramount issue.

It is not my purpose to go into a discussion of the coupler question, but in discussing Col. Dunn's paper in connection with stresses I merely wish to call attention to one phase which must receive some attention sooner or later unless railroads find it possible to prevent the occurrence of these high stresses which have become, as I have said, more and more general in every day service.

It is understood, I think, that the important dimensions of the coupler are fixed by the Master Car Builders Association because of the necessity of having interchangeability with reasonable exactness. Now, the fact of the matter is, that these dimensions are such that the automatic coupler is entirely inadequate to withsand these stresses. The Committee of the Association, in one of its recent reports, pointed out the large number of failures that take place in certain parts of the coupler as a result of buffing stresses, and make certain recommendations with a view of preventing these failures, in a measure at least. The recommendations went about as far as it seemed feasible to go in adding to the strength, but after this has been done the coupler would undoubtedly be entirely inadequate, and the fact of the matter is, that the automatic coupler is not of a form very well adapted to receive and transmit heavy compressive stresses. I might say that the knuckle, pivot pin, bar and draw-head, except the shank, are all entirely inadequate. If much of importance is to be done to advance in this direction, it appears that it will be necessary for the Master Car Builders' Association to take hold of the matter and provide for a gradual expansion of these dimensions which will permit the addition of necessary strength to meet pulling stresses, if not buffing stresses, and yet maintain interchangeability of coupling with safety.

As I have said, the form of the coupling head is not well adapted to receive heavy compressive stresses, and it is a great question whether separate buffing appliances should not be resorted to, if the conditions which Col. Dunn has pointed out are to be successfully met.

Col. Dunn points out that possibly in impact where the time limit is short the friction draft gear does not act as it has been supposed to, at least to the same degree as under static load. No doubt there may be a great difference between different designs of friction draft gear, and undoubtedly the static measure of the value of friction draft gear is not a true one, but a friction gear built upon good principles can be made to absorb energy applied by impact, very efficiently, I think, beyond a doubt.

That there may be an insufficiency of capacity or travel in existing draft and buffing devices, is undoubtedly open to question. The Committee of the Master Car Builders Association, up to the present time, has taken the position that a gear should not be of very high capacity, because if so designed, with the amount of travel now provided for, it would not properly absorb the smaller shocks which come more frequently. It would appear that if a gear were made of higher capacity it would not be necessary to consider the smaller shocks and the heavy shocks which Col. Dunn speaks of and which are the source of so much danger in the transportation of explosives might be modified.

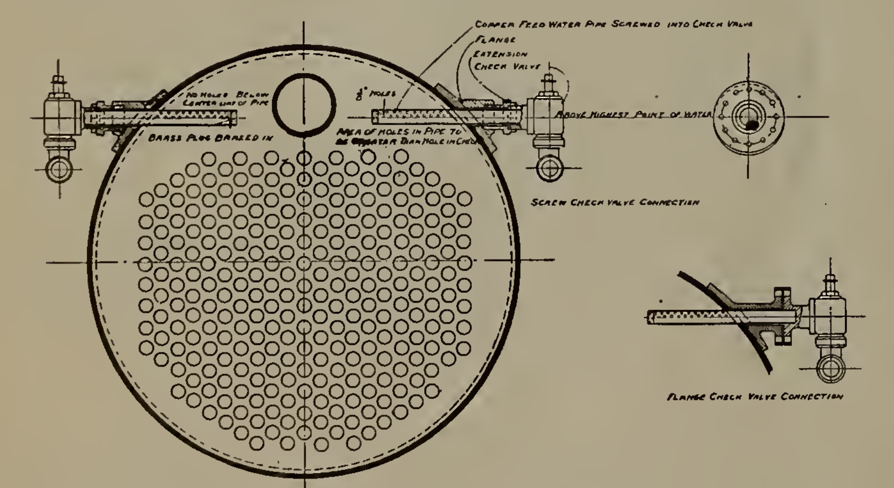
The present draft gear capacity asked for by the Master Car Builders Association is 150,000 pounds. In the light of the figures presented by Col. Dunn and those obtained elsewhere, it would appear that this must be inadequate to provide for compressive stresses that are occurring constantly, particularly in switching service. Possibly, as I have already suggested, it may be necessary to provide special buffing equipment independent of the draft appliances, and of course there is a limit beyond which it is not practicable to go in providing energy absorbing devices, and while it is important to improve and develop all such devices, the fact remains that the dangers that Col. Dunn points out would not probably be obviated except by the exercise of much greater care in the handling of railway freight cars than exists at the present time.

At the convention of Railway Electrical Engineers to be held September 27-30th at the La Salle Hotel, Chicago, papers will be presented on such subjects as "Electric Lighting of Railway Cars," "Axle Generating Systems," "Electric Traction on Trunk Lines," "Motor Driven Machine Tools," and "The Illumination of Railway Passenger Stations and Machine Shops." An interesting feature of the convention will be the exhibits by the member companies of the Railway Electric Supply Manufacturers' Association of electrical supplies used on railways. The first public demonstration of the nickel-iron Edison Storage Battery will be given, together with exhibits of the latest achievements of the electrical inventors including the electric ozonizer and the loud speaking telephone. The present officers of the association are: E. M. Cutting, Southern Pacific Ry., president; J. R. Sloan, Penna Ry., vice-president; F. R. Frost, electrical engineer A. T. & S. F. Ry., second vice-president; Geo. B. Colegrove, chief electrician Illinois Central Ry., secretary and treasurer. The officers of the Manufacturers' Association, an auxiliary to the above, are: W. L. Bliss, U. S. Light & Heating Co., president; W. E. Ballantine, Willard Storage Battery Co., vice-president; J. Scribner, General Electric Co., secretary; Edward Wray, *Railway Electrical Engineer*, treasurer.

Boiler Feed Water Delivery.*

Some three years ago we received two locomotives from the builders. After putting them in service we found it impossible to make a round trip of one hundred and fifty miles in passenger service on account of leaky flues. This continued until the transportation department condemned them and ordered them out of service until they could be put in better shape. We then turned the engines over to the builders advising them to either overcome the difficulty or take them back. They sent an expert who worked for six weeks, trying every possible thing he could think of to overcome the trouble, and finally he gave it up as a bad job. While I was experimenting with these engines, making no progress, I gave some thought to the matter myself, and came to the conclusion that the trouble must be due to the feed water delivery, and after a great deal of arguing, their expert finally agreed to allow me to try out my ideas.

We first connected an elbow to boiler check on the inside of boiler and carried the feed water as near to the surface of the water level in the boiler as possible, before discharging it. After trying this we found we were able to make about two round trips without engine failures. This experiment proved that there was an improvement and that the trouble was due to feed water conditions. I then decided to deliver the water into the steam space in a spray, as shown in the drawing, in which you will note there is a copper pipe connected to boiler check, extending about 18 ins. inside, with ⅛ in. holes drilled on upper side so as to keep the water in suspension as long as possible, allowing feed water to absorb heat from high pressure steam before mingling with other water in boiler. After applying feed water in this manner, boiler trouble on these engines entirely ceased and from that day to this we have not had a minute's delay charged against these engines, account of tube or boiler trouble.



Arrangements for Delivering Feed Water into Steam Space of Boiler.

Later on we had another engine giving trouble from tubes leaking, and, in order to further demonstrate what could be done, I decided to change the feed water delivery and apply it in the same manner as in the other cases; after the engine came in leaking badly, made the change and sent the engine out without permitting the boiler maker to go inside to make repairs, the engine going out in the same condition as when she came in. The result was the tubes immediately dried up and from that time until the engine went into shop, some six months later, we never found it necessary to send the boilermaker into this engine's firebox. This convinced me beyond any doubt whatever, that the old way was entirely wrong and I immediately ordered all our locomotives to have feed water delivery applied in the manner described. This order was put into effect about July 1907, and in the spring of 1908 we had all of our power so equipped.

I have followed the matter up very closely since that time and find our engines steam more freely, burn less fuel, and reduce boiler repairs to a minimum; where we were using five and six boilermakers on round house running repairs, we now have but two, one man days and one man nights, and it is very seldom that either of these men are ever required to go into a firebox. We have also found from feeding the water in this manner that about ninety per cent. of the foreign matter is deposited immediately underneath the spray pipe, or in the front course of boiler. We have since placed a pan under the spray pipe to catch all deposits before allowing them to fall and mingle with the tubes. This can be cleaned by removing dome cap or connecting a pipe and blow-off cock so arranged as to carry it away.

I am informed by mechanical men on a large railroad who are troubled with bad water and boiler foaming, that after applying feed water in this manner, trouble from foamy boilers is almost entirely eliminated, and I presume this is due to the fact that all solids or foreign matters are immediately precipitated and not allowed to mingle with the other water in the boiler.

A great many mechanical men have asked if the holes in the spray pipe will not clog up and put injectors out of commission. In the first place, if copper pipe is used, this is not apt to occur, as scale will not adhere to copper as readily as to iron or steel pipe. Also spray pipe is so arranged that it can readily be removed if this condition should occur. In our three and one-half years' experience we have never found it necessary to remove one pipe from this cause.

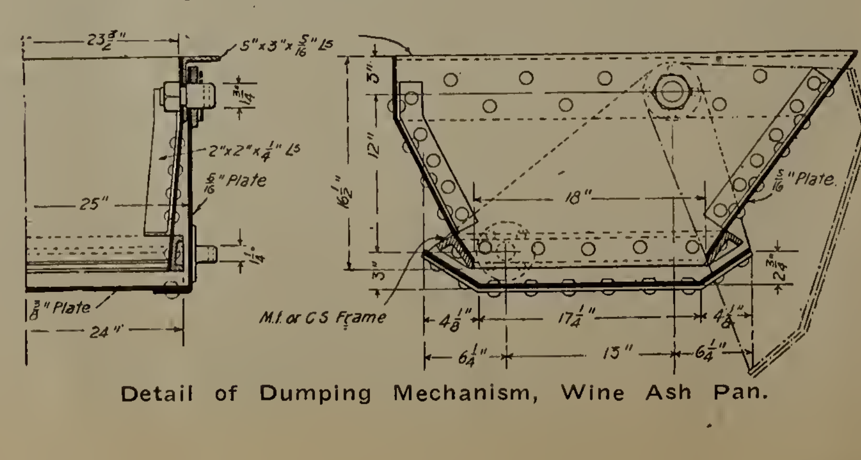
The foregoing is the result of actual experience on this railroad and our records will show that we have made a saving of at least ten per cent. in fuel, seventy-five per cent. in boiler repairs, an increased tonnage of ten per cent. and at the close of our ore season, engines tie up in better shape than ever before in the history of this road. I am, therefore thoroughly convinced that the only proper place to deliver feed water into a locomotive boiler is in the steam space and the finer it can be broken up and held in suspension, the better results will be obtained.

*From a paper by C. W. Seddon, superintendent of motive power of the Duluth, Missabe & Northern Ry., read before the International Railway General Foremen's Association.

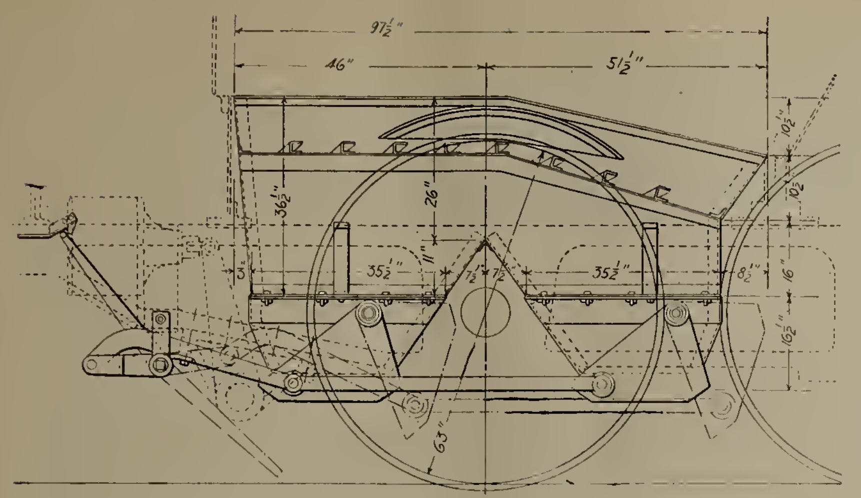
The Wine Ash Pan.

The illustrations herewith show in detail an automatic ash pan, designed by W. E. Wine, of the Atlantic Coast Lines. In designing this ash pan to conform to the recent Federal law, the designer took into consideration the numerous fires which occur from losing cinders along the right of way, and endeavored as near as practicable to design a pan which in every respect would prevent the losing of cinders and thereby eliminate the fires and other troubles occurring from this cause. It was also desired to have a pan which would not require machined or accurately adjusted parts.

The air admission passages are so arranged as to prevent the escape of ashes through them and so located as to supply the air to a point within the pan where it will be evenly dis-



Detail of Dumping Mechanism, Wine Ash Pan.



Longitudinal Section, Wine Ash Pan.

tributed over the under side of the grate. These passages are also located a sufficient distance from the mud ring to prevent cold air creeping up alongside the firebox.

The hoppers are separate from the main body of the pan and are held thereto by key bolts, so that when it is necessary for a workman to go into the pan the keys can be easily knocked out and the hoppers dropped down.

The discharge doors dump by gravity and are made considerably larger than the bottom end of the hoppers in order to allow for irregularities in workmanship and warping or buckling of the hoppers and doors. The edges are flanged upwardly around the bottom end of the hopper and stand off therefrom about ½ in. in such a way as to form an ash seal. It has been found in practice that the finer ashes will settle to the bottom and pack in the space between the door and hopper sufficiently to prevent the entrance of air. If desired the injector overflow may be discharged into the pan, which by means of the upward flanges around the bottom end of the hoppers, will form an air tight seal.

The flanges serve the purpose of preventing the escape of ashes and cinders through the space between the door and hopper. By the flanges extending upwardly about 2½ in. from the bottom end of the hoppers it will be observed that the upper edge of the flanges will have to move downward this distance before the ashes could escape over the top. Thus it will be seen that any reasonable wear in the pivotal connections will not effect the proper closing of the doors. It will also be noted that after the operating rigging has been once adjusted to the proper opening and closing of the doors there is never any need of readjustment.

From the form of the supporting arms of the doors it is possible to allow this door to drop closer to the track than with other forms of doors. The arms being in the form of gusset plates stiffen the doors considerably to longitudinal strains, such as would occur should the engine be backed up after dumping the ashes and before the doors had been closed, due to scraping down the pile of ashes on the track. In cold climates where the doors are apt to become frozen up in winter, any successful arrangement for thawing out the doors of other designs is equally applicable to this design.

The operating arrangement is such that in its closed position the crank arms are passed the dead center and any tendency of the doors to open is resisted in this way. There is also a latch which is a safety device to prevent the arrangement from unlocking. The operating arrangement is so designed as to give maximum leverage on starting to open the doors.

Over three hundred of these pans are in use on the Atlantic Coast Line, and are giving excellent results. Some of these pans have been in constant service since August, 1908.

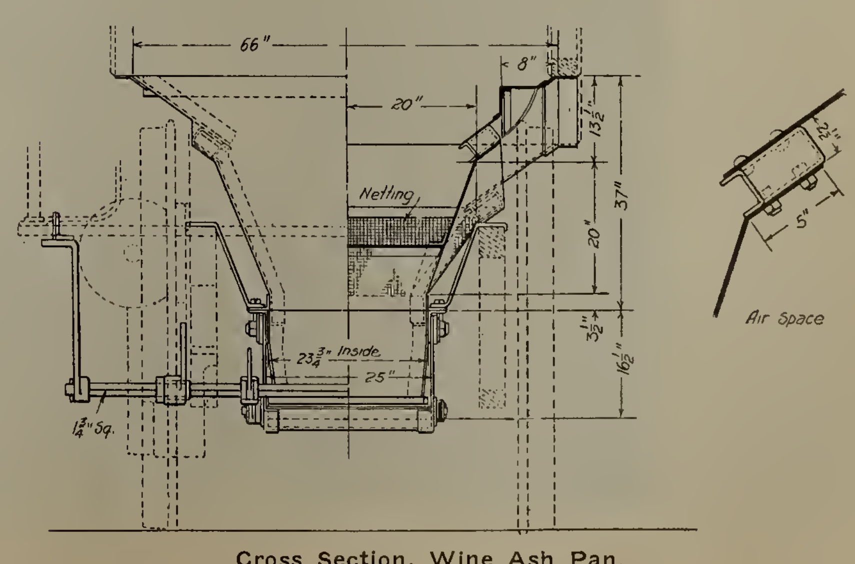
The designer, Mr. W. E. Wine, is located at Wilmington, N. C.

Copper and Steel for Locomotive Fireboxes.

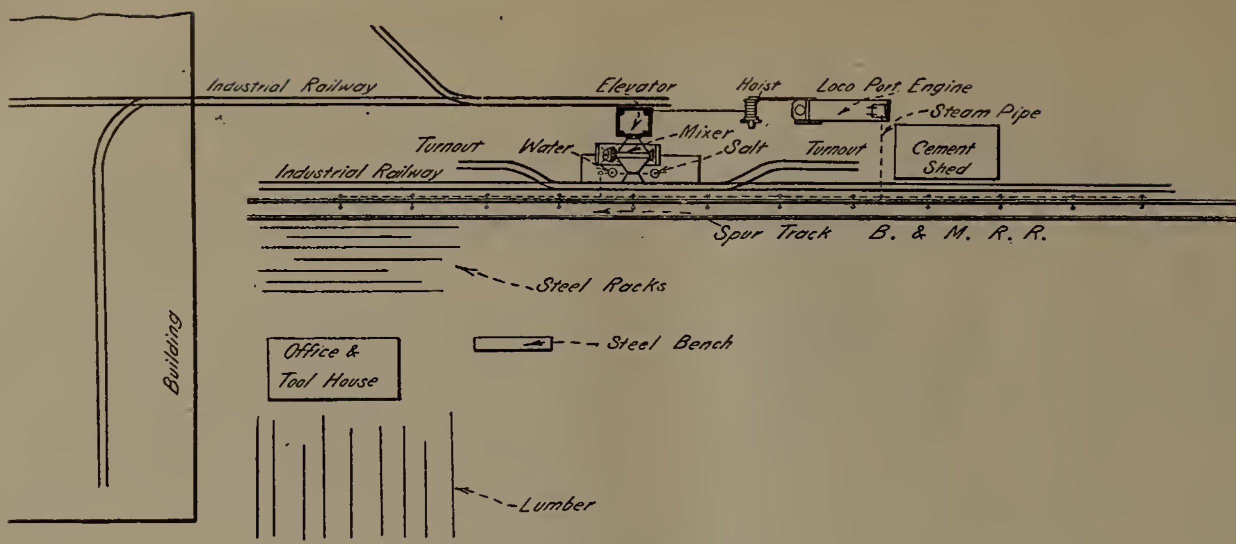
At a meeting of the Western Canada Railway Club a paper on this subject was read by Mr. H. B. Lake, chemist to the Western Pacific Railway. The author said that sheet copper weighed one-eighth more than sheet steel. Assuming the price of steel at 3 cents and copper at 21 cents, then copper costs seven times as much as steel, and as the thickness of the sheets of copper used in a fire-box was generally about twice that for steel, the initial cost of the material for the copper box would be a maximum of sixteen times that for a steel box. Allowance, however, had to be made for the value of the scrap copper, which locally was stated to be 75 per cent, and allowing 5 per cent of this for the steel scrap, this reduced the ratio of the cost of the copper plate to about five times that of the steel. As regards the labor cost of making the box, this was in favor of copper. Being the easier metal to work, it induced less wear and tear on tools, and in addition the time required to make the copper box was less. Where cost of labor bore a high ratio to cost of material then this factor would increase in importance.

The possible life of the two fire-boxes depended largely on local conditions. The life of copper boxes on English roads was about ten years, or the equivalent of about 800,000 miles, and copper tube plates last about five years in hard, constant service at high pressure. Steel boxes, under similar conditions, give a life of only one year, or about 80,000 miles, before requiring repair, and on a certain section of the Canadian Pacific Railway, where the water supplies were of medium quality, the side sheets of steel boxes in new engines required renewal inside twelve months, or after running about 45,000 miles. Hence the labor expended in making steel boxes was as much, or more, than in making copper boxes, and totally, with labor for repairs, it was safe to assume that it was five times as great. Where labor costs as much, or more, than the material used in the box, this reduced the relative cost of the two boxes to about the same figure. This reduced the considerations to the relative time engines fitted with either kind of box would spend in the shops directly consequent to the copper or steel fire-box. Evidently, if a steel box required more frequent repair the comparison would be in favor of copper.

Another important consideration was the greater reliability of one material by which engine failures, or delays, might be less than with the other. Copper is more resistant to corrosion than iron, being higher in purity than mild steel, and electrolytic copper, while equally as ductile and tenacious as that produced by smelting and rolling, was even purer. Pure iron, and more readily steel, was dissolved by pure water, and when carbonic acid and air were present the action was accelerated. Also the impurities in the steel were segregated, and were more readily



Cross Section, Wine Ash Pan.



Layout of Concrete Mixing Plant.

acted upon by local electrolysis, producing pitting. Copper was not acted upon by pure water at any temperature, and even resisted the action of hydrochloric acid if air was absent, and was far more resistant to corrosion than steel.

As to tensile strength, copper was almost equal to very mild steel, and in ductility very much higher. It was, therefore, less physically damaged by the punishing operations of riveting and beading than steel, and made a tighter and more tenacious joint than steel with the tubes or flues. This superiority was demonstrated in a series of tests made by Mr. J. A. Holden, of the Great Eastern Railway, England. He expanded steel flues into copper and steel plates, and then pulled the plates. Out of twelve tests the tubes started in the steel plate ten times, and finally eleven tubes pulled through the steel, while eleven remained tight in the copper plate. The tubes were expanded in taper and straight holes, the former giving more uniform results. The plates used were copper, 1¼ inches thick, and steel ¾ inch thick. No ferrules were used. Beading over did not improve the hold in steel plates, but increased the tenacity in copper plates from 7 to over 12 tons pull required to remove the tube.

Mr. B. A. Raworth pointed out that the merit of the copper fire-box was that it lasted a long time; the material was exceedingly tough and plastic, and withstood the very severe strains caused by differences of temperature without exhibiting fatigue. In addition, the screwing of ¾-inch or ⅞-inch stays into a ⅜-inch steel plate could never be made a secure job, although in the ⅝-inch plate, of course, the stays get a great deal better hold. The flanging of copper, of course, was a much easier matter than the flanging of steel, and the plates were not nearly so apt to crack in the corners where the flanging had been done.

In conclusion, the author stated that the initial cost of a copper fire-box was much higher than steel. The life cost, allowing for the value recovered on the scrap copper, of copper and steel was about equal. Copper sustains mechanical work better, and makes stronger and tighter joints than steel. It takes up sudden fluctuations in temperature more quickly and uniformly. Copper offers greater resistance to corrosion than steel. Therefore, engines fitted with copper fire-boxes should spend less time in shop directly consequent to fire-box trouble, and be less liable to failure on the road from leaking of stays and tubes and cracking of plates.—*Vulcan.*

Concrete Construction Plant on a Short Time Job.

When the contract for the concrete foundations of the new Boston & Maine R. R. locomotive shops was placed with the Aberthaw Construction Co., of Boston, Mass., last November, the stipulation was made that the work should be completed in the very shortest possible time. The contractors therefore decided to erect a complete concrete mixing and handling plant although the entire job contained less than 2,000 yards of concrete.

The resulting costs as well as the speed obtained fully

View of Concrete Mixing for B. & M. Shops.

justified the erection of the construction plant although it was in operation only about five weeks. These costs per yard were:

Labor, Mixing and placing	79c
Rental of plant	39c
Handling and erecting of plant	18c
Total	$1.36

It is probably fair to say that it would have been difficult to mix this material for less.

The arrangement of the construction plant was as follows: A single spur track from the railroad was run to the site approaching it at right angles to the buildings and about the middle of the same. Some two hundred feet from the building site and on the right hand side of the spur track approaching the work, the mixing platform, mixer, and elevator were placed. The railroad siding was paralleled by an industrial track on the same side as the mixer. The mixer platform and the industrial track were built about on the level with the body of a freight car. Turnouts on the industrial track were provided on either side of the mixer platform for passage of cars and storage for idle ones. The aggregate could be unloaded to the mixer platform direct from the freight cars or into industrial cars which could be dumped direct into the mixer. The cement shed was located about 100 feet from the mixer alongside the industrial track and railroad siding. Cement was unloaded from the freight cars into the cement shed and transferred to the mixing platform by wheelbarrows or industrial cars.

As the tops of the foundations were several feet above ground level, the track for delivering the concrete was raised so that it could be dumped from the industrial cars direct into the forms. The raising of the industrial track brought the dump cars too high for the mixer to discharge into them so a short elevator tower with an automatic trip bucket was erected. The mixer discharged into this bucket which was hoisted and dumped into the cars. A portable locomotive engine supplied power for the mixer and for a hoist to operate the elevator. The large panorama photograph shows very distinctly the arrangement of the industrial track for delivering concrete to the work.

The reinforcing steel and lumber for forms were unloaded on the opposite side of the railroad track from the mixer and nearer the site of the building. The steel was bent and the lumber was cut for the forms and carried into place by hand.

Explosibility of Coal Dust

The recently created Federal Bureau of Mines has recently issued a bulletin on the explosibility of coal dust, with chapters by J. C. W. Frazer, Axel Larsen, Frank Haas and Carl Scholz. The bulletin was prepared by the Technologic Branch of the United States Geological Survey, which is now a part of the Bureau of Mines, and therefore will be known as Geological Survey Bulletin 425, but will be distributed by the Bureau of Mines. The author of the bulletin, George S. Rice, chief mining engineer of the Bureau, goes fully into one of the most serious and most perplexing problems that the coal mines have had to contend with in the last few years. He traces the growth in the belief in the explosibility of coal dust, summarizes the experiments and mine investigations that have established this belief and gives the present status of preventative measures.

In the introduction, Mr. Rice says: "Only within comparatively few years has the dry dust of bituminous and lignitic coal been generally recognized as an explosive agent more insidious, threatening and deadly to the miner than firedamp. Firedamp carries its own flag of warning—the "cap" in the safety lamp—but coal dust, though visible, does not attract attention until present in large quantities.

Firedamp is of local occurence and except in notable and very exceptionable cases is controllable by careful manipulation of the ventilating currents. If by mischance a body of firedamp is ignited in a mine, the force of the explosion is terrific, but the effect is localized unless dry coal dust is present, or unless (as it very rarely happens(an explosive mixture of methane gas and air extends through large areas of the mine. In a dry mine dust accumulates everywhere, and the blast from the ignition and combustion of bituminous dust may traverse miles of rooms and entries and wreck structures at the entrance of the mine. The comparative potential destructiveness of gas and of bituminous dust is strikingly shown by the history of the Pennsylvania anthracite mines. These mines not infrequently have large inflows of gas, and the resulting mixtures of gas and air have sometimes been ignited, yet no such wide sweeping explosions have taken place, despite the presence of dry anthracite dust, as have happened in excellently ventilated bituminous mines."

Mr. Rice reviews the experiments into the explosibility of coal dust in foreign countries and dwells at considerable length upon the attitude taken in France by the engineers, who, until the great disaster at Courriers in 1906, which cost 1,000 lives, did not believe that coal dust would explode without the presence of firedamp. Since that terrible disaster a testing station has been established in France and now the French engineers are fully convinced of the dangers of coal dust.

"The coal dust question in this country," continues Mr. Rice, "can not be said to have awakened widespread interest among mining men until the terrible disasters of December, 1907, which resulted in the death orf 648 men. In response to a demand by those interested in coal mining throughout the country, Congress, in 1908, made an appropriation for the investigation of mine explosion. The United States Geological Survey was charged with the investigation. A testing station was at once decided upon and was established at Pittsburg, Pa.

"While it is probable that for several years the leading mining men in the country have believed in the explosibility of coal dust without the presence of firedamp, yet until the public demonstrations were given at the testing station at Pittsburg, during 1908-09, and reports were received of similar tests made abroad, a large proportion disbelieved. These tests were so convincing to those who saw them, and such general publicity has been given to them, that it is now exceptional to find a mining man who does not accept the evidence of the explosibility of coal dust. The question of the day no longer is 'Will coal dust explode?' but 'What is the best method of preventing coal dust explosions?'

The following are some of the tentative conclusions of Mr. Rice on the dust problem:

"That coal dust will explode under some circumstances, both in the presence of firedamp and without it, is now generally accepted by mining men. The writer fully agrees with this and takes the following views of the explosibility of dust and the conditions necessary for explosion.

"Experiments at Pittsburg indicate that under ordinary conditions the dust must be from coal having at least about 10 per cent of volatile combustile matter, though in certain foreign experiments, it is claimed explosions were obtained with charcoal dust.

"Dusts with higher percentages of volatile combusible matter are more sensitive, ash, moisture contents, and size being constant. This view is based partly on the preliminary experiments at Pittsburg and on the results of experiments of M. Taffanel and other foreign investigators. Where there is a large amount of dry coal dust, judging from the Pittsburg experiments, a humid atmosphere has little effect on ignition of dust or propagation of an explosion. A long continuance of the humid conditions renders the coal dust moist and inert, but the presence of moisture in the air at the moment of explosion is not sufficient to prevent an explosion; that is, not enough moisture is carried by the mine air to reduce materially the temperature of the flame. Fully saturated vapor at 65 degrees F., an ordinary mine temperature in this country, weighs 6.78 grains per cubic foot (15.5 grams per cubic meter.) Coal dust suspended in such a saturated atmosphere in a cloud of moderate density weighs, say, 200 grams per cubic metetr. At the figures given the weight of vapor is but 7.8 per cent of the weight of dust. The Pittsburg experiments with wetted dust showed that several times this percentage of moisture in the dust, in addition to a nearly saturated atmosphere, was required to prevent propagation.

"Probably with a low dust density, the relative humidity of the air would be an important factor in tending to prevent the initiation of an explosion. However, the great purpose of artifically humidifying mine air is that it may serve as a vehicle for carrying water to the dust."

Mr. Rice concludes by reviewing the various remedies that are offered for the coal dust problem, giving the good and bad points of each.

Personals.

J. B. Canfield has been appointed master mechanic of the Albany division of the Boston & Albany, with headquarters at West Springfield, Mass., vice A. J. Fries, promoted.

F. A. Butler has been appointed master mechanic of the Boston division of the Boston & Albany, with headquarters at Beacon Park, Allston, Mass., vice J. B. Canfield, promoted.

Alexander B. Todd has been appointed master mechanic of the Tonopah & Tidewater Co., which operates the Tonopah & Tidewater Railroad and the Bullfrog Goldfield Railroad, with offices at Stagg, Cal.

C. E. Gossett, master mechanic of the Iowa Central at Marshalltown, Iowa, has been appointed master mechanic of the Minneapolis & St. Louis, with office at Minneapolis, Minn., succeeding J. Hill, resigned.

A. J. Fries, division master mechanic of the Boston & Albany at Springfield, Mass., has been appointed division superintendent of motive power on the New York Central & Hudson River, at Depew, N. Y.

C. H. Spengler is acting as master mechanic of the Butte, Anaconda & Pacific vice D. Grattan. His office is located at Anaconda, Mont.

J. R. Frink has been appointed purchasing agent of the Macon, Dublin & Savannah with headquarters at Macon, Ga.

M. E. Sherwood has been appointed master mechanic of the Michigan Central at Jackson, Mich., vice Geo. E. Parks.

Wm. Gill succeeds C. E. Gossett as master mechanic of the Iowa Central with office at Marshalltown, Ia.

C. M. Hoffman succeeds W. B. Gaskins as master mechanic of the Oregon Short Line, with office at Pocatello, Idaho.

H. L. Jaco has been appointed master mechanic of the South Dakota Central, vice C. A. Swan. His office is located at Sioux Falls, S. D.

New Books.

FREIGHT CAR EQUIPMENT. By F. J. Krueger; 200 pages, cloth, 5x7¾; published by F. J. Krueger, 679 Ferdinand Ave., Detroit, Mich. Price, $1.50.

A reference book for car men in freight car works, describing and illustrating in detail the different kinds of freight cars now built, and various devices used in their construction and repair. The book also contains instructions on the Westinghouse air brake, tables of average weights of material, average hours of labor, and average cost of making repairs. The work is illustrated with line drawings, one of the most useful being that of a standard freight car body in perspective with a table of parts. A more or less serious error has entered the compilation in a number of the illustrations, due to the fact that the drawings have been too greatly reduced, rendering much of the lettering indistinct. This does not affect the value of the book for study and reference to a very great extent, however. The work would seem to have considerable value as an assistance in car repair work.

Among the Manufacturers.

NEW LITERATURE.

A recent catalog of the Brown Hoisting Machinery Co., of Cleveland, Ohio, entitled "Modern Ore and Coal Handling Machinery," is really a book of some sixty fine views of various installations in different parts of the country which have been made by "Brown Hoist." The views are 5x8 inches, printed on a dull finish paper, and the whole is a credit to the firm.

* * *

The Chicago Railway Equipment Co., of Chicago has issued a book of about 200 mechanical drawings, showing the standard types of brake beams, bolsters, side bearings, slack adjusters and journal boxes manufactured by the company. Each set of drawings is preceded by a half-tone illustration of the type in question.

* * *

A large and comprehensive catalog has recently been published by the Gould Coupler Co., of New York, and it is replete with half tones and drawings of the various Gould products which include couplers, draft gears, bolsters and side frames. It is divided into four sections: freight equipment, passenger equipment, locomotive equipment and electric traction appliances.

* * *

Booklet "C" of the Commercial Acetylene Co., of New York is entitled "Standard Railway Car Lighting Equipment," and describes briefly the advantages of "The Light that Never Fails."

Two of the recent booklets of the Ingersoll-Rand Co., New York, are on "Coal Punchers" and "Calyx Diamondless Core Drills," respectively. They are of the standard form for insertion in binders.

* * *

The Bridgeport Chain Co., of Bridgeport, Conn., has issued catalogue 10 showing sizes, prices and illustrations of the many type of chain and their attachments made by this firm. This catalogue contains practically everything of interest in chains.

* * *

The Joseph Dixon Crucible Company of Jersey City, N. J., has recently published a very attractive booklet of envelope size on their paint for steel cars. The booklet not only goes into the merits of the Dixon paint for this service, but illustrates a number of different types of steel cars upon which Dixon's Paint has given excellent service. The booklet also contains color chips showing the four colors in which Dixon's Silica-Graphite Steel Car Paint is made.

EXPOSITION OF BOLT, NUT AND FORGING MACHINERY.

The National Machinery Co., Tiffin, Ohio, has recently closed a very successful exposition of bolt, nut and forging machinery which was held in their shops (Tiffin) during August 19, 22 and 23.

In 1908 the National Machinery Co. completely remodeled and greatly enlarged its plant, installing a number of electric traveling cranes and adopting electric power throughout. Besides completely redesigning the former "National" line the present company has adopted and exhibited for the first time a number of new designs especially adapted to railway service with the view of greatly increasing outputs, saving of labor, etc.

The aim of this exposition was to familiarize railway officials and trade in general with the new designs by demonstrating them under actual working conditions, and the Railway Materials Co. of Chicago erected at the National Machinery Co.'s shops a number of its latest types of Ferguson Oil Furnaces for heating rods and bars for the forging machines, bolt headers and nut machines.

Over 50 machines were shown on the exhibit floor, and most of the machines were in operation. The exhibit included forging machines, bolt headers, continuous and automatic feed rivet machines, several types of semi-automatic machines for tapping and burring hot pressed nuts, vertical roll threading machines for handling bolts and long rods, lag and coach screw pointing machines which handle the screws right off the header without previous cone pointing, bolt pointers, die sharpeners, bolt cutters, etc., in fact, a complete assortment of bolt, nut and forging machinery. Many of these machines were direct motor driven to show the national way of motor application.

Invitations were extended to all railway officials, foremen of shops and others interested. Friday, August 19, was designated "Master Blacksmith's Day," and the Association, which was in convention at Detroit, Aug. 16-19, was conveyed to Tiffin in a special train. Aug. 22 and 23 was devoted to the railway officials and trade in general, special provisions, hotel reservations, etc., being made for all in attendance.

The mutual benefit to be derived from such an exhibit cannot be overestimated, for while it furthers the aim of the manufacturer in getting his product before his prospective customers, it serves also, to keep the user in touch with the latest designs and methods employed, and enables him to better his equipment by the adoption of those new designs and better methods.

REPAIR SHOP ON WHEELS.

The North Coast "Short Line" R. R. is still forcing its way through central and western Washington, from Spokane west to

North Coast Repair Shop on Wheels.

Interior of Machine Shop Car.

the rocky slope of the Cascades. The North Coast passes through some of the most fertile, irrigated valleys in the state, and will cross the Snake and Columbia rivers, the latter in two different places, and is at the present time just completing the bridge at Burbank across the Columbia, at a cost of $1,000,000. This line is the Walla Walla extension which will probably build east through the Blue mountains and make connections with some eastern line.

The line now building from North Yakima to a point on the Columbia, in Walla Walla County, making connections with the O. R. & N., will be completed and in operation early this year for the fall trade.

The North Coast equipment is all new, and of the best and latest designs, including two gasoline motor passenger cars, to handle the local business. The advance in mechanical appliances, which will be used in construction work, has been very well planned.

It was deemed necessary to devise a way for repairs for locomotives and other equipment, until such time as a permanent shop could be located and erected. Herewith we show illustrations of a machine car. The interior of the machine car shows a 12 H.-P. Fairbanks-Morse vertical gasoline engine, oil-cooled. The engine is connected to a friction clutch and to the wheels of the car by sprockets and a chain, which enables the operator to do switching with the car, also to move from one station to another, doing work without assistance of a locomotive, making eight or ten miles an hour. Tools in the car are as follows: 1 23-in. engine lathe, 1 16-in. shaper, 1 1½-in. bolt cutter, 1 6-in. pipe threading machine, emery wheel, and a 22-in. vertical drill. Dimensions of the car inside are 39 ft. 10 ins. long, 9 ft. 6 ins. wide and 9 ft. high.

HEAVY GEAR HOBBER.

The Adams Co. of Dubuque, Ia., has placed on the market a new and heavier design of gear hobbing machine which is styled the "Farwell Gear Hobber, No. 3." The machine is designed to handle work to 24 inches in diameter, cutting 12 inches of fan at once.

The head saddle has an unusually long bearing upon the housing. The spindle has no unnecessary overhang, has adjustable bronze bearings of ample size and length and is very rigidly secured to the saddle and its compact and rigid design has been a feature of the Farwell gear hobber. On account of handling coarser pitches than the No. 1 machine, this new tool is provided with a slide in the saddle that carries the hob, making it possible to adjust the hob

Heavy Gear Hobber.

spindle longitudinally, bringing any tooth exactly central with the work arbor. This is quite important in obtaining perfect gears in coarse pitches, but does not require attention on fine pitches, as the difference in position of two succeeding teeth is not sufficient to be noticeable in the gears. This longitudinal movement of the spindle head permits also the shifting of the hob to a new cutting position without resorting to moving the hob or the arbor. Several shifts may be made, bringing sharp cutting parts of the hob into action before it is necessary to grind the hob.

The head has an automatic trip to stop the downward feed and is also equipped with a power mechanism for raising the head after the cut is finished. The head, of course, returns but once for each stack of gears, and on the small machine this operation is performed by hand. There are two extra feeds on the machine, making ten, all of which are obtained in the gear box. The horizontal feed mechanism for cutting worm wheels is incorporated in the design of the machine, and supplied without extra charge, as is also the special support for upper end of arbor. This arbor is only necessary when gears must be swung on centers, for wide face gears, or in cutting a stack of gears of small diameter. A more rigid support can be secured in other cases by the use of face plates or supporting rings which rest upon the table and support the blanks immediately below the rim.

The spindle is driven by a bevel gear instead of a belt, as the coarser pitches necessitate tilting the hob to a greater angle than the belt drive would allow. This angle and the tooth depth are set with a hardened steel gauge as on the smaller Farwell gear hobber.

All important bearings have bronze bushings and the spindle and arbor may be adjusted by simply loosening a lock ring and tightening an adjusting ring nut.

The design of the base and column of this machine is exceptionally rigid, one casting forming both, as well as the knee below the table and an oil pan around the machine. The weight of the machine is about 2000 lbs. A large tank to hold lubricant is enclosed in the base, and ample passages through the hub are provided to conduct the lubricant from the table back to the tank. The lubricant pump is gear driven and has means for regulating the flow of lubricant.

NEW SELF FEED RIP SAW.

A new self feed rip saw for car shop work has recently been placed in the market by the J. A. Fay & Egan Co., 145-165 Front St., Cincinnati, Ohio.

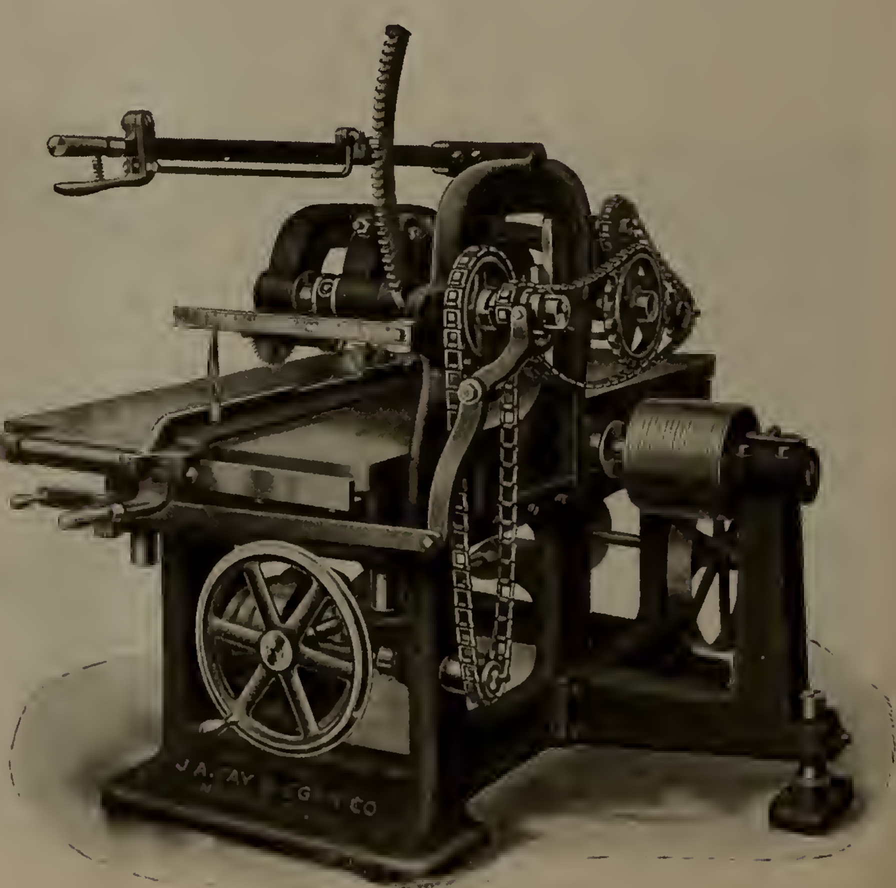
This No. 264 self feed rip saw is designed for general ripping in the car shop, and will be found a satisfactory tool for both light and heavy work. The frame is a very heavy structure, cast in one piece and is absolutely free from vibration. The machine rips 4 ins. thick with a 16 in. saw, and 8 in. with a 24 in. blade. It takes 19 ins. between saw and fence. By lowering the table and raising the feed out of the way, a timber as large as 12 ins. can be ripped. The table is raised and lowered by worm segments and is 37¼ ins. wide and 5 ft. 6 ins. long. The fence is 2¼ ins. high and 40 ins. long and is instantly moved and clamped at any position.

As will be noted from the illustration the mandrel pulley has an outside bearing supported by a heavy arm bolted on the side of the frame. The feed consists of two large rolls above and one spur, assisted by idler roller in the table. The driving mechanism consists of a train of sprocket gears and chain regulated by three step cone pulley. The machine is also made as a hand feed rip saw, with a capacity for 14 ins. thick and with the fence beveling 45 degrees.

NEW CORRUGATED IRON ROOF.

The Edwards Manufacturing Co., of Cincinnati, O., manufacturer, has perfected and placed on the market a new corrugated sheet roofing, which is interesting on account of its novelty.

There is perhaps no more popular roofing than corrugated steel. However, regular corrugated roofing as manufactured everywhere to-day has a number of disadvantages which have been the aim of all manufacturers of roofing to overcome for many years. The Edwards pressed standing seam corrugated roofing does away with many of the objectionable features of regular corrugated steel roofing, and it is a form of roofing which will appeal to builders who de-



New Self Feed Rip Saw.

sire to use a corrugated roofing, but who are not satisfied with the methods of applying same, or the results of regular corrugated steel as a roof itself.

In this age of steel the great majority of buildings on which corrugated steel is used are constructed throughout of structural steel to which the corrugated steel is applied afterwards, either as a siding or roofing. Edwards roofing is especially adapted for use on buildings of this character, as may be noted from the accompanying drawings. This roof has the advantage of having perfectly tight seams and can be applied directly to the purlins without the use of rivets of any kind. This is a feature which can scarcely be overestimated. It is a well known fact that all forms of iron and steel roofing deteriorate first at the points where the sheets must stand all of the strain of vibration, wind pressure, etc. The deterioration is especially noticeable in cases where galvanized steel is used, for at all points where the sheets are punctured for the purpose of riveting the raw metal is exposed, consequently breaking the coating at this point and permitting the oxidizing of the sheets, which is increased very rapidly by the vibration as mentioned.

In order to get the best possible results with corrugated

Fig. 1

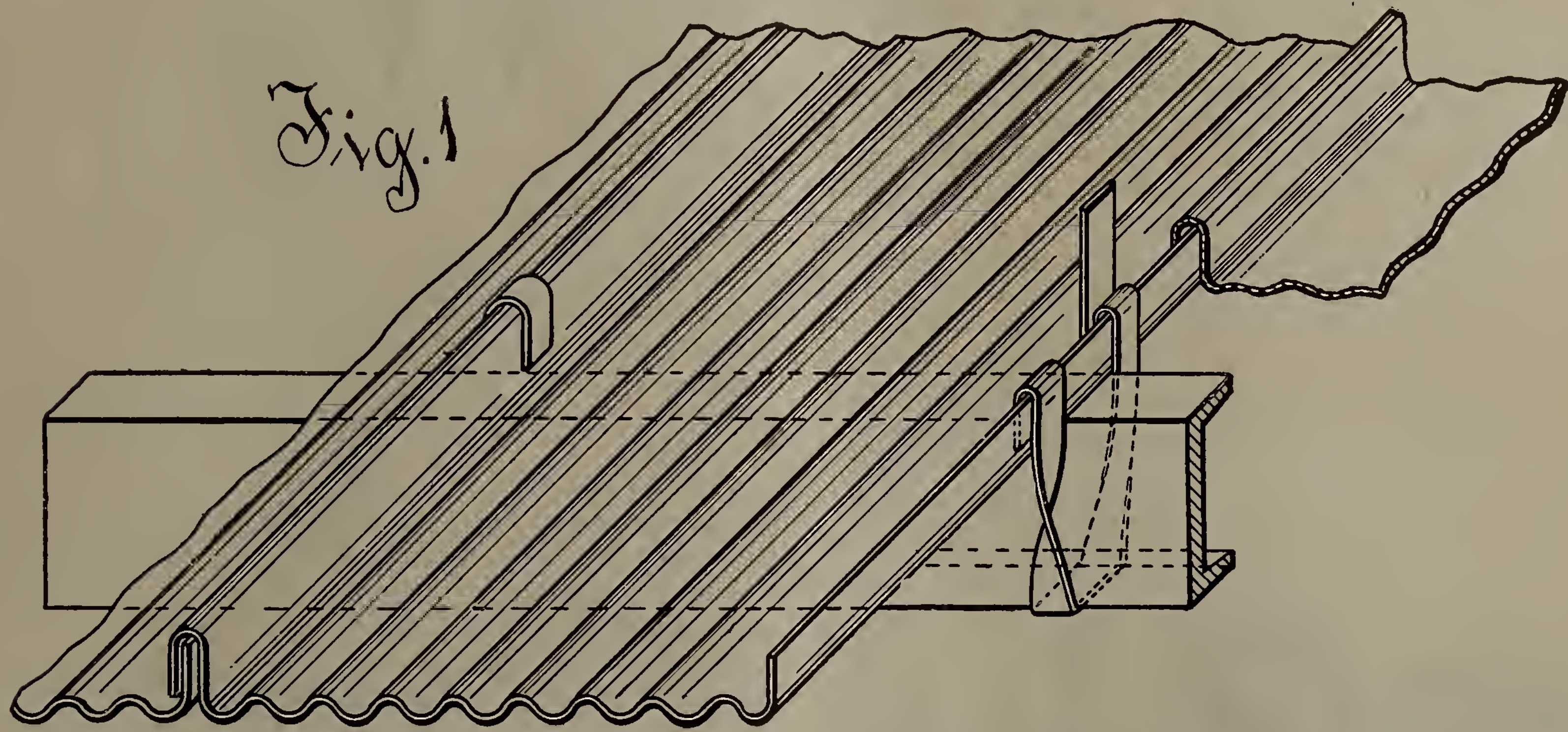


Fig. 3

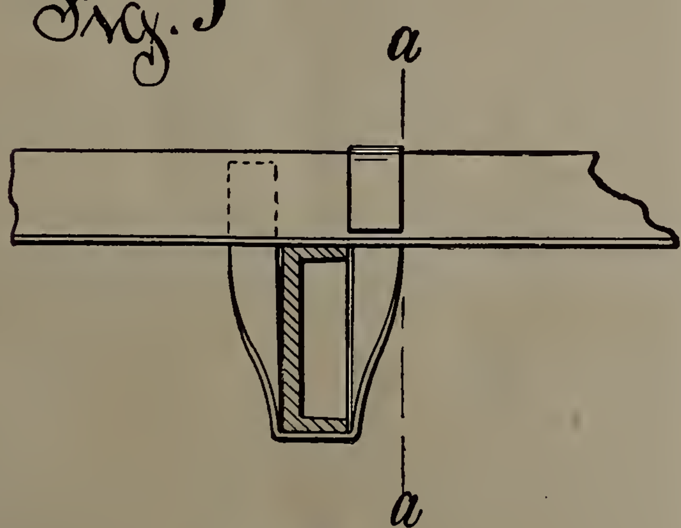
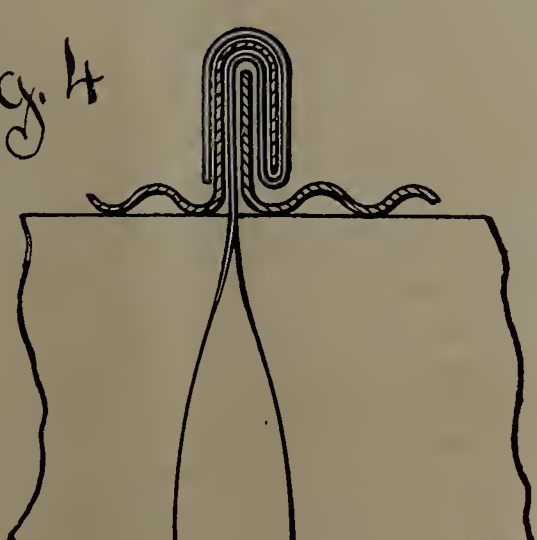


Fig. 2

Fig. 4



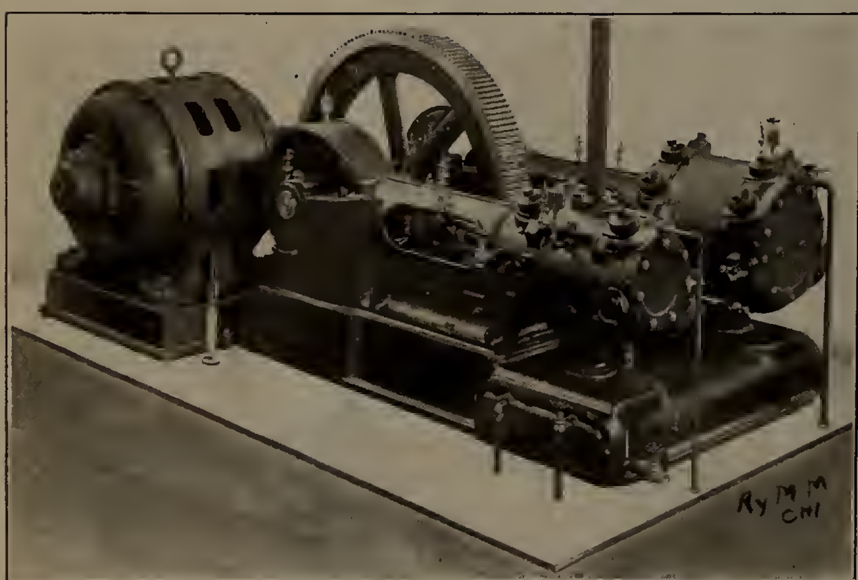
Edwards Pressed Seam Corrugated Roof.

iron it is necessary to lap the sheets two corrugations, but by using this new roofing a saving of 11 per cent can be effected on the side seams alone, and in addition to this a much tighter side lock is assured. This roofing has another advantage which will be appreciated, especially where the roofs are high and difficult to scaffold, in the fact that it can be placed on the roof and worked entirely from above, no scaffolding of any kind being necessary.

Figure 1 shows the roof as applied on iron purlins without rivets. The methods of applying the cleat will be especially noticed. Figure 2 shows the position of the cleat after the roof is completed. Figure 4 shows a section through the cleat at the point A-A indicated in figure 3.

In summing up the advantage of this form of roofing it is apparent that its greatest advantage is in the method of application, principally the fact that it can be applied without the use of rivets of any kind. It is impossible to puncture a roofing sheet, even for the purpose of riveting without destroying the value of the sheet to an appreciable degree. An entire roof can be put on of this material without puncturing the sheets. This is especially valuable where galvanized iron is used, for the coating is absolutely left intact over the entire surface and all edges. It can be applied more closely to the purlins, thus holding the sheets more firmly in position.

While this roofing is primarily adapted for use on buildings having steel purlins it can be applied on wood purlins or sheating boards quite as well, the cleat in this case being nailed to the wood purlin or sheathing in such a manner as to entirely conceal the latter after the roof is completed. The cost of the material is somewhat more than the cost of regular corrugated sheets, but the saving in side laps and in application more than makes up for the difference.



Motor Driven Air Compressor.

MOTOR DRIVEN AIR COMPRESSOR.

A good example of the simplicity, convenience and efficiency of electric motor drive is the application shown in the illustration, a 50 horsepower, alternating current Westinghouse type "MS" mill motor, direct connected to a two stage air compressor, manufactured by the Chicago Pneumatic Tool Co. The compressor has a 14 in. low pressure, and a nine in. high pressure air cylinder; an 11 in. stroke and a mechanical valve. This valve, which is connected with the high pressure cylinder by means of a ¼ in. pipe, stops the compression when the air has reached a pressure of 85 lbs. The air is used in operating the interlocking switches in the yards of the Union Railroad, near Bessemer, Pa.; the riveters, drills, etc., used on the repair tracks, and for testing the air brakes on the cars. The compressor runs 24 hours every day; during this time the switches are in operation continuously, and the repair men work ten hours a day. During the summer time box cars are painted with a pneumatic sprayer. It takes fifteen minutes to paint a car by this method.

The Westinghouse motor runs at 725 R.P.M. on a three phase, 25 cycle, 440 volt alternating current. The compressor runs at 175 R.P.M. Mr. A. F. Coulter, general car foreman of the Union R. R. stated that the equipment has been in continuous operation for six months with no more attention than an occasional cleaning and oiling.

INDUSTRIAL NOTES.

The American Society of Engineering Contractors will hold its annual convention in St. Louis, on Sept. 27, 28 and 29, in the Coliseum. Papers will be delivered by J. B. Goldsborough and Ed. Wegmann, both of New York, on "Dam Construction for City Water Supplies," and by George C. Warren, of Boston, on "Work Preliminary to Street Paving and Road Work." A banquet will be held, and several sight-seeing trips will be made to important engineering work in and around St. Louis.

David W. Pye has been elected president of the United States Light and Heating Company, succeeding William H. Silverthorn.

William J. Ball has been appointed mechanical engineer of the Crawford Locomotive and Car Company, Streator, Ill. Mr. Ball was in the engineering department of the Pullman Company for 12 years. He was mechanical engineer and sales representative of the Bettendorf Axle Company for four and a half years and spent four years in the railway supply business in Seattle, Wash., Portland, Ore., and Chicago. He is thoroughly familiar with the details of car construction, estimating and designing.

The officers of the recently incorporated Williams All Service Car Door Company, Clinton, Ill., are: W. S. Williams, president; C. W. Pifer, vice president; C. R. Westcott, secretary and treasurer. The directors are: W. S. Williams, C. W. Pifer, C. R. Westcott, William H. H. Hastings and Henry C. Koehler.

The American Concrete & Steel Railroad Tie Company, St. Louis, Mo., will build a plant in St. Louis for the manufacture of concrete railway ties. The plant is designed to turn out 2,000 ties daily.

John J. Mallay has been appointed general purchasing and supply agent of the Safety Car Heating and Lighting Company and the Pintsch Compressing Company, New York. Mr. Mallay has been associated with the Safety Company for several years in the departments over which he has now been placed in charge.

The Locomotive Superheater Company, 30 Church Street, New York, announces that it has acquired the United States and Canadian rights of what it regards as the basic patents of fire tube superheaters. The patents acquired include the inventions of Wilhelm Schmidt, H. H. Vaughan, A. W. Horsey, Francis J. Cole and others. There are more than 6,000 of these superheaters in successful operation or in course of construction in Europe and over 800 in America. The officers of the company are: President, Wilhelm Schmidt; vice president, Simon Hoffman; secretary, Otto Von Schrenk; treasurer, Samuel G. Allen. The directors include the officers and Fritz Von Briesen, Oscar Gubelman, J. S. Coffin and Le Grand Parish.

The Automatic Ventilator Company of New York has the contract for equipping 20 of the new cars which the Philadelphia Rapid Transit Company is having built by the Pressed Steel Car Company, with its ventilating system.

The G. M. Yost Mfg. Co., Meadville, Pa., has recently installed a lot of new machinery, in order to take care of its increasing business. This company recently bought out the

Williamson Vise Co., Bradford Pa., and is making a very complete line of vises for all purposes.

William H. Silverthorn, president of the Railway Steel-Spring Co., died at his home in Painesville, O., Aug. 13. He was 61 years of age and had been ill since last spring. Mr. Silverton was a son of J. H. Silverthorn, who conducted a hotel at Rocky River, near Mentor, O. He gained his early education in the common schools and high school and entered the local shops of the Lake Shore railroad, at Mentor, as a machinist's apprentice. At off hours he learned bookkeeping and, when the Winslow Roofing Co. was organized to manufacture a metal roofing for freight cars, Silverthorn became a traveling salesman for the concern. Later he became connected with the Paige Car Wheel Co., and, when it combined with others into the Steel Car Wheel Co., he became manager of the new company. When the Railway Steel-Spring Co. was organized he was elected president.

The Mexican-Northwestern Railway Company of 25 Broad street, New York, has recently placed a large order for motors with the Westinghouse Electric & Manufacturing Company. The order includes 168 induction motors, aggregating 3,736 h.p., of the types MS and HF, ranging from 3 to 200-h.p. These motors will be shipped to the company's property at Madera, Chihuahua, Mexico, to be used in the operation of the saw and planing mills.

Mr. W. M. Lalor has resigned as manager of the railway department of the United States Light & Heating Co., to accept the position of sales manager of the electrical department of the Gould Coupler Co., with offices in Chicago.

The Chicago Pneumatic Tool Co., 50 Church street, New York city, has recently taken orders for five gasoline-driven air compressors. These machines were sold to structural contractors and are of a type recently perfected by the Chicago company.

The Railway Improvement Co., New York city, has been incorporated to do general contracting, electrical work of all kinds, and mechanical engineering, etc. The incorporators are Rufus L. MacDuffie, 30 Church street, New York City; Geo. W, Fairchild, Oneonta, N. Y.; A. H. Carlisle, 74 Broadway, New York City. Capital, $100,000.

Hildreth & Co., New York and Chicago, have secured steel inspection contracts on the mill, shop and field work for the Denver post office and court house.

The Chesapeake & Ohio Equipment Corporation, recently organized, has filed at Richmond, Va., a trust agreement conveying to the Mercantile Trust Company of New York rolling stock to a total cost of $5,500,000 as security for $4,-800,000 series A and B, one year, 5 per cent equipment notes to be dated July 1, 1910. None of the notes will be sold at present.

The Hodges-Downey Construction Company, St. Louis, Mo., has received a contract from the St. Louis, Iron Mountain & Southern for the filling of about 20 trestles, approximately 460,000 yards, on the line between McGehee, Ark., and Helena, Ark.

The Safety Foot Guard & Railway Appliance Company, Columbus, Ohio, has been incorporated with a capital stock of $10,000. The incorporators are H. D. Ridenour and others.

The Kellogg Switch & Supply Co., Chicago, has been made exclusive agent of the United States Electric Co., New York, for sale of railway telephone equipments, including the Gill selector.

The Marion Shovel & Dredge Company, Marion, Ohio, has been incorporated with a capital stock of $400,000. The incorporators are J. D. Owens, Arthur E. Cheney, B. K. Evans, C. A. Owens and H. J. Barnhart.

The W. S. Tyler Company, Chicago, has moved its offices from 800 Railway Exchange building to 701 Harvester building.

E. H. Symington has been appointed mechanical expert of the T. H. Symington Co., Baltimore, Md., with headquarters at Chicago.

The Damascus Brake Beam Company will open a plant in Cleveland, Ohio, soon to replace that which was burned a few weeks ago at Sharon, Pa.

The Bucyrus Company, South Milwaukee, Wis., has secured all the rights to manufacture and sell the Heyworth-Newman drag line exacavator, formerly held by James O. Heyworth, of Chicago. A complete line of these excavators will be developed and placed on the market.

The Blue Island Rolling Mill & Car Co., Blue Island, Ill., has leased its property to the Chicago, Rock Island & Pacific. By its terms the Rock Island has rented the property for $2,500 a month, but has the right to purchase the property prior to October 31, 1910, for $150,000.

Dalton Risley, who has been in charge of the railway sales department of the National Refining Co., has resigned this position to accept a position in the railway lubricating department of the Indian Refining Co., with headquarters in Cincinnati. It is doubtful if there is a more popular man in the lubricating business than Mr. Risley. His hosts of friends in the railway and supply field will watch his progress among new associates with interest.

The Burnite Machinery Co., Denver, Colo., reports good success in the sale of the Smith hose clamp tool. This tool which was described in the Railway Master Mechanic, issue of April, 1910, furnishes a convenient and economical method of clamping air and steam hose to fittings. The tool is designed to be carried by shop or outside repair men and the features mentioned have attracted considerable attention on the part of mechanical men.

The Williams All-Service Car Door Company, Clinton, Ill., has been incorporated with a capital stock of $600,000. The incorporators are Walter Scott Williams, Charles R. Westcott and William H. H. Hastings.

Clapp, Norstrom & Riley, general sales agents of the Western Wheeled Scraper Co., Aurora, Ill., and Davenport Locomotive Works, Davenport, Iowa, have purchased a tract of land at Clyde, Ill., where they will build a shop, 60 ft. x 100 ft., to be used for handling stock implements.

The Vulcan Steam Shovel Company, Toledo, Ohio, will build a plant at Evansville, Ind., to cost $200,000.

The Universal Car Seal & Appliance Co., Albany, N. Y., has been incorporated with a capital of $60,000. The incorporators are: Howard Van Renssalaer, William C. Martineau, Clarence R. Martineau.

The Baldwin Locomotive Works have filed papers with the secretary of state of Pennsylvania providing for an issue of $10,000,000 first mortage 30-year bonds to bear interest at 5 per cent. Kuhn, Loeb & Co., New York, and Brown Brothers & Co., Philadelphia have concluded negotiations for the disposal of the entire bond issue. Brown Brothers & Co. recently underwrote a $3,000,000 bond issue for the Standard Steel Works Co., Philadelphia.

The W. H. Coe Mfg. Co., Providence, R. I., sole manufacturer of Coe's Gilding Wheels and Coe's Ribbon Leaf, has recently rearranged its railway department, making E. J. Arlein its western representative with headquarters in Chicago; Benj. A. Smith its eastern representative with headquarters in Philadelphia; and Frank Taylor its special representative with headquarters in New York City. All of these men are well known in the railway world and the new arrangement of territory will enable them to keep in close touch with their friends.

Railway Mechanical Patents Issued During August.

Draft-rigging, 965,183—George Hargreaves, Jr., Detroit, Mich.

Convertible freight-car, 965,203—Solomon C. Lindsay, Greensburg, Pa.

Sand-box for cars, 965,212—George H. Monroe, Philadelphia, Pa.

Sand heater and drier, 965,214—Charles A. Mullen, New York, N. Y.

Bolster, 965,228—John M. Rohlfing, St. Louis, Mo.

Straight-air and automatic emergency brake apparatus, 965,615—Walter V. Turner, Edgewood, Pa.

Graduated release-brake, 965,616—Walter V. Turner, Edgewood, Pa.

Nut-lock, 965,633—Thomas J. Jones, Trumbull County, Ohio.

Safety appliance for railway-cars 965,679—James T. Andrew, Montgomery, Ala.

Metallic packing, 965,688—William B. Claflin, New York, N. Y.

Means for securing wheels to axles, 965,705—Harry C. Grant, Bayonne, N. J.

Car-door, 965,751—Charles E. Salsbury and Roy O. Couch, Hampton, Iowa.

Magnetic brake-shoe, 965,798—Edgar Harry Cockshott, Leeds, and Alfred Walter Maley, West Bromwich, England.

Automatic air and steam coupling, 13,138—Joseph V. Robinson, Salem Oreg.

Mold for brake shoes, 965,869—Charles B. Carter, Chicago, Ill.

Nut lock, 965,885—Charles Ewing, Tarrytown, N. Y.

Angle cock holder for railway cars, 965,902—Louis A. Hoerr, St. Louis, Mo.

Nut lock, 965,885—Charles Ewing, Tarrytown, N. Y.

Metal underframing for cars, 965,934—Herman Pries, Michigan City, Ind.

Bolster, 965,943—John M. Rohlfing, St. Louis, Mo.

Bolster, 965,944—John M. Rohlfing, St. Louis, Mo.

Sleeping car bunk, 965,953—Max M. Schneider, Chicago, Ill.

Grain-car door, 965,958—Abram L. Smock, Guion, Ind.

Brake beam hanger, 965,964—Sidney Smith Underwood, Montreal, Quebec, Can.

Brake beam hanger, 965,965—Sidney Smith Underwood, Montreal, Quebec, Can.

Nut lock 966,003—William R. Gardner, Los Angeles, Cal.

Nut lock, 966,004—William R. Gardner, Los Angeles, Cal.

Door hanger, 966.007—George A. Glover, Bristol, Tenn.

Railway-car compartment and folding table therefor, 966,028—Frederick J. Leigh, Seattle, Wash.

Underframe for railway-cars, 966,054—George B. Robbins, Hinsdale, and William E. Sharp, Chicago, Ill.

Differential axle device, 966,073—Arnold Becker, Santa Barbara, Cal.

Dump-car, 966,075—Clinton F. Blake, Chicago, Ill.

Refrigerating apparatus, 966,076—Gabriel A. Bobrick, Los Angeles, Cal.

Draft gear, 966,114—Thomas L. McKeen, Easton, Pa.

Draft gear for railway cars, 966,115—Thomas L. McKeen, Easton, Pa.

Car truck frame, 966,123—Willard F. Richards, Lancaster, N. Y.

Brake beam hanger, 966,141—Sidney Smith Underwood, Montreal, Quebec, Can.

Brake beam hanger, 966,142—Sidney Smith Underwood, Montreal, Quebec, Can.

Sanitary car toilet, 966,158—Charles R. Blake, Richmond, Cal.

Air brake system, 966,211—Charles W. Hurl, Altoona, Pa.

Tandem spring and friction draft rigging, 966,234—John F. O'Connor, Chicago, Ill.

Friction draft rigging for railway cars, 966,235—John F. O'Connor, Chicago, Ill.

Friction draft rigging, 966,236—John F. O'Connor, Chicago, Ill.

Dumping car, 966,237—Max Orenstein, Berlin, Germany.

Attachment for driving boxes, 966,344—Charles Markel, Clinton, Ia.

Grain-door for box-cars, 966,348—Samuel Wilson Murray, Milton, Pa.

Car fender, 966,354—Martha B. Pfingst, Dorchester, Mass.

Bolster guide for truck frames, 966,375—Harry T. Anderson, Butler, Pa.

Bolster guide for truck frames, 966,376—Harry T. Anderson, Butler, Pa.

Train pipe coupling, 966,393—Samuel P. Foster, East Chattanooga, Tenn.

Revolving headlight, 966,427—John H. Clark, Rock Camp, W. Va.

Brake beam, 966,429—Frederick R. Cornwall, St. Louis, Mo.

Car panel with movable sash, 966,430—Samuel M. Curwen, Philadelphia, Pa.

Railway-car truck, 966,432—Ethan I. Dodds, Central Valley, N. Y.

Railroad-car brake, 966,446—Clarence H. Howard and Harry M. Pflager, St. Louis, Mo.

Friction draft rigging, 966,464—William H. Miner, Chicago, Ill.

Brake shoe, 966,616—Julius Stromeyer, Philadelphia, Pa.

Mail-handling device, 966,649—John H. Buchanan, Ashley, Pa.

Draft rigging, 966,656—John F. Courson, Pitcairn, Pa.

Window-cleaning apparatus, 966,660—Peter F. Daly, Chicago, Ill.

Mail crane, 966,743—Francis H. Hall, Burbank, Cal.

Rail drilling and reaming machine, 966,751—Henry W. Jacobs, Topeka, Kan.

Superheater, 966,792—William F. Buck, Chicago, Ill.

Dumping car, 966,860—Thomas P. Roberts, Knoxville, Tenn.

Locomotive, 966,884—John F. Beck, Grand Rapids, Mich.

Sleeping car berth and chair, 967,137—Frederick J. Leigh, Seattle, Wash.

Means for tightening railway car sides, 967,220—Charles F. Murray, Chicago, Ill.

Car door, 967,273—Charles I. Walker, Sacramento, Cal.

Convertible railway car, 967,318—James S. Braddock, Mount Pleasant, and Franklin G. Lindsay, Scottdale, Pa.

Draft rigging, 967,385—John A. Jackson, Chicago, Ill.

Tightening means for car sides, 967,412—Charles F. Murray, Chicago, Ill.

Railway rail, 967,414—Samuel H. McCarty and James T. Hindman, Grayville, Ill.

Brake rigging, 967,433—William G. Price, New Castle, Pa.

Automatic air coupling, 967,516—Archer H. Harrison, Orange, La.

Car wheel lathe, 967,573—Willard Thomas Sears, Philadelphia, Pa.

Combination box car, 967,615—Thomas V. Coulston and Charles E. Teeter, Springfield, Mo.

Safety valve for air brakes, 967,731—Thomas B. Coyle, Ashley, Pa.

Car door, 967,757—Alexander H. Glandon, Wabedo, Minn.

Nut locking device, 967,790—Christopher W. Levalley, Milwaukee, Wis.

Car door, 967,814—Samuel W. Murray, Milton, Pa.

Grain door for box cars, 967,856—Silas Tappin, Webster, S. D.

Grain door, 967,870—Edgar B. Gilleland, Wichita, Kans.

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MECHANICAL CONVENTIONS 1911.

At a joint meeting of the executive committees of the Master Car Builders', Master Mechanics' and Railway Supply Manufacturers' Ass'ns in Washington September 30, it was decided to hold the 1911 conventions at Atlantic City, N. J., June 14 to 21.

ELECTRIC RAILWAYS AND HIGH SPEED.

The Bluffton electric railway collision, in addition to exposing defects in the operating system of the road, calls attention to another feature, that of the inadaptability of the equipment and roadbeds to the high speeds now being attained on many electric railways. To those who have watched the years of studious work given by mechanical officials to the careful development of steam road equipment for high speed service, the haphazard selection and operation of electric equipment is a source of surprise. The principal change in the ordinary electric car when arranging for high speed interurban service is an increase in motor capacity. If this be good railroading, it is time that steam road operatives were sending their men to the electric roads for lessons in simple design. When light rail, heavy grades and sharp curves can be negotiated by heavy electric cars at high average speeds, it would seem that the limit of speeds in steam road practice, where all these conditions are so much superior, is still far from being reached. It is time that electric railway operatives adopted steam road methods in the careful design of equipment and maintenance of roadway.

WHO'S NEXT?

If anyone doubts that landscape gardening has no place in railway repair shop operation let him visit the "gold plated" shops of the Grand Trunk at Battle Creek, Mich. While threading his way through the beds of geraniums, poppies, pansies and orchids which bedeck the grounds, the doubter, if he is a pessimist, will perhaps offer the opinion that probably gardening and not locomotive repairing is the specialty of the shops. A study of the comparative statistical data, which is carefully compiled and kept to date by the motive power department, will quickly dispel any aspersions of this nature cast at the methods of Master Mechanic McGrath, however. Indeed, if the comparisons are carried far enough, one is inclined to wonder if there may not be some connection between this devotion to the aesthetic and results as evidenced in quality and quantity of the output of repair shop work.

CONVERTED LOCOMOTIVES.

We have reached a point in mechanical design where the ingenuity of those in charge of the mechanical department of our railroads has produced so many improvements that locomotive types are wearing out much faster than the machines themselves. It is hard to estimate closely the life of any locomotive, but the last few years has seen such strides in the improvement of power that practically new locomotives have been superseded in the service for which they were intended by new types better adapted. Principal among these innovations is the Mallet. The success of this locomotive need not be dwelt on here. It is being considered in prospective appropriations all over the country not only in one class of freight service but even for passenger traffic. Considering these facts it is fortunate indeed that the type lends itself readily to piecemeal construction. A road well supplied with new locomotives of the type standard three or four years ago faces the problem of obtaining the newer Mallet without too great an incidental expense of scrapping the displaced power.

The Mallets converted by the Great Northern from consolidations, which were in good shape physically but which were antidated for the service intended, have been in every way as successful as would have been the case with completely new engines. The officials of the Chicago Great Western recently found themselves "up against it" with plenty of new power too light in design for the increasing demands of the freight service. Following the example of others they have converted several prairie locomotives into very neat and efficient Mallets in every way as well suited to the work as new engines of that type would have been.

On another page of this issue we illustrate the converted locomotives of the Chicago Great Western. The slight change necessitated in the rear or old section is surprising when, it is considered that all the latest improvements are included in the completed engine. The smoke box of the older engine converts readily into the necessary combustion chamber of the Mallet. The boiler extension consists of a simple feed-water heater entirely independent of and easily attached to the older boiler. An idea, which we believe can be safely ascribed to Mr. J. G Neuffer, superintendent of motive power, somewhat out of the ordinary is the arrangement of the receiver pipe between high and low pressure cylinders to carry it through the center of the feed-water heater instead of between the frames. Doubtless the expected result is a decrease in condensation. The idea is not carried to a logical conclusion however, in the application of piston valves to the low pressure cylinders.

With traffic conditions as they are, nearly all appropriations for new power are recommended, not on account of a scarcity of available locomotives, but nearly always on account of a desire to decrease operating expenses by increasing the weight of the unit. If this end can be reached, as has been shown, by the purchase of a half a locomotive for each unit and without the waste of funds incidental to the sale or scrapping of discarded types, the advantage is evident. It is predicted that converted Mallets will soon be the rule rather than the exception.

Shops of the National Transcontinental Ry. of Canada.

The National Transcontinental Ry. of Canada is one of the roads which have sprung into existence since the general exploitation of the resources of the Canadian Northwest by the older existing trunk lines. This road has over eighteen hundred miles under construction. The shops at St. Boniface, near Winnipeg, are designed to take care of the heavy equipment repairs for the entire system and are centrally located with that object in view.

The mechanical department of the road is not yet organized to the extent of providing a complete operating force. The present head of the department is W. J. Press, mechanical engineer, whose office is at Ottawa. F. W. Walker is the superintendent of the locomotive shops now under construction at St. Boniface, Man.

An examination of the birdseye view of the St. Boniface shops, herewith reproduced from the Railway and Marine World, will show a rather close grouping of the buildings. This has been effected with the intention of reducing all outdoor transfer work to a minimum. As the shops are located on the open prairie the discomforts of a Canadian winter are accentuated, and this fact was taken into consideration when planning the original layout. The ground level about the shop buildings has been raised four feet by gravel fill to avoid difficulties incident to spring freshets and to provide for proper drainage at all times.

The various buildings are arranged about a midway, which runs north and south across the property, and are served by a series of standard gauge service tracks branching off from the yard tracks to the south. Communications between the buildings is obtained by means of narrow gauge industrial tracks and the overhead traveling crane which runs the whole length of the midway, thus serving the various shops. The buildings constituting the locomotive shop plant are located on each side of the midway and south of the through track, passing north of the power house, while the car shop plant is north of that line. The grey iron foundry and forge shops, of course, serve both branches of the work. The power house is located centrally, thus doing away with long runs of piping and wiring feeders. The whole plant is laid out so that each building may be extended 100 per cent in the future when increased space is required.

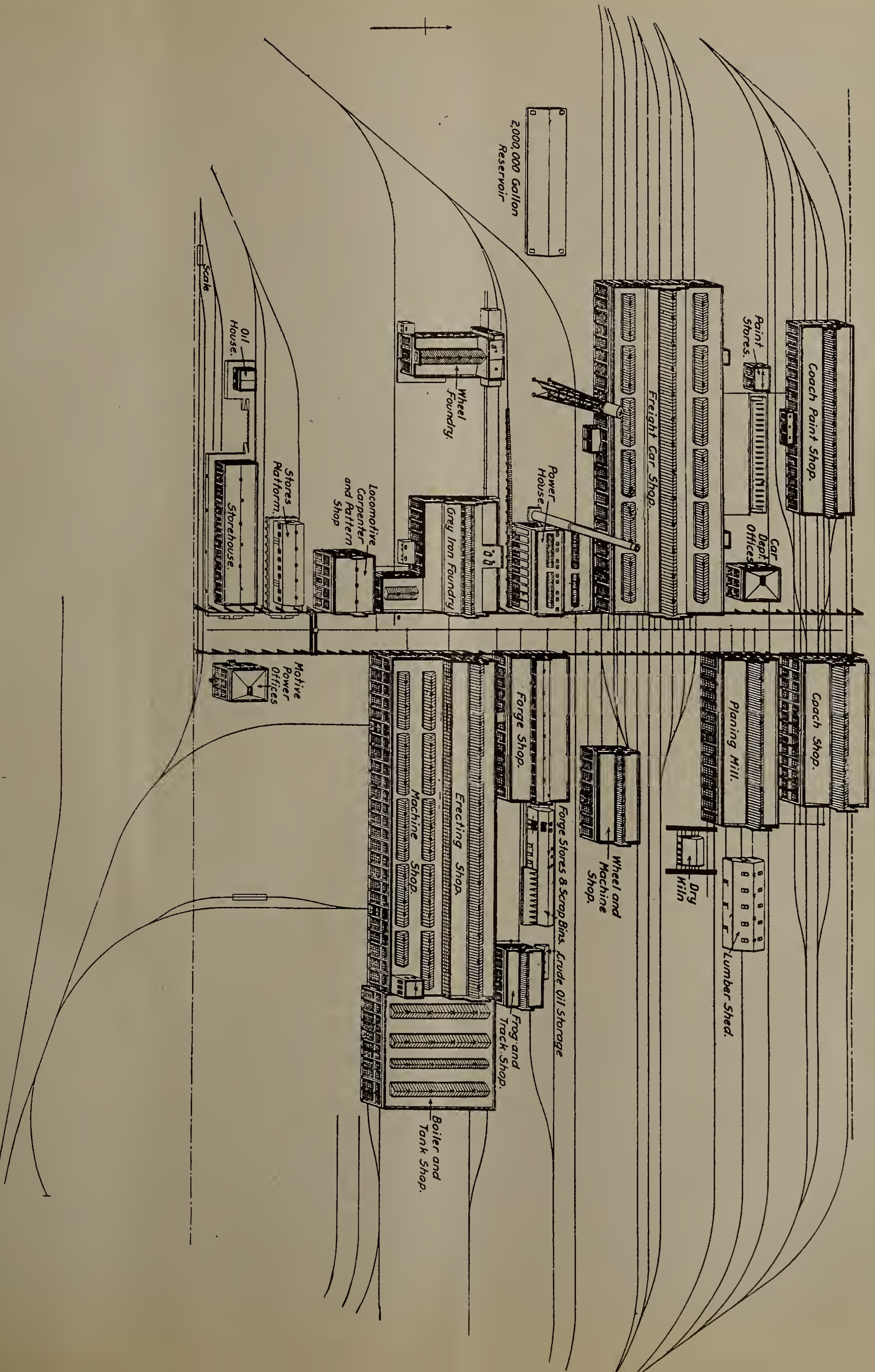
The buildings, with the exception of the storehouse, oil house and stores platform, are of steel construction with self-supporting steel frames, concrete foundations and walls up to the windows. The balance of the superstructure masonry is brick, and it is carried up into a parapet wall, all around the building, capped with a concrete coping. The roof drainage is carried down inside the buildings from receiving hoppers in the roof and through running traps to the sewers. The roofing on all the large buildings is a built-up roofing composed of felt and and asphalt covered with gravel. All window glass throughout the plant is ⅛-inch thick ribbed glass and the skylights are glazed with ⅜-inch wire glass of best quality. The skylights are carried on steel ribs with rolled copper sheathing to carry the glass. Copper is used throughout for all flashing gutters and ventilators. The shops, when completed, will have a total floor space of a little over 17 acres.

The system of general interior illumination is to be on the mercury lamp principle, with lamps and reflectors hung high in the shops. This form of illumination has been found most satisfactory, giving an easy, even light and no sharp shadows. There will be plug receptacles in all buildings at frequent intervals in order that lamps on cables may be carried to any definite point or into boilers, etc. Ample window areas and wide skylights have been laid out in order to obtain the maximum of illumination, and as the interiors of the shops are all painted white, the light is exceptionally good.

High and low pressure steam, water, compressed air and drinking water are distributed throughout the various buildings, with numerous outlets. Fuel oil is distributed under pressure from the storage tanks to the furnaces in the boiler shops, while an accumulator gives the necessary hydraulic pressure for operating the various hydraulic machines.

The electric traveling cranes throughout the plant are equipped with alternating current motors and are operated directly from the three phase circuits from the power house.

The piping distribution system is carried up and down the midway from the power house in a tunnel of sufficient size to permit of passage alongside the pipes, and branches to the various buildings are run from this tunnel in tile con-



General Layout, St. Boniface Shops, National Transcontinental Ry.

duit packed with asbestos sponge. On entering the building the piping is carried on the trusses and steel work of the shop. The shops are protected from fire by an extensive system of yard piping and fire hydrants, with hose houses at convenient spots.

Locomotive Erecting Shop.

This building consists of three bays 70, 60 and 40 ft. wide respectively and 613 ft. long. The 70-ft. bay has a height from floor to bottom chord of truss of 50 ft. and is laid out with 25 engine pits arranged across the house. There are two entrance tracks for bringing in locomotives, and the 120-ton crane which spans the 70-ft. bay lifts the locomotive and carries it up or down the shop to whichever pit is ready for it. Under the 120-ton crane is a 10-ton crane spanning the bay for general work and handling material. Each pit is furnished with plug connections for electric light and valves for steam, water and air, and there is a wall bracket crane on the column between alternate pits. The 60-ft. bay is used for the heavy individual motor driven machinery and is spanned by two 10-ton cranes for handling material. The lye vat and the fire furnace and floor are also in this bay. The last 72 feet of this bay is used as a flue shop and is equipped with all the necessary furnaces, cleaners, etc., for this work.

The 40-ft. bay is devoted to the lighter machine work on bolts, rods, motion parts and general departments, and the apparatus is grouped and driven from line shafts, each group being handled by a single motor. At the east end of this bay is the riveting tower equipped with a 20-ton crane for handling boilers. Overhead in the 40-ft. bay is a balcony running the whole length of the shop and on it are located the indirect heating plants, locker rooms, lavatories, tin shop and light repair and brass departments.

The building is heated by indirect radiation, exhaust steam being furnished from the power house to the heating coils, and the air drawn through these coils is driven by fans through the underground concrete ducts and delivered into the building at floor level through outlets along both walls, under the windows.

A 3-in. wooden floor spiked to sleepers bedded in bituminous concrete is used throughout the shop. The balcony floor is of concrete. The compressed air for this shop is furnished by two motor driven air compressors, thus making this shop independent of the central plant air compressor in the power house. Stand-by connections are made with the general air distribution in case of emergency. Across the end, and forming part of the same building, is the

Boiler and Tank Shop.

This building has four bays, 60, 50, 20 and 65 ft. respectively, 180 ft. long and 36 ft. from floor to bottom chord of truss. The 60-ft. bay is for general boiler work and is served by a 30-ton traveling crane. There is an inspection pit at the north end of the bay for testing purposes. The 50-ft. bay is devoted to heavy machinery, both individual motor driven and group driven, hydraulic flanging press, etc., and is spanned by a 10-ton crane for handling material. The 30-ft. bay is used for light group driven machinery, and over 100 ft. of it is a balcony on which is carried the indirect heating apparatus for this building, also the locker rooms and lavatories. The balance of the bay is served by a five-ton electric traveling crane. The 65-ft. bay is laid out with tracks for accommodating tenders and has a capacity for 9 tanks. A 20-ton crane spans this bay and handles the various materials.

This building also is heated by indirect radiation, a system of ducts and outlets similar to those in the locomotive shop being used. A 3-inch wood floor, also of similar construction, is used throughout the shop. An individual motor driven air compressor is installed in this shop for supplying the necessary compressed air for use with the various pneumatic tools. Stand-by connection is made with the locomotive shop pipe line. The motor driven hydraulic pumps and accumulator for supplying hydraulic pressure for the plant are located in the north end of this shop.

Forge Shop.

The forge shop is 260 ft. by 100 ft., spanned by a single truss, giving clear space for the location of equipment. Most cranes with jibs swinging from furnaces to hammers handle the heavy materials, while a line of double forges along the south side of the building look after the lighter work. The spring department is located in the southwest end of the shop and is equipped to look after the spring work for both locomotive and car departments. This apparatus is driven from line shafting driven by three 40-h.p. motors carried on wall brackets and is arranged with ample floor space close by for storage of raw and finished material. A motor driven blower furnishes the necessary blast for the furnaces through underground and overhead piping. The steam to the hammers and exhaust return the oil, and hydraulic piping are carried in concrete ducts through the shop and to the various machines. The building is heated by indirect radiation from coils along the walls under the windows. The locker room and lavatory are in a small two-story annex on the south side of the building.

The forge stores and scrap bins are close by the forge shop in a frame structure 30 by 220 ft. on light concrete foundations. The east 100 ft. is built as a roofed platform, with the floor 4 ft. above grade for handling material conveniently to cars. This platform is divided into bins for sorting and storage of scrap. The western portion is completely enclosed with plank lining inside and drop siding outside, and forms storage for coke, coal and iron stock. The iron stockroom is arranged with an extensive rack system for storing the different stock sizes for use in the forge shop. The coal and coke storage bins are arranged with roof hatches, in order that cars may be unloaded by a clam shell and crane from car and the coal and coke dropped through the roof. Industrial tracks are laid out so that the materials and supplies can be run into the forge shop on small cars.

Crude Oil Storage.

This is a concrete building 25 by 60 ft. The building is mostly underground, the floor being 8 ft. below grade, the side walls only projecting 2 ft. 6 in. above ground. A concrete roof carried on steel beams closes in the building, making it fireproof in every way.

Inside, on concrete foundations, are four iron storage tanks each with a capacity of about 8,000 gallons of crude oil. Compressed air connections are made to these tanks, and the oil is forced out and distributed to the various buildings requiring it.

The tanks are arranged so that the pressure can be cut off and the tanks filled by gravity from tank cars standing on sidings alongside the building. Piping connections to the outside of the building, fitted with lock-up valves, are supplied for this purpose.

Store House.

The store house, which is across the midway from the locomotive erecting shop, consists of a large reinforced concrete platform 4 ft. above grade in order to bring it to car platform level for handling supplies from the store house to the various buildings. On the platform is a brick building 60 by 260 ft. with reinforced concrete roof carried on concrete posts. The front portion of this building is fitted up for offices for the store keeper and clerks and has a fireproof vault. The balance of the building is equipped with an extensive system of shelving, racks, reels, etc., suitable for arranging the varied stock of materials which the store house contains. Side doors along both sides of the building give ready access to the interior from the loading platforms. The building is lighted with incandescent lamps and is heated by a system of direct radiation coils. The office portion of the building has ample flooring throughout and the balance has a cement finished top of the reinforced concrete the same as the rest of the platform. From the west end of the store house platform a connecting platform, at the same level and also of reinforced concrete, joins the store house platform to the oil house platform 100 feet away.

Oil House.

The oil house consists of a platform, 50 by 70 ft., rising 4 ft. above grade, and of similar construction to the store house platform. In this case there is a basement below the platform with a headroom of 10 ft. In the basement, carried on concrete foundations, are the 9 storage tanks for holding the various kinds of oil in stock. An additional tank for holding gasolene is buried outside the building with a pump connection into the building. The tanks are filled either by gravity from tank cars standing alongside the building through fill pipes, or else from barrels poured into fill boxes set in the platform floor and connected to the tank fill pipes. A system of draining pipes is arranged for cleaning out the tanks, the oil is handled upstairs, in the pump room, by a row of Bowser measuring pumps, each pump connected to one of the tanks. On the top of the platform is a small brick building 30 ft. long, with concrete roof and divided into two rooms by a concrete wall. One room is the pump room and the other is used for storing oil cans, waste, etc. There is a hydraulic elevator from the basement to the platform level outside the house for handling barrels, etc., from the storage in the basement. There is a stairway to the basement inside the building and there is also a pump running down from the outside. The building and basement are heated by direct radiation coils and the floor is the same as the balance of the platform. The building is made as fireproof as possible and the windows are glazed with ¼-in. wire glass.

The Stores Platform.

The stores platform, alongside and to the north of the storehouse and separated from it by two tracks, consists of a large platform similar to the storehouse platform and of reinforced construction 56 by 180 ft. carried on concrete posts and open below. It is also at an elevation of 4 ft. above grade. The platform projects into the midway 15 ft., enabling the midway crane to handle material from the platform to the other buildings. On this platform is erected a light steel framework, enclosed on the sides and ends with corrugated iron and furnished with a roof covered with prepared roofing. A five-ton hand-operated crane spans the building and has a runway the whole length on the building and a wide crane door at the front permitting the crane to run out over the platform in front of the building with its load and exchange loads with the midway crane. Access to the building is furnished by four doors on the sides, and one on each end, opening out to the platform. The building is lighted with incandescent lamps in groups with reflectors. The store platform is intended to be used as a storage for large, heavy material, such as castings, pipe, etc., and thus act as a relief to the general store house for this class of material which will be protected from the weather by the light structure and will be conveniently handled by the small crane.

Locomotive Pattern Shop.

The locomotive carpenter and pattern shop, to the north of the stores platform, is a two-story building 70 by 100 ft. with a self-supporting steel frame on concrete foundations. The first floor is of reinforced concrete and is carried on concrete columns, and the roof is also of reinforced concrete, making the first floor practically fireproof, as all communications with it are protected with fire doors, etc. The ground floor has a 3-in. wood floor, and is used as carpenter and pattern shop, being equipped with light woodworking machinery driven from line shafts. The carpenter shop is intended to look after the necessary woodwork incidental to locomotive repairs and the pattern shop for the manufacture and repair of patterns. The lavatory and locker room is on the north side of the shop and communication with the pattern storage upstairs is by an enclosed stairway, or by an elevator running in a concrete enclosed elevator shaft equipped with fire doors. The elevator is for handling patterns to and from the pattern storage room. The first floor is equipped with shelving and racks for the storage of patterns, the windows are glazed with wire glass and the room made as fireproof as possible. The heating of both floors is by indirect radiation coils.

Foundry.

The Grey Iron Foundry is a large building 130 by 200 ft., with a cleaning room annex 60 by 80 ft. The main foundry has a central bay 70 ft. wide and two side bays each 30 ft. wide. The central bay is used for the general moulding floor, and is spanned by a 15-ton electric traveling crane equipped with a 5-ton auxiliary hoist for light lifting. There are also small jib cranes attached to the columns for handling flasks, etc. The 30-ft. bay on the north side has the moulding floor for scrap castings at the west end and the core room and core ovens at the east end, each served by one ton hand-operated traveling cranes. There are three core ovens, two with shelves and rack cars for general small cores and one large oven with platform car for cylinder cores and similar large work. This core oven with platform car for cylinder and portion of core room is served by a five-ton bracket crane. Between these two departments on the north side is the cupola room with two cupolas, one 84 ins. and one 72 ins. in diameter. The scale room for weighing charges and the blower room on an elevated steel platform are also in the cupola room. The core ovens are fired from the cupola room, thus keeping all the ash, etc., in one place.

The loaded cars, after weighing, are handled by pneumatic elevator to the charging floor and are handled by pneumatic charging machines. The charging floor has a steel plate floor and is laid out with a transfer truck and storage tracks for keeping loaded cars on hand ready for charging while the cupolas are running. The cupola room and charging floor are 30 by 40 ft. The 30 ft. bay on the south side of the building has the brass foundry at the west end, and enclosed with expanded metal screens 10 ft. high. This small foundry is equipped with brass furnaces and regular brass foundry equipment and is served by a one-ton operated traveling crane. The lavatory and locker rooms are also in this bay and the heating apparatus for the indirect radiation heating system. The cleaning room is at right angles to the main building and is spanned by a five-ton electric traveling crane. In this annex are the tumblers, grinders, etc., and a service track runs right through the room, enabling cleaned castings to be loaded right on the cars for shipment. The moulding sand is stored in bins on the south side filled from cars on the service track and distributed by industrial tracks inside the building.

Along the north side of the building between the service track and the foundry is a long galvanized iron shed, roofed in and divided into separate compartments. Here are stored direct from cars, the coke, pig and scrap iron under cover and these are brought into the foundry on cars running on industrial tracks also under cover between the bins and the building. Having both material and handling tracks under cover is a great point in the handling of materials in the cold winter weather. The grey iron foundry is intended to supply the demands of both the locomotive and car departments. Besides the above equipment, a gravity moulding machine and a brake shoe moulding machine are installed.

Motive Power Office.

The motive power office building, south of the locomotive erecting shop and opposite the storehouse, is a brick structure with a steel interior frame. The floors are of maple on spruce joists carried on the walls and steel work. The building is 60 by 68 ft. and consists of two stories and basement. The basement is devoted to a large testing laboratory, lavatories and storage. The ground floor has offices for the officials and clerks for the department, while on the first floor is the drafting room, file room and blue printing room. A vault is carried up from the basement to roof with vaults on each floor. The building is plastered throughout and the halls and stairs have a wood wainscoting. The building is heated by direct radiation coils and has incandescent electric lighting fixtures.

Coach Repair Shop.

The coach repairs are carried out in a building 115 by 260 ft. There are four working tracks down the center of the shop with a standing capacity of 12 standard coaches. An industrial service track runs between each pair of tracks for handling material. Along each side is a balcony 16 ft. wide with a light wall enclosing it from the floor of the balcony to the roof of the building. There are windows in this partition giving light from the shop as well as the windows on the outside wall. Material is handed up to these balconies by large hoists, one at each corner of the building. The north balcony is devoted to cabinet work and is laid out with a line shaft operating various light working tools, such as scroll and band saws, lathes, drills, surfacers, etc. On the main floor directly below this north balcony are a number of heavier woodworking tools, most of them individual motor driven, such as rip saws, planers, mortisers, matchers, etc., for preparing the lumber before it is sent upstairs to the cabinet shop. One of the ideas in putting the cabinet work upstairs, was to get the work in a dry spot where it would not be affected by dampness, etc., as it would be if on the ground floor. The south balcony is divided into several departments: the east end is used for the upholstering repair work, then the tinsmith shop, then a varnishing room, and the west end is devoted to a small brass shop, with lathes, a small shaper, drill, etc., and a couple of buffing machines and a lacquer oven. On the main floor below this balcony are located the nickel plating department with its tanks, buffing wheels, etc., the sash washing sink, and in the center are the lavatories, locker rooms and indirect heating apparatus. The building has a wooden floor and the balconies have concrete floor. The heating is by indirect radiation. Cars are handled right through the shop, entering it at the east end, passing through the shop and undergoing the necessary repairs and then going straight across the midway and entering the paint shop.

Coach Paint Shop.

This is a building 67 by 340 ft. with four through tracks for painting cars and two industrial service tracks. This shop has a standing capacity for 16 standard coaches. The lavatories and heating apparatus are in an annex on the south side. The building is heated by indirect radiation and has a concrete floor draining between the tracks. The cars enter at the east end, either direct from the coach shop, or else from yard tracks with cross-over connections, and pass through the shop and out at the west end.

Freight Car Shop.

The freight car shop is south of the coach paint shop. It is the second largest building in the plant and is 200 by 600 ft. with nine through tracks having a standard capacity for 108 standard freight cars. The building is divided into three equal bays 65 ft. wide, and there are three car repair tracks with two industrial supply tracks to each bay. Cars enter the east end and are repaired and pass on to the west, where they are painted and stenciled, and then pass out of the west end of the building into the yard. The two side bays have a clear height to bottom chord of truss of 20 ft., while the center bay has a clear height of 30 ft. and is spanned by a 20-ton electric traveling crane with a five-ton auxiliary. This center bay is intended for the handling and repairing of steel cars in the future when required. The locker rooms and lavatories are in small annexes on each side of the building, and the two sets of indirect heating apparatus are housed in small annexes on the north side of the building with tile distributing ducts throughout the shop. The floor is 3 in. wood throughout the shop and concrete in the lavatories and heating annexes. On each side of the freight car shop are platforms, racks and bins for the storing of prepared rods, bolts, etc., for work on freight cars. These bins, etc., are served by industrial tracks running through the shop.

Car Department Office.

This building is close to the midway, and is similar to the motive power office building.

Planing Mill.

From the lumber shed or dry kiln, the lumber enters the east end of the planing mill, which is 100 by 300 ft., and is arranged so that standard cars of material can be run in at the east end and the material unloaded right at the machines. The north side of the shop is devoted to the still work, and here the machines are arranged in order so as to take the rough sill as it enters the building and dress, cut off, mortise, tenon and bore it and pass it out of the west end of the shop all ready to be run into the coach shop alongside of the freight car shop across the midway. The south portion of the shop handles the flat work for flooring, sheathing, etc., and in the same way the material entering the building is handled by the saws, planers, matchers, cut-off saws, etc., and is shipped to the shop where it is to be used. At the west end of the shop is a department for door and sash work, with the necessary planers, saws, sanders, etc., for this work. A small line shaft drives the grinders, saw menders, etc. On the south side at the center is located the lavatory and locker room, and on a steel platform above them there is arranged the indirect heating apparatus. On the same platform are arranged the exhauster fans for handling dust, chips, etc., from the various machines and driving them through pipes to the powerhouse, where they are used under the boilers. Most of the machines are driven by individual motors. The floor of the building is of wood and the heating is by indirect radiation.

Wheel Foundry.

The wheel foundry is close to the grey iron foundry and served by the same service tracks. It is some 70 by 150 ft. laid out in the straight line floor principle with four floors of 25 wheels each, giving a capacity of 100 wheels a day. This building, like all the others, can be extended when required. There are 32 annealing pits and two pitting cranes. Wheels are cleaned and loaded on to cars from platform at pit top level. The cupola room, the core room, and charging floor are at the north end of the building and are equipped with pneumatic elevator, scale room, pneumatic machine blower, storage tracks and all necessary details for operation. The building is heated by indirect radiation. The stock storage sheds are arranged on the same principle as those for the grey iron foundry, and everything is handled under cover. These sheds and those for the grey iron foundry are laid out on the same lines and may be extended and made one long storage when occasion demands. There is a wheel breaker in connection with the wheel foundry and a ball weight casting breaker between the wheel and grey iron foundry.

Wheel Shop.

When the wheels leave the wheel foundry they are taken to the wheel and machine shop building, 70 by 160 ft., spanned by a 10-ton electric traveling crane and equipped wheel press, wheel lathes, tire furnace, etc., for all wheel work, and with arch bar drills, engine lathes, planers, drills, nut tappers, grinders, etc., for general car shop machine work. The building has a wood floor and is heated by indirect radiation. The lavatory and locker rooms are on the south side of the shop. In front of the building is a storage space for mounted wheels convenient to the freight car shop across the midway.

Power House.

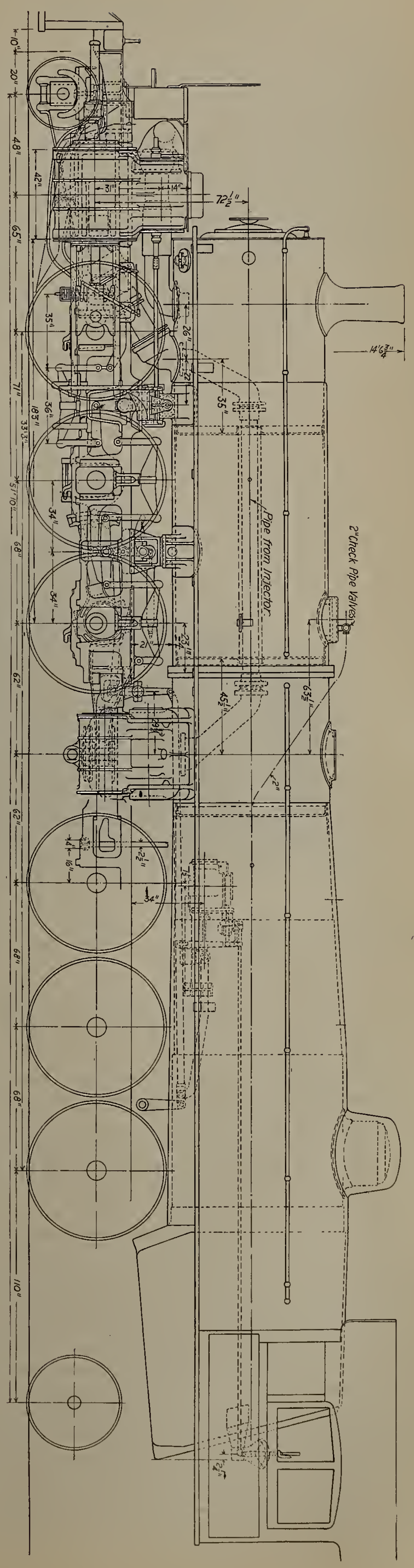
The power house is 110 by 150 ft., divided lengthwise by a brick fire wall into two rooms, 45 by 60 ft. wide respectively. The boiler room, 45 by 150 ft., is laid out to receive 10 water tube boilers in units of about 400 h. p. Two of these boilers are arranged with Dutch ovens for burning shavings, etc., and refuse from the planing mill, while the balance of the boilers are equipped with chain grate stokers. The ash pits are furnished with chutes which run the ashes into the conveyor and they are carried up to the ash hopper and thence through the wall by means of a chute into the waiting ash car outside the building. The boiler room and basement floors are of concrete and all shafting, etc., for driving the stokers is carried along the ceiling of the basement.

The engine room, 60 by 150 ft., has a pump pit 16 ft. wide and 8 ft. deep running along the whole length of the fire wall. The pit is bridged by gangways from the boiler room to the engine room floor. In the pump pit is located the air receiver for the compressor, the vacuum pump, the fire, boiler, service and well pumps and the feed water heater. The water and exhaust and other lines are carried along the walls of the pit with all connections from apparatus. The floor and retaining wall of the pump pit are of concrete. In the engine room are located three 500 k. w. a. c. generators driven at 150 r. p. m. by direct connected cross compound Corliss engines, one 250 k. w. a. c. generator driven by simple engine, and two 150 k. w. d. c. generators, one driven by simple engine and the other by motor. Two exciter units for furnishing the necessary excitation for the generators are also driven by simple engine. A 1,500 c. ft. capacity Corliss engine steam driven air compressor completes the engine room apparatus. Along the north is located the switchboard with generator, totality and feeder panels. All connections from generation to switchboard are underground in conduits. From the switchboard to the various buildings and cables are carried in tile ducts laid in concrete, all wiring distribution between power house and other buildings being made underground.

The engine room is spanned by a 10-ton hand-operated traveling crane for handling heavy apparatus, etc. The finished floor of the engine room is polished maple laid on a false floor carried on sleepers, bedded in bituminous concrete. A concrete chimney 11 ft. diameter and 200 ft. high alongside the power house, furnishes the necessary draught for the boilers, while a tank with 100,000 gals. capacity elevated 125 ft. above the grade gives pressure for general water service distribution. A smaller tank of 10,000 gals. capacity is hung just below the larger tank, giving storage and distributing pressure for drinking water, which is piped to drinking fountains throughout the shops.

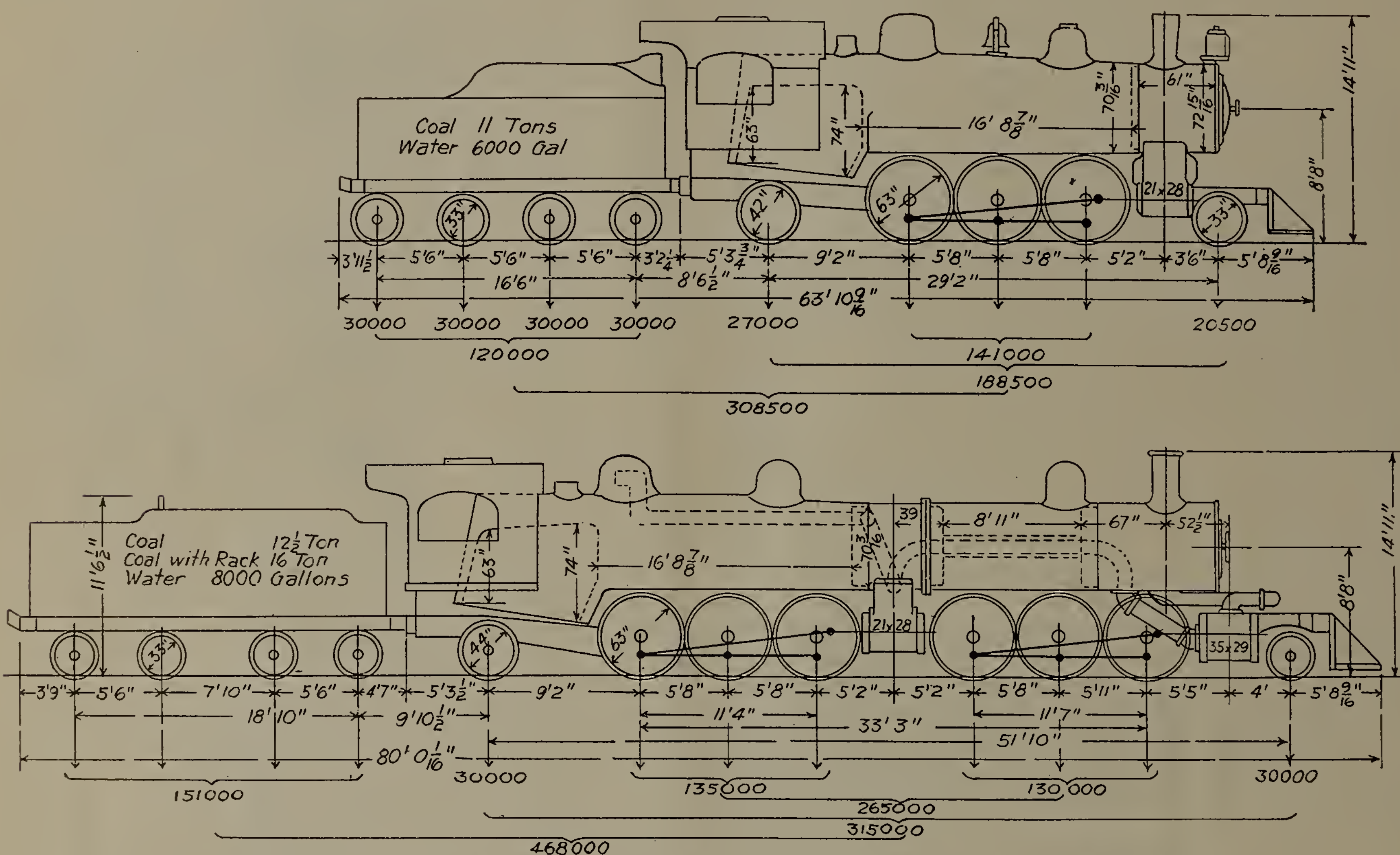
Water System.

In order to obtain a soft water supply at the shop site, a pumping station is erected on the bank of the Red River just above the city of Winnipeg. The pump house has suction pipes running out into deep water of the river connected to vertical triplex high speed pumps with a capacity of 1,000,000 imperial gallons in 24 hours. These pumps are direct connected to gas engines by friction clutches. A duplicate gas producer plant is installed and cross connected in every way in order to render a shut down practically impossible. From the pump house, the water is conveyed six miles to the shops through 12 ins. diameter wire wound wooden stave piping; pipe line being fitted with valves, access, access boxes,



Converted Mallet, Showing Elevation of New Front Section, Chicago Great Western R. R.

etc. At the shop site, the pipe line empties into one end of a storage settling reservoir with a storage capacity of 2,000,000 imperial gallons. This reservoir is constructed of concrete and is 60 by 270 ft. long and 25 ft. deep with a dividing wall running lengthwise dividing it in halves. The surrounding walls and floor are of mass concrete and the center dividing wall is of reinforced concrete, designed so that one-half of the reservoir may be emptied for cleaning, while the other half remains full. The reservoir is roofed over with a double plank roof carried on steel beams and a prepared roofing over all. This roof is to keep the dirt and drifting snow out. Close up under the roof are hung a number of pipe coils for heating in winter to prevent the ice forming too thick on top of the water and thus interfering with the outlet pipes, etc. The water is drawn off from the float in the sump below, adjusted to start and stop the pumps when the water in the sump reaches certain levels. The pumps and motor are in duplicate to have a steady increase of breakdown and the control is so arranged that if one motor fails to start the other will be started before the water reaches a dangerous level. Under heavy rain conditions, the flow from the shops and the grounds is estimated at approximately 16,000 gals. a minute, so pumps of that capacity have to be installed. The pump house is a small reinforced concrete building located about 1,400 ft. from the midway. The two pump discharges run into a single 36 ins. diameter banded wood stave pipe, which runs from the pump house to the Seine River, into which it discharges close to its junction with the Red River. The sewer pipe line is carried from the shops to the river along the N. T. R. right-of-way.



Drawing Showing Principal Weights and Dimensions of Locomotives Before and After Converting.

opposite end from that at which it enters, thus giving a good opportunity for the dirt to settle. The reservoir is arranged with by-pass piping by which it can be emptied by the pump and also with overflow outlets to prevent flooding. Water is drawn from this reservoir for the high level tank and connections are also made to the fire pumps in the power house.

Sewer System.

As there is no municipal sewer to drain the shops into, it has been necessary to install a sewer system for them, and as there is not sufficient fall from the shops to the Red River for a gravity flow sewer, it has been necessary to put in a pumping station to force the sewage to the river. A gravity system of tile collecting pipes runs through the shop site connecting with roof downspouts, sanitary sewers and all drains. This sewer line is arranged with manholes, surface drains, vents, etc., and discharge into a concrete pump forming the basement of the pump house. The next floor carried the volute centrifugal pumps of 16,000 gals. per minute capacity with suction pipes running down into the sumps and shafts running up to the floor above where are located the vertical shaft motors for driving. These motors are controlled by an automatic starter, which is operated by a

CONVERTED MALLET LOCOMOTIVES, CHICAGO GREAT WESTERN R. R.

The Chicago Great Western R. R. is converting in its own shops at Oelwein, Ia., a number of prairie type locomotives into Mallets. The locomotives before and after being converted are shown in the accompanying illustrations, published by courtesy of Mr. J. G. Neuffer, superintendent of motive power.

The prairie type engines are known as "Class F-3" the principal dimensions being as follows:

Heating surface, fire box	154 sq. ft.
Heating surface, tubes	3,071 sq. ft.
Heating surface, total	3,225 sq. ft.
Tubes	352-2 in. x 16 ft.-9¼ in.
Firebox, inside	74 in. x 96 in.
Grate area sq. ft.	49.3
Steam pressure	200 lbs.
Valve gear	Stephenson
Valves	11 in. Piston
Size of journal	9x12 in.
Size of journal main	9½x12 in.

Size of journal radial	7x12 in.
Size of journal engine truck	6x12 in.
Size of journal tender	5x9 in.
Weight per sq. in. driving	214
Weight per sq. in. tender	333
Total wheel base	54 ft. 2½ in.
Ratio heating surface to grate area	65.4
Ratio heating surface to cylinder volume	287.4
Total weight, engine and tender, empty	236,500
Total weight, engine and tender, loaded	308,500
Tractive power	33,320 lbs.
Tractive power per lb. M. E. P.	196
Ratio adhesion to weight	4.23

The front unit was designed and built by the Baldwin Locomotive Works, the details being made interchangeable with those of the rear unit as far as possible. The fitting and erecting was done at Oelwein.

In this case, as is general custom, the front section of the boiler constitutes a feed water heater. A combustion chamber makes possible the repair of the tubes by giving access to the boiler heads. Tenders of 8,000 gallons capacity for the Mallets were built at Oelwein.

The converted locomotives have been designated as "Class H-2" and the dimensions and ratios are as follows:

Heating surface, firebox	154 sq. ft.
Heating surface, tubes	4,924 sq. ft.
Heating surface, total	5,078 sq. ft.
Tubes 352-2in.	16 ft. 8⅞ in.
Tubes, 400-2in. F. W. Heater	8 ft. 11 in.
Firebox inside	74x96 in.
Grate area	49.3 sq. ft.
Steam pressure	200 lbs.
Size of journals	9x12 in.
Size of journal main	9½x12 in.
Size of journals, radial truck	7x12 in.
Size of journals, engine truck	6x12 in.
Size of journals, tender	5½x10 in.
Weight per sq. in. driving	205
Weight per sq. in., tender	343
Total wheel base	80 ft. 6½in.
Ratio heating surface to grate area	65.4
Ratio heating surface to cylinder volume	287.4
Total weight, engine and tender, empty	367,500
Total weight, engine and tender, loaded	466,000
Tractive power	52,100
Tractive power per lb. M.E.P.	306
Ratio adhesion to weight	5.1

Converted Mallet, Chicago Great Western R. R.

AUTOMATIC CONNECTORS FOR FREIGHT AND PASSENGER CARS.*

BY MR. WILLIS C. SQUIRE.

Automatic connectors have been designed and experimented with for at least thirty years or more. A resume of the patents that have been issued for automatically connecting up the air brake between two cars shows that the earliest designs were generally of the butt face type; the side port or lapping type, where two planes carrying gaskets are arranged to slide by each other, was almost as early in the field as the butt face type. In the early stages of the development, the arms or method of gathering for directing the gasket carrying faces into register, embodies the same principles that are seen in those practical types which are in use today.

Among the earliest types of gathering arms for automatic connectors, the pin and funnel type seems to have held the general attention, because it seemingly presented a very simple and drect method for accomplishing the end in view, namely, the directing of the two gasket bearing faces into register, and without the use of manually operated attachments.

The pin and funnel type has probably been selected for use and put into service oftener and then abandoned than any other design. The pin and funnel type connectors in practical test have been, unfortunately, limited to special service and on a few cars only at a time. As has been stated above, the pin and funnel design has been used by connector designers and patentees ever since the art was developed and practically all the designers and inventors and patentees have used, or considered its use, at one time or another. Therefore, this general design of the gathering or collecting feature is old, but notwithstanding its age, has not had the amount of general service the type deserved. There must be some inherent defect in the design or it would not have been abandoned so often; but at the same time it does possess features that recommend it to every one who first approaches this subject, either as a designer, experimenter or investigator.

The general subject of automatic connectors has been dealt with by the Master Car Builders' Association at various periods. The last definite action taken was at the annual meeting in 1908 at Atlantic City. At this meeting the committee on automatic connectors reported favorably and suggested an outline or contour as a proposed standard, the form of gathering arms of the pin and funnel type for a butt face connector. On page 272 of the 1908 proceeding of the Master Car Builders' Association is shown the proposed outline of the face and gathering

*From a paper read before the Western Railway Club September 20, 1910.

arms of the connector recommended by that committee. See Appendix "A".

This committee reported as follows:

"Four types were found which were perfected to a point that your committee felt they could consider them, one being of the side port type and three of the butting type."

This committee further reported:

"The collecting and registering devices are principally of two types: First, the pin and funnel; second, some form of wings, or wing and tongue. One of the connectors referred to, the side port connector had a wing and tongue collecting and registering device, and two of the butting connectors different forms of wings and one a pin and funnel type. Your committee has considered all these carefully and is of the opinion that the pin and funnel, or some modification thereof, seem to offer the best possibilities."

The committee then went on to say as follows:

"From a careful study of these designs, your committee recommends the butt type of connector. That the center line of the air-brake port should be 17½ inches below the center line of the coupler or passenger car connectors, the sequence of ports from the top to be as follows: Air-signal, air-brake and steam heat, to be located on the vertical center line of coupler. Air-signal and air-brake ports to be spaced 3 inches centers; the center of the steam heat port 3½ inches below the center of air-brake port."

The committee went still further and took into consideration the possibility of future development in the operating of electrically propelled and controlled trains, and suggested as follows:

"There are in a few instances four ports required between passenger cars. The connector is recommended so located that a fourth port can be added above the signal-port.."

As the matter stands at present, to one who can read the signs of the times it is clearly up to the manufacturers and designers of automatic connectors to get together, decide upon a specific form of connector contour that will be acceptable to the Master Car Builders' Association, and then confine all their efforts towards perfect development on the lines laid down, and thereby overcoming many of the difficulties of the problems of design and development of special parts which are peculiar to the manufacture of automatic connectors.

The action of the Master Car Builders committee of 1908 was to recommend a connector contour that embodies mechanical points that have not been tried out by long service. The pin and funnel type of connector had, as has been stated before, been used and tried out and abandoned on a large number of designs. It is true possibly that the connectors themselves failed of accomplishing what the inventors desired, but it should be borne in mind that the general abandonment and final elimination of such type of connector contour or gathering feature by the early experimenters meant that there was some fatal defects in the design that would not meet all the excessive conditions of service. Not the least important of these is, in the length of the pin that would be required to insure a wide range of gathering makes it possible that a slight distortion of this unsupported pin length would cause a failure of registration because the pin itself is a vital function of the interlock and registration. If one were to write the history from the earliest date that experimenters tried to design a mechanical connector, it would be seen that the pin and funnel had been specified more times than any other type.

The writer is of the opinion that the gathering arms should be capable of severe and extensive distortion without destroying their gathering feature or the possibility of the connectors registering and locking in position once the faces of same were brought together, and he does not believe it possible that such conditions can be met with the pin and funnel type. A modification of this design is possible, which would make it more adaptable to the general conditions of service. and that would be the adoption of what might be termed a "cone and funnel attachment." With this construction the cone would present an almost unbreakable contour and would withstand very heavy blows, and in fact, would withstand a shock without distortion that would be capable of tearing the whole connector from its brackets or main support on the draw bar shank.

Location of Connectors.

Every connector, whether found practical or not, that has been put into service, as far as the writer knows, has been placed below and coincident with vertical plane containing the center line of the M. C. B. coupler. If not for convenience and for mechanical reasons alone then owing to the fact that the location shall be such as to make it possible to couple hand hose with the automatic connectors during the transition period they should be placed below the coupler.

We are limited to a comparatively small space directly below the Master Car Builders coupler. As a matter of fact, no consideration of an automatic connector can now be given except that it takes into account this particular detail of both freight or passenger cars.

As noted above the Master Car Builders committee recommended 17½ inches below the center line of the draw bar as the proper location of the center line of the proposed connector, which is also the center line of the air-brake port.

Experience and service have both shown that the chosen location directly below the Master Car Builder coupler, is the logical one and any other location would cause interminable confusion and unnecessary complication and expense.

If it were only the freight train cars that were to be considered, any other location, either above or below the draw bar, could be considered and made satisfactory to all users of automatic connectors. As freight train cars and passenger cars are run in the same trains and the construction of our American passenger equipment is such that a free passage way must and does extend from one end of the train to the other, no location that will interfere with such free passage can or ever will be considered by railway officials.

We are then of necessity brought down to a very narrow range for location of connectors and as the Master Car Builder committee have specified 17½ inches below the draw bar center as a center line of the proposed connector, any connector that may be adopted by the railroads of America will have to be so located and then designed to meet all the extraordinary conditions of traffic operation, not only in trains but also in the switching yards and terminals, whether it be of the "pin and funnel" or any other type.

From this general introduction to the subject of location lines for automatic connectors, we find ourselves confined and limited at the outset. The lowest range of position of attachments of the M. C. B. coupler is the limit at the top. At the sides we are practically not limited, except by the desire to keep down the weight and to make the device practical, sightly and reasonably inexpensive. On the bottom we are limited by arbitrary clearance line established by the American Railway Association and the Master Car Builders Association.

The figure given by the Master Car Builders Association of 1908, namely, 17½ inches below the center line of coupler, seems to the writer to have been wisely chosen, as it will give the designer and manufacturer plenty of room to make all the necessary height of gathering arms for the purpose of insuring perfect registration. The cubical space into which this device can be placed is limited to the standard length of the draw bar; a lateral dimension of 7½ or 8½ inches either side of the axial center line of draw bar, and not to exceed 22 inches below same center line.

Range of Action Necessary for the Registering Devices.

To one who has watched connectors in service and seen the wonderful positions they can take and still not destroy the value of the connector, it seems that there would be no necessity of connectors registering when the coupler heads pass, but if investigation were made of these connectors which have seen the longest service and a careful record were kept of the condition of such connectors, I believe there would be no one of you here tonight who would not come to the positive conclusion that connectors would give far better service if their range of gather to insure registration were increased to that point that they would couple and register even when the coupler heads passed one another at the extreme limits of such conditions, and it is a possibility in the future if connector attachments and locks are provided that a temporary car coupling can be made by means of the connectors themselves whereby it would be possible to move a car to a point of safety by careful manipulation of such couplings.

Locking Devices for Automatic Connectors.

From experience based on a careful investigation made several years ago of the types of connectors then in practical daily use the writer hazards the opinion that some automatic locking devices which will hold the faces of connectors together once they have registered, in order to insure the constant and perfect contact of the gasket faces, will be required and developed for the standard connector that is adopted by the railroads of this country. The reason for this opinion is that in the inequalities of the road bed, found at some point on every railroad and also in yards and on industry tracks, necessitates that the connector adopted shall be free to swing in its supports and allow of excessive vertical and lateral displacement of the cars without disturbing the relation of the connector faces carrying the gaskets. All except one of the connectors which have been developed to date have depended upon compressed springs to keep the faces in contact and to insure an air-tight joint. By the breaking of this retaining spring, the registration features and the possibility of a perfect coupling is nullified. For these reasons alone, the writer believes that a connector should, after once coming into contact and registering, be as flexible and as free of motion upon their supports as does the present hand coupling supported with the flexible hose. This feature can best be explained by a simile. The connectors being coupled should be like an extended link in a chain which is held in position by the supported ends of the chain.

Such a lock as is suggested will require several features which are capable of mechanical solution that will be developed by trial and service conditions. The lock must drop into place and must have sufficient retaining force to insure perfect junction of the gasket faces when the locks drop into position to withstand the higher fluid pressure of the high-speed air-brake, namely, 110 pounds per square inch; air-signals having a pressure of 60 to 70 pounds; and the steam pressure required for heating of passenger cars. We all know that the steam pressure is liable to vary from 5 pounds to 150 pounds or even more, if the hose will stand it. It is not intended that any such pressure shall be carried on steam-heated trains, but it is a fact that sometimes more pressure accumulates back in the steam train lines than is necessary. This is done to hurry the heating of a chilled car, or it may be due to the imperfect regulation of the steam heat reducing valve.

There is a possibility of meeting the conditions mentioned by a combination of the best features and methods of support, contact and registration embodied in several of those types of connectors that have been in service for the past decade. This combination is possible, is desirable and will be accomplished when the connector manufacturers finally get together to decide upon a standard form and features for manufacturing automatic connectors for freight train and passenger train service. When this condition of affairs is an accomplished fact, refinements of designs and the elimination of unnecessary parts and the simplification of the entire mechanical problem will be possible.

Certain refinements of designs are made necessary even today in automatic connectors; not the least of these is that of providing in an automatic connector a simple and ready means of renewing air-brake air-signal and steam heat gaskets without the necessity of uncoupling a train of cars to part the connectors. Several designs covering this feature have been developed and will be placed in service within a very short time, if they have not already been applied to cars. Even this development does not elimiate the necessity of trainmen or air-brake inspectors from going between cars to perfect a coupling when such couplings are to be required. It is a condition of daily service that an engine is usually attached to the newly made-up train but no movement of the train is allowable until the air-brake inspector or the trainman has given a clear signal and that only after a final trial of the air-brake system has shown it to be serviceable. Where a train of cars are tested in yards fully equipped with air pressure pipe lines, there is no possibility of injury to the inspector or trainman if he will protect himself by the usual blue flags placed at each end of the train before he attempts to enter between the cars to inspect or replace gaskets. In the latter instance, it would be necessary, in case of a defective connector gasket, to secure a switching engine or run a locomotive to make the cut between the cars where the defect is located. The removable gasket feature, therefore, will be a necessity and must be provided for in a connector that is adopted by the Master Car Builders Association. These gaskets must be removable from the back of the connector by means of an ordinary wrench, and the gaskets, when once placed in position, must automatically make their own seal with the plug which retains them in position.

Supporting Attachments of Connectors.

There are points to be taken into consideration in designing an automatic connector, not the least of which is the amount of compression necessary to give the springs that hold the faces of the connectors together during the registration period. Connectors must therefore extend beyond the inside face of the knuckle in its closed position and after having come together the plane of contact between the faces of the connectors should be coincident with the normal neutral plane of the Master Car Builders knuckle. The wear of the knuckle changes the relative position of this neutral plane, but such change must not affect the relation of one conductor to another on any two cars. The definition of the position or location of the connector face when coupled must be standardized by the Master Car Builders Association in order that uniformity in design will be assured.

The logical position of the connector has been described by the M. C. B. Committee of 1908. They did not touch upon or describe any method of attachment of the connectors to the cars themselves. A preponderance of preference has been practically expressed by the large number of designs submitted by inventors and manufacturers for the permament attachment or support to the draw bar head of shank. This is a reasonable and logical location for the reason that the M. C. B. coupler has considerable range of motion longitudinally due to compression of the draft springs, both in buffing and in pulling, and also has a wide lateral movement. It is apparent to those of you who are acquainted with the conditions of service that the proposed automatic connector must be attached to the draw bar shank in order to relieve the connector itself, of carrying in its mechanism a spring of sufficient capacity to overcome the entire range of extension and buffing of the draw bar spring in addition to having sufficient compression when the draw bars are extended to their limit, to retain the faces of the connector in perfect contact and be air tight under pressure. Such attachment to the draw bar shank is not objectionable in itself and it adds a secondary safety feature to the coupler from pulling out beyond the carry irons.

One of the most important things that the M. C. B. committee must decide and adhere to rigidly for all time is the exact location of the center line of the connector, the location of the air-brake port on this line and definite position of the steam heat gasket below the air-brake port center, the interchangeability of the gaskets in both air and signal port, and finally a range or limit for the location of supplementary ports or electric connections that will be necessary for electrically operated interurban equipment that may in the future be operated interchangeably, not only on electric roads but also on steam roads. This feature is now a possibility and will have to be considered for equipment that is running into several of the large cities of the United States.

Many inventors and manufacturers of the automatic connectors have given serious consideration to the combination of electrical contacts with the automatic connector, not only for train lighting purposes but also for signal service control of motor-driven cars, as for instance in elevated and interurban service. The electric feature must take into consideration the elimination of any possible short-circuiting, of blowing out the arc when cars are parted, while current is still flowing through the connections. There may be other items that will be apparent to the electrical engineer whose experience has been directed towards an automatic electrical connection.

I believe it is a possibilty, without fear of contradiction, that any manufacturer or designer, inventor or patentee, whose type of connector were adopted or recommended by the Master Car Builders' Association, would be willing to waive all rights and give the railways of America the contour lines of his particular connector. The prestige of this action would be of great value to the party whose design is adopted as standard, but it is a foregone conclusion that no such design will be adopted unless all rights are waived, and therefore it is most necessary and imperative that the connector manufacturers get together and take action while there is time for careful analysis to determine what type of gathering feature of contour shall be adopted and presented to the railroads of the country. Those who have watched the development of the M. C. B. coupler know that no progress whatever was made towards the standardiation of couplers until the Master Car Builders' lines or contour was given outright by the manufacturer and owners of the said line to the railroads of the United States. There should be no necessity at this late date of a repetition of the conditions that surrounded the final adoption of the M. C. B. coupler. At present there are only a few manufacturers and a limited number of patentees who are prepared to go into the question of automatic connectors and present it to the railroads for favorable consideration. The air-brake connector is a very important part of the air-brake system and therefore any device that is adopted and presented to the railroads of this country for consideration must, or should bear the approval of the Master Car Builders' Association and the Air Brake Manufacturer.

No drastic action, either by law enacted by states or the federal government, nor untoward pressure on the part of the manufacturers or others should force upon the railroads of this country a device for the purpose of automatically connecting air-brakes between cars. There are a number of connectors on the market today that will give very good service in general passenger train service and yet those devices have developed some defects which would be very undesirable if they were put into general service in freight train cars. We cannot consider for a minute that the design has yet been perfected up to this date that would give an acceptable contour for an automatic connector. There is so much to be taken into consideration, the interests at stake are so large and the expenditures that will be necessary to equip all the cars of this country will be so great that it would cause unnecessary and undesirable conditions to arise which would defeat the end that it is desired to accomplish.

An automatic connector to be practical must be readily capable of making quick connections with the present standard hand hose attachments on passenger train cars. There are three connections necessary to be made, and during the transition period, when it comes, that device which is the simplest, most convenient, has the least number of parts and takes the least time to manipulate will receive merited recognition; therefore, it will be necessary for all parties interested in this subject to bear in mind that they have not met success in a design of an automatic connector until they have made a simple and efficient attachment that will not entail great money loss by their final abandonment when all the cars are finally equipped. It is a fact well known to many railroad men that it was necessary, even after a standard contour had been settled upon for the Master Car Builders' coupler, to have emergency knuckles and other special features for the purpose of making quick repairs on the road. All this meant expenditures of considerable sums of money, and could only be eliminated by the final development of the Master Car Builders' coupler to its present state of perfection, which may or may not be satisfactory even today.

Those railroads that have made extended service tests of automatic connectors have found that the rubber hose connections have had longer life and have been worn out only by deterioration due to age. Mechanical wear and similar deterioration have been the exception rather than the rule. There are several metallic connections on the market today that have had long service tests but are not entirely satisfactory from all points of view. The rubber hose, with all its deficiencies, is really the simplest and most efficient connection presented for consideration to date. The manufacturers of that automatic connector which may be finally adopted and put into general use, will find the problem simplified if provisions are made in the earliest stage of development to use standard length air hose, signal and steam hose for making their permanent connections.

Barnett Connector.

The Barnett Connector is of the pin and funnel type and it practically follows the M. C. B. Committee's details as recommended by them in their 1908 report. This connector has been subjected to some extended service tests during the past few years, but like all connectors of this general design its actual service has been limited to special service on a limited number of cars and under reasonably favorable conditions. So far the results obtained have been reported as satisfactory. The more recent trials of this connector have been made in special service and again the results are reported to be satisfactory.

The Barnett Connector embodies some additional features not found in any other connector presented for the consideration of the railroads, namely, the Barnett Automatic Safety Chain Attachment. This attachment is an essential feature of this general design. The safety chain feature, however, is independent of the connector proper and is as readily applicable to any other type or design of connector.

At the top of the Barnett Connector is cast a flat "shelf" designed to carry the free ends of the Safety Chain, which consists of a hook, links, a disengaging tongue, two eye bars and two anchor bars or link, suitably mounted and connected so as to permit of automatic engagement of hooks and links simultaneously with the connectors coming into register. Means are also provided to disengage or unlock the safety chain simultaneously with the uncoupling of the draw-bar knuckles. The whole combination is attached to a suitably designed casting permanently attached to the draw-bar shank near the yoke. In fact, several of the yoke rivets are used for the permanent attachment of this lug or knee casting.

In case of a draw-bar knuckle opening or the coupler failing the draft strain is carried by these safety hooks. The two anchor links at the back are designed to prevent the draft rigging from pulling out, they being "anchored" to the center sills of the car. These safety chains are so designed that they are not under stress except in case of draw-bar failures.

The whole combination is such as to present a very valuable safety attachment for passenger car train operation as well as for freight service. The two half-tone reproductions show the Barnett equipment attached to two ladle cars for transporting molten metal in the Pittsburgh district. In this equipment the hand hose is left intact to couple readily with the unequipped cars. The upper or signal port is blank, the air brake and air dump occupy respectively the center and lower steam ports in the connector head.

Kelly-Arnold Connector.

The Kelly-Arnold connector is of the straight port butting type, also employing the pin and funnel for gathering and registering the several ports and in this regard is practically the type and outline on which the 1908 committee based its recommendations. This connector is made of cast steel throughout. The body is merely an outline or metal shell carrying the single or multiple portages for air, signal and steam and to which are riveted the pin and funnel of special design. The manufacturers claim they can secure better registration, better and stronger castings and consequently a stronger finished connector by making it in this manner.

As in the other types shown, this connector is permanently attached to the shank of the draw bar. The construction is plainly shown in the illustrations.

A system of all metallic connections has been developed for this connector that have been given service tests during the past year with very satisfactory results. This connector has had some extended trials on a limited number of cars in special service on several railroads.

The gaskets of this connector are cylindrical in section 38 inches diameter and have been adopted because the manufacturers have determined that they can maintain a better joint than with a flat face gasket. The gaskets are relatively soft. This form of gasket is an innovation for the steam joint as is also the fact that the same quality of rubber is used in both air and steam ports. 1¼ inches I. D. gaskets are used for air and signal ports and 1½ I. D. for steam ports.

These soft rubber steam gaskets have given as high as 3 months' service between cars that have been shifted four (4) times daily during that time. To apply gaskets in the yard when cars are coupled, the manufacturers recommend that the connectors are jacked up or down by placing a jack under or above the connector body as may be required, which opens the connectors top or bottom a sufficient amount to permit of the top or bottom gaskets being removed and applied. It is not stated what movement is required to remove the air port gasket. This feature while simple is subject to criticism owing to the danger of the jack slipping allowing the heads to close and possibly cause personal injury. The pins and funnels are riveted to the connector body in order to obtain more perfect contours and register lines. The several parts are assembled on a templet for the purpose of adjusting and riveting those parts to the connector body.

The method adopted by the Kelly-Arnold Co., for permanent metallic attachments to the connectors permit of the attachment of these flexible joints direct to the present standard train pipe locations.

For coupling to cars not equipped with connectors the Kelly-Arnold Co. have designed and make as part of their regular equipment what they term a "swivel joint" in which is used the same gasket as in the connectors. By the opening of the swivel joints the connector is at once disconnected from the train pipes. Special nipples with hand hose couplings attached for the signal, air brakes and steam attached thereto, are connected to the free ends of the several train pipes by means of these "swivel joints" to enable the direct connection by hand to non-equipped cars.

Mohun Connector.

The Mohun connector is of the straight port butting type, employing the pin and funnel principle for gathering and registering the various ports, and in this regard also follows the recommendation and contour lines of the M. C. B. Association Committee's report made at the June 1908 Convention.

The connector is made of metal throughout, the air and steam being carried through passages in the connector body and by construction eliminating all rubber hose connection to train pipe lines.

The manufacturers of this connector have used the pin and funnel idea for bringing the ports together, believing this device will cover a greater range than any other arrangement they know of, and because it is compact and strong with a minimum weight.

They provide the same arrangement and size of ports as recommended by the M. C. B. Association Committee, with the exception of the steam port which they believe should be 2 inches, which size has been proven very satisfactory in service and by tests. That a 2 inch steam line throughout the train has many advantages over the smaller lines, they claim to have proven by extended tests.

When coupled, the connectors are entirely free from the action of the car coupler or draft springs, and all strains are removed from the car coupler carrying irons and car platform. The base of the connector is permanently attached to the centre sills of the car back of the platform.

In order to couple cars which have the ordinary air brake and steam heat couplings, with those having the Mohun automatic connectors, it is proposed using an emergency head which would be clamped on the face of the connector, the back of this head to have the proper fittings for connecting to the ordinary hose couplings.

Means are provided for renewing or inserting the gaskets while two connectors are coupled. The train line and signal gaskets are made of soft rubber. The train line gasket is inserted from the side of the connector head and the signal gasket from the top side of the connector. By removing the caps at those joints, the gaskets can be removed and reinserted by hand. They are held in place by wedges, which are drawn up and kept rigidly in place by the caps. The steam heat gasket is of harder material (a moulded rubber compound). It is inserted from the under-side of the head. By removing the cap at this point the gasket can be taken out and re-inserted by hand. On account of the hardness of the gasket, it is necessary to provide a small amount of movement, which is obtained by placing a spring of a special form behind same. This spring is held in place by a wedge, which is drawn up and kept in place by the cap. A plug cock is placed in the back of the head to open or close the signal and train line ports simultaneously, operated by the handle at the top. The steam heat port is controlled independently by the handle at the bottom, and is provided with a small leakage groove for the discharge of condensation. The cylinders and plungers in the stem of the connector take care of the longitudinal movement of the drawbar and also of the initial compression due to coupling of the connectors.

The plungers are packed with asbestos-graphite ring packings, having a small spring adjustment in addition to the ordinary stud and nut adjustment of the gland. A sheet metal shield is placed around the three plungers, it being attached to the back portion and slips over the front part of the connector. The springs which hold the connectors together are placed on each side of the cylinders; the forward ends of these springs fit into pockets attached to the back half of the connector. In addition to the springs holding the connector together, there is also the force due to the steam and air acting on the ends of the plungers. At the back end of the connector there is a universal joint of a special type, in connection with which tapered plug cock, under spring tension, are used. This joint is provided to take care of the lateral and vertical movement of the connector. The back portion of this joint is attached to the bottom of the car by means of a hinge arrangement, which allows the connector to swing laterally a small amount, thus permitting a slight twisting movement of the connector, which will occur when two cars are passing through a cross-over. The signal, train line and steam heat passages are carried through the connector head, the plungers and thence to the universal joint. At the back of these universal joints, these passages are connected to the signal, train line and steam heat pipes under the car. These pipes are clamped rigidly to the car body a few feet back from the universal joint, thus permitting the flexibility of the pipes to take care of the small lateral swing of the connector. When not in use, the front half of the connector is forced by the main springs against two vertical members of the yoke, which are on each side of the connector and which are attached to the under-side of the car coupler. This yoke, and that portion of the front section of the connector which comes in contact with it are shaped in such a manner that the action of the springs brings and holds the connector in the proper vertical and horiontal position for coupling. In the act of coupling, and when coupled, the connector at the front end is free to move in all directions, as in coupling the front portion of the connector is moved back from contact with two vertical members of the yoke. At the back end of the connector, this movement is taken care of by the universal joint referred to above.

New York Air Brake Co.'s Automatic Connector.

The New York Air Brake Co.'s automatic connector is the one known as the Forsyth. This connector has been on the market, as well as in service for a number of years, which has been improved from time to time, and is the development of a type of butt face connector having wings cast integral with the connector face. Originally this connector had a much wider port face. The port face is now reduced to 4 inches width and is 10⅛ inches high. The signal, air steam ports are arranged as per suggestions of the M. C. B. Committee referred to heretofore. This latest design presents for the consideration of the railroads, a connector in which the gasket can be removed from the back of the connector when same is coupled. The cap at the back of the air-brake port is somewhat restricted by construction and therefore presents some disadvantages against the ready removal of this gasket. However, it is possible to remove the cap of this gasket with a special wrench that will fit the other caps holding the signal and steam gaskets in place. This connector is possibly the shortest in length over all of the butt face type, being connected to a bracket directly below the M. C. B. Coupler head. The center line of the connector body is only 16 inches below the center line of coupler, but this center line can be dropped 1½ ins. to meet the requirements laid down by the M. C. B. Committee's report.

This connector is held in place by a volute spring which rests upon a plate forming part of the ball and socket joint, the other part of which is in the bracket supporting the connector. It has a wide gathering range laterally and will couple readily when draw bars will pass each other. Its vertical range is possibly quite as great as its lateral range. The spacing of the air and signal ports is not in exact accordance with the recommendations of the M. C. B. Committee. This is a detail, however, which it is possible to alter to suit the requirements, as the variation from the recommended dimensions is only 1-16 inch in each instance.

The gaskets for signal and air ports are interchangeable. The steam port gasket is metallic throughout and has been given considerable trial under service conditions. It has proven to be steam tight and very satisfactory wherever it has been used. It does not differ enough from the old design to cause any question as to practicability, in fact, the change made is believed to be advantageous for several reasons.

This connector has been in service on one line for over seven years and the present equipment on that line has had four years continued service. Two other roads have had these connectors in service for four years. It has been tried on several other roads with equally satisfactory results. There is this to be said about this particular connector: the service rendered has only been on passenger cars and therefore, it has not met with the severe and rigorous conditions that are found in freight service.

Robinson Connector.

The Robinson Connector is quite similar in construction and design to the Forsyth, above described. The head with its gathering wings are cast integral and is supported by a volute spring of special design. The method of holding spring and giving universal movement to the sliding center port is similar, in some respects, to the original Forsyth connector. The spacing of the ports does not conform with the recommended practice.

This connector has not yet been placed in service, as far as the writer knows, but it is capable of practically the same service as has been rendered by the Forsyth connector, which it resembles very closely.

The steam heat port of this connector forms one of the three bearing points of the coupler face. It is expected that this design will preserve the resiliency of the gaskets and to prevent foreign substances interfering with a perfect coupling. All gaskets can be removed and replaced by hand.

In the Robinson connector the manufacturers believe that the relatively small area of the faces will be advantageous, because of their compactness and strength and also that all three ports are brought near the center of the spring's resistance, which will relieve the faces of all angular displacement. Considerable benefit is hoped to be derived from the special design of the tapered wire forming the volute spring.

The air and steam gaskets are of the same general shape as those used in the standard hand hose couplings but of greater dimensions.

Means have been provided whereby the Robinson connector is capable of easy and reliable interchange with any car fitted with the present hand-type of coupling.

Rubber hose or metal pipes with any well known form of flexible joints, may be used to connect the connector with all the pipes.

No change in train pipe line locations or the M. C. B. Coupler is required to install the Robinson connector. The usual lug is attached to the draw-bar and the coupler is ready for service. By design the manufacturer believe that this connector will operate in less area than any other connector, thereby requiring, so it is claimed, no changing the location of the pipes, rods, etc., surrounding the draw bar.

Rutherford Connector.

The Rutherford connector is one that has followed individual lines, inasmuch as the coupler head, gathering wing or arms and a barrel enclosing the retaining springs for holding the couplers in a locked position, are cast integral. As originally made, its narrow port's face made it necessary to put in specially formed elongated gaskets in order to gain the necessary port openings. This connector has had a limited amount of actual service but it is reported that the results of the tests have been quite satisfactory.

This connector is much more rugged in design that the other type of butt face connectors that have been presented to the railroads and presents certain features that are well worth investigating and taking into consideration when considering the entire subject of connectors.

The Rutherford connector will engage within a limit of variation in any direction of eight inches. It is claimed that after the connectors are engaged and the cars are coupled they will stay tight so long as the cars remain coupled. The arrangement for flexibility is such that there is no strain on the automatic connector in taking any position required by the position or movement of the cars or when the draw bars slip by.

The manufacturers of this connector believe it is readily adaptable to freight service by arranging a special hanger in the form of a sleeve around the drawbar and depending from it: then by dropping the coupler carry iron about two inches, this hanger or bracket for the automatic connector could be readily applied to any freight car without the necessity of drilling holes in the coupler.

It is felt that the transition period can best be taken care of by having the angle cock to the automatic connector line placed underneath the end sill of the car and a little farther away from the car coupler making the connection with the train pipe by means of a "Y" or "T" and a short nipple, allowing the present angle cock to remain in its standard position and if necessary, with hose attached, until the transition period is passed, at which time the present angle cock can be taken off and the train pipe capped. The cost of this automatic connector for pasenger cars so the manufacturers claim should not exceed $20.00 and for freight cars should not exceed $15.00. It is hoped to develop an arrangement for fastening the brackets to the car couplers so that it will not require the couplers to be drilled, thus making an easy method to apply the automatic connectors and when necessary, to replace them.

The cost of maintenance of the Rutherford connectors has been very slight. The only renewals necessary after considerable service being the application of new spring rods which failed on account of crystallization.

Westinghouse Automatic Air and Steam Connector.

This type of Westinghouse Connector is the only one of the side port type that has been put into long and varied service. It is a special individual design and has been given such general and extended practical service on freight and passenger train cars that it has developed into a very efficient and practical connector. Its range of gathering, both vertically and laterally, is great enough to allow of the connectors coupling and registering, even with excessive variation in car heights and also when coupling on curves where M. C. B. couplers will pass each other, and also when some of its own supports have been defective allowing the connectors to fall below their normal horizontal position.

The signal and air gaskets are interchangeable. The steam gaskets are made of a special grade of vulcanized rubber, and have been given quite a few years of service. The steam port and the parts carrying same are backed by a retaining spring which allows for expansion and contraction due to the heat of the steam passing through them. These retaining springs allow the steam gaskets to be pushed back flush with the face of the connectors when they are coupled, and they have sufficient strength to maintain a contact between the gasket faces, even with high pressure steam. The gathering arm of the Westinghouse is now made of cast steel, and the yoke to which it is attached is made of the same material—is attached to the malleable iron head which carries the port openings and the interlocking registering faces.

The registering faces of this connector are specially designed and suited to this type and make of connector. In order that this side port connector may come together, couple up interlock and register the ports—there are two parallel—planes provided in the registering faces. The two abutting shoulders connecting these two planes of faces are at right angles thereto and one is connected with the center line of the three ports. These planes are spaced ¼ inch apart horizontally and are connected on the other two junctions of the planes by a plane of 45 degrees. These inclined planes allow the two faces to slide together when the faces of the connector have approached to within ¼ inch of final registration. The gasket faces are 1-16 inch above the lower or inner registering plane and therefore are compressed, when final registration takes place, at least 1-16 inch and, during this compression the coupler faces move longitudinally 1-16 inch.

This type is so well known and has given so many years of practical service that further description is hardly necessary.

The method of support of these connectors, as mentioned above, has a very good feature that recommends it strongly to those who will investigate this subject of automatic connectors. The connectors when coupled, are practically a unit and are supported at their rear ends in the brackets which carry them loosely and in normal position without the aid of the buffing springs. The design of bracket and support for the connector has been very carefully worked out, and the writer believes this method of support could be followed in any practical design of connector that is adopted by the railroads of the United States. It has those features that appeal to the investigator and the designer and is worthy of careful consideration.

Westinghouse Automatic Car and Air Coupler.

A more recent development of an Automatic Coupler-Connector is that of the Westinghouse Air Brake Co., known as their automatic car and air coupler (a type unusual to steam railroad practice), for electric roads, more particulary elevated and subway train cars, although it is not limited to such.

In this design of coupler-connector the manufacturers have aimed to make a device to absolutely prevent accidental uncoupling after having once been coupled, which on an exclusive passenger railroad is a very important point.

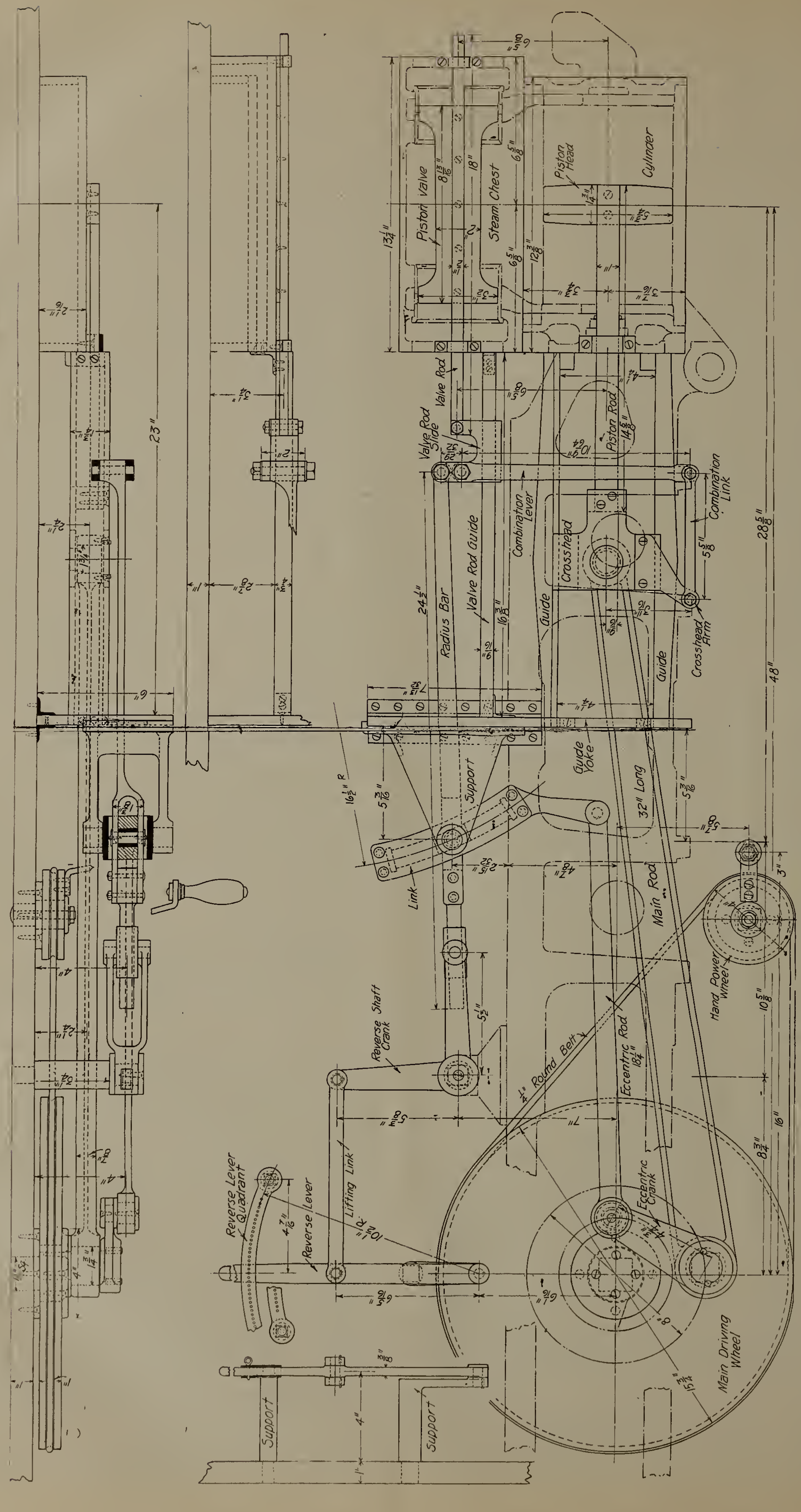
This coupler eliminates the danger to employes in making up trains, as it couples for car and air connections simultaneously. When locked it is not possible to separate them by accident as there are two locks to be disengaged simultaneously before coupler connector can be uncoupled, either lock in either coupler being sufficient to maintain the coupling.

Wide range of gathering and of variation in height of cars in coupling or when running is provided for.

There is no slack between cars except that due to pin wear.

Renewals and replacements of gaskets can be accomplished only by parting the cars, a feature not objectionable in motor trains when at least 50 per cent of each train is a motor car capable of individual movement.

An adopter head has been designed to permit of coupling up with other cars not similary equipped.



Walschaert Valve Gear Model for Locomotive Apprentices, New York Central Lines.

A WALSCHAERT VALVE GEAR MODEL.

The accompanying drawings represent the standard Walschaert valve gear model in use for apprentice instruction on the New York Central Lines. It was intended to reproduce the drawings in such a way that any shop official can make up the model from materials at hand.

Mr. M. J. McCarthy superintendent of Beech Grove shops of the Cleveland, Cincinnati, Chicago & St. Louis Ry., by whose courtesy the drawings are reproduced, has used one of these models very successfully since the apprenticeship course was started.

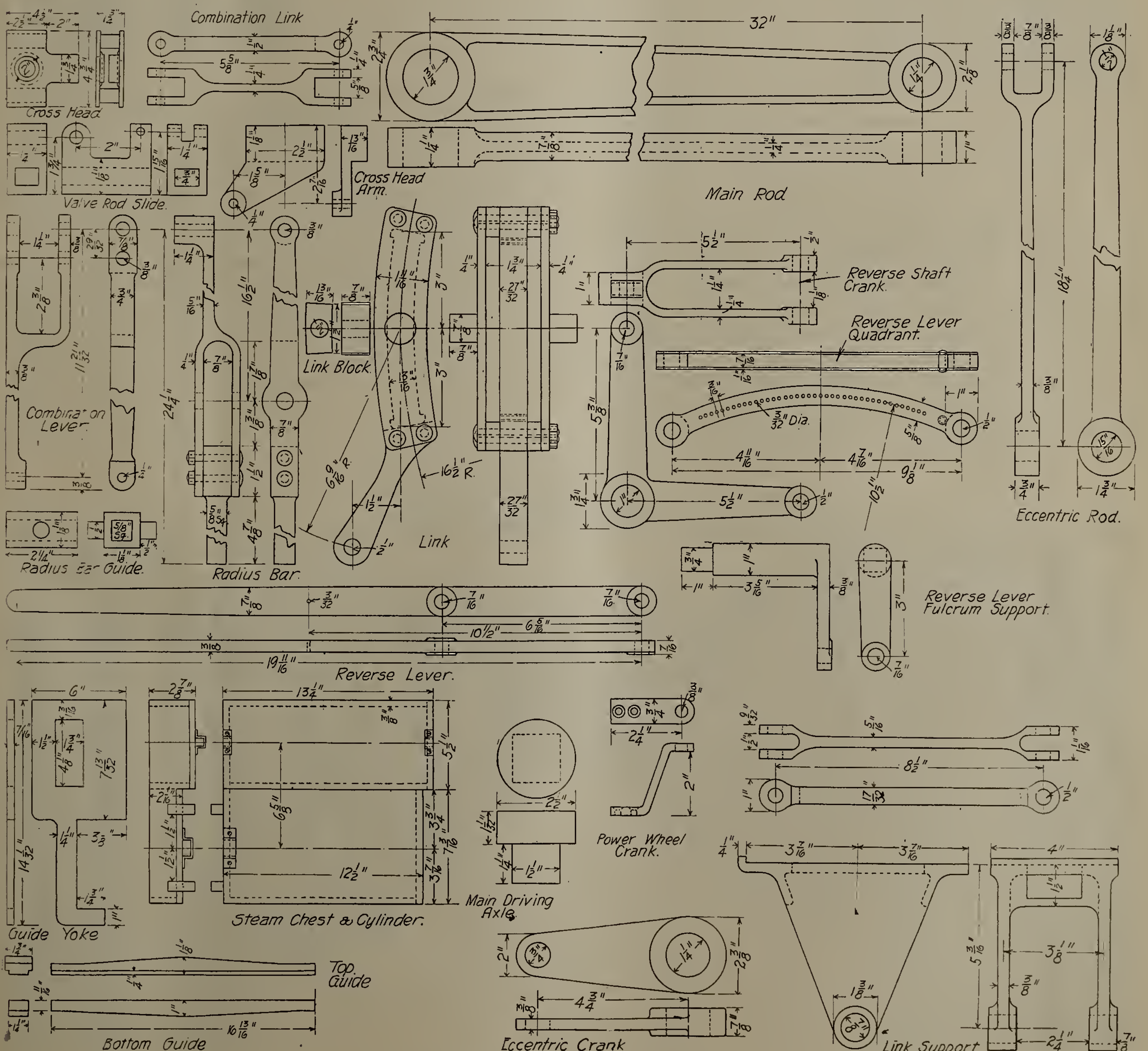
It is suggested that the finished apparatus be painted as follows:

Frame—Dark red.
Cylinder Heads—Slate.
Cylinder Bushing—Brown, and barrel-light red.
Journals—Red.
Steam Chest—Light red, and Bushing—Brown.
Ports in Steam Chest Bushing—White.
All working parts—Aluminum Bronze.
Mounting Board—Black.

In the detail drawing, it is simply intended to show the general outline of each part, the construction being left to the builder, who may use his own judgment in making. Dimensions must be closely followed as a slight variation of detail parts may make a considerable difference in the movement of the valve. All holes should be bored true for a sliding fit. The details as shown on the drawing are to be made of wood unless otherwise specified.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.

The 41st annual convention of the Master Car and Locomotice Painters' Ass'n was opened Tuesday morning, September 13, at the Southern Hotel, St. Louis, Mo., with John D. Wright, Baltimore & Ohio, presiding. The membership attendance was 161, with 170 guests. The convention opened with an invocation and an address of welcome by the mayor of St. Louis, to which R. E. Miller, Delaware, Lackawanna & Western, responded. The secretary's report showed a total membership of 268 and a balance of $200.50 on the books. The election of officers resulted in the following: J. H. Pitard, Mobile & Ohio, president; John T. McCraken, Interborough



Details of Walschaert Valve Gear Model.

WEIGHT OF STEAM IN CYLINDERS AT 180 pounds pressure per square inch.

STROKE IN INCHES

Diam.	2	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38
6	.01415	.05573	.06859	.08574	.09860												
7	.01929	.07717	.09431	.11575	.13290												
8	.02486	.09860	.12432	.15005	.17577	.19888											
9	.03172	.12432	.15862	.18863	.22293	.25376											
10	.03901	.15433	.19720	.23579	.27437	.30867	.34725	.38583	.42442	.46300	.50458	.54017	.57875	.62590	.66449	.70307	.74166
11	.04716			.28294	.33018	.37726	.42442	.47157	.51873	.56589	.61305	.66020	.70736	.75452	.80168	.84883	.89599
12	.05573						.50158	.55731	.61305	.66877	.72450	.78023	.83596	.89170	.94743	1.00316	1.05889
13	.06485						.58365	.64850	.71335	.77820	.84305	.90790	.97275	1.03760	1.10245	1.16730	1.23215
14	.07638						.68744	.76382	.84020	.91658	.99296	1.06934	1.14572	1.22210	1.29848	1.37486	1.45124
15	.08768						.78911	.87678	.96446	1.05214	1.13982	1.22750	1.31518	1.40286	1.49054	1.57822	1.66590
16	.09976							.99759	1.09735	1.19711	1.29687	1.39663	1.49639	1.59615	1.69591	1.79567	1.89543
17	.11253							1.12535	1.23788	1.35042	1.46295	1.57598	1.68851	1.80104	1.91357	2.02610	2.13863
18	.12604							1.26039	1.38643	1.51247	1.63851	1.76455	1.89059	2.01663	2.14267	2.26871	2.39475
19	.14062							1.40615	1.54677	1.68737	1.82800	1.96862	2.10924	2.24986	2.39048	2.53110	2.67172
20	.15587								1.71463	1.87050	2.02637	2.18224	2.33815	2.49398	2.64985	2.80572	2.96159
21	.17184									2.06206	2.23390	2.40574	2.57758	2.74942	2.92126	3.09310	3.26494
22	.18863									2.26356	2.45219	2.64082	2.82945	3.01808	3.20671	3.39534	3.58397
23	.20578										2.67512	2.98090	3.08668	3.29246	3.49824	3.70402	3.90980
24	.22424										2.91519	3.13943	3.36367	3.58791	3.81215	4.03639	4.26063
25	.24321										3.16169	3.40490	3.64811	3.89132	4.13453	4.37774	4.62095
26	.26315										3.42106	3.68421	3.94370	4.21045	4.47360	4.73675	4.99990
27	.28393										3.69114	3.97507	4.25900	4.54293	4.82686	5.11079	5.39472
28	.30545											4.27632	4.58177	4.88722	5.19267	5.49812	5.80357
29	.32765											4.58713	4.91478	5.24243	5.57008	5.89773	6.22538
30	.35062											4.90866	5.25928	5.60990	5.96052	6.31114	6.66176
31	.37444												5.61670	5.99114	6.36558	6.74002	7.11446
32	.39896													6.38340	6.78236	7.18132	7.58028
33	.42441													6.79067	7.21508	7.63949	8.06390
34	.45054													7.20866	7.65920	8.10974	8.56028
35	.47720													7.63522	8.11242	8.58962	9.06682
36	.50480													8.07678	8.58158	9.08638	9.59118
37	.53347													8.53550	9.06897	9.60244	10.13591
38	.56272													9.00364	9.56636	10.12908	10.69180
39	.59269													9.48293	10.07561	10.66829	11.26097
40	.62349													9.97594	10.59943	11.22292	11.88641

W.N.A.

Rapid Transit Co., first vice president; John Hartley, Atchison, Topeka & Santa Fe, second vice president; A. P. Dane, Boston & Maine, secretary and treasurer. The regular program was then taken up.

Forty-seven supply firms were represented, and temporary officers were elected as follows: W. E. Orr, C. A. Willey Co., New York, president; H. G. Kittredge, Kay & Ess Co., Dayton, Ohio, secretary; William Marshall, Anglo-American Varnish Co., Newark, N. J., treasurer. The entertainments, arranged by T. J. Lawlor, American Roll Gold Leaf Co., Providence, R. I., consisted of an automobile and theater party on Tuesday, card party and river trip on Wednesday, and an inspection of the Anheuser-Busch plant and the annual ball on Thursday. The supply companies made no exhibits, with the exception of a small display in the sample rooms of the hotel.

TABLES FOR COMPUTATION OF LOCOMOTIVE RATIOS.

By Wm. N. Allman.*

The accompanying tables have been computed for the purpose of assisting in the computation of locomotive ratios. The tables as they are represent the weight of steam as contained in cylinders of a range that will cover any locomotive of any consequence. They are conveniently arranged and save time in calculations when used in conjunction with the computation of locomotive ratios, especially when desiring to find the relation of grate area and heating surface to the weight of steam in the cylinders. There are a number of ratios in connection with the design of a locomotive that are of vital importance

*Office of Mechanical Engineer, Baltimore & Ohio R. R. Baltimore, Md.

WEIGHT OF STEAM IN CYLINDERS AT 190 pounds pressure per square inch

STROKE IN INCHES

Diam.		8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38
6	.01480	.05843	.07192	.08990	.10338												
7	.02001	.08091	.09887	.12136	.13934												
8	.02611	.10338	.13035	.15732	.18429	.21040											
9	.03305	.13035	.16651	.19777	.23373	.26678											
10	.04068	.16181	.20676	.24744	.28812	.32880	.36948	.40454	.44522	.48590	.52658	.56726	.60681	.64749	.68817	.72885	.76953
11	.04944	.		.29666	.34610	.39554	.44498	.49442	.54388	.59332	.64276	.69220	.74164	.79108	.84052	.88996	.93940
12	.05843						.52590	.58433	.64276	.70119	.75962	.81805	.87650	.93493	.99336	1.05179	1.11022
13	.06928						.62478	.69406	.76334	.83262	.89897	.96825	1.03753	1.10681	1.17609	1.24058	1.30986
14	.08000						.71918	.79918	.87918	.95918	1.03753	1.11922	1.19922	1.27922	1.35922	1.44285	1.52285
15	.09179						.82705	.91884	1.01063	1.10242	1.19421	1.28600	1.37543	1.46722	1.55901	1.65080	1.74259
16	.10439							1.04281	1.14720	1.25159	1.35598	1.46037	1.56476	1.67209	1.77648	1.88087	1.98526
17	.11838							1.18513	1.30351	1.42189	1.54027	1.65865	1.77703	1.89541	2.00921	2.12759	2.24594
18	.13225							1.31861	1.45184	1.58509	1.71833	1.85188	1.98412	2.11635	2.25193	2.38416	2.51640
19	.14743							1.47432	1.62175	1.76918	1.91661	2.06404	2.21147	2.35890	2.50633	2.65376	2.80119
20	.16318								1.79795	1.96113	2.12431	2.28339	2.44657	2.60702	2.77020	2.93338	3.09656
21	.18013									2.16203	2.34216	2.52229	2.70142	2.88155	3.06168	3.24181	3.42194
22	.19777									2.37329	3.57106	2.76883	2.96661	3.16438	3.36215	3.55992	3.75769
23	.21575										2.80480	3.02055	3.23630	3.45205	3.66782	3.88357	4.09932
24	.23496										3.05651	3.29147	3.52643	3.76139	3.99145	4.22641	4.46137
25	.25500										3.31272	3.56772	3.82272	4.07772	4.33755	4.59255	4.84755
26	.25571										3.58691	3.84262	4.09833	4.35404	4.68366	4.93937	5.19508
27	.29758										3.86998	4.16756	4.46514	4.76272	4.05673	5.35431	5.65189
28	.33028											4.48588	4.81616	5.14644	5.47672	5.76245	6.09271
29	.34357											4.80952	5.15309	5.49666	5.84023	6.18494	6.52851
30	.36764											5.14663	5.51427	5.88191	6.24955	6.61719	6.98953
31	.39256											5.49723	5.88979	6.28235	6.67491	7.06747	7.45699
32	.41856												6.27934	6.69790	7.11646	7.53502	7.95143
33	.44526												6.67938	7.12464	7.56990	8.01516	8.45935
34	.47328													7.57252	8.04582	8.51910	8.99238
35	.50118													8.01885	8.52003	9.02121	9.52239
36	.52940													8.47033	8.99973	9.52913	10.05853
37	.55933													8.94929	9.50862	10.06795	10.62728
38	.59001													9.44013	10.03014	10.62015	11.21016
39	.62141													9.94266	10.56407	11.18548	11.80689
40	.65372													10.45957	11.11329	11.76701	12.42073

W.N.A.

WEIGHT OF STEAM IN CYLINDERS AT 200 pounds pressure per square inch

STROKE IN INCHES

Diam.	2	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38
6	.01551	.06112	.07523	.09404	.10814												
7	.02116	.08464	.10344	.12695	.14575												
8	.02727	.10814	.13635	.16456	.19277	.22004											
9	.03479	.13635	.17596	.20688	.24449	.27928											
10	.04278	.16926	.21628	.25859	.30091	.33853	.38085	.42316	.46548	.50779	.55011	.59242	.63474	.68646	.72878	.77109	.81341
11	.05172			.31032	.36204	.41376	.46548	.51720	.56892	.62064	.67236	.72407	.77580	.82751	.87923	.93096	.98267
12	.06112					.48899	.55011	.61123	.67235	.73347	.79459	.85571	.91683	.97795	1.03907	1.10019	1.16131
13	.07233						.65104	.72337	.79570	.86803	.94036	1.01269	1.08502	1.15735	1.22968	1.30201	1.37434
14	.08359						.75229	.83588	.91947	1.00306	1.08665	1.17024	1.25383	1.33742	1.42101	1.50460	1.58819
15	.09602						.86513	.95916	1.05518	1.15120	1.24722	1.34324	1.43926	1.53528	1.63130	1.72732	1.82334
16	.10904							1.09081	1.19896	1.30800	1.41704	1.52608	1.63512	1.74416	1.85320	1.96224	2.07128
17	.12563							1.24127	1.36510	1.48893	1.61276	1.73659	1.85320	1.98064	2.10467	2.22850	2.35233
18	.13823							1.38232	1.52055	1.65878	1.79701	1.93524	2.07349	2.21172	2.34995	2.48818	2.62641
19	.15425							1.54310	1.69735	1.85160	2.00585	2.16010	2.31328	2.46753	2.62178	2.77602	2.93028
20	.17105								1.88072	2.05177	2.22282	2.39387	2.56718	2.73823	2.90928	3.08033	3.25138
21	.18807									2.25686	2.44493	2.63300	2.82107	3.00914	3.19721	3.38528	3.57335
22	.20687									2.48254	2.68941	2.89628	3.10318	3.31005	3.51692	3.72379	3.93066
23	.22268										2.93391	3.15957	3.38528	3.61096	3.83664	3.06232	4.28800
24	.24573										3.19722	3.44295	3.68868	3.93441	4.18014	4.41968	4.66541
25	.26677										3.46757	3.73434	4.00111	4.26922	4.53599	4.80276	5.06953
26	.28854										3.75203	4.04057	4.32911	4.61765	4.90397	5.19251	5.48105
27	.31132										4.04824	4.35956	4.66887	4.98019	5.29151	5.60238	5.91415
28	.33503											4.69003	5.02506	5.36009	5.69622	6.03125	6.36628
29	.35902											5.03091	5.38993	5.74895	6.10797	6.46699	6.82601
30	.38452											5.38355	5.76807	6.15259	6.53711	6.92103	7.30555
31	.41059												6.16251	6.57310	6.98369	7.38651	7.79710
32	.43782													7.00567	7.44349	7.88020	8.31802
33	.46561													7.44763	7.91324	8.38329	8.84890
34	.49396													7.90371	8.39767	8.89108	9.38504
35	.52341													8.37389	8.89730	9.42239	9.94580
36	.55370													8.85817	9.41187	9.96779	10.52149
37	.58508													9.36126	9.94634	10.53142	11.11650
38	.61717													9.87470	10.49187	11.10904	11.72621
39	.65002													10.40036	11.05038	11.70040	12.35042
40	.68381													10.94106	11.62487	12.30868	12.99249

W.N.A.

and we know from experience with certain designs of locomotives and the service for which they are intended what these ratios should be in order to produce an engine that will give the most satisfactory service.

The tables cover a range in boiler pressure from 180 to 210 lbs. per square inch, which practically covers all modern conditions, and are based on steam weighing as follows:

180 lbs. gauge pressure .4287 lbs. per cu. ft.
190 lbs. gauge pressure .4500 lbs. per cu. ft.
200 lbs. gauge pressure .4702 lbs. per cu. ft.
210 lbs. gauge pressure .4924 lbs. per cu. ft.

The formula for deriving the figures (or the weight of one cylinder of steam) in the tables is:

$D^2 \times .7854 \times L \times w = W.$

where

D=diameter of cylinder in inches.
L=length of cylinder in inches.
w=weight of steam per cu. ft. at desired pressure.
W=total wt. of steam in one cylinder.

SHOP EXTENSION AT WEST ALBANY, N. Y. C. & H. R. R. R.

During the past two years the New York Central & Hudson River R. R. has been making extensive improvements in capacity and arrangement at its West Albany shops. The accompanying drawings of the new buildings, with the layout of machinery equipment should prove interesting as they represent several years of planning by the best authorities in American railway work.

The general building at the shop site shows that there was

WEIGHT OF STEAM IN CYLINDERS AT 210 pounds pressure per square inch

STROKE IN INCHES

Diam.	2	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38
6	.01641	.06401	.07877	.09847	.11324												
7	.02215	.08860	.10832	.13290	.15263												
8	.02855	.11324	.14275	.17130	.20186	.23041											
9	.03643	.14278	.18215	.21858	.25501	.29144											
10	.04450	.17725	.22648	.26880	.31360	.35810	.40260	.44312	.48762	.53212	.57662	.62036	.66486	.70936	.76315	.80765	.85215
11	.05416			.32495	.37911	.43327	.48743	.54159	.59575	.64991	.70407	.75823	.81238	.86654	.92070	.97486	1.02902
12	.06401					.51205	.57606	.64007	.70408	.76807	.83208	.89608	.96009	1.03394	1.09795	1.16196	1.22597
13	.07580						.68437	.76017	.83597	.91177	.98471	1.06051	1.13631	1.21211	1.28504	1.36084	1.43664
14	.08629						.78776	.87405	.96034	1.04871	1.13500	1.22129	1.30758	1.34321	1.42950	1.51579	1.60208
15	.10064						.90593	1.00657	1.10727	1.20791	1.30855	1.40813	1.50877	1.60941	1.71005	1.81186	1.91250
16	.11435							1.14226	1.25661	1.37096	1.48391	1.59826	1.71261	1.82696	1.94972	2.06407	2.17842
17	.12986							1.29981	1.42967	1.55953	1.68939	1.82171	1.95157	2.08143	2.20082	2.33068	2.46054
18	.14495							1.44752	1.59247	1.73742	1.88079	2.02574	2.17069	2.31898	2.46393	2.61440	2.75935
19	.16154							1.61585	1.77739	1.93893	2.10047	2.25990	2.42144	2.58298	2.74733	2.90887	3.07041
20	.17922								1.96941	2.14863	2.32785	2.51100	2.69022	2.86944	3.04767	3.22689	3.40611
21	.19716									2.36329	2.56045	2.75761	2.95412	3.15128	3.34844	3.55479	3.75195
22	.21663									2.59963	2.81626	3.03289	3.24954	3.46617	3.69265	3.90928	4.12591
23	.23663										3.07229	3.30892	3.54555	3.79112	4.02775	4.26438	4.50101
24	.25765										3.34308	3.60073	3.85838	4.12592	4.38357	4.64289	4.90054
25	.27953										3.63468	3.91421	4.19374	4.47327	4.75121	5.03074	5.31027
26	.30250										3.92898	4.23148	4.53398	4.84476	5.14726	5.44976	5.75226
27	.32635										4.23777	4.56412	4.89047	5.21682	5.55375	5.58010	5.90645
28	.35061											4.90773	5.25834	5.60895	5.95956	6.31198	6.66259
29	.37643											5.26819	5.64462	6.02105	6.40060	6.77703	7.15346
30	.40265											5.63853	6.04118	6.44383	6.84372	7.24637	7.64902
31	.42992												6.45210	6.88202	7.31194	7.73488	8.16480
32	.45788													7.32623	7.78411	8.24200	8.69988
33	.48696													7.78904	8.27600	8.76882	9.25578
34	.51738													8.27600	8.79338	9.31533	9.83271
35	.54802													8.76882	9.31533	8.86335	10.41137
36	.57981													9.27595	9.85576	10.43790	10.01771
37	.61267													9.80276	10.41543	11.02810	11.64077
38	.64627													10.34042	10.98669	11.63296	12.27923
39	.68068													10.89087	11.57155	12.25223	12.93293
40	.71607													11.45708	12.17315	12.88922	13.60529

W.N.A.

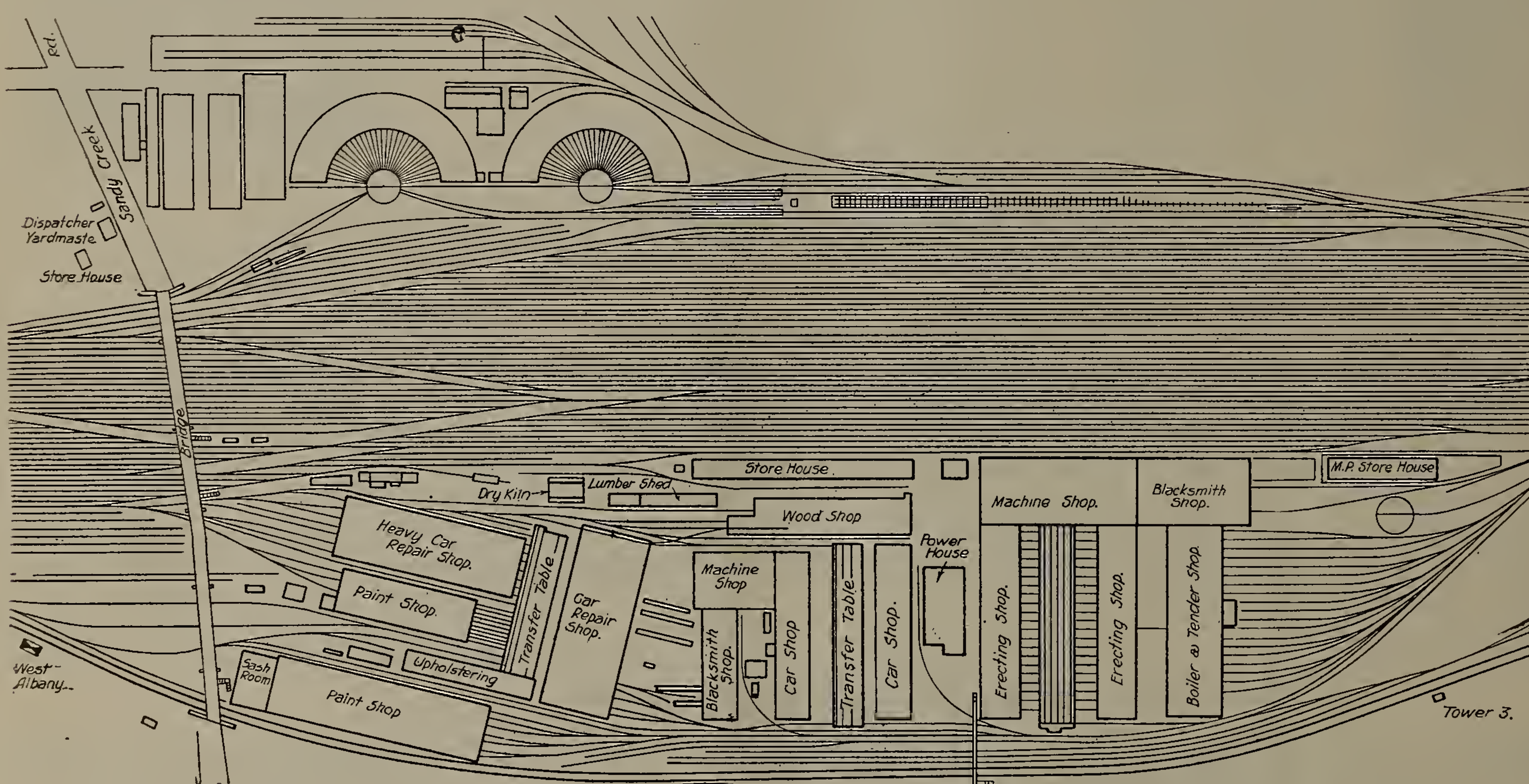
considerable difficulty met with in arranging for extension. It appears that the future requirements were entirely underestimated in the original plans. Considerable ingenuity has been necessary in the construction of the new buildings, as will be noted from the general layout.

The cross section of erecting shop No. 2 shows nothing unusual in buildings of this kind. The very excellent crane arrangement calls for some attention however.

The new boiler shop is principally interesting on account of the location of the heavy machinery with respect to the tracks and the furnaces.

In the blacksmith shop the equipment will be seen to be as near perfection as is seldom attained. The arrangement of the hammers and forges is such as to preclude the limiting of the capacity of either an account of the other. Each forge and each hammer is served by a jib crane the reach of which overlaps its neighbor.

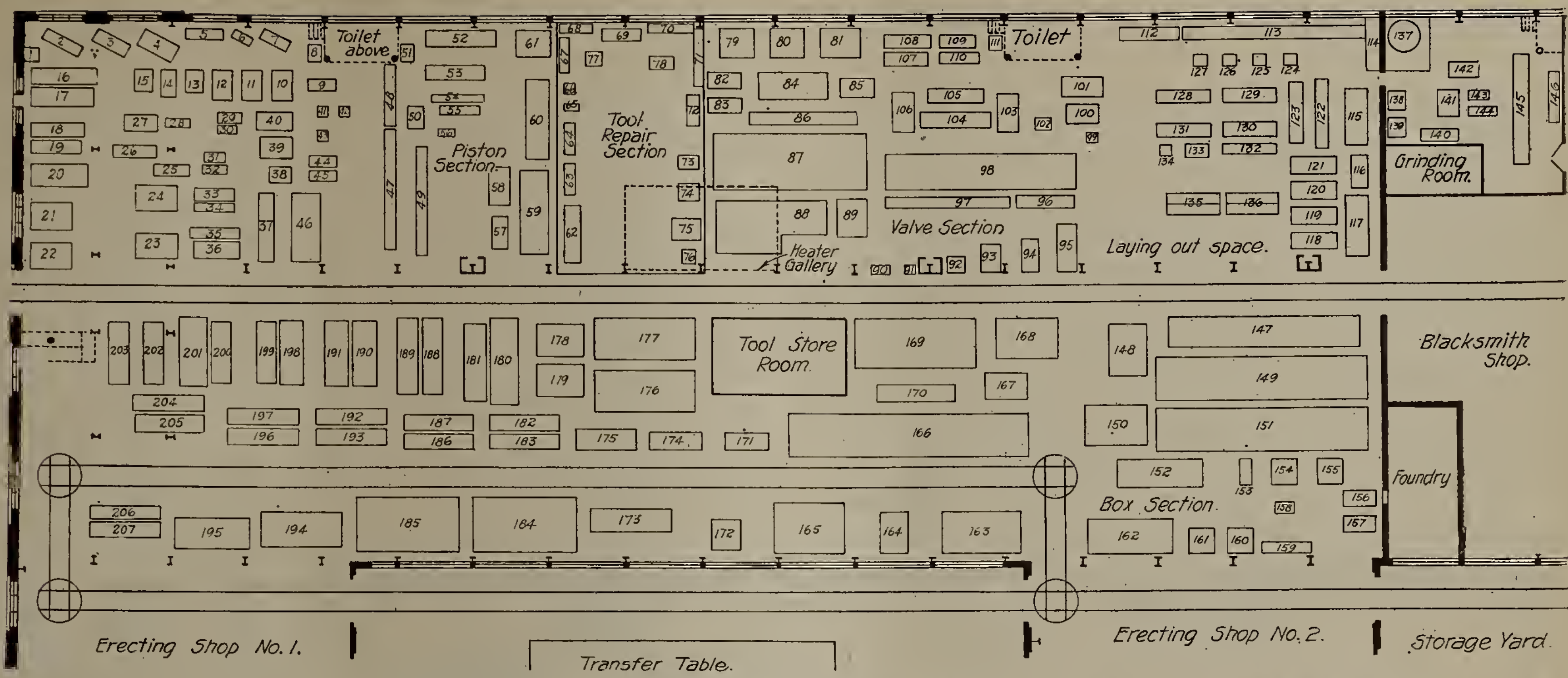
At first appearance the machine shop seems to be sadly crowded. A study of the arrangement, however, shows the grouping is such as allow of a free movement of materials and tools in the proper direction. Individual drive has been



General Layout, West Albany Shops, N. Y. C. & H. R. R. R.

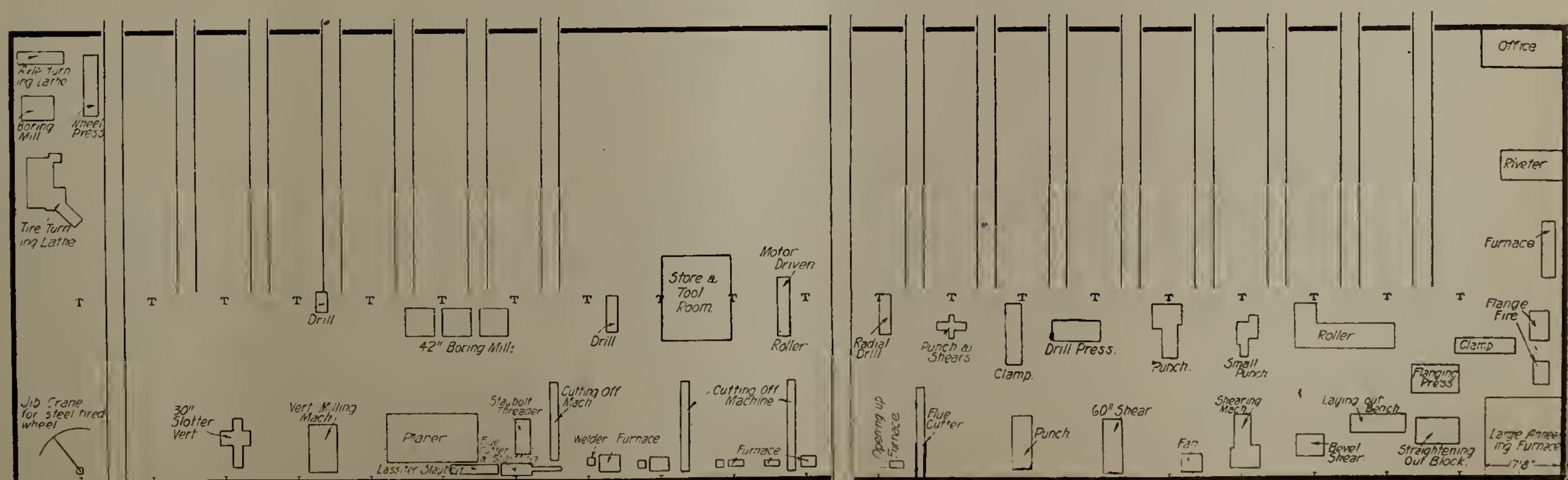
carried further than has been thought best practice heretofore. In the following table can be found, by reference number, any of the machines shown in the drawing. The motors are all built for the shop circuit voltages of 440 or 220.

No.	Machine.	Old or New	H. P.
1	Motor	....	35
2	Turret lathe	Old	5
3	Turret lathe	Old	3
4	Turret lathe	Old	7
5	Lathe	Old	2
6	Turret lathe	Old	½
7	Turret lathe	Old	5
8	Motor	...	35
9	Lathe, 16 in	Old	2
10	Planer	Old	5
11	Planer	Old	5
12	Planer	Old	5
13	Shaper	Old	5
14	Shaper	New	5
15	Shaper	Old	5
16	Lathe, 36 in	Old	7½
17	Lathe, 42 in	Old	8
18	Lathe, 20 in	Old	6
19	Lathe, 24 in	Old	5
20	Shaper, D. H	Old	7½
21	Radial drill, 6 ft	New	5½
22	Radial drill, 6 ft	New	5½
23	Radial drill, 6 ft	New	5½
24	Radial drill, 6 ft	New	5½
25	Radial drill	Old	5
26	Radial drill	Old	5
27	Radial drill	Old	5
28	Lathe	Old	½
29	Lathe	Old	..
30	Lathe	Old	2
31	Lathe	Old	½
32	Lathe	Old	½
33	Lathe (nut)	Old	2
34	Lathe	Old	2
35	Horizontal boring machine	Old	5
36	Horizontal boring machine	Old	5
37	Lathe, 18 in. x 8 ft. c	New	6
38	Milling machine	Old	..
39	Vertical milling machine	Old	8
40	Slotter, 15 in	Old	7½
41	Drill	Old	1
42	Press	Old	5
43	Drill	Old	..
44	Lathe 16 in	New	5
45	Lathe, 16 in	New	5
46	Horizontal boring and milling machine	New	7½
47	Rocker box and reverse lever bench	...	..
48	Link bench	...	..
49	Crosshead bench	...	..
50	Keyway machine	Old	5
51	Motor	...	16
52	Lathe	Old	7½
53	Lathe	...	..
54	Centering machine	Old	4
55	Lathe	Old	2
56	Drill	Old	2
57	Shaper	New	5



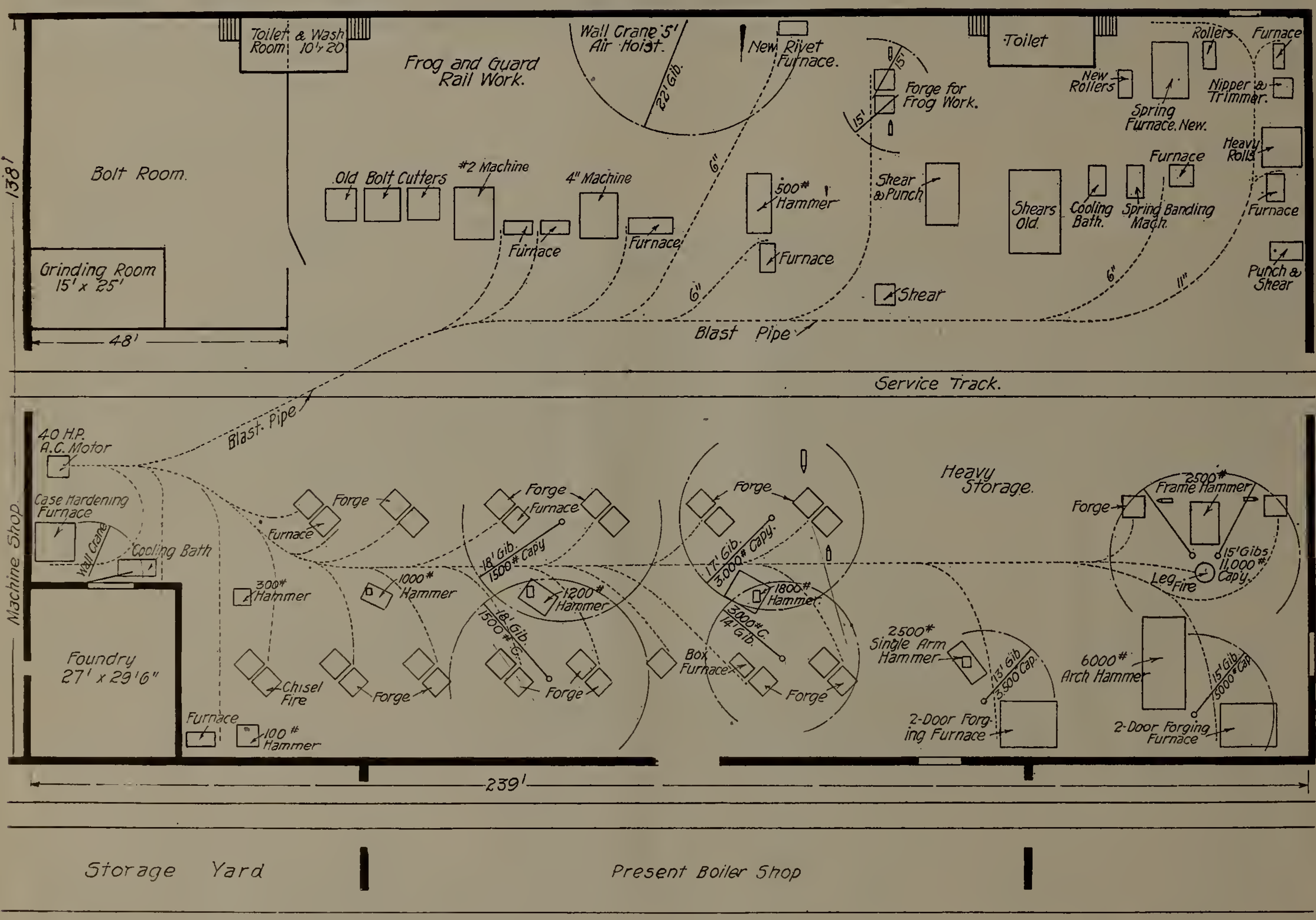
Layout of Equipment of New Machine Shop, West Albany Extension. (For Key to Numbers See Text.)

58	Radial drill	Old	5½	88	Milling machine	Old	74
59	Planer, 10 ft. x 36 in.	Old	..	89	Vetical Milling Machine	Old	15
60	Gap Grinder	Old	10	90	Centering machine	New	1
61	Boring mill	New	12	91	Drill	New	2
62	Lathe	Old	6	92	Profiling machine	New	3
63	Lathe	Old	2	93	Boring mill	Old	8
64	Lathe	Old	2	94	Shaper	New	5
65	Drill	Old	½	95	Planer	Old	8
66	Drill	Old	2	96	Lathe	Old	..
67	Cabinet	...	..	97	Work bench	...	..
68	Bench	...	..	98	Side rod benches	...	..
69	Lathe	Old	3	99	Drill	New	2
70	Bench	...	..	100	Radial drill	Old	5
71	Bench	...	..	101	Slotter	Old	7½
72	Lathe	Old	2	102	Press	Old	5
73	Slotter	Old	5	103	Radial drill	Old	5
74	Milling machine	Old	4	104	Laying out bench	...	..
75	Milling machine	Old	4	105	Boring mill	Old	8
76	Motor	New	20	106	Radial drill	Old	5½
77	Shaper	Old	3	107	Lathe	Old	4
78	Shaper	Old	4	108	Lathe	Old	4
79	Boring mill	Old	12	109	Lathe	Old	3
80	Boring mill	Old	12	110	Lathe	Old	2
81	Milling machine	Old	12	111	Motor	New	30
82	Shaper	New	5	112	Pump rack	...	..
83	Shaper	New	5	113	Benches	...	..
84	Planer, 8 ft. x 36 in.	Old	8	114	Bench	...	..
85	Slotter	Old	7½	115	Pump storage, after washing	...	..
86	Work bench	...	..	116	Potash vat	...	..
87	Main rod benches	...	..	117	Pump storage, before washing	...	..



Layout of Boiler Shop Heavy Machinery, West Albany Extension.

118	Brake rod racks	...	..
119	Brake rod racks	...	..
120	Brake rod racks	...	..
121	Brake rod racks	...	..
122	Storage, small parts	...	..
123	Test rack	...	..
124	Pump table	...	..
125	Pump table	...	..
126	Pump table	...	..
127	Pump table	...	..
128	Pump rack	...	..
129	Pump test rack	...	..
130	Pump test rack	...	..
131	Pump rack	...	..
132	Lathe	Old	7
133	Drill	Old	4
134	Drill	Old	2
135	Work bench	...	..
136	Work bench	...	..
137	Boiler for brake section	...	..
138	Bolt cutter, triple head	Old	4
139	Bolt cutter, triple head	Old	5
140	Bolt cutter, single head	Old	5
141	Bolt cutter, triple head	Old	7
142	Lassiter bolt machine	Old	7½
143	Pointing machine	Old	..
144	Stud cutter	Old	..
145	Storage bins	...	..
146	Lassiter stay bolt machine	Old	10
147	Planer, shoe and wedge	Old	12
148	Boring mill, 66 in	New	18
149	Planer, 26 x 60 in	Old	12
150	Slotter, 28 in	Old	15
151	Planer, 26 x 60 in	Old	12
152	Planer, 10 x 36 in	Old	12
153	Press	Old	5
154	Boring mill	Old	12
155	Boring mill	Old	12
156	Shaper	New	5
157	Shaper	New	5
158	Hydraulic press	Old	5
159	Lathe (D. H.)	Old	5
160	Boring mill	Old	12
161	Boring mill	Old	12
162	Planer, 10 ft. x 36 in	Old	12
163	Boring mill, 90 in	Old	15
164	Radial drill, 6 ft	New	5½
165	Boring mill, 90 in	New	35
166	Planer, 28 x 42 in	New	15
167	Radial drill, 6 ft	New	..
168	Slotter, 28 in	New	15
169	Planer	New	..
170	Cylinder boring machine	New	..
171	Crank pin lathe	Old	7½
172	Tire fire	...	..
173	Wheel press	Old	15
174	Axle lathe	Old	7½
175	Quartering machine	Old	8
176	Planer, 12 ft. x 42 in	New	12
177	Planer, 12 ft. x 42 in	New	12
178	Slotter, 22 in	New	15
179	Slotter, 22 in	New	15
180	Lathe (gap), 42 in. x 12 ft	New	10
181	Lathe, 24 in. x 8 ft	New	7½
182	Lathe, 18 in. x 8 ft	Old	5
183	Lathe, 18 in. x 8 ft	New	5



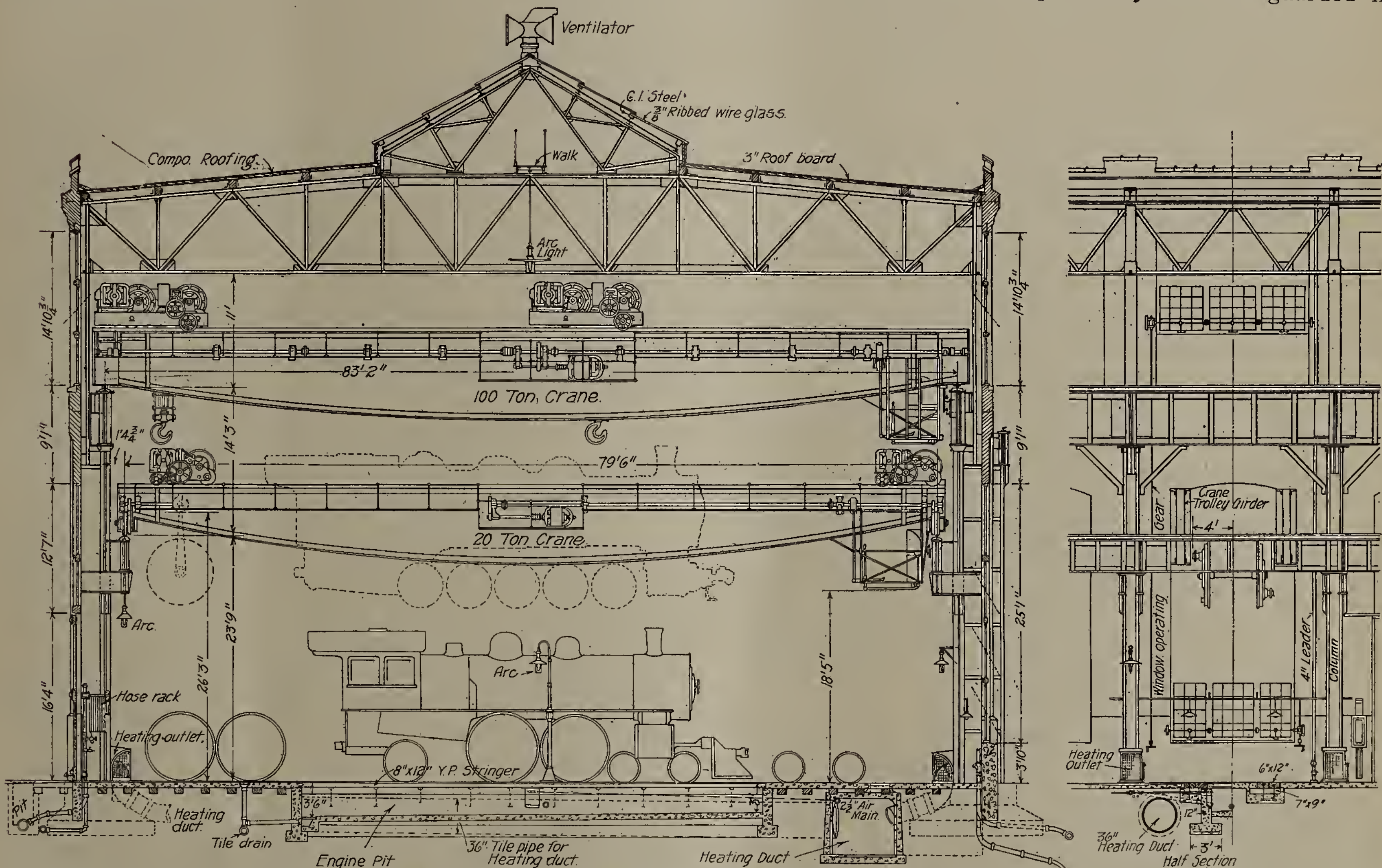
Plan of Blacksmith Shop Equipment, West Albany Extension.

184	Wheel lathe, 90 in.	Old	40
185	Wheel lathe, 90 in.	Old	40
186	Lathe, 18 in. x 8 ft.	New	5
187	Lathe, 18 in. x 8 ft.	Old	5
188	Lathe, 36 x 12 in.	New	15
189	Lathe, 36 x 12 in.	New	15
190	Lathe, 30 x 12 in.	New	6½
191	Lathe, 30 x 12 in.	New	6½
192	Lathe, 20 in. x 8 ft.	New	5
193	Lathe, 20 in. x 8 ft.	New	5
194	Wheel lathe, 90 in.	Old	15
195	Journal lathe	Old	7½
196	Lathe, 20 in. x 8 ft.	New	7½
197	Lathe, 20 in. x 8 ft.	New	7½
198	Lathe, 30 x 12 in.	New	6½
99	Lathe, 27 x 12 in.	New	6
200	Lathe, 27 x 12 in.	New	6

at least once a year. This also saves much on the cost of artificial illumination.

Considerations of economy often lead to the overcrowding of machinery, that is, too many machines are placed in a given space. The width of the passageways between the machines is thus reduced to the point of danger. Any undue curtailment of space interferes with the proper handling of the machines and adds to the risk and probability of accident, owing to the operator being exposed to contact with gears, pulleys, belts and other moving parts, for even where guards are provided in fullest measure, it is rarely possible to eliminate absolutely all danger. Space should not be held of more value than safety.

Slippery floors constitute an element of danger, especially in conjunction with unguarded machinery. And even where a slippery floor is not in proximity to an unguarded ma-



Section of Erecting Shop No. 2, West Albany Extension.

PREVENTION OF ACCIDENTS IN THE SHOP.

The study of the prevention of avoidable accidents is a very important part of the duties of a master mechanic, shop, superintendent or foreman. Many accidents are improperly classed as unavoidable and it is expected that most of the men belonging to the class of officials mentioned may benefit to the material gain of the company by scanning the following hints suggested by the Fidelity and Casualty Co. of New York:

Care and Foresight.

Not only the safety of workmen, but the maximum output of the plant, are promoted by making the physical surroundings of the workmen as comfortable as possible. Plenty of light, good air, safety, and comfort pay in a financial sense.

Satistics show that the greatest number of accidents occur during the months of diminishing light. Dirty windows and insufficient artificial illumination often make conditions much worse than they need be. Great improvement in illumination may be had by whitewashing the walls of a dark room

chine, it may yet cause a bad fall, resulting in serious injuries. This is likely to be the case where workmen are engaged in carrying heavy material.

Many accidents, and very often those of a serious nature, are due to the ignorance of the workmen. New hands are put to work on dangerous machines without proper preliminary training or sufficient instructions. Even where apprenticeship is not necessary or customary, new hands should nevertheless work with and under the instruction of experienced hands until there can be no question of their competency. All workmen should be carefully instructed, in language they can understand, the proper and safe way to do their work. Especial care should be exercised in the case of minors employed as operatives on dangerous machines. Some machines are too dangerous ever to allow a young person to operate them. The monotonous nature of the work, so contrary to the natural active propensities of the young, will lead to a moment of thoughtlessness in the operator, and that to a grave accident.

The importance of carefulness cannot be overestimated.

In Germany "out of 45,971 accidents noted in the industrial accident statistics for 1897, there were 9,363 caused by the 'improvidence or inattention of the workmen,' 533 cases by 'frivolous behavior,' 2,422 cases by 'acting in contradiction to instructions,' 861 cases on account of 'non-use of existing devices for protection,' and 220 cases by 'unsuitable clothing.'" Probably in the case of American workmen the consequences of lack of discipline are an even more prolific sources of accidents. Under the conditions the employer is warranted in making strict rules governing the employees in his plant. In fact, it is his duty to do so. By the maintenance of discipline, to which punitive measures are added where necessary, many accidents may be prevented. Disobedience of orders should not be tolerated.

Ragged sleeve ends, loose cravats, and coats or overalls not properly buttoned, often catch on moving parts of machinery and cause serious and fatal accidents. It is a wise precaution in many classes of work to roll the sleeves of all garments up above the elbows.

Very often workmen will object to the use of safeguards provided, claiming that they interfere with quantity of output and so cut down their earnings. This is likely to be the case particularly with piece-work. By the exercise of a little ingenuity, however, the guard may often be adapted to perform its function and yet not interfere with the speed of the work. No guard should be condemned simply because the workmen at the outset object to its use. Rather this should lead to further study of the matter and modification of the guard to suit the conditions.

Fatigue leads to carelessness, and long hours of labor without rest are responsible for many accidents. Overworking workmen should be avoided wherever possible.

A continuous supply of pure air is no doubt of greater importance from the standpoint of maintenance of health than it is from the standpoint of prevention of accident, but the two are related. Whatever lowers the vitality of the workman, decreases his alertness and watchfulness to avoid accident. Impure air, gases, vapors, dust, and smoke therefore all increase the chances of accident, in addition to imperiling the health of workmen.

Wherever possible, it is advisable to prohibit absolutely the drinking of intoxicants during working hours. No man under the influence of liquor, even slightly so, should be permitted to remain in the works, much less to work. Nor should a man whose nerves have been rendered unsteady by the habitual use of alcohol or by a recent debauch be permitted to operate dangerous machinery, or to carry on dangerous work. He endangers not only his own life, but also the lives of others.

Whether accidents are frequent or infrequent will depend in no small measure upon the character of the supervision and management. If those in positions of authority are careful and prudent, their conduct will be reflected in the conduct of the workmen, who will tend to be careful and prudent also. Unconscious imitation is one of the strongest forces that mold men. Imitation grows into habit. Master mechanics, superintendents, foremen, and others in authority then, should be persons of experience and given to exercising a high degree of care in all that they do. The utmost care should be taken in selecting them.

The education of the workmen in proper and safe practices will be promoted by the posting of printed rules regarding the things they should avoid doing, and the precautions they should take to avoid accidents. In the case of especially dangerous machines, it is advisable to furnish the operatives with special rules and instructions relative to their operation. It is also particularly important to warn workmen of dangers not apparent except to experienced and intelligent men, and to show them how such dangers may be avoided.

Regular and frequent inspections by competent men should be made of all the ways, works, machinery and appliances, so that defects and unsafe conditions may be discovered promptly and remedied.

Electrical Apparatus.

When operating at a potential in excess of 550 volts, dynamo and motor frames and bedplates, ladders, and other metallic parts, should be jointly and efficiently grounded. It is even better to ground all parts whenever the potential is in excess of 250 volts, as there are persons to whom a higher potential is dangerous. Grounding at a less potential than 550 volts is, however, against the rules of the National Board of Fire Underwriters. Whenever machines operated at a less potential than 550 volts are grounded, a permit should be obtained from the Fire Underwriters.

Dynamo and motor frames may be insulated from the ground when operating at a potential of less than 550 volts. Better still is a limit of 250 volts within which the machines may be insulated. But if a limit of 250 volts is adopted, care should be taken to get the permission of the Fire Underwriters, as noted in the preceding paragraph.

The rail-fencing about dynamos and motors should be made of some non-conducting material, such as wood. In addition, a high-potential machine, should be surrounded by an insulated platform. This may be made of wood mounted on insulating supports, and so arranged that a man must always stand upon it in order to touch any part of the machine. The platform should be covered by a rubber mat, preferably perforated so that oil and water accidentally dropped will not remain on the surface.

The terminals, brushes, connectors, and other parts of high-voltage dynamos, motors, and transformers, should be so arranged or boxed that no person can accidentally establish connection between two parts at a high-potential difference, with his body, clothing, or conducting tool.

Belts in exposed positions where a person's clothing is liable to be caught should be railed or boxed off. Ragged edges of belts should be removed, to minimize the chances of clothing catching.

When a belted dynamo or motor must be set close to a wall, the pulley side should always be next to the wall if possible. This will locate the belt out of the way, as well as make the commutator and brushes easily accessible.

Tools and pieces of iron and steel should be kept away from dynamos and motors while running, as they may be drawn in by magnetism, and perhaps get between the armature and pole-pieces and ruin the machine. Therefore zinc, brass, or copper oil-cans should be used, never iron or "tin" (tinned iron).

Before starting work on any machine not in service, a man should always satisfy himself that the machine is disconnected from the switchboard or circuit.

In oiling, cleaning, or adjusting any part of a dynamo, motor, or transformer in service, the attendant should wear rubber gloves, first examining them to see that they are in good condition. In making adjustments, especially on high-voltage machines, it is well in addition to stand on an insulated board and never touch opposite sides of the circuit at the same time. The attendant should use one hand only wherever possible. A safe rule is, "Keep one hand in your pocket," in order to be sure not to use it. He should also be careful not to allow any portion of his clothing to get caught in the machinery or belting. The handles of oil-cans, and wipers and cleaners, should be insulated so that they cannot act as a conductor between the hand and the thing touched.

Rubber mats or other equally efficient insulating material, kept in a dry and efficient state, should be placed wherever it is possible for an attendant to make an accidental dangerous connection with any conductors, or to be grounded by contact with gas, water, or waste pipes.

Switchboards should invariably have rubber mats or insulated wooden platforms placed in front of them. All switchboards should have at the back a clear space of at least four feet which should never be used for storage, or otherwise obstructed. This space should be kept closed off, except when making adjustments or repairs.

As far as possible, all work should be done using only one hand at a time. It is best to keep the other hand behind the back, the most dangerous shocks being those from hand to hand. Before touching any portion of a switchboard or its conductors or connections, if the voltage is over 115, the attendant should put on rubber gloves, first satisfying himself that the gloves are in good condition. In case a circuit-breaker "opens," the attendant should open switch immediately before touching the "breaker," and should see that both are in good condition before making "circuit" again, first setting "breaker," then throwing in switch. It is very bad practice to close a circuit by resetting the "breaker." Any circuit on which the "breaker" opens at short intervals should be investigated, and the trouble located and remedied.

The following simple precautions should also be carefully observed:

Never place any switches in the factory over wet floors or iron floor-plates, or behind running belts.

Screen off "live" sections of high-pressure switching boards from "dead" sections, when working on cleaning has to be done on "dead" portions.

Standard enclosed fuses should always be used wherever possible. If there is anything amiss, or any fault upon the circuit, the fuses will generally blow at the moment of switching on the current. If the fuses are of the open type, the operator is likely then to receive the full benefit of the explosion of molten metal and the heat of the arc on his hand or in his face. For instance, a fuse may have blown from a short circuit on the line. In attempting to renew this fuse (if an open one), a flash will occur should the short circuit have not been remedied, and burn the operator. Bare metal fuses had best not be used at all, but if used, should be so protected that when they come into operation the fused metal cannot be scattered. In any event, switches and fuses should not be fixed to the same base in such a way that in switching on, the operator's knuckles will touch the bare fuse-metal. The advantages of using enclosed fuses cannot be over-emphasized.

All transformer-cases should be effectually and permanently grounded, and so constructed that the event of "running to frame," the earth connection will not be broken by the removal of the fuse-box or other part of the case. Transformer-cases, iron ladders, and all permanent metallic parts contained within the transformer-chamber and not forming part of the electric circuit, should be metallically connected. All holes in transformer-cases through which high-voltage conductors pass, should be bushed with effective non-conducting material. All high-voltage connections within a transformer-chamber should be so protected with insulating material that it is impossible to touch them. Switches for cutting off both the high- and low-voltage connections of transformers should be operated as far as possible from the outside. All transformers should be periodically inspected. Leads exposed for long periods to the weather are likely to become bare of insulation and come into contact with the case, thus connecting the primary and secondary windings.

Overhead cables and wires in shops should be insulated all over, and so supported that there is no possibility of anyone coming into contact with them. The use of exposed or moulded wiring in basements, especially in damp basements, or about rooms having grounded surfaces, such as baths, toilets, and the like, should be avoided. Very many serious and fatal accidents have been caused by the use of brass-shell key-sockets and flexible cords, accessible to persons from baths, sinks, metal or damp floors, gas, water, or waste pipes, and the like. The use of porcelain sockets in such cases is strongly recommended, provided such use does not constitute a violation of the "Fire Underwriters' Rules." These state that "porcelain-shell sockets being subject to breakage, and constituting a fire hazard when broken, will not be accepted in places where they will be exposed to hard usage."

(To be continued.)

NEW NORTHWESTERN PASSENGER STATION.

Work on the new passenger station and terminal of the Chicago & Northwestern in Chicago is being rushed in the endeavor to complete it on Jan. 1, 1911. It is to be one of the most complete stations ever built. The main building will be four stories high, of early Italian renaissance architecture, with a high Doric portico at the Madison street entrance supported on a colonnade of six granite columns each 61 ft. high and 7 ft. in diameter at the base. Immediately behind the colonnade with three granite arched entrances will be a vaulted vestibule. At each end will be grand stairways of granite leading to the main waiting room on the track level floor. Similar vestibules will give entrance from Canal and Clinton streets. These vestibules lead to a large public rotunda, where the ticket offices, lunch rooms, baggage room, news stand, telegraph office and parcel check rooms are to be.

NEW LITERATURE.

A PRACTICAL COURSE IN MECHANICAL DRAWING. By W. F. Willard. 134 pages, cloth, 5x6¾; published by Popular Mechanics Co., Chicago. Price 50 cents.

A book of elementary instruction for the student, or workman who wishes to educate himself in this line, the chapters are so arranged as to take the student through a complete course from the selection of instruments and other accessories through the simple exercises of mechanical drawings until, as he becomes proficient in each step, he is led through the more difficult problems of descriptive geometry. The book is excellently adapted to the instruction of the young or those of limited education, and its careful study will result in a good understanding of the subject.

* * *

FACTORY ORGANIZATION AND ADMINISTRATION. By Hugo Diemer. 316 pages, cloth, 6x9; published by the McGraw-Hill Book Co., New York.

The author is professor of industrial engineering at the Pennsylvania state college. His experience covers some twenty years and his present practice as a consulting industrial engineer has peculiarly fitted him for the authoritative treatment of his subject. It is taken for granted that factory management constitutes a part of the work of the engineer. The book is intended for the education and assistance of officers of manufacturing corporations and the heads of departments and of all those interested in acquiring a comprehensive grasp upon all problems concerned in the layout, construction, organization, production and general operation of large manufacturing plants. Much that is applicable to the needs of the small business man or to the departmental head of a railway company. The chapters on the machine shop, the tool room and on shop cost keeping are particularly useful. While intended for the practitioner the books will prove valuable to the engineering student. A bibliography of works management is one of the extremely valuable reference features.

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RAILWAY SPECIAL WORK. By W. E. Silsbee and P. E. Blood; 108 pages, flexible leather, 4x6¾; published by the McGraw-Hill Book Company, New York City. Price $2.00.

The use of this book by the track man must necessarily result in the saving of much time in computation by means of tables and trigonometric functions. Primarily the work is intended to cover a highly specialized field not conveniently touched upon by other publications of like nature,—the laying out of frogs and special curves in the shop. Logarithms and the slide rule, in so far as they are concerned in the subject, are treated in a simple and concise manner. The tables are arranged for quick reference and the examples of special curves are such as cover, in principle, all cases ordinarily met with.

* * *

The Peerless Rubber Mfg. Co., of New York has issued a small folder descriptive of "Peerless" belting, hose and packings.

* * *

"Industrial Recording Gauges" is the subject of the latest bulletin issued by the Industrial Instrument Co., of Foxboro, Mass.

* * *

The Edwards Mfg. Co., of Cincinnati, O., has issued a leaflet illustrating the corrugated steel roofing manufactured by this company.

* * *

The latest issue of the Graphose Age is a spicy booklet in which the scribe of the Chicago Bearing Metal Co., Chicago, skips from Rudyard Kipling to bearing metals and throws in a few of his own observations on the side.

* * *

"Gear Cutting Speeds" give data showing the advantages of cutting gears by the hobbing method. It is published by The Adams Co., of Dubuque, Iowa.

* * *

The Electric Controller & Mfg. Co., of Cleveland, O., has issued a pamphlet pointing out concisely the advantages of E. C. & M. lifting magnets; also a leaflet on "Dinkey" ventilated controllers.

* * *

General Catalogue 102 of C. W. Hunt & Co., New York, is a neat compact affair and is well supplied with illustrations of the various sorts of installations which this firm has placed.

* * *

The Carnegie Steel Co., of Pittsburg has published a pamphlet on vanadium steel giving descriptions of the various types and the heat treatment of the same. The whole is very conveniently arranged.

* * *

A very attractive booklet on "Toncan" metal sheets has been issued by the Starks Rolling Mill Co., of Canton, O. Section one takes up rust and corrosion of metals, section two brings out the advantages of "Toncan" metal as proven by test and section three is a catalog of the aforesaid metal in its different forms.

* * *

Publication 391 of the National Brake & Electric Co., of Milwaukee, Wis., is devoted to the various types of air compressors made by them for industrial service; both stationary and portable.

* * *

Luitwieler pumping engines are different from the ordinary pump in that they are non-pulsating and avoid dead centers, thereby pumping with greater efficiency. They are fully described in the latest catalog of the Luitwieler Pumping Engine Co., of Rochester, N. Y.

* * *

"A Triumph of Achievement," a booklet illustrative of the work and works of the Con. P. Curran Printing Co., St. Louis, Mo., railroad printers, is rightly named. It is well illustrated with half-tones of the new home of the company.

* * *

The Glazier Headlight Co., of Rochester, N. Y., in catalog number 4 shows a complete line of their headlights, a noteworthy feature being the large clear illustrations.

PERSONALS.

C. M. Stansbury has been appointed master mechanic of the Ocean Shore Ry., with office at San Francisco, Cal.

C. Hardis has been appointed mechanical engineer of the Kansas City Southern Ry., with office at Pittsburg, Kan.

Walter Evans has been appointed superintendent of motive power of the Indiana Union Traction Co., with office at Anderson, Ind., succeeding R. C. Taylor.

L. C. Engler, road foreman of engines of the Hocking Valley, at Columbus, Ohio, was killed in the derailment of a north-bound passenger train on that road September 12, near Lemoyne, Ohio.

C. J. De Vilbiss, superintendent of motive power of the Hocking Valley, was kiled in a derailment of one of that company's trains on September 12. Mr. De Vilbiss was born July 31, 1875, at St. Joe, Ind. He attended the common schools and later studied mechanics through a correspondence school. He began railway work in 1889 as an apprentice on the Wabash Railroad and was later made roundhouse foreman on the same road at Peru, Ind. He then went to the Grand Trunk as general foreman of the Battle Creek shops, but was compelled to resign this position on account of ill health. His next position was roundhouse foreman of the Chicago, Rock Island & Pacific, which he resigned in 1904 to go to the Baltimore & Ohio as a master mechanic. In 1907 he was appointed superintendent of motive power of the Hocking Valley, which position he held at the time of his death.

W. B. Lipscomb has been appointed master mechanic of the Augusta Southern Ry. with office at Charleston, S. C.

The jurisdiction of J. P. Stevens, general superintendent; L. B. Allen, engineer maintenance of way, and W. T. Smith, superintendent motive power of the Kentucky general division of the Chesapeake & Ohio Ry., has been extended over the Chesapeake & Ohio Ry. of Indiana.

C. A. Brandt has been appointed mechanical engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry. with office at Indianapolis.

C. C. Anthony has been appointed purchasing agent of the Denver, Northwestern & Pacific Ry. with office at Room 723, Majestic Bldg., Denver, Colo.

J. E. McLean has been appointed master mechanic of the Kansas City Southern Ry., with office at Pittsburg, Kan. He succeeds G. S. Hunter.

G. L. Lambeth has succeeded A. D. Minton as master mechanic of the Mobile & Ohio R. R. with office at Jackson, Tenn.

E. F. Tegtmeyer has been appointed master mechanic of the Nebraska and Colorado divisions of the Rock Island Lines with office at Goodland, Kan., succeeding D. H. Speakman, resigned.

G. W. Russell, master mechanic of the New York, Philadelphia & Norfolk at Cape Charles City, Va., has been appointed general equipment inspector, reporting to the superintendent. J. L. Cunningham succeeds Mr. Russell, both with offices at Cape Charles City.

F. S. Wynn, assistant secretary of the Southern Railway at Washington, D. C., has been appointed purchasing agent, with office at Washington. Mr. Wynn will report to H. B. Spencer, vice president.

B. T. Jellison, purchasing agent, and R. L. Morris, general storekeeper of the Chesapeake & Ohio, have had their authority extended over the Chesapeake & Ohio of Indiana, both with offices at Richmond, Va.

Paul L. Grove, formerly assistant master mechanic of the Pennsylvania Railroad at Altoona, Pa., has been made assistant superintendent of motive power of the Buffalo & Allegheny Valley division, with headquarters at Buffalo, N. Y. Mr. Grove was born in Altoona, October 3, 1878. He entered the service as a messenger in 1894, became an apprentice later and an inspector on the Philadelphia division in 1902. In 1904 he was appointed foreman of the State Line shops and a year later assistant master mechanic of the shops at Altoona. His successor in the last mentioned position has not yet been named.

The Chicago, Milwaukee & St. Paul has accepted recent ordinances passed by the city council of Chicago providing for extensive track elevation in the suburbs of that city. On the two divisions affected there is something over six miles of track to be elevated, requiring a total of 73 subways, besides street improvements. Plans and specifications are now being prepared.

Members of Executive Committee, C. I. C. I. & C. F. Assn.

Chas. Waughop.

A. Berg.

J. L. Stark.

T. J. O'Donnell.

W. R. McMunn.

F. C. Schultz.



H. Boutet, Pres. F. W. Trapnell, V. P. S. Skidmore, Sec.

Officers of the Chief Interchange Car Inspectors' and Car Foremen's Assn.

Report of the 11th Annual Convention, C. I. C. I. & C. F. Assn.

The eleventh annual convention of the Chicago Interchange Car Inspectors' and Car Foremen's Assn. of America, was held in Washington, D. C., September 6, 7 and 8, 1910. The meeting proved very successful and all were well satisfied with the arrangements for business and pleasure. The general officers were re-elected and one change was made in the executive board. The officers re-elected are: President, H. Boutet, C. I. I., Cincinnati, O.; Vice-President, F. W. Trapnell, Kansas City, Mo.; Secretary and Treasurer, Stephen Skidmore, F. C. D. C. C. C. & St. L. Ry. Co., Cincinnati, O.

The members of the executive board are: Chas. Waughop, C. I. I., St. Louis, Mo., H. Boutet, C. I. I., Cincinnati, O., A. Berg, Erie, Pa., Jas. Starke, Gen. Insp., Toledo, O., T. J. O'Donnell, A. R. B., Buffalo, W. L. McMunn, Special Inspector, Albany, N. Y., F. C. Schultz, Chief Car Inspector, Chicago, Ill.

The papers read at the convention are published below. It is intended to publish a verbation report of the meeting in November issue of the RAILWAY MASTER MECHANIC.

Address by James E. Jones.

A few days since I received a letter from Mr. Moseley, in which he advised me of your courteous invitation to him to be present at this convention, expressing his regret at his inability to attend on account of his absence from the city, and delegating me to speak on his behalf the friendly greetings he himself would utter were he here in person. No one appreciates more thoroughly than Mr. Moseley the public benefits accruing from the labors of this organization, and in addressing you I voice the recognition by my colleagues of innumerable acts of courtesy and co-operation on the part of your various members. It is within the common experience of every inspector of safety appliances to have received at the hands of the Chief Joint Inspectors assistance which if not forthcoming would have materially impaired the efficiency of the Government's representatives. And it is to me personally a source of gratification to assure you that from my own experience there is no organization more thoroughly conversant with the duties imposed upon it or more capable of performing well those obligations.

All laws designed to minimize the dangers incident to railroad operation are suggested by philanthropy and humanity. There is no stronger obligation vested in the Government than its duty to protect the lives and limbs of those who carry on the transportation of its traffic. And its citizens can manifest no stronger evidence of their loyalty than by aiding in the fulfillment of that obligation. There is no reason why the execution of these laws should be accompanied by the least unpleasantness or friction between the corporations and their employees or the Government. For in the last analysis the administration of the law redounds no less to the advantage of the railroads themselves than to the benefit of the general public. The countervailing benefit is offered by reductions in disbursements on account of damages arising out of injuries to railroad operatives, and by the approbation of the public for efficient operation.

It is in your province, gentlemen, by a continuance of the cordial policy you have always heretofore evinced, to aid in the execution of the law. Team-work should be our slogan, and we should manfully respond to the obligation imposed no less upon the wiper in the round-house than upon the director in his council chamber, a duty resting on each individual to exert his best endeavors for the common good of all. This duty and the object of its imposition have been well described by Secretary Moseley in his speech before the forty-second annual convention of the Master Car Builders' Association, held at Atlantic City, June 18, 1908, in which he said: "From deductions based upon reports made to the Commission I find that every two hours and fourteen minutes a railroad employee is killed, and one is injured more or less seriously every seven minutes with the regularity of clock-work. During the few minutes that I am speaking here today at least two employees have been injured, and between the time this convention was called to order this morning and its adjournment this afternoon it is certain that two railroad employees will have given up their lives. This one fact will impress upon you in the most emphatic manner your solemn responsibility to railroad employees and the public."

Perhaps the most prolific cause of friction in the past has been attributable to the lack of uniformity in the application and maintenance of safety appliances. The various carriers equipped their rolling stock in consonance with their own ideas. Legislation on the subject was not explicit and the Master Car Builders' standards were in many instances ignored. The obvious result is too well known to you to need elaboration.

The recent amendments to the safety appliance statutes were designed primarily to obviate this situation. No radical innovations in the construction of cars are contemplated. The only purpose of the amendment has been to unify the standard of equipment now in use. Of course, some minor changes in equipment must be made to meet the standard of uniformity, but there is no doubt that ample time will be permitted to the railroads to adjust the situation, and the expense involved should be gradually absorbed in the ordinary cost of maintenance. The Interstate Commerce Commission has already received a number of communications from car foremen, in which they have expressed their sanction of the changes contemplated and their willingness to co-operate in the enforcement of the law.

The intention of the committee was to produce an ideal car, viewed from the standpoint of safety to the traveling public and employees. Perhaps this consummation is not yet attained. It is not improbable that vital points have been neglected and untoward errors made. But I can assure you, gentlemen, that perfection is the end towards which we all are striving, and if any defect is discovered in the new arrangement, information of that fact will be thankfully acknowledged. Most serious difficulty has been experienced by the Government inspectors of safety appliances at the so-called points of interchange. It is at such points that the greatest tact has been necessary to prevent unwholesome friction, and it is there that this organization has invariably extended a helping hand and vouchsafed its friendly offices.

In conclusion, this single proposition is self-evident: that is, that if the cars are properly equipped when accepted at interchange points, they cannot be materially defective when they are sent out upon their journeys across state lines. The burden of responsibility, therefore, devolving upon you, gentlemen, is proportionate to the interest which you individually feel in the administration of the law.

It has afforded me much pleasure to look into your friendly faces this morning, and to convey to you the kindly greetings of Mr. Moseley and of my several colleagues, every one of whom owes debts of gratitude to you for timely aid. The success of this convention is assured already. Under the direction of its chairman and his able adjutants it could not fail. And throughout the progress of your labors you may rest assured of our appreciative co-operation and of our cordial and sincere good wishes.

Cincinnati Methods of Inspection.
By J. J. Gainer, John L. Brady.

Since the inspection and interchange of passenger and freight cars are of so much importance to the railways and their officials, it occurred to us that it might be well (being in the trenches) to make some comparisons between the rules governing the interchange of cars in Cincinnati terminals to-day, which are known throughout the states as "Run, Repair or Transfer," as against the system previously used here when the inspectors of the receiving road were stationed in the delivering roads yards where cars were refused and could not be delivered until repaired or marked O. K. by the chief interchange inspector or one of his assistants, and also with some of the other important interchange points where cars are refused on account of slight defects which do not, in any way, interfere with their carrying the load to the destination.

Some are of the opinion that under the "Run, Repair or Transfer" agreement, the inspectors become careless and allow a great number of cars to pass through the terminals and move out on the receiving line in bad order and not fit for traffic, thereby burdening the receiving line with more bad order cars than they are entitled to, and it has also been charged that it permits one road to load bad order cars that necessarily must be transferred by, and at the expense of, the other. The cost of transferring cars account of bad order which cannot be repaired under load is chargeable to the delivering line in accordance with American Railway Association's Rule No. 15. If the inspectors allow cars in bad order, not fit to load, to get out on their line, the inspection is faulty and its supervision is bad. In the first place a great deal depends on the attention given the work by the foreman in charge; the interchange inspector should be thoroughly familiar with the rules governing the inspection of cars, know the defects that must be repaired to make the car safe to run, those that may be run on record, those that are chargeable to car owners, those which should be carded and the penalty defects under the interstate commerce law, which should be repaired before the car is forwarded, and it is the duty of the foreman in charge to confer with the inspectors and repairmen in train yards and instruct them individually and collectively from time to time, as the rules may change, in order to keep them prepared to interchange only such cars that are fit for traffic and have an earning capacity.

When a train of from 40 to 60 cars reaches these terminals, they are promptly inspected in the delivering line's yard by their inspectors who see that all cars have the safety appliances in good condition, and that they are safe to run to the repair or transfer track of the delivering line, which inspection consumes from 15 to 20 minutes for two men; the train is then broken up and cuts built up for the various lines and delivered; the delivery is not established until cars reach the receiving line's yard, where they are thoroughly gone over by their inspectors. Cars requiring shopping are so marked and carded, those with physical defects that can be repaired are repaired, and forwarded, and those that require transferring are shown to the chief interchange inspector or his assistants, who orders car transferred and issues transfer order against delivering line. All of the inspecting is done under the immediate supervision of the foreman in his yard, and if the inspector sets in on the repair track a car or cars going away from him that should not have been set in, and instead should have been allowed to go to the receiving line, or if he allows cars to go out on his line that are unfit to load and for traffic, the foreman can immediately take the matter up with the man at fault and possibly prevent a reoccurrence; at least he makes the inspector more careful and prompts him to exercise better judgment.

During the month of June 1910, there was interchanged at Cincinnati, Ohio, an average of 3,500 cars each day; 135 cars shopped and repaired by receiving line and 32 cars had their lading transferred, which is by no means a large percentage; many of the cars interchanged each day, had defects that did not effect the vital points and were purely imaginary so far as the safety of car and lading was concerned, which if shopped would have made the percentage much higher, a lot of unnecessary work such as switching, etc., and a big delay to the car and freight. We are not permitted to return any car to the delivering line account of its condition, except on authority of the chief interchange inspector or his assistants, and he will not return it only when the amount of work necessary to put the car in good condition exceeds ten hours labor for two men; cars set back will not average five per month. With an active foreman to properly instruct and assist the inspectors as to what is the proper interpretation of the M. C. B. and inspection rules, there will be a smaller percentage of cars set out under the interchange agreement known as the "Run, Repair or Transfer," than any other that we know of, largely due to the fact that under the old systems, entirely too many cars are refused and held up causing unnecessary delay account of defects that do not in any way prevent the car from being handled to its destination with perfect safety to trainmen, car and its lading. Cars with defects which the delivering line are responsible for are charged to the delivering line in accordance with M. C. B. code of rules.

Under the old system which is in full force at many interchange points, a train of 40 to 60 cars comes into the delivering line's yards where they carefully inspect all cars to be interchanged, shop those that in their opinion will be refused by the receiving line inspectors either for repairs or transfer of lading, card all that have defects that the delivering line are responsible for, that are safe to run, and pass the others to be interchanged, which in their opinion should be accepted by the receiving line inspectors without objections, account of being in a serviceable condition. This will consume, in our opinion, from sixty to ninety minutes, the time of course varying with the general condition of the cars; the cars are then switched out and placed on the interchange tracks, where they are inspected by the receiving line, who consume almost as much time on the cut as the delivering line inspectors did, and reject a number of cars and cause to be taken back to the delivering line's yards for defects that do not in any way affect the vital parts and could not interfere with their carrying loads to destination. It is claimed by some that this kind of inspection is due to improper interpretation of the rules, inexperience, lack of judgment, being too exacting and many other reasons, but the shipments are badly delayed and if there is a joint inspector, he is called in and in all probability runs the car. It does not seem to occur to some men that they are standing in the way of handling important business with prompt despatch that has been solicited by the freight department with the understanding that shipments would reach their destination at a given time, and there is in our opinion, no better way to overcome these obstacles than by getting together men of experience, that will help to bring about uniformity in the interchange of cars, have interchange rules and live men to put them into effect, who are progressing with the times, and the cars will move with little friction or delay.

M. C. B. Repair Rules.
By J. J. Devanny.

It seems to me it is about time this association should get in line and help the M. C. B. Association to make the rules, instead of going over the rules after they are made, as we are now doing. I feel sure if we could get together on rules, they would help to facilitate the movement of cars at interchange points. The M. C. B. Association would be pleased to hear from us and no doubt adopt, if not at all, part of our recommendations.

As the M. C. B. rules now stand, they place penalties on parties delivering cars with minor parts missing, bursted air hose, etc. This might have been all right years ago when delivery tracks were close together, but now they are usually from eight to twenty miles apart and to stop a car to make these repairs at the end of a division is a loss of time, as, no matter how well you may adjust the car, when the receiving line gets it they will stop it and give it their necessary inspection, and do brake repairing, oiling, etc., to put it in first class condition to go over its division. Now, if the latter will do this, what is the use of delaying car at the end of the division? If car is to go to another line, they might just as well do it all. This would break even in most all cases and would be in line with our present manner of handling loaded cars, and there should be nothing in the rules that would tend to move freight backwards, except safety appliances.

I notice in reading the minutes of the last M. C. B. Association meeting, there was, or will be, a committee appointed to suggest rules, etc., regarding the defects of steel cars. These steel cars are becoming plentiful and we all know the rules as to handling both the repairing and interchanging them are very lax. While this committee may be of the best in this country, I can't help but feel that they would like to have recommendations from a party of men like this one, which is composed of men who handle the business all over the country, and it seems to me we should get together now and see just what rules are best for all concerned, to move this steel equipment throughout this country and avoid having a car carded for defects at one interchange point and not at the other, or to have a car pass one interchange point not carded, and carded at the next, for the same defect. In fact, get them as near universal as we can, before it becomes a rule and then we will not have to deviate from the rules as is now the practise all over the country. There are many defects on steel cars these days being carded that in no way mar the strength of the car and often there is no intention of repairing it. In fact, to do so would sometimes weaken the car. We have all seen end sills, etc., bent enough to card under the present rules, but the car would be better off in strength and looks to leave it that way.

I think, if in your opinion it is proper, a committee of this association should be appointed to adopt a set of rules to govern steel cars and at least offer them to the M. C. B. Association. They could do no less than turn them down.

"Miner Defects in New Freight Cars."

By H. H. Harvey.

When our worthy president wrote me a few weeks ago, asking me to prepare a paper to be read at this meeting, I replied that I would not undertake a lengthy paper on the subject he suggested, but, if agreeable, would prepare a brief one on the subject, "Minor defects in new freight cars."

My reason for selecting this particular subject is, that too little attention is paid small details on new cars and if, by a short discussion here, notice can be called to a few of the ones frequently overlooked in the building of new equipment, the object sought will at attained. Practically all the items to which reference is made can be taken care of at the time cars are built, at very little expense, and the ultimate saving during the life of the car will much more than offset any expense necessary at this time. For the purpose of ready reference in discussing the items to which attention is called they are arranged in numerical order.

1. Truck column and journal box bolts should be provided with efficient nut locks, split keys or cotters to prevent nuts jarring loose. A very common sight, during the winter time when road bed is frozen solid, is a car repairer with a string of nuts over his sholder and a long wrench in his hand, going through switch yards to replace nuts that have shaken off.

2. Inspect carefully journal box wedges and tops of journal boxes to see that they conform to M. C. B. specifiications and save future trouble on account of hot boxes.

3. See that journal box cover pins have cotters of proper size and that both legs of cotters are properly opened up so as to keep pins from coming out and covers losing off.

4. See that train line has enough clamps to hold it securely in place and prevent its shifting lengthwise.

5. Have angle cocks set at an angle of 30 degrees as recommended by M. C. B. Association, to avoid trouble on account of the air hose being too short in cold weather.

6. See that cylinder and reservoir block bolts are previded with efficient nut locks or cotters, so the bolts will always keep the cylinder and reservoir tight on the car. This is especially important, now that all cars are equipped with air brakes.

7. See that brake cylinders and reservoirs are so located that triple valve and cylinder head can be easily gotten at for cleaning or repairs. Frequently, either triples or cylinders are so close to the needle beam that trouble is experienced in getting them down.

8. See that brake hanger pins are so applied that cotters or split keys will always be visible to inspectors and avoid accidents account keys coming out and being overlooked by inspectors.

9. Pay particular attention to the design of hand brakes to avoid the following trouble:

A. Floating lever binding in carrier or fulcrum.

B. Top rod so long that it comes in contact with sheave or brake staff before brakes are fully set.

C. Chain so long that it knots up and binds in bottom brake step casting.

D. Bottom casting poorly designed so that it will not always remain in line with upper casting or does not prevent chain dropping over bottom end of casting or brake staff.

E. Brake staff not properly lined up so it does not bind in either the top or bottom casting or in brake step board.

F. Top casting of such a design that it cannot be securely fastened to end plate or plank.

G. Brake pawl bolt applied in a way that nut cannot readily be seen by inspectors.

10. When post and brace pockets are used, they should be secured to sills and plates by at least one bolt in addition to post rods so as to prevent tipping.

11. Where end sheathing between posts comes down only to top edge of deadwood or buffer block, some provision other than nailing should be taken to prevent grain leakage. If malleable buffer blocks are used, they should be made with a flange about 1½ in. high located either ¾ in. or ⅞ in. from back face of block and just long enough to fit between end posts, the bottom end of sheathing to go back of flange. If wooden blocks are used, they should be provided with a gain about 1½ in. deep into which bottom end of sheathing will fit or an angle iron through which carrier iron bolts would pass will answer the same purpose.

12. Make girth and triangular grain strips of one piece instead of two, as is general practice.

13. Use 6 in. flooring in grain cars and the wider widths on other classes of cars, as the shrinkage on the wider widths is often so great that grain leaks through cracks in floor.

14. Provide good substantial corner bands near roof to tie end and side plates together to prevent ends bursting out at top in ordinary service.

15. Use facia wide enough to prevent rain getting in over top of sheathing and turn bevel on bottom edge next to car,

so as to provide a water table from which rain will drop off instead of following around bottom of facia.

16. Have side door fastener bolts extend through both the stop and post to prevent splitting of stops.

17. Make door hasp holders long enough to take at least three bolts through door to prevent splitting of door sheathing.

18. Precaution should be taken to make a water proof job where running board saddle bolts go through ridge pole.

19. Roof grab iron should be so designed that bolts will not pass through roof sheets. Nuts on these bolts should be on outside where inspectors can see them.

20. All carlin and purlin bolts should be provided with efficient nut locks or double nuts to prevent nuts losing off and permitting roof underframing to get loose and shaky.

There are doubtless many other small items that have come under your personal observation and probably will be brought out in the discussion, but the above seem to me to be the most important ones that can be easily overcome at practically no expense if they are looked after when the cars are built.

Hot Box Troubles.

By James Reed.

The subject assigned to me by our president is not a new one. It is one that has been written up a number of times and has been discussed by railroad men throughout the country. It is a subject that is known to everyone connected with maintaining railroad equipment and is commonly called the "Hot-Box."

There is no part of the railroad equipment that gives more dissatisfaction, more cause for investigation, and more cause for complaints than a hot-box. It is very inconvenient to the traveling public for trains to be delayed and at times a sleeping car or a car containing valuable shipments to be cut out and transferred for a hot-box. We, as car foremen, have got to explain to our superiors the cause for these journals running hot. The question that is usually put to us is: What are we going to do to overcome the trouble?

There are a great many causes for hot journals and likewise a great many different opinions among men who are directly connected with the business. Nearly every car foreman has different ideas. There is no question but what they are all doing their very best to overcome the trouble; still there is not much of an improvement in this line and we continue to have trouble. Our trains are being delayed and cars are cut out along the road for this same cause. We had the same trouble years ago.

The writer has followed this matter up very closely for some years past, has taken particular notice of the causes given by car foremen for hot-boxes; and for a period of two months in the year 1910 there was a total of twenty-six hot-boxes on one division. The reasons given by car foremen for these journals running hot were as follows: brass worn thin (2), brass worn unevenly (4), journal rough or seamy (1), new brass or axle (1), doubtful (18).

Our mechanical men have got together with a view of overcoming the trouble, our journals are smoothed with the very best of skill, journal bearings are of the very best material, oil and other lubricants of the very highest grade, waste that is used in the boxes has been proven the best that can be produced; still we do have an epidemic of hot-boxes which we cannot explain. It seems the opinion of a great many railway officials that the cause of a large percentage of hot-boxes is due to lack of attention. This may be true to some extent, but there are cases that we all know of where cars receive the very best of attention by the very best workmen, the boxes are packed by skilled oilers in accordance with instructions furnished by the oil companies' experts, and everything possible is done to avoid the journal running hot, but occasionally they break out and do run hot for some reason that we cannot explain.

Expert oil men will tell us that too much oil in a box is detrimental, that the weight of the oil will overload the waste, carry it away from the journal, the latter will become dry, cause friction and subsequently heat. Others will tell us that boxes must have sufficient oil to keep the journal well lubricated at all times. The use of free oil has been discontinued for a number of years on a large number of railroads with very good results. The oil cans have been taken away from oilers and it has been proven that where prepared dope is used instead of free oil, with careful spudding up, that better results have been obtained, making no mention of the large saving that has also been brought about by this method.

We have had considerable trouble with application of new wheels to cars, especially so with cars in long distance and fast trains. Everything possible is being done to put these cars in perfect condition before starting, journals and brasses are very carefully examined and all parts apparently in the best of condition. Still, it appears they will run hot no matter how carefully we treat them. For example: Take a train that is running regularly every day, making four hundred miles per day, wheels are changed under a certain car in this train and given the best of attention by the very best workmen, brasses are carefully fitted before being applied to the boxes, the best of oil and waste is used for lubrication; but, after this car with the new pair of wheels has run cool for two hundred miles, it will then commence to run hot so that it is necessary to change the brass, and in a great many cases, two or three brasses, before we get it down to its bearing.

The question is: Do we overload cars when wheels are applied? Is the percentage of weight greater on the new bearings that have recently been applied to new wheels, than on the remaining bearings which have been running for some time? Another question is: Why did not this journal run hot before the car made two hundred miles? It certainly is not for the want of attention, and as far as we are able to ascertain, our trucks are not out of tram. Our brasses and journals are all properly fitted, still there must be a cause for the trouble and in the writer's opinion there is no better place to discuss this matter than right here where we have men who are directly connected with this line of work every day.

It is true that we do not experience the trouble with hot-boxes that we did some years ago but we are having far too many at the present time and what we would like to do is to reduce the number of hot-boxes to a minimum. It is a well-known fact that in extreme cold weather, when the roadbed is hard and rigid, we have trouble with snow and ice getting into the boxes, thereby giving us an epidemic of hot-boxes The cause to a great extent is due to the waste getting away from the journal on account of the packing becoming frozen and settling down in the boxes, creating friction due to the journal becoming dry. On the other hand we also have epidemics in warm weather, and our superiors look to us to make improvements along these lines and to advise them the causes for journals running hot.

As everyone connected with the railroad from the general manager down to the oilers are personally trying to overcome the trouble, I would ask that you gentlemen give us the benefit of your experience and knowledge as I know you are qualified to discuss the subject in a way beneficial to us all and from the discussion we may learn something and go back to our respective places of business and improve the hot-box situation.

Among the Manufacturers.

THE MACHINE TOOL MANUFACTURERS OF CINCINNATI AND THE OHIO VALLEY EXPOSITION.

We have long been in the habit of looking first to Cincinnati, the greatest machine tool center in the world, when in the market for machine shop equipment. But as the occasions for the issuance of requests for bids for complete machine. boiler, wood working and blacksmith shop machine equipment are seldom met with in the experience of many. The scope of Cincinnati's machine tool industry is not generally realized.

It is probable that some such idea as this prompted a number of the more ambitious of the machinery manufacturers to take advantage of the opportunity offered by the Ohio Valley Exposition to exhibit their product to all who were able to attend. This exposition which was held in Cincinnati, August 29 to Sept. 24, 1910, proved a success in every way. It was intended to set forth the resources of the Ohio Valley and the South, but the machinery and railway supply exhibit was an exposition of considerable scope in itself. The accompanying photographs of the exhibits give a general impression of the general excellence of the arrangements.

The following list of seventy-two machinery manufacturers in and near the city of Cincinnati contains a few names of concerns not active in railway business; however, the greater number of names are all familiar to the readers of this paper, as active in the outfitting of railway shops:

Advance Mfg. Co., American Tool Works Co., Andrews, M. L. & Co., Atlas Machine Tool Co., Aurora Tool Works, Barker, Wm. Co., Bental and Margedant Co., Bickford Drill & Tool Co., Bradford Machine Tool Co., Buckeye Equipment Co., Carroll-Jamieson Mach. Tool Co., Chambers Mach. Co., Champion Tool Works, Cincinnati Electric Tool Co., Cincinnati Machine Tool Co., Cincinnati Milling Machine Co., Cincinnati Planer Co., Cincinnati Punch & Shear Co., Cincinnati Shaper Co., Cordesman Machine Co., Cordesman, Myer & Co., Day J. H. & Co., Dean, Waterman Co., Dietz Machine Tool Co., Drèsses Machine Tool Co., Economy Machinery Co., Fay & Egan Co. J. A., Fosdick Machine Tool Co., Gang, Wm. E. Co., Gray, The G. A. Co., Greaves & Klussman Co., Greenwald I. & E., Hamilton Machine Tool Co., Hisey-Wolf Machine Co., Hoovens, Owens & Rentschler, Houston, Stanwood & Gamble, Keene Geo. C. & Co., King Machine Tool Co., Kinsey, The E. A. Co., Knecht Bros. & Co., Laidlaw-Dun-Gordon Co., Lane & Bodley Co., LeBlond R. K. Machine Tool Co., Lodge & Shipley Machine Tool Co., Long & Allstatter Co., McGowan, John H. Co., Morris Foundry Co., John B., Muller Machine Tool Co., National Machine Tool Co., Oesterlein Machine Tool Co., Park Ball Bearing Machine Co., Queen City Shaper Co., Rahn, Mayer & Carpenter Rechtin, L. E. & Bro., Robinson, J. M. Mfg. Co., Schacht Mfg. Co., Schumacher & Boye, Sebastian Lathe Co., Shepard Lathe Co., Shellenbach & Radcliffe, Silk P. P. Machine Tool Co., Smith & Mills, Steptoe, John Co., Streit, A. Machine Co., Towsley, John T. Mfg. Co., Tucker Machine Co., Von Wyck Machine Tool Co., Wais, Chris, Watkins, F. M. Laundry Machine Co., Watkins, F. M. Mfg. Co., Willard Machine Tool Co.

Exhibitors.

The exhibiting firms identified with the railway supply trade were as follows:

The Eagle Rotary Engine and Electric Headlight Co., Newport, Ky.

The Cincinnati Pulley Machinery Co., Covington, Ky. Builders of Streit pulley machinery, rivet spring machines, ballbearing sensitive drills.

Richter & Company, Cincinnati, Manufacturers of brass goods.

H. W. Johns-Manville Co., Cincinnati. Roofing, insulation and asbestos material.

Lunkin Steel Window Co., Cincinnati, Ohio. Manufacturers of metallic, fire-proof windows.

The Yellow Pine Manufacturers' Association, St. Louis, Mo. Manufacturers of yellow pine lumber.

W. J. Baker Co., Newport, Ky. Manufacturers of window screens, sheet metal and wire specialties, dies and small tools.

Cincinnati Gear Cutting Machine Co., Cincinnati. Manufacturers of gear cutting machinery.

Cincinnati Time Recorder Co., Cincinnati. Manufacturers of time recording clocks.

Indian Refining Co., Cincinnati. Petroleum products.

Lodge & Shipley Machine Tool Co., Cincinnati. Manufacturers of machinery.

The Vulcanite Roofing Co., Cincinnati. Roofing.

Chicago Pneumatic Tool Co., Chicago. Manufacturers of electric and air tools.

Bradford Belting Co., Cincinnati. Manufacturers of "Monarch" leather belting and lace leather; and dealers in rubber belting, hose, packing lace leather.

The Link Belt Co., Indianapolis, Ind. Link belts.

Philip Carey Mfg. Co., Lockland, O. Manufacturers of 85 per cent carbonate of magnesia steam pipe and boiler coverings, standard asbestos pipe and boiler coverings, asbestos paper, asbestos pitch for roofing, etc.

Exhibit of Acme Machine Tool Co., Mr. Pierson in Attendance.

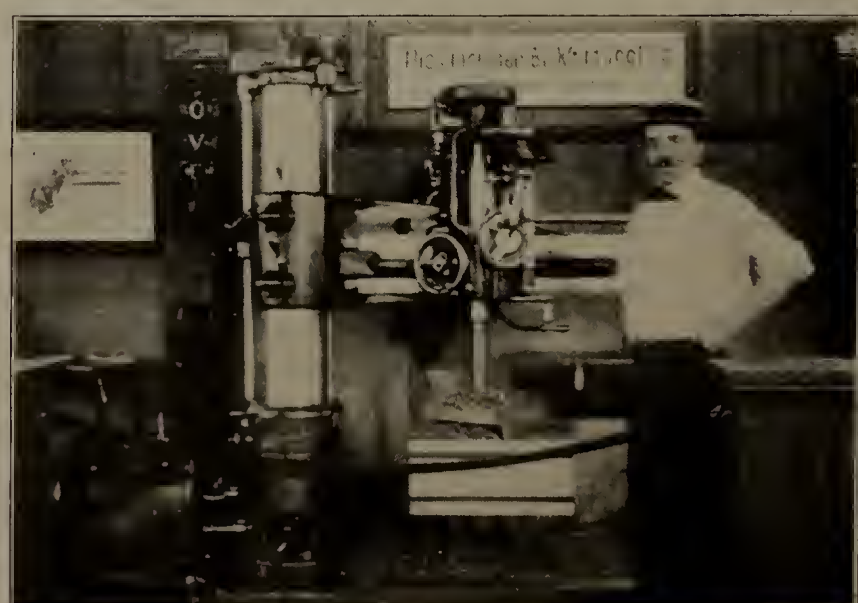


Exhibit of Cincinnati-Bickford Tool Co., Mr. John L. Bishop in Attendance.

Exhibit of the Eagle Rotary Engine Co., Mr. C. A. Wissel in Attendance.

Exhibit of the Chicago Pneumatic Tool Co.

The Hisey-Wolf Machine Co., Cincinnati. Manufacturers of portable electric tools, consisting of electric drills and electric grinders.

Cincinnati-Bickford Tool Co. and Cincinnati Milling Machine Co. Manufacturers of heavy machinery.

Triumph Electric Co., Cincinnati. Manufacturers of electrical machinery.

The Westinghouse Electric & Manufacturing Co., Pittsburg. Manufacturers of electrical machinery.

Allis-Chalmers Co., Cincinnati. Engines, electrical apparatus, mining and crushing machinery.

J. A. Fay & Egan Co., Cincinnati. Manufacturers of woodworking machinery.

Cincinnati Planer Co., Cincinnati. Manufacturers of planers and heavy machinery.

Cincinnati Milling Machine Co., Cincinnati. Manufacturers of milling machines and universal cutter and tool grinders.

The Lunkenheimer Co., Cincinnati. Manufacturers of superior brass and iron specialties for steam, gas, water and oils.

The General Electric Co., Schenectady, N. Y. Electrical machinery.

The Carborundum Co., Niagara Falls, N. Y. Manufacturers of abrasive materials.

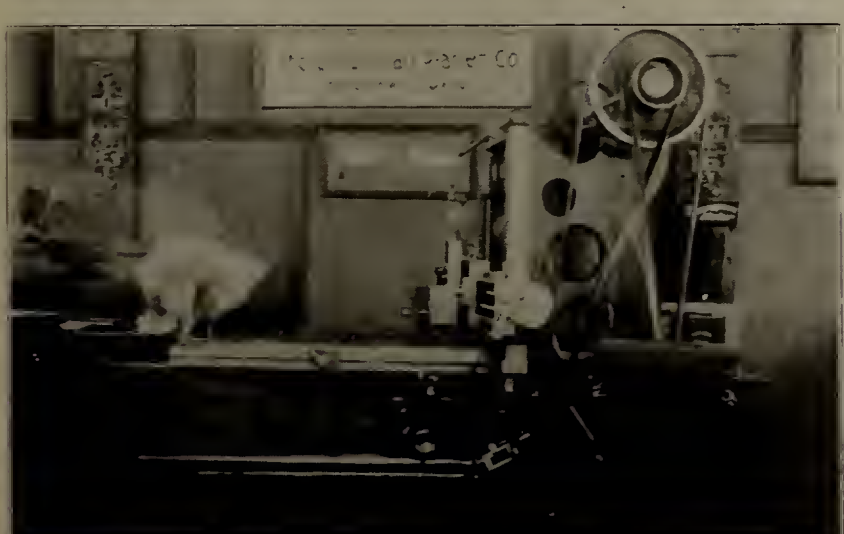
One Lock Reamer Co., New Haven, Conn. Manufacturers of small tools.

Following are a few brief descriptions of Cincinnati manufacturers and their product:

The Cincinnati Planer Co.

The Cincinnati Planer Co. is now occupying a new plant at Oakley, O., a suburb six miles from Cincinnati. It has a nine-acre tract on which it has erected a one-story brick and steel structure 150 ft. wide by 400 ft. long and a separate office building of two stories. This building immediately adjoins the front end of the shop, separated by a brick wall with two entrances, which are protected by automatic fireproof doors. The shop is equipped with two electric cranes, one of 15-ton and another of 20-ton capacity. These large cranes are used in handling the heavy planer beds and tables and in serving the big tools located in various departments along the main aisle. In the west bay is a 5-ton Pawling & Harnischfeger electric crane and in the east bay a 4-ton Shepherd crane, both controlled from the floor. These cranes are used in handling the rails and other smaller parts of the machines. In the front end of the shop is a depressed track, of sufficient length to admit two 40-ft. cars and so located that both cars can be loaded or unloaded at the same time by use of the large cranes in the main aisle and the 5-ton crane in the west bay, this railroad track being used mainly for shipping. On the west side of the building there is another spur used for receiving castings and raw material in carload lots. This spur runs through the casting yard located in the rear of the building. Cars are unloaded with an electric crane, which travels over the cars and the full width of the building.

Each department is driven by an individual motor, the line shafts being put up in short sections, making each department independent of the others. All the larger tools are driven by motors, mounted direct on the machines. Hyatt roller bearings are used on all line shafting throughout, reducing the friction to a minimum. The motors are mounted on concrete piers about 3 ft. high, where all cars and adjustments can be made readily from the same floor. All the heavy tools are mounted on solid concrete foundations, the lighter machines setting direct on the floor. In the planer department, located in the northwest end of the building,



Cincinnati Planer Co.

Triumph Electric Co.

Cincinnati Gear Cutting Machine Co., Mr. Beiler in Attendance.

Cincinnati Milling Machine Co., Mr. Bishop Again.

all the heavier planers are mounted on improved leveling wedges, which are embodied in concrete, making these tools solid on their foundations. These wedges also enable accurate adjustments when releveling after inspection every few months, therefore insuring the work coming from these machines, such as beds, tables, housings and rails, being planed perfectly, requiring little or no scraping. The greatest care is exercised in the planing operations, especially on such work as is likely to spring when released from the clamps. This is especially noticeable in the planing of tables. To secure the best results, the casting is first completely roughed, then drilled and allowed to lay for a few days, giving it time to resume its natural form, after which it is returned to the planer for finishing. On small work like gibs, the same practice prevails.

The lathe department, located in the northeast end of the building, receives its raw material and castings by trucks over an industrial track from the casting yard. All the various boring lathes and mills are arranged at this entrance. The castings, being first bored and rough turned, pass down to the different lathes for finishing, then to the grinders, and into the milling department, but never criss-cross anywhere throughout the shop. The heavier machines in this department are equipped with single I-beam cranes. Shafts are made of high carbon steel and are first turned, keywayed and then ground. All spur, bevel and mitre gears are cut on automatic machines of the latest type. All driving gears are cut by a system of special cutters for each gear, thereby obtaining perfect rolling spur gears. All bevel and mitre gears are matched and tested on a special testing machine. The table rack, which is cut with special cutters or tools on the planer, is also tested and matched in this department, using a large spur gear with corresponding pitch.

All boring and drilling is done by jigs in the drill press department, which is centerly located in the shops. A novel feature of this department is the system of driving all tools from a single line shaft, no countershafts being used. Beds and housings are also drilled by jigs, the boring bars being driven by knuckle joints, doing away with all side thrust, giving a perfect circumference to all work done in this manner.

The distributing and stock room is located in the center of the shop, where all jigs, tools, screws, drawings and supplies are to be had, thus making it accessible from all departments. The main erecting floor occupies a large portion of the main aisle, where it can also be served by the large cranes. The large pit for erecting the big boring mill is also in this department. There are three test shafts in this department, each driven by individual motor of reigning capacity. The final tests of every planer are made under these shafts, where the feeds are tried and the machine finished by taking a cut off the table on its own bed and the tee slots finished to standard plugs. All finished work is brought here to be matched and fitted. The housings, rails, etc., are all scraped to surface plates, using straight edges and indicators in squaring them with one another.

A word about the principal features of the finished machines:

The Link Belt Co., Mr. R. S. Dyson in Attendance.

Exhibit of Lodge & Shipley.

Cincinnati Time Recorder Co., Mr. Campbell in Attendance.

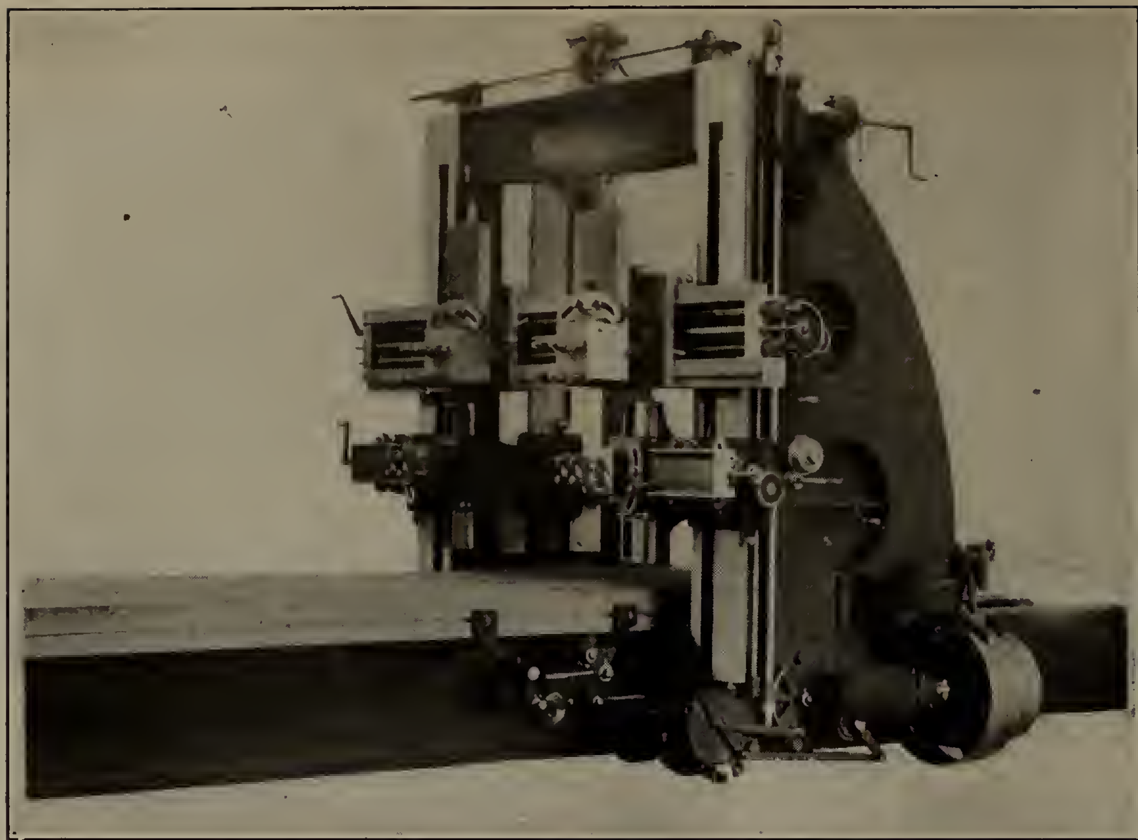
Cincinnati Pulley Machinery Co.

Take, for example, a 36-in. standard planer. It will be noticed that the bed is bored out to a jig, it is especially strengthened wwhere the gearing and housings are mounted, and is braced at short intervals with heavy box girths. The ways are hand scraped and are fitted with a series of automatic oilers, which keep the tees thoroughly lubricated. The shaft bearings or boxes are ground and fitted solidly into the bored holes in the bed, and have oil grooves that furnish a sufficient supply of oil. The driving shafts are made from high carbon crucible steel, and after being turned and keywayed, they are ground to insure the greatest possible accuracy. The pulley shaft, which is the only high speed shaft in a planer, is made ring oiling. All gears are cut from solid stock, semi-steel being used in the large gears and steel forgings for the pinion. They are placed on the inside of the bed, obviating all danger to the workman and protecting the gears from dirt and chips. The table is of considerable depth, and is braced and thoroughly ribbed underneath, insuring unusual stiffness. It is fitted with a dirt-proof feature, which prevents chips from falling into the tees. Holes are drilled and reamed from the solid and T-slots planed its entire length. The housings are carried down to the bottom of the bed, and are fastened to it by heavy bolts and dowel pins. They are braced by a box-shaped arch at the top, giving great rigidity and resistance to jar from heavy cuts when tools are at the highest point. The face of the housings are scraped to surface plates and great care is taken in fastening them to the bed, so that they are parallel with each other and are square with the bed. The housings are also held in place by tongue and groove, preventing spring under heavy work.

The cross rails are accurately scraped to straight edges and surface plates. They have a generous bearing on the housings, which are scraped on the front and back. The rail is made of sufficient length to allow either head to have full traverse across the table. The heads are carefully scraped to the rail and are graduated for swiveling up to 90 degrees. They are of a new shape, the end of tool block and slide being made round to avoid projecting corners on angular work. The heads have adjustable taper gibs on the down slide and the front and rear of saddle. The slides are hung on ball bearings, allowing them to work easy, and both heads can be raised at the same time with very little effort. They are right and left and are provided with automatic feeds in all directions. The tool block swings on a tool steel taper pin and carries four heavy steel bolts for clamping the tools. A power elevating device is furnished on all machines with double head rails, being operated by friction rings, and it is noiseless and is subject to very little wear. Being in the center of the arch, it exerts equal tension on the elevating shaft. A bearing next to the large raising gear does away with any side thrust that may occur. The gears are so arranged that a slow speed is used for raising and a fast for lowering. The device is engaged by a long handle at the side and when idle is locked by a binding screw. The pulley and shaft are the only revolving parts when not in use.

Part of the Exhibit of the Indian Refining Co.

Another View of the Indian Refining Co. Exhibit.



Cincinnati Locomotive Cylinder Planer.

The Indian Refining Co.

The Indian Refining Co., Cincinnati, occupied approximately 700 sq. ft. of exposition space, constituting one of the largest individual displays in the main building. The accompanying illustrations show the novel and decidedly interesting line of Indian products. The attention of visitors, especially those who were engaged in railway mechanical work, was secured by displaying a complete and perfectly constructed miniature locomotive in the space allotted to the railway lubrication department. The miniature engine, owned by Mr. T. O. Sechrist, master mechanic of the Queen & Crescent Route, at Summerset, Ky., was kindly loaned for the purpose of demonstrating the efficiency of Indian lubricants. In close proximity to this display was that of the Havoline Oil Co., for whose products the Indian Refining Co. is western distributor. Aside from the effective display of automobile and motor boat lubricants, the Havoline Co. showed many comparative tests covering the carbon residue in their own oil and in the oil of two competitive concerns. The Indian specialty department showed the possibilities and progress made by oil companies in general and the Indian in particular in the production of useful lines, such as harness oil, belt dressing, axle grease and other goods, which are aptly termed oil specialties.

Typical of the growth of the Indian Refining Co., and probably the most comprehensive and effective feature of their excellent exhibit, was the array or grouping of 30 grades of oil, starting with the crude petroleum fresh from the well and winding up with the headlight burning oil, which is considered one of the msot highly refined of all the oil products. The various oils were contained and displayed in specially constructed glass tubes, one inch in diameter and four feet in height, which showed the large variety of Indian products, including fuel, dynamo and journal oils, to the best advantage. The efficiency of Indian road oil was cleverly illustrated by the operation of two small electric railroad cars, speeding over lines of rail about three inches wide. One track set in a perfectly oiled roadbed showed its marked superiority over the second track, which covered a dry, dusty, unoiled road surface. In connection with this, the Indian timber treating department made a display of cross-sections of railroad ties showing the effects of their specially prepared

Indian Lubricating Oil Stills, Georgetown, Ky.

Shop View of the Cincinnati Planer Co.

"Timber asphalt" as applied to the preservation of railroad ties. Many practical railroad men evinced their interest by repeated tests and close analytical inspection of this display up to the closing day.

The Triumph Electric Co.

The product of the Triumph Electric Co., of Cincinnati, directly applicable to railway use, is a line of motors well adapted to direct machine drive. Triumph steel frame motors have been designed to supply the demand for a strong light-weight machine of high efficiency and good wearing quality. They are capable of withstanding heavy overloads and sudden fluctuations of load—are universal in their application, and all parts are readily accessible. These motors are built in all standard sizes, and for 115, 230 or 500 volts, except one or two of the smaller sizes, which are not wound for 500 volts. The smaller sizes, that is, up to 5 h. p., moderate speed, are bi-polar machines—the larger machines are of the multipolar type. Any of these motors can be furnished shunt, series or compound wound, as may be desired, or as the exigency of the service demands. The company has recently built larger and more commodious shops, which have been fitted with new machinery of approved pattern. In addition, only the best labor and material obtainable are employed, and each machine is thoroughly tested before leaving the works, so that they are known to be mechanically and electrically perfect when shipped.

In considering motors it is well to keep in mind the following facts:

Shunt wound motors maintain a practically constant speed regardless of the load. They are used when constant speed is required under changing load conditions, and are particularly suitable for driving line shafting or groups of machines operated by one motor.

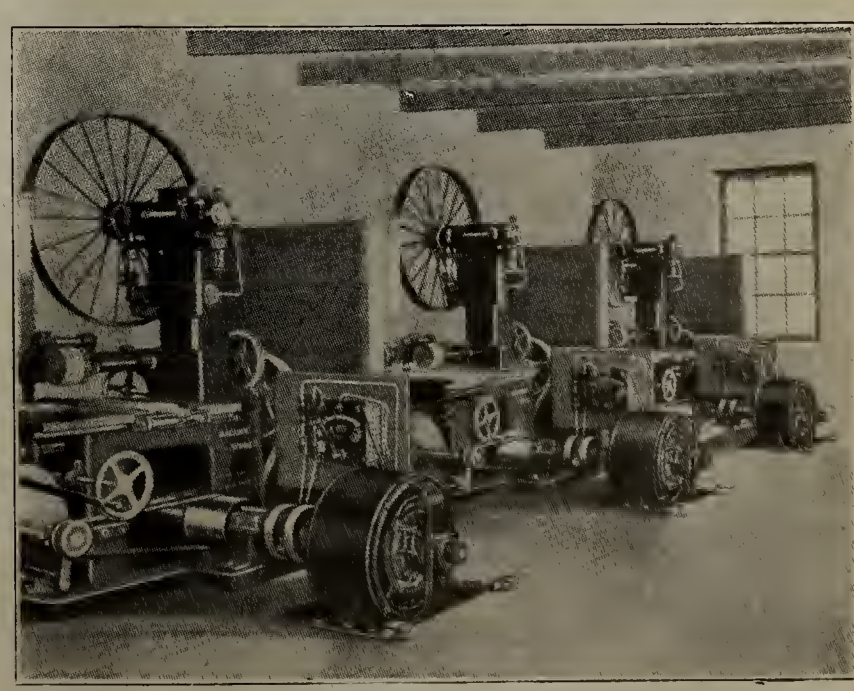
Series wound motors vary in speed in proportion to the load carried. They exert a very strong starting torque and will race if allowed to run free. This type of motor is particularly suitable for operating cranes, hoists, turntables, etc., when frequent reversals of rotation are necessary and when the speed of the motor is constantly under the control of an operator. Very satisfactory results can also be obtained from a series wound motor when directly connected to some known definite load, such as a fan or blower under free circulation.

Compound wound motors combine to some extent the advantages of the shunt and series wound motors. They will vary in speed with changing load conditions more than a shunt wound motor, but will not race or slow down under a heavy load to such an extent as a series wound motor. They are, therefore, well adapted for driving machine tools, printing presses, pumps, etc., when fairly steady speed and good starting torque are required. The percentage of shunt and series winding in a compound wound motor must necessarily be determined to some extent by the nature of the work to be performed. Generally speaking, a motor with 20 per cent of the magnetizing force in the series turns gives excellent results, and motors will be furnished wound in this proportion unless otherwise requested.

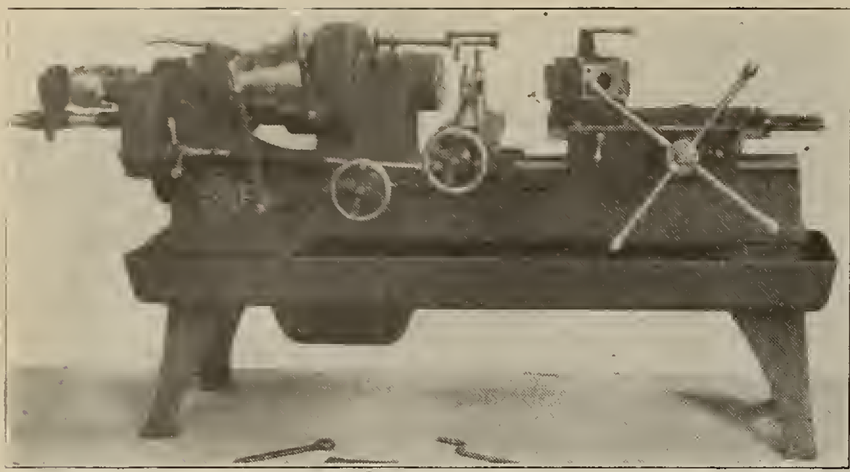
The Acme Machine Tool Co.

The accompanying halftone illustrates the Acme screw machine and turret lathe, recently brought out by the Acme Machine Tool Co., of Cincinnati. These machines were designed to meet the demand for a high grade, powerful tool for use with high speed steel. The head is cast solid with the bed and is provided with 3-step cone and friction back gears, so arranged that the spindle can be stopped by throwing the operating lever in the middle position. The spindle runs in a ring oiling babbitted bearing of ample size, all end thrust is taken by the bearing, thus avoiding any binding due to the unequal expansion of the steel spindle and the cast iron bed.

The automatic chuck is forged solid on the end of the spindle, reducing the overhang from the front bearing and supporting the collet to the extreme end. A master collet is furnished with each machine, also one set of bushings to take stock of the largest capacity of the machine. The chuck and stock feeding lever is placed within easy reach of the operator; in fact, special attention has been given to getting all the operating levers, etc., so they can be reached by the operator without changing his position. The turret is hexagonal in form and is provided with tapped holes for attaching tools to the face, in addition to the regular holes with binder bushings. A hole the same size as holes in turret is bored through turret stem, thus allowing long work



Triumph Motors Driving Band Saws.



Acme Screw Machine and Turret Lathe.

to be turned with short stiff tools. The tool clearance over top of slide is made extra large to permit the use of large dies and turret tools. The turret slide is made wide to give extra rigidity to the turret and tools. Independent adjustable stops are provided for each hole in turret; the abutment for stops can be shifted to allow a slight further movement of any tool beyond stop when desired, without disturbing the adjustment of the stops.

The power feed is of the geared type, giving four changes instantly obtainable by the movement of a lever placed directly over the rear spindle bearing. The cut-off is provided with a large graduated dial and positive stops for cross-slide, also hand longitudinal adjustment by the means of hand wheel and screws, with bronze nut on front cap. The screw is completely protected from chips and dirt by means of two steel tubes fastened to the nut. The cut-off is also supplied with power cross feed when desired. The machine is so arranged that power feed to turret, power feed cut-off, etc., can be attached later without additional work. The stock feed can also be attached at any time to machine with automatic chuck, without altering the spindle. A double taper friction countershaft of improved design accompanies each machine.

The Cincinnati-Bickford Tool Co.

The Cincinnati-Bickford Tool Co. is known for its drilling and tapping machinery. One of the more interesting machines is shown in the illustration.

This machine is a four spindle, 20-in. sliding head, high speed gang drilling machine, designed for the drilling of light work rapidly. This is an excellent tool for drilling holes up to ¾ ins. in diameter, and even larger holes can be drilled by using slower feeds. It is a heavy and substantial machine, driven with large belts, the spindles being geared two to one, furnishing abundant power to the twist drills. The table is continuous, very heavy and substantial, surrounded by an oil groove and has planed T slots. It is easily raised and lowered by a very substantial elevating device operated with a crank wrench in connection with worm and worm wheel, racks and pinions, at all times insuring perfect alignment with the spindles. The sliding heads are balanced, can be easily and quickly adjusted to any desired position, and are independently clamped to the columns by the movement of one lever. The spindles are also balanced, provided with ball thrust bearings and steel jam nuts, which minimize friction and afford adjustments to take up wear. They are provided with automatic stops, that any number of holes can be drilled to a fixed depth. The spindle sleeves are fitted with steel racks and graduated, providing means for setting the automatic trip collars. The feeds are operated by hand or power. The hand feed levers are arranged to slide freely endwise, so that greater leverage can be brought on the drills when desired, plunger springs keeping a limited amount of friction on the levers holding them in the position placed by the operator. The power feeds are supplied to each spindle independently, operated through pulleys, worms and bevel gearing, the worms operating the worm wheels on pinion shafts in heads revolving in baths of oil contained in the worm boxes, insuring long life. The drive is effected through tight and loose pulleys, and a continuous rear shaft fitted with friction clutches and mitre gearing in connection with each of the lower cone pulley shafts, providing means for starting or stopping either of the spindles by levers brought to the front of the machine.

Motor drive can be supplied when wanted, and the arrangement consists of a bracket to support the motor and suitable gearing.

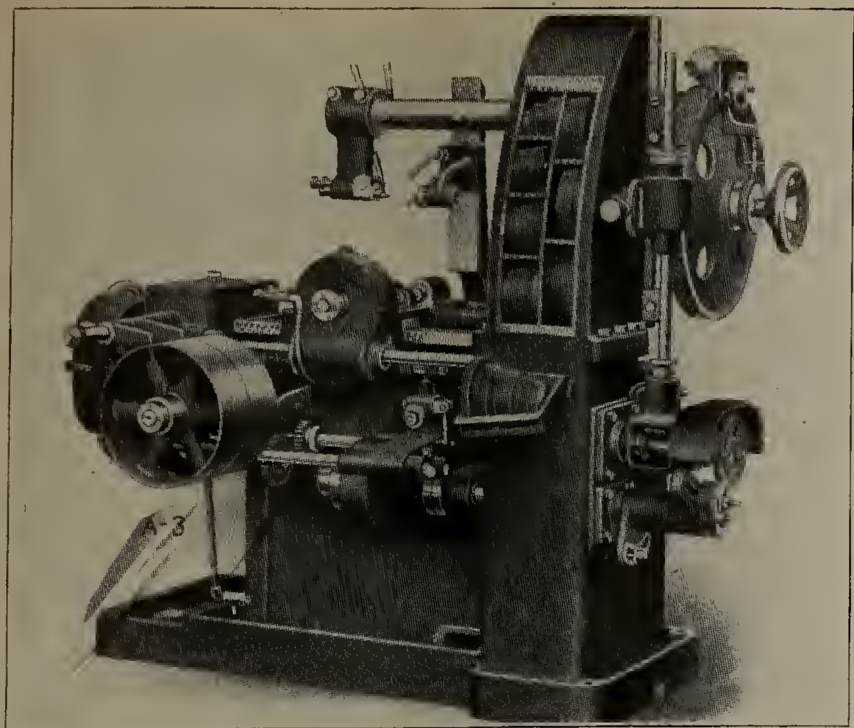
The Cincinnati Gear Cutting Machine Co.

One of the gear cutters manufactured by the Cincinnati Gear Cutting Machine Co. is shown herewith. This machine has been designed with a view to securing rigidity, large wearing surfaces and simplicity of parts. The power is transmitted through one pulley, running at a constant speed, and the various speeds and feeds are obtained by transposing gears, conveniently located. All gibs are of the taper type, adjustable from the ends. All shafts and spindles are accurately ground, and are journaled in bronze bushes. The movements are all automatic, each being dependent on the preceding one and cannot take place until it has been completed.

The work saddle is so gibbed to the housing that the work arbor and blank do not drop out of parallelism when the clamps are loosened for adjusting the work for the tooth depth, a fault common in most gear cutters, that makes the micrometer on the screw worthless. A graduated collar, or micrometer, reading .001 of an inch, is provided on the elevating screw, which is operated by hand, from the front of the machine. The work spindle, of steel, is accurately ground and journaled in bronze bushes, and has provision for taking up wear. The tapered hole, to receive the arbor, is No. 12 B. & S. This arbor is drawn in and forced out by a threaded shaft and hand wheel. The cutter slide has rectangular guiding surfaces (instead of the usual dovetail), with long taper gibs, for taking up wear, both vertically and horizontally.

The indexing mechanism is of simple construction, there being fewer gears in the index train than is usual. The index worm can be disengaged from the wheel quickly and brought

Cincinnati-Bickford Gang Drill.



Heavy Gear Cutter, Cincinnati Gear Cutting Machine Co.

back into the exact meshing depth, or the worm can be disengaged from the index gears and rotated any desired amount for re-setting work, and again secured to the index gears. This indexing mechanism is so interlocked with the cutter slide feed that it is impossible for the cutter to advance until the work is properly indexed, or when the cutter is feeding to index, thus making it impossible to spoil work. The work spindle can be made to space once or revolve continuously by a hand movement, under control of the operator.

The Hisey-Wolf Machine Co.

The Hisey-Wolf Machine Co., of Cincinnati, is a manufacturer of portable electric drills and grinders. Its product is familiar to railway shop men, but a new breast drill has recently been placed on the market. One of these drills equipped with a two-speed motor is shown in the accompanying illustration.

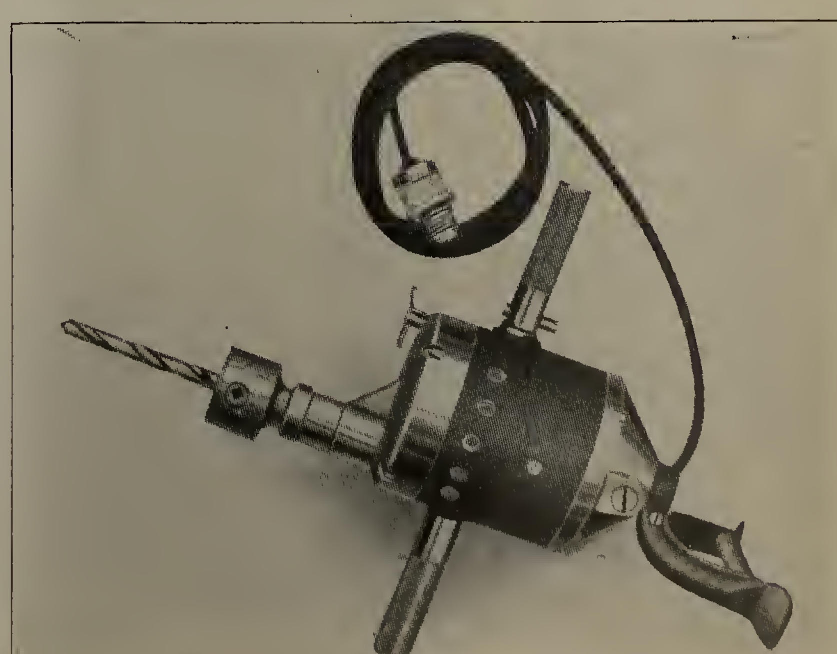
This tool is the result of extensive experimental work. The motor is completely enclosed, air-cooled, air-holes being placed in housing, protected by brass screening, instead of in chuck end, thereby preventing any cuttings from getting inot motor, no matter in which position this drill is used. The gears, cut from solid steel and hardened, are separately encased, running in grease, not oil. Brush-holders and all wire connections are enclosed, preventing any short-circuiting. Brushes can be renewed without disturbing any connections by simply removing fibre cap. Drill and armature spindles are fitted with ball thrust bearings. The operation of the drill is controlled by a new patent, an enclosed automatic switch. This switch controls the motor by means of a brass trigger operated through the permanent handle. This marks a great advancement in portable electric drills, it being impossible for the operator to burn his fingers or short-circuit the motor, while he has the drill under complete control at all times. .

The John Steptoe Shaper Co.

The John Steptoe Shaper Co., of Cincinnati, is the manufacturer of the heavy shapers which are familiar machines in every well equiped shop. The illustration herewith is that of a newly designed 24-in. back geared shaper, manufactured by this company. It is built especially for very heavy work, and the ram and cross rail bearings were therefore made exceptionally heavy. A new form of table support is used to avoid the possibility of any springing of the table while the cut is being taken. A roller in the table support rolls under a planed surface on the bottom of the table, out of the way of chips and dirt, with a minimum amount of friction while the table is moving. This table support is also directly under the cut, where it is most needed. The machine is of very simple design, and has nothing on it to get out of order. The back gear arrangement consists of a pair of sliding gears, and when one gear is working, the other is out of mesh. The only wear that occurs on these gears is when they are actually working. These gears are keyed to the shaft, and there are no idle gears running loose on shafts. There is no wear on the hole in the gears, which avoids the rattling that is very often heard in back geared shapers.

All shaft bearings in this machine are provided with cast iron bushings, which are pressed into place. The shaft bearings are also equiped with ring oilers, and spiral oil grooves are turned in the shafts to insure the oil being washed back and forth over the entire length of the bearing, thus keeping these bearings constantly flooded in oil, which prevents the possibility of their getting hot and cutting. The bull gear bearing in this machine is also provided with a chain oiler, a new feature in shaper construction. The column, ram and base have been very heavily ribbed and braced, and the column of the machine has been made exceptionally heavy on the operating side. The column has been made in the shape of a basin on the operating side, which adds rigidity to that part of the machine.

The back gears are shifted by means of a lever at the back of the column, and the machine can be operated as either a single geared or a back geared shaper. Two changes of speed are secured for each step of the cone-pulley, by the shifting of this lever, and the speed is increased or decreased and the power increased or decreased. The length of stroke is adjusted by means of the bar, which projects through the feed plate. This can be done while the machine is running. The position of the ram can be changed by means of the lever shown at the center of the ram. This operation can also be performed while the machine is in motion. The head can be very quickly swiveled to any angle by means of the lever immediately in back of the head, thus avoiding the necessity of the use of bolts. The elevating screw for the table is entirely enclosed, and is of telescopic construction; the telescopic screw being made of three metals, the nut being made of bronze, the sleeve screw being made of cast iron and the screw under the table being made of steel, thus producing a minimum amount of friction. A ball bearing is provided under the table, so that it can be very readily raised or lowered. The cross feed screw for the table and the feed screw for the harp are both provided with hand wheels, which have been found far more



Hisey Hand or Breast Drill.

convenient to the operator than the ball crank, which was formerly used on the machine.

The base of this machine has been made exceptionally heavy to eliminate the possibility of a vibration, which might become very serious at the tool. The vise is graduated at an angle, to enable the operator to read the graduations readily without stooping over. The upper jaw of the vise is held in position by means of slats, which grip firmly around the lower jaw. Two extra clamping bolts are provided or the top of the uper jaw, as the work has a tendency to crawl when being tightened in the vise. By tightening these bolts, the work is pulled firmly against the lower jaw, thereby insuring accuracy. This is found to be very necessary in tool room work. The holes in the feed plate are drilled in accordance with the teeth in the feed ratchet. The holes are reamed tapered, and the pin which fits into these holes is also tapered, so that any wear that may occur is taken up automatically.

Lodge & Shipley Machine Tool Co.

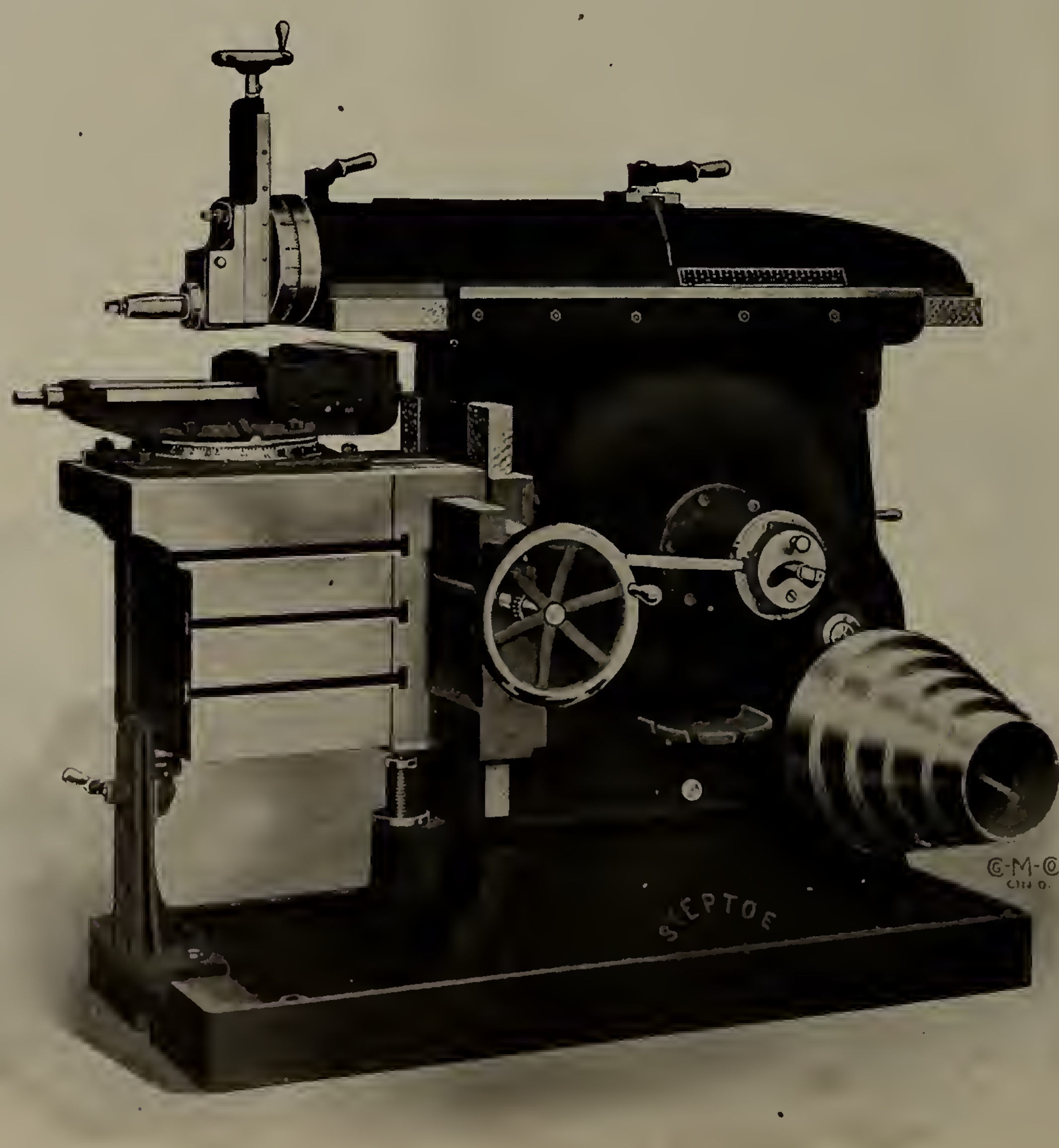
A very interesting machine tool manufactured by the Lodge & Shipley Machine Tool Co., Cincinnati, is shown in the illustration. This is a portable lathe of recent design especially adapted to railway shop use.

This lathe is specially designed for turning studs, bolts, etc., in railroad repair shops, and for doing the various odd jobs on the assembling floor of shops building a line of heavy machinery, where heretofore it has been necessary to carry the parts to be fitted from the erecting floor to the lathe department. The lathe has been designed with the sole idea of doing this one class of work with the greatest rapidity. A wide belt is used, which travels at a high speed, so as to deliver plenty of power. As this is a specialized machine for a narrow range of work, there are but two spindle speeds and two feeds. The lathe bed is mounted upon three wheels, and on a fairly level floor can be pulled about by one man. The motor, which is constant speed and fully enclosed, is suspended beneath the headstock and belted to a two-step cone pulley mounted upon the back gear shaft. The spindle is carefully ground and runs in renewable white metal bearings. The bed is of such depth as to give the greatest rigidity for heavy cuts. The bridge of the carriage has been widened 50 per cent, and is deep, to resist spring under cutting tool. The apron is tongued and grooved into carriage, as well as bolted to it. The power length and cross feeds can be reversed at the apron. Tailstock is clamped by two bolts, operated from top of barrel, and the tailstock spindle is locked by two clamps without splitting the barrel. The regular equipment consists of plain swivel rest, steady and follow rests, large and small face plates, and wrenches. The lathe is arranged for motor drive.

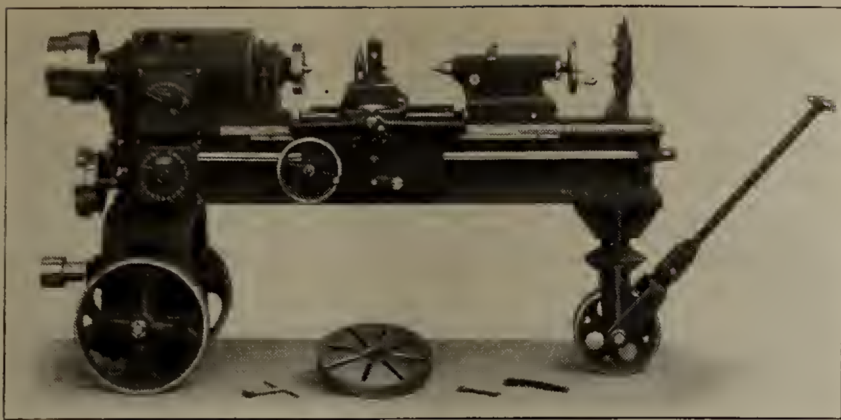
The shops of this company, built especially for the manufacture of lathes, are located within about twenty minutes' ride of the center of the city, on a plot of ground ten acres in extent. Shop No. 1 is 90 x 650 feet, brick and steel construction, and is fireproof. Shop No. 2 is 60 x 250 feet, with two floors. In addition there is a large warehouse, and separate buildings contain the pattern shops, screw machine department, power house, etc., a total of about 130,000 square feet of floor space. The shops are fully equipped with the most up-to-date power appliances, including steam, electricity and compressed air. Electric traveling cranes materially reduce the cost of handling. The machine-tool equipment consists of about three hundred and fifty machine tools of the best makers. Each size of lathe is manufactured by the use of a separate and complete set of jigs and templates.

Cincinnati Time Recorder Co.

The Cincinnati Time Recorder Co. is engaged in the manufacture of several styles of employer's time recording machines. The Cincinnati time recorder is a clock combined with a printing mechanism on which employees record the time of coming to and going from work. As the recorder is entirely automatic and as the registration is a voluntary act



John Steptoe Shaper.



Lodge & Shipley Portable Lathe.

on the part of the employees, all errors and prejudices in records for pay roll are reduced to the minimum. The system enables the proprietor to obtain full and accurate record of all times. It saves the time of the proprietor, manager and foreman, consuming less expensive time of book-keepers or clerks.

A shop signal system to operate either a whistle or gong is one of the features developed by this company. Another improvement is a complete cost keeping machine, combined with a time recorder.

The company is about nine years old and its product is well known among shop operatives.

The Link Belt Co.

The Link Belt Co., of Indianapolis, Ind., is the manufacturer of the "Maximum" silent chain drive. This system consists of the silent chain and cut toothed wheels. The chain is made of stamped links of special form, hardened-steel pins, removable bushings and washers. It is made in eight pitches, and in many widths in each pitch. The wheels are made of best quality iron, and the teeth accurately cut.

The silent chain drive has the following qualifications: It can be run at high speeds, will run in either direction, will transmit any amount of power, gives a positive velocity ratio, can be used on short centers, can be used in a hot, cold, or damp place, does away with excessive journal friction.

The silent chain drive is a well adapted machine tool drive as positiveness, impossible to obtain in belt drives, is secured. In attaching motors to tools, the flexibility of the silent chain, its quite running, its efficiency and its ease of application simplify a great many difficult problems.

Eagle Rotary Engine Co.

A new concern has been added to the list of Cincinnati machinery manufacturers in the Eagle Rotary Engine Co., of Newport, Ky. The engine manufactured by this firm is designed to perform the work of a turbine in high speed, direct connected service. It is particularly adapted to locomotive headlight work as it is compact and efficient.

This engine is constructed symmetrically with a minimum cooling surface. The main casing is cast of gun iron, free from flaws or any defects.

The steam enters through a stationary brass feed shaft inserted in a hollow revolving steel shaft, supplying two port holes corresponding to two rollers simultaneously, each drawing the rotary one-fourth of revolution, carrying the remainder by expansion. Each governor corresponds and acts on the port holes causing it to be an automatic cut-off which can be regulated by means of set screws to the speed required. Each governor acts independently of the others. The rollers are perfectly fitted, and are made of hardened ground steel.

The shaft is made of the best quality of "chrome-nickel steel," ground and closely fitted. The bushings are made of best phosphor-bronze insuring wear and highest efficiency. The coverlid is accurately fitted, making the engine steam tight. Its simplicity and high grade of workmanship insures an engine of one-horse power capacity for every twenty pounds of metal used in the construction. No packing of any kind is required.

Cincinnati Milling Machine Co.

The product of the Cincinnati Milling Machine Co., has been so well known for years as to need no description so far as the milling machines themselves are concerned. Owing to a confusion of names, it is not always understood that this company makes the "Universal" cutter grinders so necessary to the equipment of a large shop.

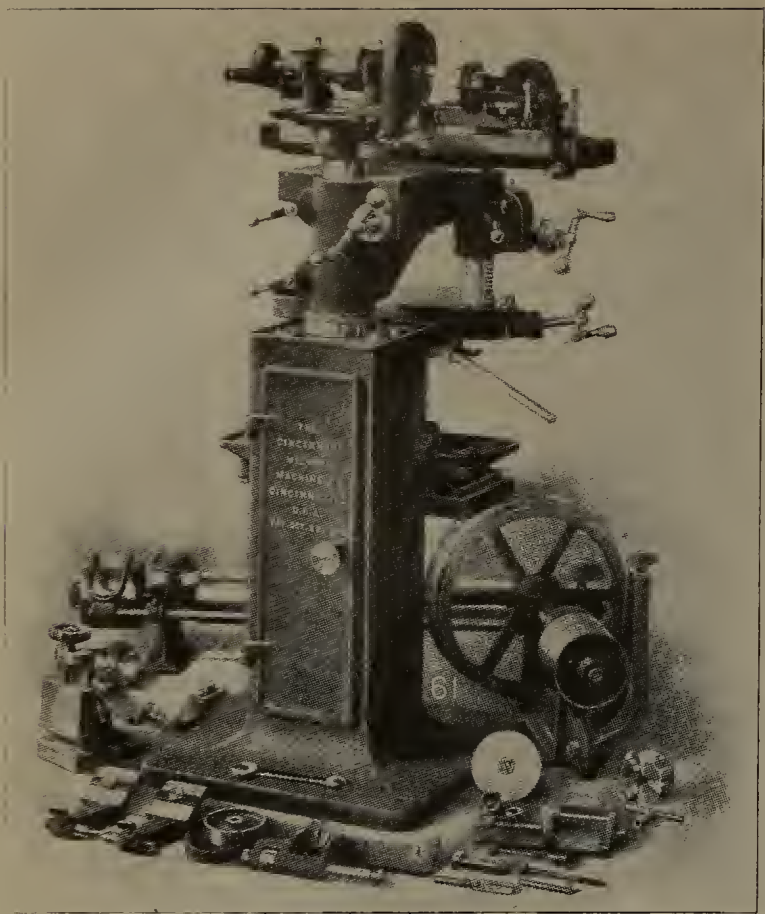
The machine, which is illustrated herewith is properly termed universal. It will grind any style or shape of milling cutter within its range—anywhere that a cutter is ground. It is equally efficient for cylindrical, internal, face, surface and angular grinding, which adapts it for a large variety of general tool grinding, such as flat and cylindrical formed tools for turret lathes or automatic screw machines; shear blades, straight edges, snap gauges, slitting knives, jig bushings, etc., and is consequently an indispensable machine for general toolroom work. The knee can be swiveled completely about the column and thus brings the table into any desired position with relation to the emery wheels. The table itself can be swiveled, further facilitating the settings. In addition to this the swiveling head (on which face and angular cutters are held when grinding) can be swiveled at any angle in both a horizontal and vertical plane, so that a cutter of any angle can be brought into proper position to the emery wheel for correct grinding. Engine-divided dials, from which the angle can be read direct, in degrees, form an index for all adjustments. Each adjustment can be made independently of all others and the machine permanently clamped in position as soon as the adjustment has been obtained. That this is of great importance when adjusting the work vertically for obtaining the desired clearance when using cup-shaped wheel, will be obvious to those who have tried to make this vertical adjustment on machines that do not permit clamping the knee until both adjustments have been made.

Instead of measuring with a scale as heretofore, the setting of the tooth rest is made by means of an adjustable dial reading to thousandths of an inch. The advantage of this arrangement is obvious when we remember that a slight error in setting the tooth rest seriously affects the angle of clearance, and that on this angle of clearance depends the successful working of milling cutters, reamers, etc., and the machines on which they are used.

Because of the complete universality obtained by these movements, a large amount of work can be ground by using cup-shaped wheel, giving a straight line clearance to the cutting edge of the tooth, which is the universally acknowledged correct method of sharpening cutters. The old method of grinding past the periphery of a disk wheel—sometimes a very small disk wheel—gives a hollow clearance, resulting in a weak cutting edge and all the difficulties incident thereto, chief among which is the tendency of cutters to chatter. It is also possible to grind the face of work held between centers, by using the periphery of a dish-shaped wheel. This finds its application in grinding the faces of arbor nuts as shown on page 46, and in grinding the hubs of straddle mills dead true with the hole as shown in pages 44 and 45, which is extremely important in order that such cutters will run true when set up in "gangs" for accurate milling to gauge.

General.

Others of the Cincinnati machine tool manufacturers whose product is so familiar to readers of this paper as to need no discription, are: J. A. Fay & Egan, makers of a large number of designs of wood working machinery excellently adapted to present day car repair work; Cincinnati Punch & Shear Works, makers of punches and shears for



Universal Grinder, Cincinnati Milling Machine Co.

boiler shop work; R. K. LeBlond Machine Tool Co., makers of lathes and milling machines.

Long & Alstater, builders of punches and shears, although properly classified with Cincinnati machine tool manufacturers are located at Hamilton, Ohio. This firm has made a specialty of tools for railway repair shops with the result that its product may be seen in almost any boiler shop in the country.

NEW OIL FOR LOCOMOTIVE HEADLIGHTS.

For some time there has been a demand for a headlight that would produce a better light than the oil lamp at present in general use. The Galena-Signal Oil Co., has come to the front with an improved oil that meets the requirements in every respect. This oil is known as "Galena Railway Safety Oil B." It is stated that recent Government tests, made by the Bureau of Standards at Washington, show this oil to produce, with headlights of ordinary construction, a minimum of 1,800 candle power, and with a headlight equipped with sixteen inch optical lens, costing no more initially than the ordinary reflector and much less for maintenance, a minimum of 2,400 candle power; and exhaustive service tests on one of the prominent railways of the country have proven its adaptation to this purpose. The high fire test of this oil (F) enables it to withstand the great heat generated by headlight burners without becoming gaseous, a condition developing with inferior oils and resulting in the consumption of much more oil than is necessary.

The use of this oil insures immunity from danger resulting from smoked chimneys, damaged reflectors and the frequent burning up of headlights, and reduces, to a great extent, the labor necessary in caring for headlights.

TONCAN METAL.

The disintegration of iron and steel by corrosion is far more rapid than that of wood, concrete or other building materials and on the prevention of this decay depends the extent to which iron will be used in all future building operations and consequently the future growth and expansion of the sheet metal industry.

"Toncan Metal" is an iron ore product, in the same sense that both iron and steel are iron ore products, because they all start from one and the same common origin, iron ore. Toncan metal differs from iron and steel only in its chemical and physical qualities, just as modern iron, in this respect, differs from modern steel and the good old time iron differs from both.

The method or principle by which toncan metal is made represents the latest and most important step in the evolution of principles from early days to the present time—by which iron ore is converted from the raw material into a workable, useful and practical material for commercial purposes. It is nature's law, however, that iron or any product whose base is iron, will rust, in time returning to its original form, namely, iron ore, which is itself merely a form of iron rust, consequently the length of life of any iron product depends solely on the length of time necessary for this change to take place.

All rusting is a corrosive action, but there is a vast difference between the term "rusting" as applied to the old time iron and the term "corrosion" as applied to the disintegration of modern mild steel. In fact, the word "corrosion" was never used to describe the disintegration of iron products until after the introduction of Bessemer and open hearth steels. The reason for this being that with the introduction of mild steel an entirely new form of disintegration developed. All rusting and corroding is simply the passing of the metal into solution in the presence of moisture or some other corrosive elements through electrolytic causes. With the old time iron this solution action was even and uniform over the entire surface of the metal, producing a brown uniform coating of iron oxide and because of the purity, density, and homogeneity of the iron, the dissolution action was extremely slow and no part of the iron would disintegrate or go into solution more rapidly than any other part. This action is what was known as rusting.

With the introduction of mild Bessemer and open hearth steels it soon became apparent that when subjected to the effects of moisture or other corrosive elements, that its solution action or disintegration differed materially from that of iron under similar conditions. The disintegration started at distinct points throughout the metal and once started, spread over the entire surface of the metal like a disease, but at the same time the dissolution continued most active at the original starting points till holes had been eaten through the metal, thus forming what has become commonly known as pits or pitting. The presence of these pits is the distinctive feature between rusting as applied to old time iron and corrosion as applied to both modern iron and modern mild steels. The reason or cause of pitting is lack of homogeneity due to the presence of excess foreign chemical elements in the steel; principally sulphur and manganese or the combination of these two elements, sulphide of manganese. In other words, these chemical elements or their compounds, have been collected or deposited at the points where the pitting takes place during the process of manufacture and as they are most sensitive to the solvent action of corrosive elements than the surrounding iron, they must of necessity disintegrate more rapidly than the surrounding iron, and consequently the metal will be eaten through more rapidly at these points, resulting in the total destruction of the metal long before the balance of the material. Alfred Lang in his work entitled "The Corrosion of Iron and Steel," has this to say on the question of pitting.

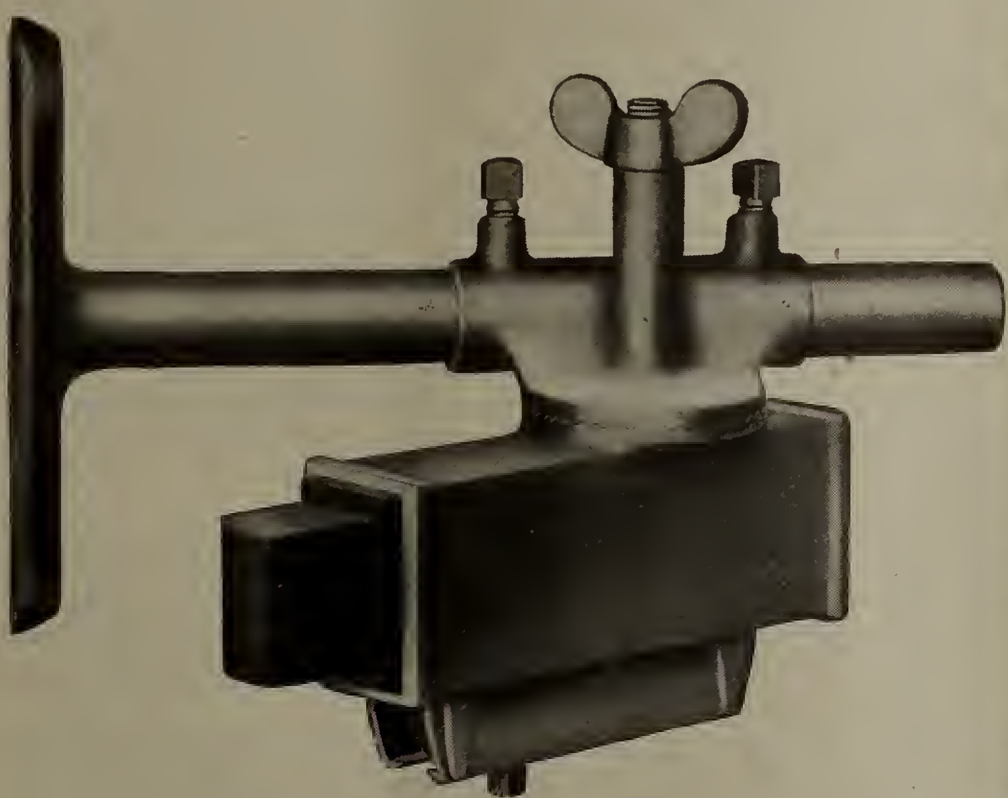
"When pitting is serious, corrosion may reach through a plate long before the greater part of the surrounding surface is seriously rusted." It will, therefore, be readily seen that if a metal rusts evenly and uniformly over its entire surface that it must and will out last a similar metal which corrodes with the formation of pits. This is one of the objects aimed at and accomplished in the manufacture of toncan metal. It will not pit. To accomplish this, lack of homogeneity, which is the cause of pitting, is guarded against by eliminating the sulphur and manganese to the lowest possible point and by special treatment preventing the slight traces which still remain from segregating or collecting in spots or small areas throughout the metal. While toncan metal will not pit, it will rust, and as rusting may be rapid or slow, any metal to be really rust-resisting must be of such a nature that the rate at which it rusts is reduced to a minimum. It has been fully demonstrated that the rate of corrosion will vary according to the structure of the metal and the mechanical treatment which it has received in making, apart from any chemical or electrical causes. Also the more porous the metal the more rapid, deep and destructive will be the corrosion. Blow holes also cause corrosion and the better a metal conducts electricity the better it will resist corrosion. Crystalline formed metals are the best electrical conductors. Careless fabrication of iron or steel is a common cause of rapid corrosion and explains why modern steel, which is tortured into shape at such a high speed during manufacture, is so susceptible to corrosion. Under modern forced treatment the molecules of the metal have not time to readjust themselves. Iron made a generation ago was made in small quantities without the addition of other metals, such as manganese, was rolled slowly and allowed to cool naturally, and was for this reason so much more resistant to corrosive influences. Toncan metal, while it will not pit, will rust, but in rusting the disintegration will be slow, even and uniform, due to its physical structure.

Toncan metal is rust-resisting and anti-corrosive because it is rolled much slower than steel and at a much lower temperature; because it is of a crystalline formation of small, even, uniform, well knit crystals, and its high electrical conductivity. It is rust-resisting and anti-corrosive because of its purity, density and homogeneity. Its purity as regards the absence of foreign chemical elements is proven by analysis, these being lower than in old time iron. Its density is demonstrated through its high specific gravity. Its homogeneity and uniformity are ascertained through both chemical and physical tests—through its uniform resistance to acids, salts and alkalis, and finally through its resistance to the action of corrosive elements as demonstrated in actual everyday service. It is manufactured by the Stark Rolling Mill Co., of Canton, Ohio.

COLLINS FLANGE LUBRICATOR.

A new wheel flange lubricator has recently been placed on the market by the Collins Metallic Packing Co., 107 Cherry street, Philadelphia, Pa. The construction of the apparatus is shown in the accompanying illustration. The device may be applied either by means of a bracket or bolted to the engine frame. The lubricating substance is in the form of a solid block, which is very easily and quickly applied, making the maintenance cost almost negligible.

While the adjusting device makes it possible to set the lubricator at any angle, the best results are obtained when it is adjusted at about 25 degrees. And while it may be set either at the front or back of the wheel, it is preferable to place it at the front of the leading wheel and a little below the center. It is claimed that when the lubricator is once set and properly adjusted it requires no attention during an ordinary trip of 200 to 300 miles. The only attention that it then needs is the pulling back of the latch, which is in communication with the adjusting mechanism, which provides for the pressure of the lubricating block against the wheel. This operation is completed in an instant. The life of one lubricating block used on an engine in switching service is from 3,500 to 4,000 miles and from 2,500 to 3,000 miles on a passenger engine in high speed service.



Collins Wheel Flange Lubricator.

Lubricator Attached to Frame for Service on Rear Driving Wheel.

The Pennsylvania R. R. has let the contract for the erection of the new power plant, locomotive and car repair shop at Orangeville, Md., comprising a group of brick and concrete buildings, in connection with that company's improvements at Baltimore, Md., to Irwin & Leighton, of Philadelphia, Pa. The same company has awarded to the Great Lakes Dredge & Dock Co. the contract for concrete docks in Cleveland, O. In addition to grade crossing elimination work in Cleveland, the Pennsylvania R. R. is figuring on some similar work just outside the city that will take about 2,500 tons of steel.

The Baltimore & Ohio and the Pittsburg & Lake Erie railroads, according to report, will join in building a passenger station at Ellwood City, Pa. The two roads have also agreed to pay one-half the cost of construcing a subway to the station, the cost of each line being estimated at $7,500.

SOMETHING NEW IN PAINTS.

One of the features of the Master Car and Locomotive Painters' convention at St. Louis was the series of tests on the paints of the Best Oil Co., 30 Church street, New York, con-

A. Concklin Knapp, Pres. & G. M. Best Oil Co.

ducted by B. F. Mueller, chemist for the company. Mr. Mueller is the very bright German who invented the substitute for linseed oil, which forms the base of the new paint.

The new oil forms a protection against corrosive action which seems practically perfect, and its application is as easy and simple as is that of the old style paints. The tests conducted by Mr. Mueller were of the severest nature and were calculated to show the resistance of the paint to both mechanical and chemical destructive agents. The pigments are so well protected by the oil that the delicate shades of red and green seemed to show no change when subjected to the action of the strongest acids and alkalies.

Boiling hydrochloric, sulphuric and nitric acids were placed on tin protected by a coat of the paint, with no effect. An electrolytic test proved very interesting. Oxygen, produced by electrolysis, especially corrosive in the nascent state and which attacked and destroyed with rapidity metals exposed to its action, did not affect those protected by a thin coat of Bestol paint.

Mr. A. Conklin Knapp, manager of the railway department for the Best Oil Co., was the very genial representative in charge of the St. Louis exhibit.

INDUSTRIAL NOTES.

The Westinghouse Air-Brake Company, Pittsburg, Pa., has moved its Richmond, Va., and Cincinnati, Ohio, offices to Atlanta, Ga., the new address being Candler Building.

The United States Metal & Manufacturing Company, Chicago, has moved its office from the Railway Exchange Building to suite 1104-1105, McCormick Building, Michigan avenue and Van Buren street.

The Locomotive Superheater Company, of New York, has received orders for twenty-five superheaters each from the Chicago, Rock Island & Pacific and the New York Central & Hudson River.

The contract for the erection of the National Carbon Company's plant at Niagara Falls has been awarded to the Hunkin-Conkey Construction Co., of Cleveland, Ohio. The plant will have four one-story buildings and one five-story building.

The Bucyrus Vulcan Co., Evansville, Ind., has been incorporated to manufacture steam dredges, shovels, etc. The incorporators are: H. P. Eells, G. F. Steedman, W. W. Coleman, E. K. Swigert and Carl Horix. Capital stock, $600,000. This new company is the organization which has taken over the Vulcan Steam Shovel Co., of Toledo, notice of the purchase having been made some time ago. It was proposed at the time to remove the plant to Evansville.

J. G. White & Company, Inc., engineers and contractors, 43 Exchange Place, New York, have been awarded a contract by the New York, Ontario & Western Ry. for the erection of railroad shops at the Mayfield yards, Mayfield, Pa., near Carbondale. The work to be carried out consists of the erection of a ten-stall roundhouse, with a 75-foot turntable, machine shop, carpenter shop, with complete power plant, storehouse, office building, oil building, sand storage, drier and loading house, and a complete coaling station, with a storage capacity of approximately 1,000 tons. The buildings will be of the usual type of brick and steel construction. The estimated cost is approximately $150,000.

The Pittsburg Testing Laboratory, Pittsburg, Pa., has moved its New York office from 1 Liberty street to 50 Church street, and its interests in New York and in New England are now in the hands of Wm. F. Zimmerman, M. E., the second vice president of the company. Mr. Zimmerman reassociated himself with the company last spring.

W. N. Matthews & Brother, St. Louis, Mo., have bought a controlling interest in the Davis Expansion Boring Tool Company, St. Louis. The stock bought formerly was held by Alexander Landau and A. E. Leussler. W. N. Matthews will be president and treasurer of the company; Emery E. Davis, vice president, and Claude L. Matthews, secretary. The company's business will be increased and several new tools added to the line it handles, particularly an expansion reamer invented by Mr. Davis.

The Isthmian Canal Commission will receive bids until October 17 for hose, packing, torpedoes, diaphragm pumps, hose strainers, valves, cocks, grease and oil cups, lubricators, engine gongs, flue ferrules, scales, machinists' clamps, flue cleaners, squilgees, headlight glass, carbide, drawing paper, cover paper, etc. (Cir. No. 607.)

The Strong, Carlisle & Hammond Company, Cleveland, Ohio, has received an order from the Bengal & Northwestern Railway of India for Randall graphite sheet lubricator for use on 200 cars.

A. R. Wight, assistant resident engineer of the South Australian Railways, Quorn, South Australia, wants catalogues of materials used in the engineering department of American railways.

The Homestead Valve Co., has opened an office at 1135 Park Row Bldg., New York City, for the sale of valves in that territory. The office will be in charge of Frank Boyle who will carry a stock of valves for immediate delivery.

At a meeting of the directors of the Best Oil Co., A. Concklin Knapp was elected president and general manager of the company.

Among recent oil furnace contracts taken by Walter Macleod & Co., of Cincinnati, are, a large plate heating furnace for the J. Baum Safe Co., of Cincinnati, Ohio, complete furnace equipment for the Southern Motor Works, Nashville, Tenn., and a complete furnace equipment for the W. H. Clore Mfg. Co., Washington, Ind.

Judge Landis, in the United States District Court on September 21, appointed the Hibernian Banking Association as receiver of the West Pullman Car Works, which is alleged to have profited to the extent of $300,000 in padded car repair bills in the Illinois Central railroad conspiracy. A petition asking that the corporation be adjudged bankrupt was filed by Thomas F. L. Henderson. Fears that the State

Bank of West Pullman and the Brownell Engineering Co., of Cleveland would foreclose mortages given by the concern caused the action.

John B. Milliken, comptroller of the Crocker-Wheeler Company, Ampere, N. J., has accepted a position as treasurer of the Yale & Towne Manufacturing Company, New York, with headquarters at New York.

To facilitate handling its rapidly increasing business in the Middle West, the Rockwell Furnace Company, New York, has opened a branch office in the Fisher building, Chicago, with A. L. Stevens, an experienced furnace engineer, in charge.

The Glacier Metal Company, of Richmond, Va., is placing on the market a new ribbonized plastic metallic packing for steam, air, water, gas, ammonia, etc. This packing is satisfactorily made, from an allloy of white metal, into fine shreds or ribbons, and is therefore very pliable. It will not score the rods nor show corrosion when in contact with acids.

The annual report of the Westinghouse Air Brake Company, New York, just issued, for the year ended July 31, shows net earnings of $4,653,102, as against $2,039,273 in 1909. After charging off $429,824 for depreciation, etc., a surplus of $4,223,278 remained, as against $1,920,557 in 1909.

Mr. George L. Sprague has resigned as supervisor of apprentices at the Dunkirk works of the American Locomotive Co., to accept a similar position with the Allis-Chalmers Co., at Milwaukee, Wisconsin.

The Hicks Locomotive & Car Works, Chicago, was, on September 19, placed in the hands of the Commercial Trust & Savings Bank, as receiver. The Chicago officers of the company explain that it has suffered, together with other railway equipment companies, in the slump of business during the last three years. The receiver will continue to operate the plant, and it is expected that it will soon be working full force.

Owing to the great increase in business in the vicinity of Atlanta, Ga., and Rochester, N. Y., the H. W. Johns-Manville Company, New York, has recently opened new offices in each of these cities. The Atlanta office is in the Empire building, with W. F. Johns, who has been traveling in this territory for the company for a number of years, in charge. The Rochester office is at 725 Chamber of Commerce, with H. P. Domine, formerly with the Buffalo branch of the company, in charge.

The McKeen Motor Car Company, Omaha, Neb., advises that 85 of its cars are now in service, that 37 railways are operating or have ordered them, and that 10 of these lines have placed additional orders for cars.

The Chicago Bridge & Iron Works, Chicago, has bought land in Greenville, Pa., and will build a fabricating shop to have an ultimate capacity of about 4,000 tons. It is expected that the new shop will be ready by the first of the year.

The Rail Joint Company, New York, has moved its general office to the Cameron building, 185 Madison avenue.

Victor H. Cochrane and Ira G. Hedrick have formed a partnership to practice consulting engineering under the firm name of Hedrick & Cochrane, with office at 1118 McGee street, Kansas City, Mo.

James A. Sherwood has been appointed Canadian agent for Thos. Firth & Sons, Ltd., Sheffield, England, effective October 1, with headquarters in Montreal. For the past five years Mr. Sherwood has filled a responsible position in the sales organization of E. S. Jackman Co., Chicago, agents for the Firth-Sterling Steel Co. Prior to that time he was the railway representative in Canada for the Ewald Iron Co. He is thoroughly posted on the fine steel business in all its branches, having been closely associated in the development of the Firth-Sterling business in Chicago, and also having had valuable experience as assistant manager and salesman in the old Chicago staff of Howe-Brown & Co., and Park, Bro. & Co., when these firms were under Mr. Jackman's management in Chicago, during the period 1889-1893.

The Frick Company, Waynesboro, Pa., have placed an order with Tate, Jones & Co., Inc., Pittsburg, Pa., for a large heating furnace, 8 ft. x 10 ft., inside. It will be equipped with the Kirkwood fuel oil burning appliances manufactured by this firm.

The Marion Shovel & Dredge Company, Marion, Ohio, has recently been organized, with John D. Owens as president, A. E. Cheney, secretary and general manager; George D. Copeland, treasurer, and H. J. Barnhart, chief engineer. It is the intention of the company to build steam shovels, dredges, ballast unloaders and other similar machinery. The company has secured 125 acres of land near Marion, located between the Hocking Valley and the Pennsylvania railways, with the C. D. & M. electric railway running the full length of the site. Bids are now being taken for the plant of structural steel, reinforced concrete and brick. It will be equipped in a modern way, and arranged to meet future extensions without changing the general plan. At the outset the plant will have a capacity of about 10 machines per month. It is the expectation of the company to have it ready for operation in February.

The Chicago Steel Car Company has given a trust deed to the First Trust and Savings Bank in order to secure a bond issue loan of $75,000, five years at 6 per cent, secured by the plant of the company. The loan is stated to be for extension and improvement purposes.

The Pittsburg Screw & Bolt Co. has organized the Gary Bolt & Screw Co., which, in a large new plant at Gary, Ind., near the works of the Indiana Steel Co., will manufacture a general line of bolts, rivets, nuts and screws. It is being erected to take care of the large western customers of the Pittsburg concern, whose tonnages have been steadily on the increase. The officers of the Gary Bolt & Screw Co. are as follows: William G. Costin, president; Thomas W. Smith, vice president and treasurer; John A. Collins, general superintendent.

The Missouri Pacific Ry. and the Metropolitan Street Ry. Co., of Independence, Mo., have entered into a contract for the construction of a concrete bridge across the Lexington branch of the Missouri Pacific at Independence.

The Pennsylvania has begun work on the construction of a steel and concrete bridge at Etna, Pa., the new structure to replace the present bridge at that place. The new bridge will be about 200 feet in length, including the approaches, and will be one of the best of its kind on the road.

The Hocking Valley Ry. will build freight yards and terminals in Columbus, O., the cost of which will be about $2,000,000. Other construction at that place includes an enlargement of the Hocking Valley shops, the machinery for the new shops being already at hand. The offices in Columbus will also be enlarged as the business of the road increases through new traffic.

The Ft. Worth & Rio Grande, building between Ft. Worth and Benardville, Tex., is reported to be planning the location of its repair shops at Comanche, Tex.

The Minneapolis, St. Paul & Sault Ste. Marie, it is reported, is preparing plans for a brick union depot to be erected at Bemidji, Minn., at a cost of $20,000.

The Lake Shore & Michigan Southern has begun the construction of its new shops at Elkhart, Ind. The plant complete will involve the expenditure of about $3,000,000 and will be one of the largest on the New York Central system.

Railway Mechanical Patents Issued During September.

Car door structure, 968,568—Belden D. Jones, Chicago, Ill.
Dump car, 968,595—Spencer Otis, Chicago, Ill.
Rotating light for railroad cars 968,714—Thomas A. Teate, Thomasville Ga.
Car door lock, 968,727—George E. Allison, Stonington, Conn.
Reach rod guide, 968,835—Francis J. Cole, Schenectady, N. Y.
Railway car wheel, 968,879—John A. McLennan, Chicago, Ill.
Locomotive smoke-stack, 968,882—Augustus F. Priest, Chicago, Ill.
Brake, 968,893—Osmer M. Taylor, Albion, Pa.
Car lighting installation 968,913—Charles H. Anderson, Seattle, Wash.
Buffer for automatic couplings for railway and street cars, 968,917—Louis Boirault, Paris, France.
Brake operating mechanism, 968,957—Jacob F. Kieffer, Plimpton, Ohio.
Load retaining attachment for freight cars and the like, 969,002—William Ross Teachout, Huntingdon, Tenn.
Draw head, 969,023—George C. Abbe, Lansdowne, Pa.
Head rest for car seats, 969,030—Henry W. Bowman, Barbourville, Ky.
Attachment for car trucks, 969,043—Arthur C. Dennis, Pocomoke City, Md.
Air brake system, 969,046—Arthur Doan, Elmhurst, Cal.
Steam superheater, 960,088—George J. Churchward, George H. Burrows and Clifford C. Champeney, Swindon, England.
Car buffer fender, 969,143—David L. Newcomb, Los Angeles, Cal.
Truck brake appliance, 969,146—Andrew L. Saxon, Whitfield, Tex.
Brake, 969,167—John A. Landers, Jackson, Mich.
Reverse lever operating mechanism for locomotives, 969,181—James L. McGee, La Junta, Colo.
Method of reworking car wheels, 969,275—John M. Hansen, Pittsburg, Pa.
Automatic safety hose coupling, 969,276—Adolphus H. Harris, Denver, Colo.
Car construction, 969,278—John B. Heverling, St. Louis, Mo.
Cut-out and release for air brake apparatus, 969,344—Simon Peter Cota, Dickinson, N. D.
Stay bolt, 969,383—Myles Mahoney, Montreal, Quebec, Canada.
Grain door, 969,405—Edward Posson, Chicago, Ill.
Triple valve device, 969,427—Walter V. Turner, Edgewood, Pa.
Center bearing for cars, 969,444.—John C. Barber, Chicago, Ill.
Dump car, 969,462—Roderick W. Davies, Columbus, Ohio.
Car coupling, 969,575—Clinton A. Tower, Cleveland, Ohio.
Pasenger car, 969,602—Charles A. Coons, Buffalo, N. Y.
Door for grain cars, 969,604—William G. Craig, Marshalltown, and Aubrey R. Ramsdell, Toledo, Iowa.
Car coupling, 969,674—James Timms, Columbus, Ohio.
Brake hanger, 969,704—William H. Kaldrider, Heaters, W. Va.
Brake shoe, 969,705—William H. Kaldrider, Heaters, W. Va.
Ventilating cowl for railway cars, 969,708.—Frederick J. Leigh, Seattle, Wash.
Car door, 969,711—Andrew Gains Lott, Camden, Tex.
Grain car door, 969,730—Anton Christian Smith, Winnipeg, Manitoba, Canada.
Railway engine for cars and locomotives, 969,750—James D. Donovan, Kansas City, Mo.
Brake beam, 969,861—Broderick Haskell, Franklin, Pa.
Air brake system, 969,877—Oscar Johnson, Chicago, Ill.
Car door, 969,878—Belden D. Jones, Chicago, Ill.
Journal box, 969,933—Leonard G. Woods, Pittsburg, Pa.
Car roof, 969,972—Peter H. Murphy, Pittsburg, Pa.
Passenger car, 970,010—Samuel T. Bole, Philadelphia, Pa.
Railroad car, 970,047—Anders Hansen, Philadelphia, Pa.
Car coupling, 970,113—Willard F. Richards, Lancaster, N. Y.
Underframe for railway cars, 970,128—Charles S. Shallenberger, St. Louis, Mo.
Friction draw gear, 970,131—Frank M. Snyder, Cresson, Pa.
Journal box, 970,133—Sven J. Strid, Chicago, Ill.
Side play liner for locomotive trucks, 970,138—William H. Thomas and Horace Walter Dummert, Charleton Place, Ontario, Canada.
Car door, 970,147—Frank Ward and Joseph C. Hollingsworth, Dallas, Tex.
Noiseless car wheel, 970,185—Peter Park Cookingham, Longbeach, Cal.
Safety device for railway cars, 970,231—Walter S. Jackson, Waterville, Me.
Lubricating journal box, 970,271—George Philip Simmons, Utica, N. Y.
Locomotive frame, 970,287—George C. Abbe, Lansdowne, Pa.
Bolster construction for railway, 970,302 and 970,303—James R. Carmer, Wilmington, Del.
Locomotive trailer truck, 970,333—William S. Hodges, Philadelphia, Pa.
Combined car and brake wheel, 970,378—Charles A. Lindstrom, Pittsburg, Pa.
Locomotive, 970,389—Oscar G. Pendleton, Girard, Ill.
Manually operated railway brake, 970,402—Alex A. Searway, Buffalo Creek, Colo.
Snow plow, 970,451—George W. Ruggles, Charlotte, N. Y.
Locomotive, 970,512—Hermann Liechty, Berne, Switzerland.
Seal for car doors, shipping receptacles, etc., 970,529—John J. A. Miller, Denver, Colo.
Railway power transmission, 970,543—Albert S. Parsons, Berkeley, Cal.
Car coupling, 970,553—Frank C. Reynolds, Columbus, Ohio.
Train ventilator, 970,685—Robert Chadwick, Lexington, Neb.
Car door hanger, 970,752—Lucius S. Pratt, Union Center, N. Y.
Car truck side frame, 970,757—Charles A. Schroyer, Oak Park, Ill.
Uncoupling mechanism for cars, 970,778—Olof Anderson, Chicago, Ill.
Draft gear, 970,802—John F. Courson, Pitcairn, Pa.
Car door closure, 970,806—Arthur Faget, San Francisco, Cal.
Freight car door, 970,837—Francis Lawrence Lane, Leeds, England.
Truck fender, 970,967—John W. Sprint, Boyce, Va.

The Southern Pacific Co. has made the necessary appropriations for the construction of machine and repair shops at Roseville, Cal. The buildings will be fully equipped with necessary machinery and tools for car repairs, but it is not the intention at the present time to do any casting or heavy forging work at that point. The second roundhouse, which was started some three years ago but never completed, will probably be finished and put in commission. The new roundhouse, it is expected, will be made large enough to accommodate the Mallet engines.

The St. Louis, Iron Mountain & Southern, it is stated, intends erecting at Baring Cross, near Argenta, Ark., a brick and steel roundhouse, to have a capacity of eighty-two engines, and require machinery costing about $35,000.

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RAILWAY TESTING DEPARTMENT.

The meeting rooms of the New York Railroad Club on September 16, were the scene of a highly interesting discussion of the merits of the railway department of tests. A paper on the subject was prepared by B. S. Hinckley, engineer of tests of the New York, New Haven & Hartford. While he made many points of unquestionable value in the course of his efforts in setting forth the usefulness of a comprehensive testing system, Mr. Hinckley would have done well however, to have left out the following paragraph:

> "The testing department should be independent of all mechanical or engineering departments for the chief economical results are secured only by giving freedom to the department of tests in its work of checking the quality, handling and use of the materials purchased."

Perhaps it was fortunate for Mr. Hinkley that he was unable to appear in person for the reading of his paper as an attempt to defend his statements could not but have resulted disastrously. He broadens on his subject by arguing that there is no protection from favoritism where the mechanical or engineering head is allowed the final word in the selection of supplies or equipment for his department, that the efficiency of the person doing test work is eliminated by the system which compels the reporting of his results to the heads mentioned.

Let us suppose this ideal system of Mr. Hinkley's in effect. A serious wreck due to defective materials in rolling stock or track takes place. Who is responsible, the officials in charge of either department directly concerned? But these men were not allowed to use their judgment in the purchase or installation of the defective parts. The head of the testing department? But the basis of the whole system is disinterestedness on his part. What steps then are to be taken to prevent a repetition?

It will be argued that all departments should co-operate, but this doesn't fix responsibility and the necessity for responsibility is the first lesson in business economy. It would be ridiculous to make any man, official or employee, responsible for the proper functioning of equipment in the purchase of which he has no word. It is generally agreed that favoritism sometimes plays a part in railway purchase recommendations. Suppose it does? Would the head of a "disinterested" testing department be immune to the overtures of the alleged crafty supplyman? The true difference lies in the fact that while the mechanical or engineering department head must stand responsible for the results of his "favoritism," the testing department head can go along in the same old way without troubling himself as to the cost.

Years ago it was customary for the purchasing agent to be his own judge as to the purchase of all materials and supplies. As the scope and complexity of the railway's operations increased the mechanical and engineering departments gradually took distinct shape. Large salaries were offered high grade men for assuming charge of these departments. These men were made responsible and just as soon as they assumed responsibility they rightfully demanded final voice in all but the purchase of minor staple articles. The purchasing agent's office then assumed the duties of carrying out recommendations by the employment of business tactics not so familiar to the mechanical or engineering official.

Mr. Hinkley is therefore about thirty years late in placing before those interested, a plan for a system which would, during the period above mentioned, have been an essential sub-department to the purchasing agent's office.

It is customary for the high grade general superintendent of motive power or chief engineer to surround himself with men whom he regards competent to perform such tests as are considered necessary. The results of these tests are then carefully compared with service results in order that theory may be supplemented by practice or service evidence. It would be a distinctly backward step to organize a testing department along the lines suggested, which has within its scope opportunities for theoretical study only. If the object is to make berths for a few influential but unsuccesful college professors, let them pass the initiative tests and report to S. M. P. or C. E.

It can but be considered a case of cast iron, nerve and monumental egotism for a man to say, "I alone am honest: proof against favoritism and therefore the sole person competent to direct the spending of a railway company's gold."

EXPRESSING YOUR IDEAS.

As a general rule articles published in the technical papers or delivered before the various railway clubs are of great interest and value to those engaged in the particular field of endeavor which such papers cover. The technical press and railway associations have been the means by which men's views have been broadened, by which they have learned what the other fellow is doing and have profited by his ideas. Incidentally they lift men out of their own little ruts and give them more respect for what others are doing.

But it is not alone the readers who derive benefit from such papers; the one who expresses his ideas is also greatly benefited. Perhaps you are accustomed to preparing papers from time to time—didn't it ever strike you that your ideas were a great deal clearer to yourself when you had finished? A man may have a number of good ideas upon a certain subject but when he attempts to work them up into a paper which others are to read and perhaps discuss, he takes care to express them in such a clear logical way that everyone may get his meaning. In doing this, new ideas and new view-points are apt to occur to him. As a result he has a better understanding of the subject and is better able to express himself clearly and logically. Often a man thinks that his own opinions are of no particular value when it may be that they will open up an entirely new view for discussion. If you have certain views, let them grow out instead of in; be willing to spare some time to prepare papers and take part in the discussions at your railroad club; he who puts the most in, will get the most out.

Consolidation Type Locomotives, Chicago & Northwestern Ry.

An interesting event in the motive power development of the Chicago & Northwestern Ry. has been the recent adoption of Pacific and consolidation type locomotives for heavy passenger and freight service respectively. Physical conditions have heretofore made it possible for this road to handle its traffic efficiently with comparatively light engines; but increased demands upon the motive power have now required the introduction of heavier locomotives, and consequently the types referred to above have been placed in service.

The Baldwin Locomotive Works has recently built for this road, 25 of the new consolidation type engines, known as "Class Z." These engines were built to drawings and specifications furnished by the railway company. A comparison of their leading dimensions with those of the "Class R-1" ten-wheelers built for the same road in 1907, shows clearly the increased power of the new locomotives. Such a comparison is presented in the following table:

Class	Cylinders	Drivers	Steam Pressure	Grate Area	Heating Surface	Weight on Drivers	Weight Total	Tractive Force
R-1	21"x26"	63"	200	46.2	2958	133400	173300	30800
Z	25"x32"	61"	170	52.5	3741	202600	235500	47300

A conspicuous feature of the new design, is the moderate pressure carried. The boiler is built for a pressure of 200 pounds, but the safety valves are set at 170 pounds, and large cylinders are used. The boiler barrel is composed of two rings, and is straight topped. The fire-box side sheets are corrugated, in accordance with the railway company's practice. The bracing of those parts of the tube sheets usually stayed by fire tubes alone, is here re-enforced by four stay rods, each consisting of a 1¼ inch rod welded, at the front end, to a short section of 2-inch tube. The smoke box is self cleaning, with a short extension and single low nozzle. The stack is tapered, and has a diameter of 20 inches at the choke.

The frames are of steel, 5 inches wide, and are each cast in one piece with a single front rail. The Markel style of flangeless shoes and wedges are used on these locomotives. The frames are widened at the pedestals, and chafing plates are riveted to the sides of the pedestal legs. These plates are drilled to gauge and are interchangeable. The pedestal binders and transverse braces are cast steel, and of most substantial construction. A transverse brace is bolted to the back leg of the first, second and third pairs of pedestals. The brace back of the third pair is arranged to take a vertical expansion plate, which supports the front end of the mud ring. A similar plate supports the mud ring at the rear.

The front frame rail measures 5 inches wide by 10 inches deep, and each cylinder is secured to its corresponding frame by eight 1½ inch bolts placed horizontally, and two 1¼ inch bolts, placed vertically. The cylinders are lined with steeled cast iron bushings, ¾ inch thick. The steam distribution is controlled by inside admission piston valves, 14 inches in diameter. These have a steam lap of 1 inch, and are line and line on their exhaust edges. They are set with a maximum travel of 6 inches, and a constant lead of ¼ inch. The valve centers are placed 4 inches outside the cylinder centers, and the valve gear, which is of the Walschaerts type, can thus be conveniently arranged without the use of rockers. The link and reverse shaft bearings on each side, are combined in a single steel casting. This is bolted to the guide yoke, and its location is such that ample room is provided for convenient lengths of eccentric and radius rods. The link block is up when in forward gear, so that the eccentric crank leads the main pin.

The tender frame is composed of 13 inch steel channels, with a wood bumper at the front end and a cast steel bumper at the back. The trucks are of the arch bar type, with cast steel bolsters and steel tired wheels. The tank is U-shaped in plan, with sloping sides and back in the fuel space, so that the coal is automatically shaken forward to the fireman.

This is an interesting development of a high powered consolidation type locomotive, in which a return has been made to the more modern pressures in vogue fifteen or twenty years ago. The result should be a marked reduction in boiler repairs. The special details embody various features previously tried out on the Chicago & Northwestern Ry., and satisfactory results may therefore be expected in service.

The principal dimensions, weights, etc., are given below:

Gauge	4 ft. 8½ in.
Cylinders	25 in. x 32 in.
Tubes.	
Material	Iron
Thickness	No. 11 W. G.
Number	443
Diameter	2 in.
Length	15 ft. 2 in.
Heating Surface.	
Fire box	189 sq. ft.
Tubes	3521 sq. ft.
Firebrick Tubes	31 sq. ft.
Total	3741 sq. ft.
Grate Area	52.5 sq. ft.
Driving Wheels.	
Diameter outside	61 ins.
Diameter, center	54 ins.
Journals, main	10½ ins. x 12 ins.
Journals, other	9½ ins. x 12 ins.
Engine Truck Wheels.	
Diameter, Front	31¼ ins.
Journals	6 ins. x 12 ins.
Wheel Base.	
Driving	17 ft. 6 ins.
Rigid	17 ft. 6 ins.
Total, Engine	26 ft. 5 ins.

New Consolidation Type Locomotive, C. & N. W. Ry.

Valves	Balanced Piston
Boiler.	
Type	Straight
Material	Steel
Diameter	81½ in.
Thickness of sheets	¾ in.
Working pressure	170 lbs.
Fuel	Soft Coal
Staying	Radial
Fire Box.	
Material	Steel
Length	108⅛ in.
Width	70¼ in.
Depth, front	83 in.
Depth, back	63 in.
Thickness of sheets, sides	⅜ in.
Thickness of sheets, back	⅜ in.
Thickness of sheets, crown	⅜ in.
Thickness of sheets, tube	½ in.
Water Space.	
Front	4½ in.
Sides	4½ in.
Back	4½ in.
Total, Engine and Tender	60 ft. 9½ ins.
Weight.	
On Driving Wheels	202,600 lbs.
On Truck, front	32,900 lbs.
Total, Engine	235,500 lbs.
Total, Engine and Tender, about	390,000 lbs.
Tender.	
Wheels, Number	8
Wheels, Diameter	34¼ ins.
Journals	5½ ins. x 10 ins.
Tank Capacity	8,275 gals.
Fuel Capacity	13 tons
Service	Freight

BALLOON FOR AN ENGINE.

A railroad on which the motive power is supplied by a balloon is certainly a novelty. Such a railroad has been constructed in Austria under Government supervision. Its object is to carry passengers up and down Hochstaufen Mountain at Bad Reichenhall, a watering place in the Austrian Alps.

The top of this mountain affords a splendid view; but the climb to the summit is tedious and uninteresting. Accordingly, it was decided that the tourists who visit the place would appreciate the labors of the captive balloon devised to convey them to the summit.

The balloon was made to run along a track built at the side of the roadbed. A trailer with many wheels clasps this wooden rail, or track, and the passenger car is fastened to the trailer. The operator sits in the car, with a cord swinging between him and the balloon by which he can regulate the supply of gas. Safety devices are at hand in case of accident.

Before the car starts up the mountain the balloon is charged with sufficient gas to enable it to ascend to the summit, and when the top is reached and all is ready for the return journey some of the gas is permitted to escape, whereupon the car starts down hill, its speed being checked by the retarding effect of the gas still left in the balloon.

It was not, until rigorous investiggation had been made and the comparative safety of this method of journeying demonstrated, that permission was given to build the railroad. There are many novel safety devices to prevent accident.

The tank and generator from which the gas is drawn answer the double purpose of supplying power for the railway and furnishing gas for illuminating the town.—Associated Sunday Magazines.

OLD ENGLISH RAILWAY EQUIPMENT.

A correspondent in Kent, England, has sent us the accompanying photographs. The locomotive is the old "Invicta" built by Stevenson and first used in the opening of a single track railway nine miles long between Canterbury and Whitstable, Kent, in May, 1830. The weight of the engine with its tender is nine tons. It stands in "Dane John" park in Canterbury.

The car was built for the private use of the first Duke of Wellington and was operated on the Southeastern Ry. The car is kept in the Ashford shops of the Southeastern and Chatham Ry.

Old English Locomotive, "Invicta."

PREVENTION OF ACCIDENTS IN THE SHOP.

(Continued from Page 449, October Issue.)

All dangerous apparatus and cable should be painted *bright red,* and large-type notices prohibiting any unauthorized person going within six feet of them should be fixed in a conspicuous position. All dangerous parts should be protected against accidental contact, as far as is consistent with convenient operation.

Rubber gloves should be provided by the employer and used on both hands in the handling of cables and wires, whether the parts are "live." or not. The workman should satisfy himself before beginning work that the gloves are in good condition. Working on "live" circuits, especially alternating current, should be avoided as far as is practicable. A man should not work on wire or conductors of any kind with sleeves rolled up or arms exposed, nor should wires ever be handled while standing or sitting in a wet place, without extra precaution to obtain insulation from the ground. In handling any circuit over 115 volts known to be "live," it is best, if possible, to use only one hand. Keep the other in the pocket or behind the back.

Car Built for Duke of Wellington.

If the power has been cut off by opening a switch located some distance from where the work is being done, a sign should always be placed on the switch stating that men are working on the line. No examinations, repairs, or alterations, necessitating the handling of cables, wires, machines, or other apparatus under high voltage, should be made if it is possible to avoid so doing. In any case such work should be done only by a trained electrician.

The neutral wire of either direct or alternating current three-wire systems and one side of an alternating-current two-wire circuit should be grounded, provided (a) that such circuits are so arranged that under normal conditions of service there will be no passage of current over the ground wire, and (b) that the maximum difference of potential between the grounded point and any other point in the circuit does not exceed 250 volts. The "Fire Underwriters" do not permit grounding of a two-wire direct-current system having no accessible neutral point. All ground connections should be made as specified in Rule 13 A of the "National Electrical Code" of the National Board of Fire Underwriters.

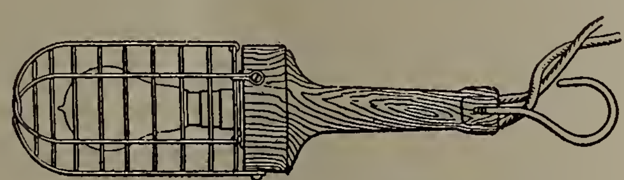
If alternating-current secondary systems are not grounded, a dangerous, and possibly fatal, shock may be received by anyone touching the secondary wiring if a ground should exist on the high-tension system.

Serious, and even fatal, shocks have been caused by the use of faultily constructed hand-lamps. A portable lamp intended for use in places where the person holding it is in contact with earth, such as damp ground, metal plates, or inside boilers or tanks, should be especially well insulated. It is important that there be no metallic connection between the holder and any metal part of the fitting and that the wires from the lamp holder shall not be led through a metal tube or otherwise touch any part of the fitting.

The drawing herewith shows a home-made lamp. The body is made from a piece of oak about 3½ inches in diameter at one end, and turned down at the other to form a handle. The wires pass through a hole in the center and are clamped near the end of the handle, so that no stress can come upon the connection in the lamp-holder which is of the "batten" type, and is screwed to the flat disk-end. The wire cage is attached by screws to the outside of the disk. There should be no metallic connection between the lamp-holder and the wire cage. The hook shown at the end of the handle for hanging up the lamp should be replaced by a leather or other non-metallic loop, as with constant use it may injure the insulating covering of the flexible wires where it rubs against them.

Emergency outfits* for immediate assistance in cases of electric shock should be provided, and it should be made the duty of some competent person to see that they are kept in good condition. All enginneers, electricians, etc., should be familiar with "first aid" treatment for shock, in order to be able to render prompt assistance pending the arrival of a physician. The following precautions and rules for procedure should be borne in mind:

In cases of accident due to contact with a "live" cable or wire, the injured person may retain his grasp on it. If



Homemade Safety Portable Lamp.

possible, the current should be shut off immediately. If this cannot be done, it is dangerous to seize any part of the victim or his clothes with bare hands. The rescuer should protect his hands whenever possible with rubber gloves, and if the wire is lying on top of the vicitm, it should be flipped off with a *dry* stick. Where gloves are not available, a coat or other garment, if made into a thick pad, or a thick layer of rags or paper, may be used to pull the victim away from the wire. It is much safer to take hold *only* of his *clothes* rather than to grasp or touch his body. After rescuing him, he should be carried immediately out into the fresh air and placed on his back on a flat surface, with a coat rolled (not folded) under his shoulders and neck in such a way as to allow his head to fall backward far enough to straighten the windpipe. A physician should be summoned at once. The patient's clothing should be loosened, and if breathing is irregular or suspended, artificial respiration should be proceeded with. Burns caused by electricity should be treated the same as burns from fire.

The Machine Shop.

Machinery should never be cleaned while in motion if it can possibly be avoided. The soft materials used in cleaning, such as waste and the like, catch easily in the gears, or other moving parts, and the workmen's fingers, hands, or arms are drawn in and broken and crushed. Out of 1,866 accidents in the State of Massachusetts in the year 1907 (fatal accidents not included) which occurred in the operation of machinery, 826, or over 44 per cent., were to "persons who met their injuries while attempting to clean the machinery when it was in motion, in trying to remove waste or some other article which had become caught in the machine, in oiling the bearings, or in some other way incurring risks which carefulness and prudence would have avoided." It is particularly important that minors under sixteen years of age shall not be required to clean shafting or other machinery while it is in motion. A young person will be much less likely to realize the danger than an adult, and will fail to exercise the caution that is necessary.

All shafting and pulleys less than seven (7) feet above the floor should be securely fenced. Housings of sheet-metal, iron grille-work, wire netting, or wood, or railings of pipe or wood, may be used for this purpose. If it is impracticable to fence certain pulleys, their arms should be covered with a disk of sheet-metal or wood fastened thereto with screws or wire. The use of inverted U- or V-shaped sheet-metal shields, extending for a length of fifteen inches on each side of shaft bearings requiring attention when the shafting is in motion, is recommended. Even perfectly smooth shafting is highly dangerous when in motion, and no one should ever be allowed to come into contact with it when it is in motion.

All *moving* painted parts of machinery, and other *moving* parts wherever practicable, should be painted *bright red.* Although this method of warning has thus far been confined in this country almost entirely to high-tension electrical apparatus, it has been extensively applied to machinery in general in European countries, and has proved a most efficient aid in the prevention of accidents.

The oiling of shafting should be done whenever possible while the machinery is at rest. Better still, the bearings may be fitted with automatic lubricators which need be refilled only when the shafting is not in motion. But sometimes the shafting requires attention while in motion, and safe means of access should be provided for this purpose.

A ladder provided with hooks or hangers to fit over the shaft at the upper end, and with some material to prevent slipping at the lower end (a ladder should never be permitted to lean against shafting in motion if it is possible to avoid so doing). For wood or cement floors iron straps pointed at the end and screwed to the sides of the ladder, so as to project some two inches below the bottom, are considered best. These "feet" are made of malleable iron and are fastened to the ladder with ordinary wood-screws. Rubber is also used to some extent for this purpose, but is liable to slip on a wet or greasy floor.

In no case where a line of shafting is close to a wall should an attendant be allowed to fix a ladder against the wall, and thus place himself between the shafting and the wall. Working in a cramped space like this, close to a rapidly revolving shaft, is dangerous.

The oil-cans used in oiling shafting and heavy machinery should have necks at least nine inches long.

Whenever the shafting or machinery thus requires oiling or other attention while in motion, the work should be done preferably by one man, who should be required to wear exceptionally tight-fitting clothing to lessen the chances of his being caught in the machinery.

Projecting set-screws when on line-shafting and revolving parts of machines are a constant menace to life and limb. This hazzard may be overcome at a trifling cost in any of the following ways:

1st. By countersinking. The set-screw may be adjusted by

*These should contain the following articles:

(a) A bottle of aromatic spirits of ammonia.

(b) A bottle of ordinary ammonia with sponge attachment.

(c) A package of bicarbonate of soda (ordinary baking soda).

(d) A tin cup.

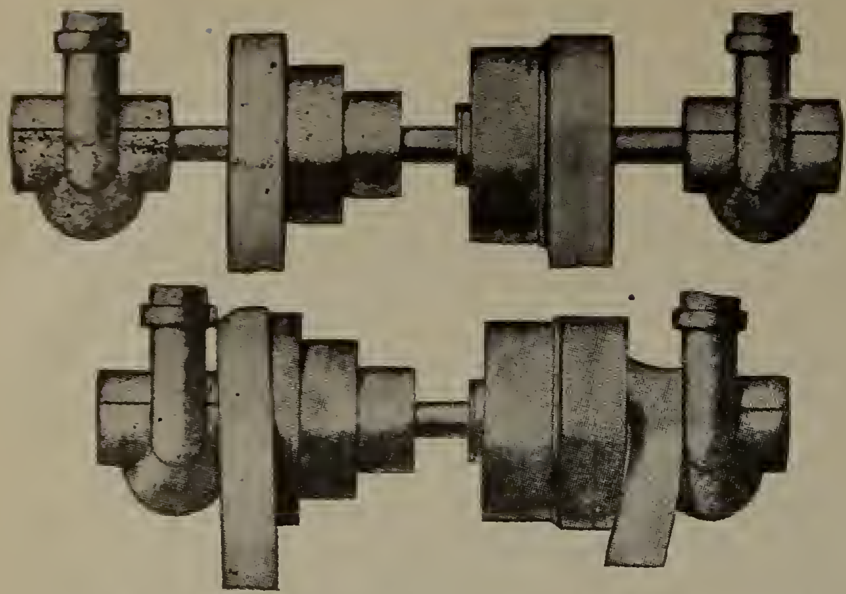
(e) A pair of tongue-pliers.

(f) A towel.

(g) A package of antiseptic cotton.

(h) A roll of antiseptic bandaging.

(i) A roll of adhesive tape.



The Proper Way (above) and Improper Way (below) of Spacing Belt Pulleys with Respect to Location of Shaft Hangers.

the box-key. Of course this method requires either a shorter screw or a thicker collar.

2nd. By using a flat-head set-screw slotted to take a screw-driver.

3rd. By the use of hollow set-screws. These are made to take a hexagonal key or socket-wrench.

Either of the latter two may be used instead of the old square-head screws. As it does not matter whether they come flush with the surface of the collar or pulley-hub or set below it, only one length of each size of screw is required for any depth of hole. These screws may be protected against rust by filling the hole above the screw with wax. If the hole is quite deep and it is desired to lock the screws, one screw may be put down on top of the other. The hollow type is to be preferred to the slotted-head screw because there is not the danger of twisting the head off as in the case of the latter.

In a case where for any reason it is imperative that the old square-head set-screws be retained, it is strongly recommended that one of the following guards be applied:

1st. A sheet-metal plate curved to fit snugly over the screw and to spring on around the shaft. This serves both to keep the head from catching in clothing, and incidentally to retain the screw should it loosen.

2nd. A piece of leather-belting laced about the screw. This is the method used to guard projecting set-screws at the plant of the Lidgerwood Manufacturing Company, New York

3rd. Wooden guard-rings. These are made in halves with a recess bored for the screw-head to fit in, and screw together, thus forming a perfectly smooth ring which may be easily removed and replaced.

4th. When set-screws or keys project at the end of a shaft they may be covered by a sheet-metal cap fitting over the shaft.

Main belts which run through the floor should be boxed to a distance of six feet above the floor, small belts if running close to the floor should be guarded sufficiently to prevent contact with a workman's clothing. If a man gets caught, cut a belt if this is quicker than stopping the machinery. Where belt connections are made with motors or exhausters, the belts run usually at very high speed and it is well to fence off the whole apparatus.

Pulleys should not be nearer a shaft-hanger or other obstruction than the width of the belt. This precaution will prevent the belt becoming wedged if it slips off the pulley, with the attendant danger of pulling the shaft down on a workman.

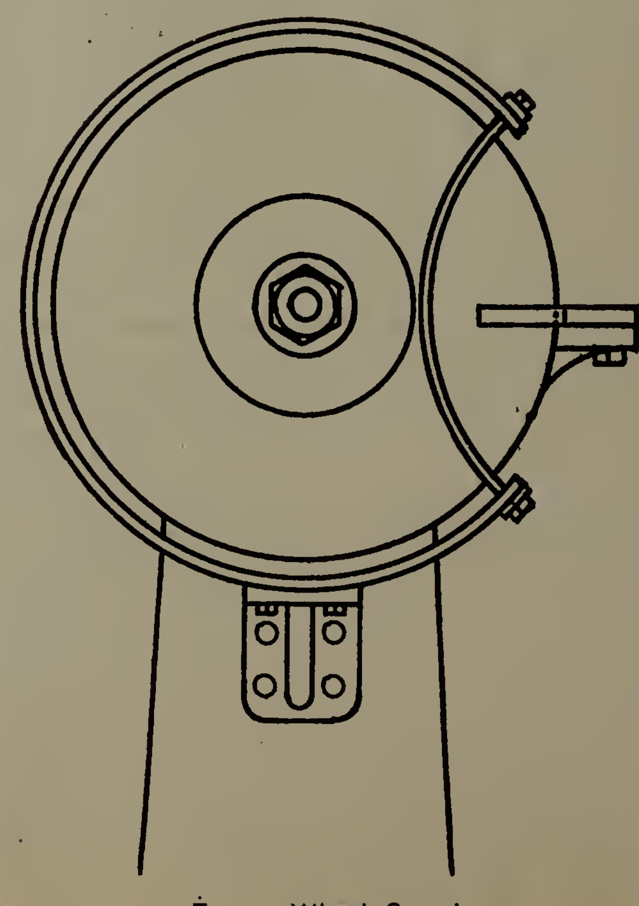
In unshipping belts, a belt should always be thrown off the driving and not off the driven pulley.

Loose pulleys and belt-shifters, or clutches, should be used wherever possible for throwing machines out of motion when not in use. No employee should be allowed to shift a belt with his hands or a stick while the machinery is in motion. The practice of shifting belts by hand is dangerous, even though they travel comparatively sclowly. In cases where belt-shifters are not provided, or where it is necessary to shift or repair belts on single pulleys while the machinery is in motion, these operations should be performed by one man detailed for all such work, who should be provided with suitable applicance for the purpose.

Care should be taken to make the belt-shifter action used for removing a belt to the loose pulley, of a positive character, either by employing one of the many forms of locking-gear or a balance-weight. Many accidents have arisen through the lack of this precaution, the belt creeping back on to the tight pulley, and the machine thus starting unexpectedly. This applies particularly to wood-working and other high-speed machinery.

Machinery of this class is also set in motion without warning, sometimes, by the loose pulley seizing upon the shaft or by the side friction of the adjacent rims of the pulleys. This danger may be avoided by the mounting of the loose pulley on a well lubricated idle stud, co-axial with the machine-spindle, and using a collar which prevents any end motion in the direction of the tight pulley. The same object may be attained with existing troublesome loose pulleys by encasing the necessary bearing length of the shaft in a collared sleeve which does not revolve with it and on which the loose pulley runs.

All gearing, sprockets, and chains with which a workman may come into contact, should be completely covered, so as to leave no point of danger between the guard and the gearing. Small and moderate-sized gears may usually be well guarded by a strip of sheet-metal screwed on to some adjacent stationary part and bent to conform to the contour of the gears. Very large gears may often be fenced to advantage. A train of small gears is best guarded by a wooden or metal casing, so constructed that it may be easily removed for repairs or oiling.



Emery Wheel Guard.

Frequent inspections of the numerous small pulleys in use in every plant should be made. The arms of cast-iron pulleys are very liable to crack. When this occurs, a piece of the rim may be thrown out by centrifugal force and may cause serious, if not fatal, injury to any workman nearby. The wheels should be hammer-tested frequently, to detect cracks.

Cranes should be carefully inspected at frequent intervals for such dangerous defects as worn chains, ropes, sheaves or pins, broken split-pins, etc. All platforms should be provided with skirting-boards to prevent the accidental rolling off of spanners or necessary tools in use.

All overhead cranes should be provided with a railed walk the entire length of the bridge. It seems strange that manufacturers would build cranes without these walks, but they do. These cranes should also be equipped with foot-gongs for the use of the operator, with a box on the bridge in which to keep tools and oil-cans, and with limit-switches to prevent running the hoist-blocks into the drums and probably breaking the cables, allowing the burden to fall on to workmen below.

Each crane should have a switch installed at some point on the ridge which will cut off all power, making it impossible to start the crane from the cab. Many men have been injured while working on the top of a crane by a thoughtless craneman forgetting for the moment that they are there and starting the machinery.

Each man working on a crane should be provided with a warning sign bearing his name, which he should attach to the safety-switch, warning all not to throw in that switch, as he is working on the machinery.

All overhead cranes should be equipped with sweep-brushes extending out from the truck-wheels, sweeping the rails, the purpose being to warn a person resting his hand on the rail of the approach of the crane. The number of arms and hands lost by persons working on scaffolds along crane-runways, who thoughtlessly rest against the runway and fail to notice the approach of the crane, is appalling. Four instances have come to my personal knowledge within the past year where these brushes have prevented such accidents.

No man should ever be allowed to go on to an overhead crane runway without permission from his foreman, and then not until the cranemen have been notified and steps taken to protect him from the cranes while he is on the runway."

Under no circumstances should machinery be crowded, so that those using passages are placed in danger.

Any passage toward which a planer-platen self-acting mule, or other carriage, should have eighteen inches space in the clear between the carriage and fixed structure.

Emery wheels and grindstones should be enclosed by a substantial guard, fastened to the wheel base of sufficient strength to withstand the shock of the flying parts of a burst wheel.

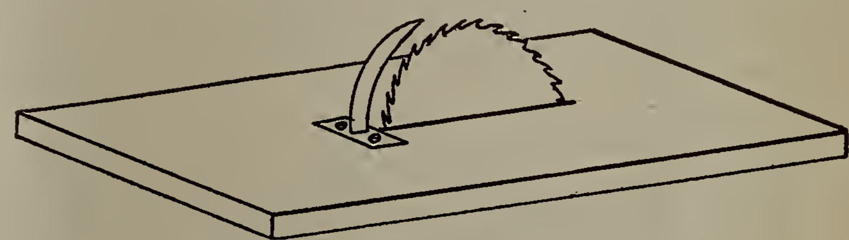
The illustration shows what is considered to be the best guard of this kind. The wheel is entirely surrounded except for a small open space at the front of the wheel above the rest. There is ample space to work conveniently, and yet the wheel is well guarded and the workman protected.

Another good safety-device is so designed that the wheel plays a part. The sides, instead of being parallel, are divergent, so that the thickest part of the wheel is at the center. A number of sets of steel safety-collars are furnished, varying in size so as to allow for wear of the wheel, which fit the wheel tightly to a distance of two inches from the grinding surface. In case the wheel ruptures, the tapered sides cramp between the collars and so do not allow the pieces to fly. A number of manufacturers of emery wheels loan safety-collars free of charge to the users of their wheels. Advantage should always be taken of this offer.

The Car Shop.

The machinery used in wood-working is exceedingly dangerous. It is important, therefore, that the utmost care be exercised in its operation and that all practicable safeguards be utilized. Owing to the usually high speed of belts on woodworking machinery and the commonly exposed positions of such belts, they are a constant source of danger to the machine hands. Loose clothing catches easily on these belts and the pulleys over which they run, and serious, and often fatal, accidents are caused thereby. The greater number of such belts and pulleys can be readily guarded, and guards should be provided wherever they are feasible. Where it is necessary that the guarded parts shall be easily accessible, guards may be so constructed as to be removable. Guards should also be put over exposed gears, sprockets, and chains.

Owing to the smoothness of the floors in wood-working shops, there is always the danger of the machine hand slipping and falling on the machine he is operating, especially when working on a heavy piece. A rubber mat placed in front of the machine and secured to the floor is one of the best safeguards against such accidents. The mat should be kept free from sawdust and renewed when torn or badly worn, else it will fail to accomplish the purpose for which it is provided. Rubber mats are useful in preventing accidents when placed in front of circular saws, band saws, planers or jointers, shapers, and all machines of like character.



Simple Application of a Riving Knife.

The dangers incident to the use of circular saws are too well known to require description. A "riving knife" or "spreader," when properly attached to the table immediately back of the saw, will spread the cut sufficiently to prevent cramping of the saw. It is very important that cramping shall not take place, as it usually stops the saw and throws the belt off, or throws the work back on the operator, often with serious results.

The riving knife itself is simply a piece of sheet-steel mounted in a vertical position back of the saw and preferably curved to conform somewhat to the outline of the saw. The edge nearer the saw should be a little thinner than the saw itself, so that the saw cut will slide over it easily. The opposite edge should be at least the thickness of the saw, and it is even better to have it a slightly greater thickness. The length of the knife will, of course, depend upon the size of the saw with which it is used. One of the illustrations shows the general scheme of the appliance.

A very simple device that will often prevent the work being thrown back in case of cramping, consists of a board 4 or 5 inches in width fastened perpendicularly to the ceiling directly over the saw and of such length that its lower end will just clear the saw. The plane of the board should be at right angles to that of the saw.

If a saw without a guard is permitted to run while the operator is away from it, a small oblong wooden box placed over the saw will serve as a safeguard to persons passing the table. If practicable, this box or cover should have a dowel pin in each end, and these pins should fit into holes in the table.

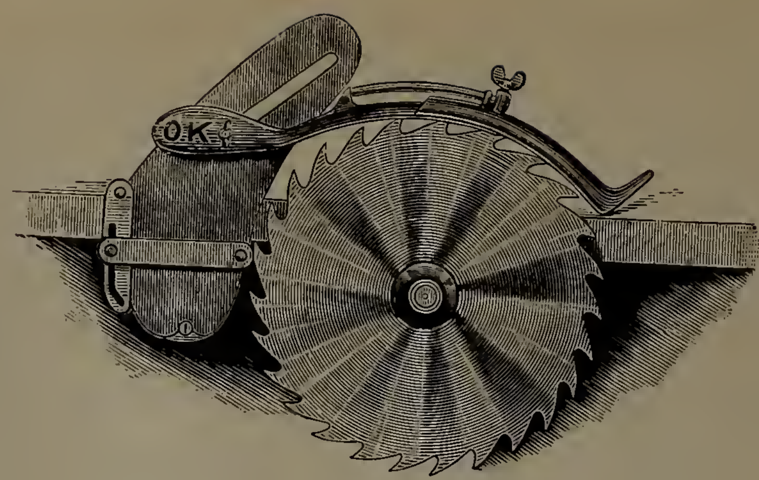
The use of saw guards is strongly recommended. The object of these devices is to prevent the operator's hand coming into contact with the saw in case either the work or his hand should slip. these, or similar guards serving the same purpose, should always be used.

A saw guard which automatically adapts itself to different thicknesses of material is shown herewith. Being attached to the ceiling above the saw, it leaves the table clear for wide work, and in the case of bevel work, as shown in the cut, it is always in posiiton, no matter how the table is tilted. It is also adjustable lengthwise on the table for combination saws. The guard may be raised, moved to one side, and held there by the hand-wheel while changing saws, making repairs, etc., or while doing high end-work. No tools or wrenches are needed in its adjustment. The small dog or digger on the back of the guard holds the board so that it cannot catch on the saw and fly back and strike the opetrator.

Another drawing shows a guard which combines the riving knife with the guard. It is adjustable, to accommodate saws of different sizes. Like the guard described in the preceding paragraph, it is provided with a device to prevent the board rising on the teeth of the saw and kicking back at the operator.

Both the upper and lower wheels of a band saw should be completely guarded. For this purpose a wire grating, a sheet metal covering, or a wooden housing, around the wheels, may be used. With these in place, it is impossible for the workman to get his hand or foot caught in the spokes of the wheels. In case the band saw breaks and flies, as it usually will sooner or later, these guards will, as a rule, prevent the saw from striking the operator or other person standing by.

Another place which should have more efficient guards than those usually provided by the manufacturers, is the idle part of the saw between the wheels, on the left-hand side of the machine. The saw at this point commonly runs



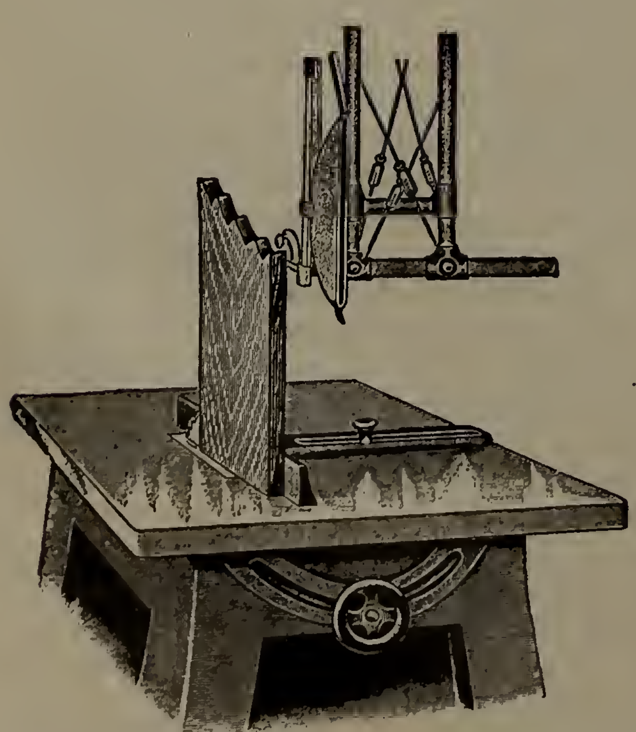
Combination Saw Guard and Riving Knife.

close to a wooden strip placed on one side of it as a guard. While this guard is useful in a measure, it is hardly sufficient. The guard should either cover the face of the saw, or enclose it closely on both sides. Tubing may also be used effectively to guard the vertical portions of the saw not used in cutting.

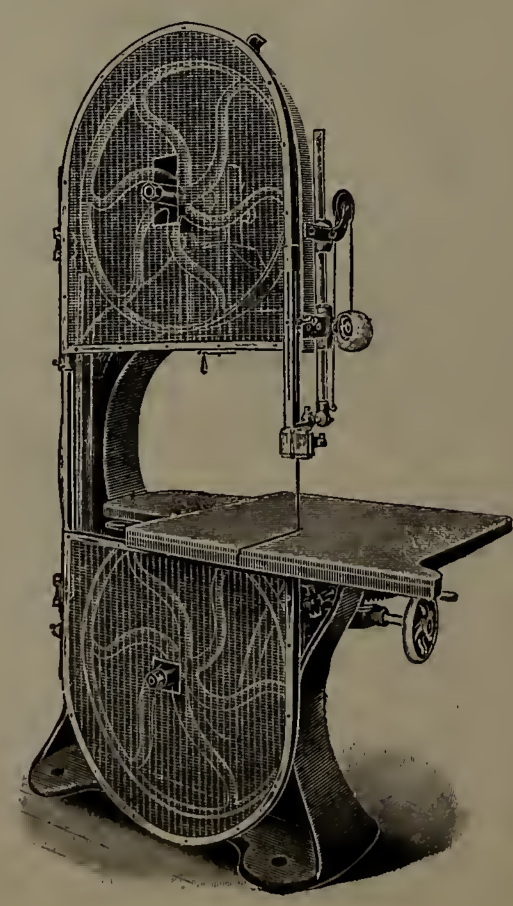
One of the illustrations shows a band-saw guard devised to attach to the frame of the machine. It has adjustable joints, so that it may be easily attached to any style of machine. The guard consists of an angle-iron frame covered with heavy wire screening. A sliding-piece guarding the working portion of the saw, rises and falls automatically with the saw-guide, so that the only portion of the saw necessarily exposed is that for a height above the table equal to the thickness of the work.

The hand planer or jointer is a most dangerous machine when operated without a guard. In using it, accidents often occur in unexpected ways. A change in the grain of the wood, the striking of a knot, or too heavy a cut, may hurl the piece from the machine and throw the workman's hands into the knives.

A workman should always try a jointer before using it. The knives may be set to take too heavy a cut, with the result that the piece is hurled back on him. In using a jointer, the operator should not allow his hands to rest on that portion of the stock over the knives if it is possible



Guard for Circular Saw, Swung Out of Way for End Work.

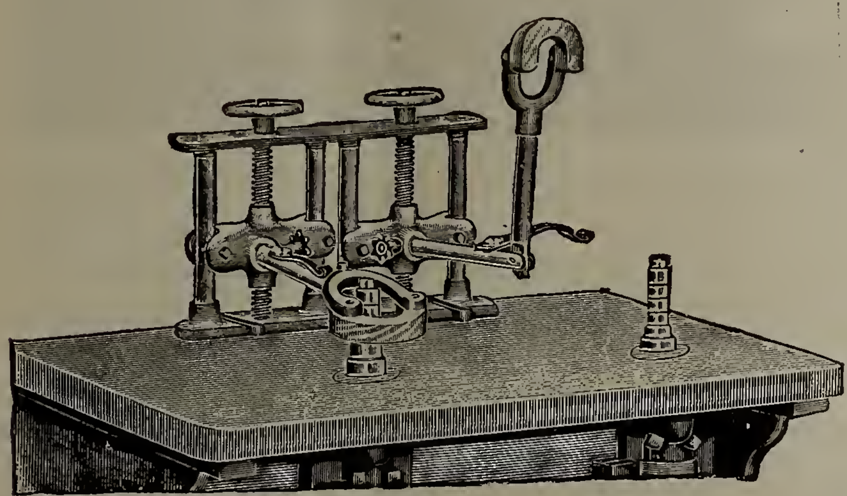


Band Saw Guard.

to avoid doing so. Yet a jointer may be simply and easily guarded, so as to render it safer than many other wood-working machines.

The most common guard is made up of a number of interlocking sliding sections or shells, by which the length of the guard is changed to suit the length of the knives exposed. It is attached to the machine by a bracket and two cap-screws. A round rod passing through the bracket is held in position by the hand-screw, which makes the guard adjustable, without the use of a wrench, for facing off different thickness of material. In operation the piece passes under the guard and the workman's hands pass over it. The operator's hands are thus protected should the board be hurled from the knives. The guard may easily be telescoped and lowered down to the side of the machine when the machine is to be used for rabbeting, or during repairs, etc., as shown by the dotted lines, so that it need never be detached from the machine.

A continually increasing recognition of the danger attendant on operating a wood shaper without a guard, has resulted in the invention of a number of suitable guards, several of which



Wood Working Shaper Guard.

are described in the following paragraphs. By the use of such guards, or similar ones, the shaper may be rendered reasonably safe, and it should never be operated without such a guard.

The illustration shows one form of shaper guard. The arm is jointed to permit of its being raised for dropping inside-work over the spindle, changing knives, etc. The height of the arm may be so adjusted, if desired, that the spring which holds it down will put pressure on the work. The hand-wheel and screw allow independent adjustment of the arm for each spindle.

The base of the guard is hinged at the back edge of the table-top, so that, if necessary, the guard may be turned back out of the way, clearing the whole top of the machine, yet leaving the guard attached to the machine.

The forked piece around the spindles is made in duplicate and in different sizes, so that one may be removed and another put on, to suit the particular work. It may be fitted with other wood shoes for special work, to suit the convenience of the user.

The use of the sign "Whoever uses this machine without the guard, uses it at his own risk,"—is particularly appropriate in connection with wood-working machinery.

SHOPS OF THE SOUTHERN PACIFIC CO., AT EMPALME, MEX. II.

Note: The August issue of this paper contained on page 357, an article on the Empalme shops of the Southern Pacific Co., illustrated with a drawing of the general layout of the shops. Addtional information on this installation is contained in the following paragraphs:—Ed.

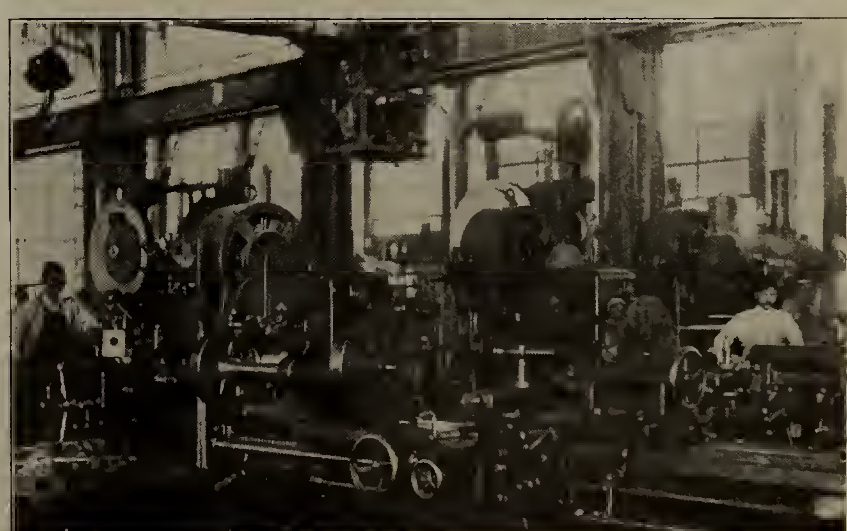
Among features of the complete plant at Empalme are machine and erecting shops, boiler and blacksmith shop, material shed, belt shop, flue shop, foundry, pattern shop, car and paint shops and mill. Work is about to begin on the erection of the dry lumber storage building and a dry kiln. Special attention has been paid to light. All buildings are

General View of Empalme Shops, Southern Pacific Co.

exceptionally well lighted, and, to eliminate the disagreeable feature of the strong sunlight, factory ribbed glass is used throughout.

Particular attention has been given to labor and time saving devices. Cranes, push car tracks, turntables, floor air jacks, air hoists, etc., have been provided wherever considered practicable, and a telephone system connecting all shops, offices, stores, etc., is installed. A general fire alarm system, with fire alarm boxes located at suitable places about the shops and connecting with the power-house, is provided for. An independent fire line with hydrants has been installed, and is used only in case of fire or fire drill by the shop fire department, thus insuring piping in good condition that will stand high pressure in case of fire, and eliminating the dangerous practice of allowing general service and other taps to be connected to the fire line, which is always bursting when a good pressure is called for. The coal storage has a capacity of ten thousand tons, the coal being dumped from an elevated trestle twenty-two feet high.

The shops are electrically driven throughout, power being furnished from a central power station, which is a handsome reinforced concrete building 88 feet wide and 106 feet long. This building is divided longitudinally by a wall extending its full length, separating the engine and the boiler rooms. The engine room floor is about five feet above the boiler room floor, which provides for a basement to accommodate condenser, air pumps, hot well, boiler washing, general serv-



10-H. P. Motor Driving Engine Lathe, Empalme Shops.

ice, hydraulic and fire pumps, steam and exhaust headers, and all piping. In the powerhouse there are two Westinghouse 200 kw., three-wire, 250 volt D.C. engine type generators direct connected to reciprocating engines.

There are about 200 Westinghouse type "S" motors, from 1 to 50 h.p., operating the various wood and iron working machinery in the different departments. The machines are all direct driven and the necessity of overhead belts and line shafting is precluded. By means of the adjustable speed motors that are used, the speed control of the different machines is extremely flexible; and, hence, a considerable gain in the productive capacity of the machine is made. This flexibility of control is especially advantageous in the machine shop.

Wood Working Dept., Empalme Shops.

The application of individual motors to machines in railroad shops is being generally advocated, and the installation at the Empalme shops is an addition to the many examples that speak for the superior advantages of electric motors in this class of service.

The transfer table is operated by a Nichols tractor manufactured and installed by Geo. P. Nichols & Bros. of Chicago.

The shops are complete in every respect, being built to take care of locomotive, passenger and freight car repairing and rebuilding, and are also equipped as a manufacturing plant, making them, to a large extent, self-supporting.

REPORT OF TEST OF JACOBS-SHUPERT FIREBOX, A., T. & S. F. RY.

During the early part of August, 1908, Mr. H. B. MacFarland, present engineer of tests of the Atchison, Topeka & Santa Fe Ry., then acting as consulting engineer, made a report on the Jacobs-Shupert firebox. The report included the statements that on account of its great strength the firebox would not be liable to blow up, and if it did blow up the results would not be disastrous, owing to the sectional construction of the firebox.

In April, 1909, a Jacobs-Shupert firebox was completed and placed in freight service on a "Santa Fe" type locomotive. This firebox has given first-class service and has demonstrated all the claims made for it so far as evaporation, efficiency and low cost for repairs are concerned. The results of its performance has justified the equipment of thirty-two engines now in active service and of sixty-six engines on order with the Jacobs-Shupert fireboxes.

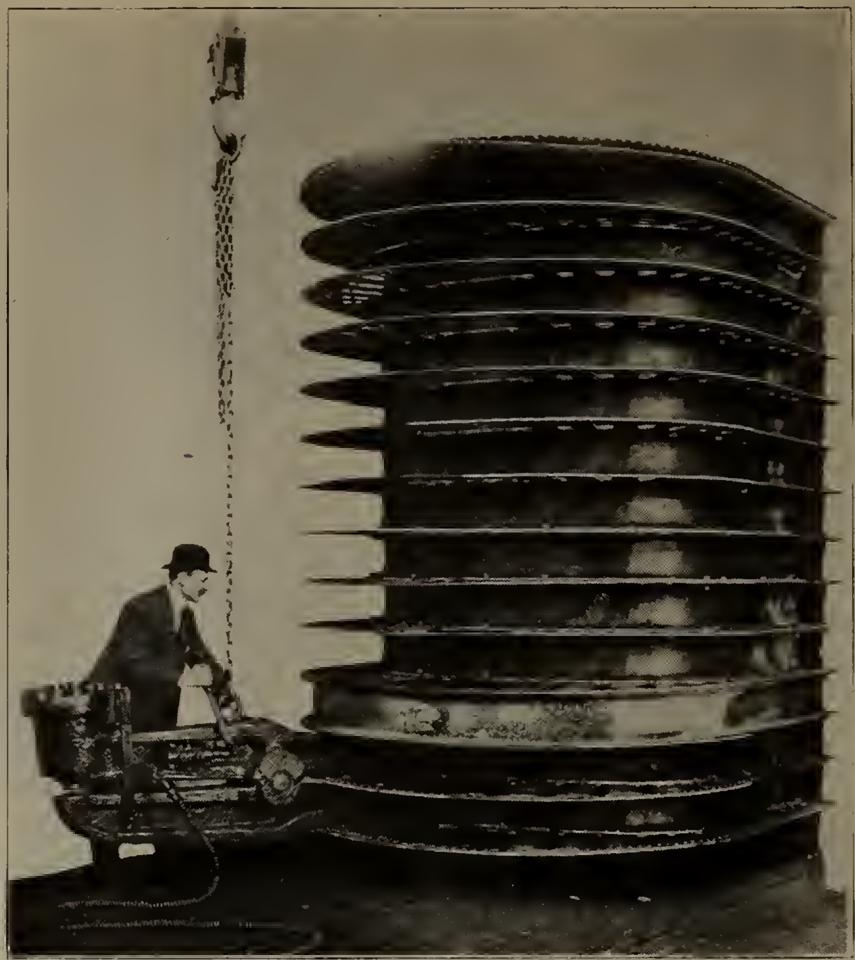


Fig. 1—Jacobs-Shubert Firebox in Course of Construction, Showing Method of Riveting.

A test on this firebox was conducted at Topeka, Kan., September 26, 1910.

Object of Test

The object of this test was to demonstrate the value of this style of firebox as an appliance of real safety as applied to a locomotive under unusual conditions of operation. The fireboxes in service have demonstrated so thoroughly and so satisfactorily the claims made for this sectional form of construction of a firebox that it was deemed advisable, after careful consideration of all things involved, to demonstrate whether or not the Jacobs-Shupert firebox would stand the severe stresses without the usually disastrous results that accompany fireboxes of ordinary construction when the water is lowered below the crown sheet and the crown sheet is overheated. A further object of the test was to determine whether or not extreme pressures occur when cold water is injected into a firebox with an overheated crown sheet. Ordinarily the claim is made that an explosion occurs only when cold water is injected, although Professor Thurston, who was an authority on the subject of boiler explosions, stated that only once was he able to produce an explosion by the

Fig. 2—Interior of Jacobs-Shubert Firebox During Construction.

injection of cold water into a highly heated boiler. He stated, however, that explosions from this cause were more frequent in locomotive than in stationary boilers.

It is a well established fact that for an ordinary firebox the strength of the crown sheet, with its numerous stays, is very much reduced when overheated. The construction is such that the stresses set up in the metal on account of increased temperature and consequent tendency for expansion, with little or no provision for explosion, are enormous. At the same time, on account of increased temperature, the holding power of the staybolts is decreased 65 to 75 per cent. The result of an increase of stresses in the metal due to temperature changes, in addition to the stresses due to usual boiler pressure, together with the great decrease in the holding power of the staybolts, causes the crown sheet to be forced from the staybolts. The sheet once opened is at the mercy of all the latent energy of the boiler, with a consequent collapse of the interior of the firebox. The test in question was made to demonstrate that the Jacobs-Shupert firebox was of a substantially safe construction for high pressures and unusual conditions of service.

Firebox and Boiler.

The Jacobs-Shupert firebox subjected for test was applied to the boiler of one of the "Santa Fe" type engines and has been in stationary practice since November, 1909. As shown by the accompanying photographs and by the drawing, Fig. 7, this is a large firebox and boiler, being capable of evaporating 50,000 pounds of water per hour in road service. The dimensions, heating surface and proportions are as follows:

Boiler and Firebox—	
Total length, feet	39
Height, feet	11
Weight, pounds	75,000
Capacity, cubic feet	722
Water capacity, gallons	4,350
Water space, cubic feet	580
Steam space, cubic feet	142
Pops, number	3
Flues—	
Number	373
Outer diameter, inches	2.25
Thickness, inches	0.125
Length, feet	19.5
Total fire area, square feet	4,098
Firebox—	
Sections, number	11
Length, inside, inches	109.6
Width, inside, inches	79.5
Depth, front end, inches	76.7
Depth, back end, inches	76.7
Volume, cubic feet	359.7
Fire area, square feet	60
Thickness, inner section, inches	0.313
Thickness, outer section, inches	0.5
Heating surface, square feet	265
Boiler—	
Number of rings	3
Diameter of first ring, inches	88
Diameter of smallest ring, inches	77
Thickness of shell, inches:	
First and middle rings	0.9375
Third ring	0.875

Fig. 3—Boiler Equipped for Test, with Apparatus in Place and Arranged for Oil Burning.

Fire Pan—

Depth, inches	18
Draft holes, number	56
Burner, Standard, width inches	2.5

The characteristic feature in the construction of this firebox is the elimination of all staybolts on crown and side sheets. Figure 1 is a photograph showing the firebox in process of construction, ready to rivet, with one outer section in position. In Figure 2 the interior of the firebox, nearly completed, is shown. This photograph enables one to get a comprehensive idea of the sectional form of construction within this firebox and shows the great amount of heating surface, free from staybolt heads, characteristic of this firebox. The sectional construction provides for expansion of the arches so that stresses may not be set up due to great changes in temperature. The sections are supported by stay sheets with properly cut holes to allow for horizontal circulation of water and steam. The stay sheets are in retreat from the fire side of the box, so that they are protected from the more intense action of the active flames.

Preparations for Test.

Due consideration of all points involved lead to one proposition only as to the method of making the test. Test should be made on one of the largest boilers, with no special changes except for purpose of record, and under conditions that might occur in service.

A boiler was, therefore, set up as shown in Figure 3 at a point north of the Topeka shops, sufficiently removed so that in case of an explosion the least possible danger to life and property might result.

Water was forced into the boiler by a pump to the left of the boiler, eighty yards away. The boiler was fired by oil. A special valve was introduced so that the oil might be shut off quickly.

The usual working pressures of these boilers is 225 pounds. The pops were set as close to 225 pounds as practicable. No provision was made for carrying away steam generated except by allowing boiler to pop off. Compressed air was piped to the stack in order to produce sufficient draft to maintain combustion and keep up boiler pressure. Two pressure gauges were used so that one might check the other. A lever was connected to blow-off of boiler so that it could be operated from a point near the pump in order that water might be reduced in the boiler. A second or special gauge glass was attached to the boiler head so as to indicate the level of the water relative to top of crown sheet during the period of test.

Two pyrometer couples were inserted in the steam space of the firebox, with leads extending to a proper shelter where temperature readings were made. The pyrometer couples were placed in the second sections from back and front of firebox and indicated the temperatures of the crown sheet on the steam side.

The projection of the lower portion of the crown sheet was painted on the back head of the boiler, as shown by Figure 3. In this photograph the location of the gauge glasses, pressure gauges and pyrometer leads are also shown.

Fig. 4—View Showing Boiler, Fuel Tanks and Shield for Observers.

A position of safety was provided for witnesses of the test, such that one could see by the aid of field glasses and telescopes the water levels and gauge pressures. Observers taking readings were provided with a steel shell for protection, placed on a flat car a little to the left and back of the boiler head. This shell was cabled to the track and braced so as to eliminate as far as possible the element of danger in case of explosion.

The photograph reproduced in Figure 4, taken immediately after the test, shows the boiler as set up, the oil tank supplying oil for fuel and the protection shield used by the engineer of tests and his assistant in making records during the period of test. From the fire door of the second firebox used as a shield, a plain view was obtained of pressure gauges and water glasses during the period of test. The leads from the pyrometer couples are shown entering the fire door, while temperatures on top of the crown sheet were indicated on the pyrometer placed on the floor of the shield directly before the observers.

Arrangements were made with E. A. Moseley, secretary of the Interstate Commerce Commission, to furnish a representative on the part of the government to witness and report results of test. E. L. Gibbs, inspector of safety appliances, reported as government representative to wit-

Fig. 5—Photograph Taken in Midst of Test—Water Level 4½ Inches Below Crown Sheet.

ness the test and was provided with full information regarding the firebox and boiler in question, the various connections for pieces of apparatus, as well as any other information to enable him to make proper report as to the firebox as a safety appliance. Frank G. Ewald, an inspector of the Interstate Commerce Commission, also reported as a government representative, but was unable to make train connections in time to witness test. He, however, was able to make inspection of the firebox after tests were concluded.

Test.

A hot crown sheet test was made on the Jacobs-Shupert firebox on the morning of September 26, 1910, between six and seven o'clock. The boiler had been fired up for some time previous to the test, and pops were registering intermittently with boiler pressure at 225 pounds, as shown by gauges recently calibrated and checked against test gauges. The water was lowered in the boiler until it showed only one inch above crown sheet, when all witnesses to the test, except two, retired to a distant place of observation. The water was then lowered by means of opening the blow-off valve until it was level with top of crown sheet. During the period of lowering of water the boiler was popping continuously and boiler pressure was constantly maintained with a usual fire in the firebox as results from the proper combustion of oil.

The water was then blown off to four inches below the top of crown sheet in three minutes and at the rate of 1,210 pounds per minute. Two minutes after the crown sheet was bare the firebox showed the effects of expansion due to heating of crown sheet, by very slight openings in stay sheets near the middle of the firebox. The leaks from these openings were very slight and would not be considered of any consequence whatsoever in ordinary service. The reason for the opening of these stay sheets was on account of the construction, which allowed the stay sheets to be butted together instead of being formed from one piece, as is the present practice.

The crown sheet heated up gradually at an average rate of 67 degrees per minute for a period of ten minutes, at which time the temperature of the front section of the crown sheet (as indicated by pyrometer) was 1,125 degrees; that of the back section was 1,065 degrees. The pressure, as shown by both gauges, was 230 pounds, although all the pops were blowing off. The water level was six inches below the top of the crown sheet. In Figure 5 a photograph is shown, taken a short time after the crown sheet was bare, with the water level showing four and one-half inches below the crown sheet, and the gauges standing at 225 pounds pressure. The pops were blowing off at this time as shown by photograph. The photograph also shows a very slight steam leak occurring a little below the pyrometer leads. The steam from the pops indicated soon after the crown sheet was bare that the crown sheet was getting hot. Toward the end of the test, when practically all of the crown sheet was bare and a large amount of hot metal was exposed, the steam shown from the blow-off was considerably superheated.

Ten minutes after the crown sheet was made bare and it had been heated to a temperature of 1,125 degrees, a signal was given to put on the pump, and water at 60 degrees was forced into the boiler. The fire was cut off at this time, as it was not deemed advisable to continue a fire in the box with exposed crown sheet during period of filling the boiler with cold water. Simultaneous with the injection of the water into the boiler the pressure dropped a few pounds and the water fell in the lower gauge glass so that it was not visible by observers.

Several witnesses approached the firebox when water was still three inches below the crown sheet and observed that crown sheet was still red. Eight and one-half minutes after pumps were started the water was at crown sheet and the pressure at that time was 215 pounds. Within fifteen min-

Fig. 6—View of Crown and Tube Sheets After Test, Showing Parts Overheated.

utes after close of test the interior of the firebox was inspected by George Austin, general boiler inspector, Santa Fe System; Frank W. Shupert, boiler foreman and inspector; Gustave Mihleisen, assistant boiler inspector, Santa Fe Eastern Lines, and John K. Nimmo, boiler inspector, Gulf, Colorado & Santa Fe Ry. They reported no distortion of sections nor opening of seams, but indications of an overheated crown sheet, such as that in a firebox of ordinary construction might cause a dangerous explosion.

Results of Test.

As soon as the boiler was sufficiently cooled down the water was removed, the boiler dismantled and the fire pan removed. Three hours after the test had been concluded the boiler was turned over so that an opportunity was afforded for a more rigid and closer inspection to determine exact condition of firebox.

Several photographs were taken to show the condition of the sections and that portion of the crown sheet overheated, as well as the condition of the flues and flue sheet. The whitened portion of the photograph, Figure 6, shows that portion of the crown sheet overheated during test.

Close examination of the sections showed no distortion whatever in any portion of the sections due to being overheated. There were no leaks between any of the sections and no flue leaks. An inspection of the interior of the boiler on top of the crown sheet showed the characteristic blue color that accompanies the overheating of a crown sheet. The intensity of the color increased towards the center of the sections, showing that the temperature of sections of the crown sheet were much higher at the central portion than at sections where pyrometers were located.

The boiler tubes, as may be noted from careful examination of Figure 6, were not inserted in the back flue sheet in the usual manner, but were welded in by the oxy-acetylene process. This boiler, as previously stated, had been in service and under test for a considerable period of time. During this time an experiment was made to determine the service that might be expected from welding flues into the back flue sheet.

A diagram, Figure 7, was prepared showing the general dimensions of the boiler and the location of various pieces of apparatus during test. On this diagram the customary water level is shown, as well as the ordinary low water level which indicates the danger point to the engineer. A line has also been drawn to show the actual low water level as recorded during the test when water was six inches below crown sheet. Eleven tubes were fully exposed to the hot flames, while eight were only slightly in contact with hot water.

Deductions and Conclusions.

As a result of the test, in consideration of experience with locomotive fireboxes of ordinary construction, and the manner in which test was conducted, the following deductions and conclusions seem to be warranted:

1. The Jacobs-Shupert section firebox is stronger than an ordinary locomotive firebox with sheets held together by staybolts.

2. The overheating of the crown sheet of the Jacobs-Shupert sectional firebox does not decrease holding power of the staybolts and rivets, owing to protection afforded by being in retreat from the flames. The ordinary firebox, with its numerous staybolt heads fully exposed to the intense heat of the flames, has its strength reduced 65 to 75 per cent, due to the overheating of a crown sheet in case of low water in boiler.

3. The Jacobs-Shupert sectional firebox is not subject to undue stresses due to changes in temperature, on account of provision being made for free expansion of individual sections.

4. The form of construction of the Jacobs-Shupert sectional firebox gives protection from explosion and consequent danger in case of water being below crown sheet and crown sheet getting red hot.

5. The form of construction is such that in case of rupture the firebox will not be entirely torn apart, as results with ordinary fireboxes, and thereby cause a dangerous explosion.

6. The firebox was subject to a pressure, temperature and low water test such as would have caused a violent explosion in case of an ordinary firebox with staybolts.

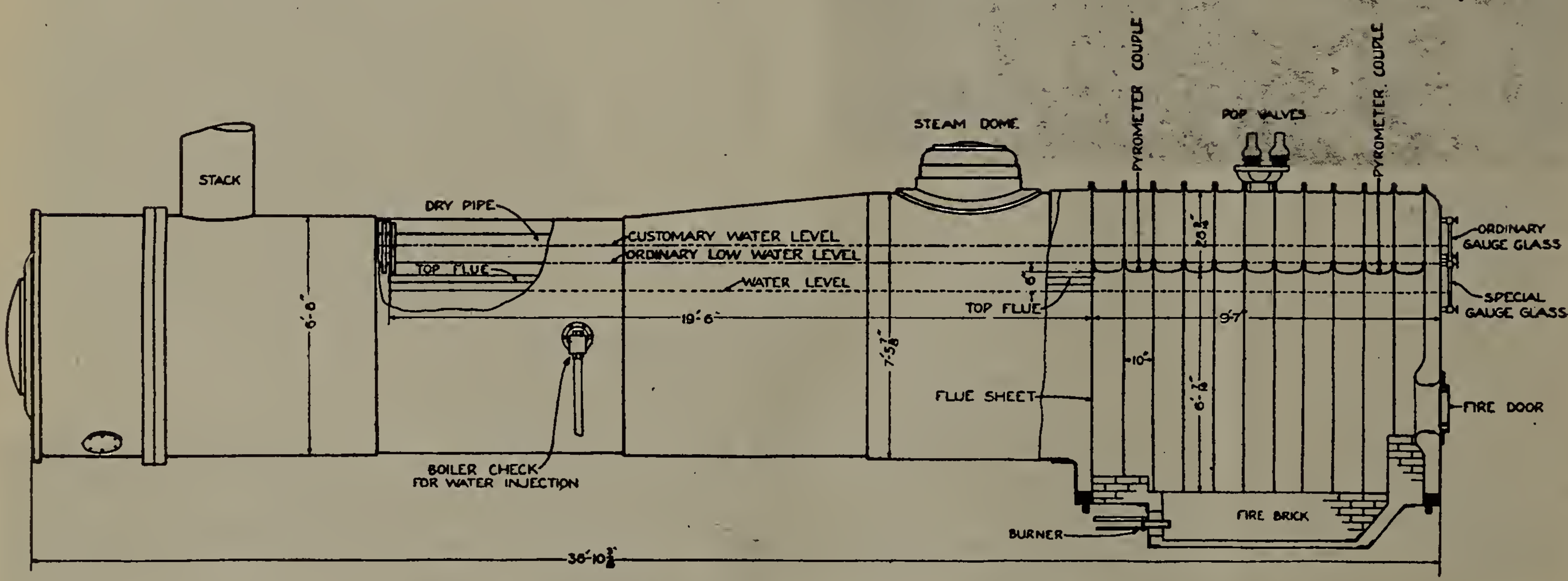


Fig. 7—Diagram of Boiler, Showing Location of Apparatus for Test.

AIR TRAVERSE.

By Theo. Rowe, General Foreman, Great Northern Ry.

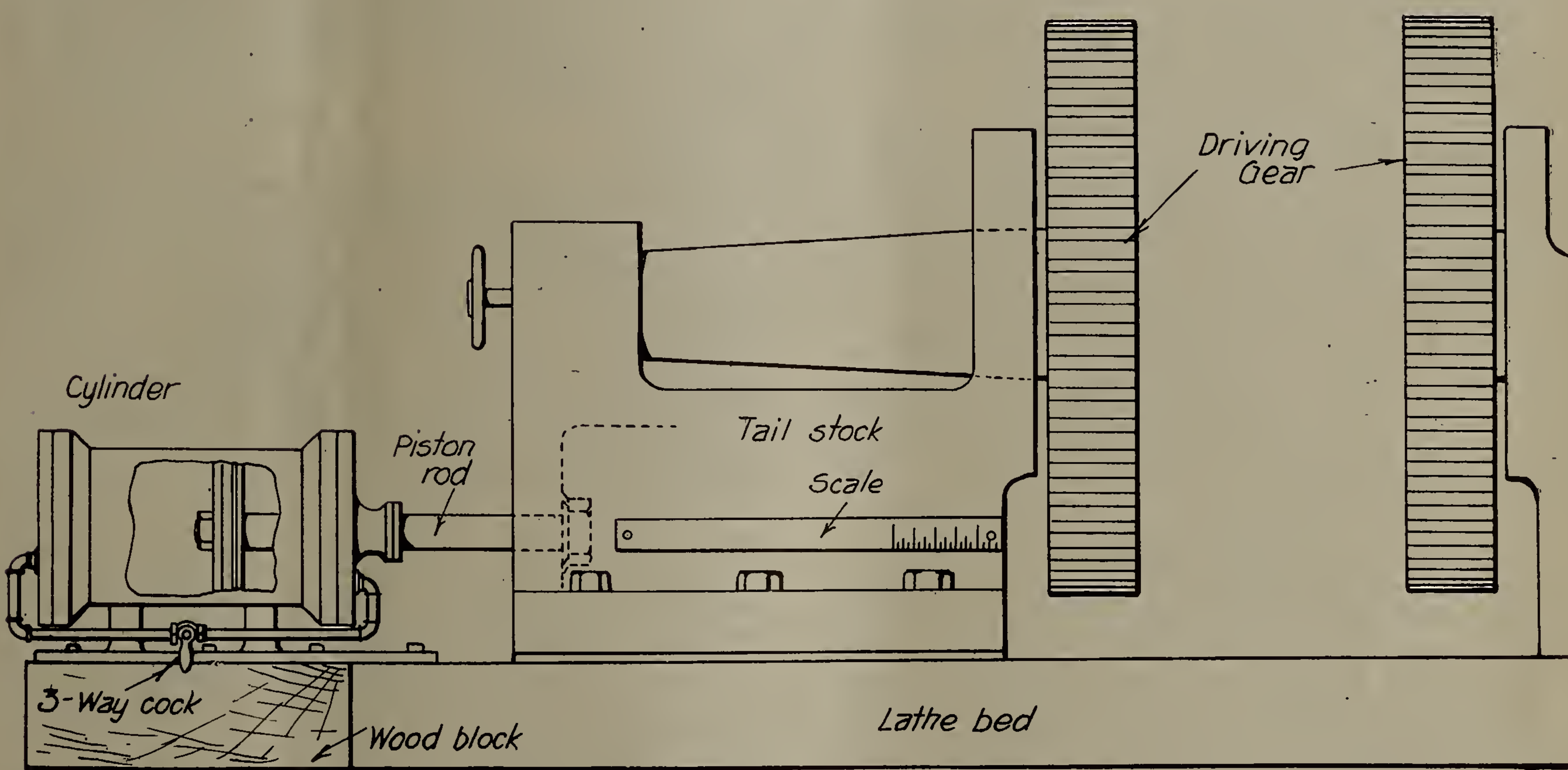
About Feb. 1st, 1910, we installed a new 42-inch Putman Coach wheel lathe, at Jackson St. shops, and as usual great things were expected of it. A record of 22 pairs of wheels in 10 hours was claimed for the machine by the Putman people. But this was impossible, owing to the fact that northern roads brake their trains harder in the mountainous district than eastern and southern roads do on level track. There isn't any steel outside of the 20th Century Mushet that will go through the nigger heads, caused by this heavy breaking. Furthermore, we didn't have any of this high duty steel, and it was a problem for me to solve, how I was going to increase the output over our old lathes.

I started the machine up and managed to turn 7 pairs in 10 hours. This, however, was not satisfactory to me. So I looked about for a remedy. The first thing that came to my attention was the length of time spent in changing the wheels in and out of the machine. The Putman people had a hand rigging to move the tailstock back and forth. This consisted of a gear, a gear rack and a long lever. The time consumed in racking the tailstock back and forth with this device was usually 10 or 12 minutes for the wheels from floor to floor. At the same time it was very laborious.

This time, I knew, would have to be cut down if we wished to increase the daily output. So I got up an air cylinder and applied it in the following manner, as shown in the sketch herewith: I set the air cylinder on a wood block, about even with the base of the tailstock, that being the most convenient place to operate it, then piped it from both ends using a 3-way cock for admission and release of air, this making it double acting. I then removed the hand device that the Putman people had furnished for this purpose and I am pleased to state that we haven't needed it since, as the air traverse is giving every satisfaction both in point of service and time spent in changing.

The repairs on this lathe have been absolutely nothing since the application of the device described and we have cut the time down to two minutes for changing, and increased the output to 12 or 13 pairs in 9 hours.

In addition to this I made a scale forty-eight inches long graduating it for a distance of 24 inches for the operator to use when setting his calipers.



Device Used for an Air Traverse.

NICKELIZED CASTINGS A DISCOVERY IN METALLURGY.

By Robert C. Totten.

In the last fifty years there has been little improvement in the quality of a cast iron mixture. Millions of dollars have been spent in improving the quality of wrought iron and steel, but comparatively little has been done to improve the quality of cast iron. In fact, fifty years ago when nothing but cold blast charcoal iron was used, castings for rolling mill machinery, cannon and car wheels were stronger than they are today, and in the case of chilled rolls and car wheels were more durable.

This is the present situation with reference to the mixtures of cast iron, at the very time when ten times as much tonnage is required from rolling mills, and five times as much burden placed on car wheels as 20 years ago. It accounts for the increasing demand for steel castings, although in many respects they are not so well adapted for machinery purposes. No one would think of substituting a steel roll for a chilled iron roll for rolling sheet iron or hoop iron, and the same will prove to be the case with the rolled or forged steel car wheel. A steel wheel can never satisfactorily take the place of the chilled iron wheel.

Recognizing that with all the care and money expended in the selection of the best pig irons and scrap available for present cast iron mixtures, even with the assistance of analytical chemists, the limit of improvement has been reached, and believing that no improvement is possible except by adding something new to the present mixtures, the writer has been experimenting with nickel in cast iron, and with very remarkable results; so much so that he makes the broad claim of having produced a new metal that can be said to be half way between cast iron and wrought iron and yet in no sense malleable. It possesses the peculiar property of uniting in cast iron both tensile and transverse strength to the greatest degree. Heretofore, the only way of increasing the tensile strength of cast iron was to remelt it. When the writer made cannon for the U. S. Government fifty years ago at the Fort Pitt Foundry in Pittsburgh, under the supervision of such well known names as Major Wm. Wade and Lieutenant Rodman of the Army, and Admiral Dahlgren of the Navy, nothing but charcoal iron was used. The tensile strength of this iron in the pig, was about 20,000 to 22,000 lbs. To increase it the iron was melted in an air furnace and then cast into pigs. This remelted iron ran up to 25,000 lbs. tensile strength, and when remelted and cast into cannon, increased to 30,000 to 33,000 lbs. But as it increased in tensile strength it also increased in brittleness, and the cannon that showed the greatest tensile strength broke the quickest under the shock of the powder used in the charge.

The writer was very much surprised in pursuing his experiments to find that a prominent railroad that manufactures its own wheels did not take any account of the tensile strength in the mixtures it used, and relied entirely on its transverse tests, that is, the ability to stand the shocks of a crossing or the effect of a curve. Without knowing the reason for it, they were following the best practice for producing a good car wheel with an ordinary cast iron mixture, and were satisfied with 8,600 as a transverse test.

Until the writer produced it in his experiments with nickel, there never was a piece of cast iron made that combined high tensile strength with high transverse strength, which is of course what is required to meet the exigencies of modern rolling mill and railroad demands. That is in an ordinary mixture of cast iron, when the tensile strength is high the transverse is low and vice versa. The nickelized mixture has both.

In these experiments the tensile strength of a car wheel mixture has been increased from 26,800 pounds to 43,698 pounds per square inch, approximating wrought iron, which is put down in scientific books at 50,000 pounds per square inch, and at the same time the transverse strength went beyond the limit of the 10,000 pounds that the testing machine was built to register. That is, it did not break at 10,000.

Another evidence of increased transverse strength was manifested in the results under what is known as the Lobdell Car Wheel Co. "drop flange test." A weight of 21 pounds, falling 12 feet, is allowed to strike the inside of a car wheel flange, giving practically, but in a more perfect way, the same result as if a sledge hammer was used. The nickelized car wheel stood 36 blows, while a Standard chilled car wheel made from a good mixture, broke at 5 blows.

It has been demonstrated that the nickel goes into the chilled surface of the roll or car wheel and so modifies it, as to prevent the chilled surface from fire cracking under the heat of rolling, or the sliding caused by the brake shoe. In the case of a hammer die for breaking down heavy billets, no fire cracks developed in twelve months' use, and in the case of a large sheet roll used for making black plates for tinning, no fire cracks were developed in rolling 400 tons.

These are important discoveries, and place nickelized castings in the rank of a new metal, with great possibilities for usefulness. Nickelized chilled car wheels have been in use for eighteen months and have proven their ability to endure all the work required of a rolled or forged steel wheel.

Nickel makes an expensive alloy, but when used in connection with a mixture for cast iron containing an excess of combined carbon like scrap chilled rolls or scrap chilled car wheels, it only requires 14 pounds per 2,000 pounds to obtain the effects we have stated. The nickel required in a mixture for steel axles for instance, requires 70 pounds, and the cost would be $28 per ton owing to the small amount of carbon present which would be prohibitive in a cast iron mixture, but 14 pounds per ton only adds $5.60, a very moderate addition to the cost when such valuable results are derived from its use. Then too, the nickel unlike titantium and venadium, remains in the scrap roll or car wheel and is just as valuable for recasting as when it was new.

As the nickel melts at 500 degrees above cast iron, it cannot be used in its pure state, but must be introduced into the cupola or air furnace in the shape of an alloy composed of old car wheels with a proportion of steel. When handled in this shape there is no change in foundry practice whatever, as the alloy in the shape of small ingots is placed in suitable quantities in each charge and melts readily in an ordinary cupola or air furnace.

It has been demonstrated that it has great resiliency, that is, ability to recover itself after a shock, and it is claimed that is has a lower co-efficient of expansion than any other alloy known. When its merits are generally known, it will rapidly take the place of all cast iron mixtures where wear is desired in combination with strength.

It is especially desirable for locomotive cylinders, giving a finer grain and a greater wearing surface. Also for railroad journal boxes and brake shoes. It is a well known principle in mechanics that two surfaces of the same kind give the greatest friction, and a nickel-chrome brake shoe which approaches the hardness of a chilled wheel surface, would give the best breaking results, and at the same time last longer.

PORTABLE OIL BURNER.

A portable oil burner for firing locomotives is shown in the accompanying illustration. This oil burning apparatus is complete but very simple in construction. The piping is the only difficult feature. Two designs of a burner proper are shown. One is used in ordinary firing up of locomotives, the other is to be used for special cases when it is necessary to secure a short and hot flame.

We are indebted to M. J. McCarthy, superintendent of the Beech grove shops of the "Big Four," for the drawing.

A SUCCESSFUL AIR AND STEAM CONNECTOR.

By Jos. V. Robinson.

Mr. Willis C. Squire, of Chicago, a consulting engineer who, by his close study of railway equipment has become an authority, in a paper recently read before the Western Railway Club, of Chicago, laid down features, which in his judgment, were essentials for any automatic air connector that would prove efficient.

The Robinson coupler has been designed to satisfy all these requirements.

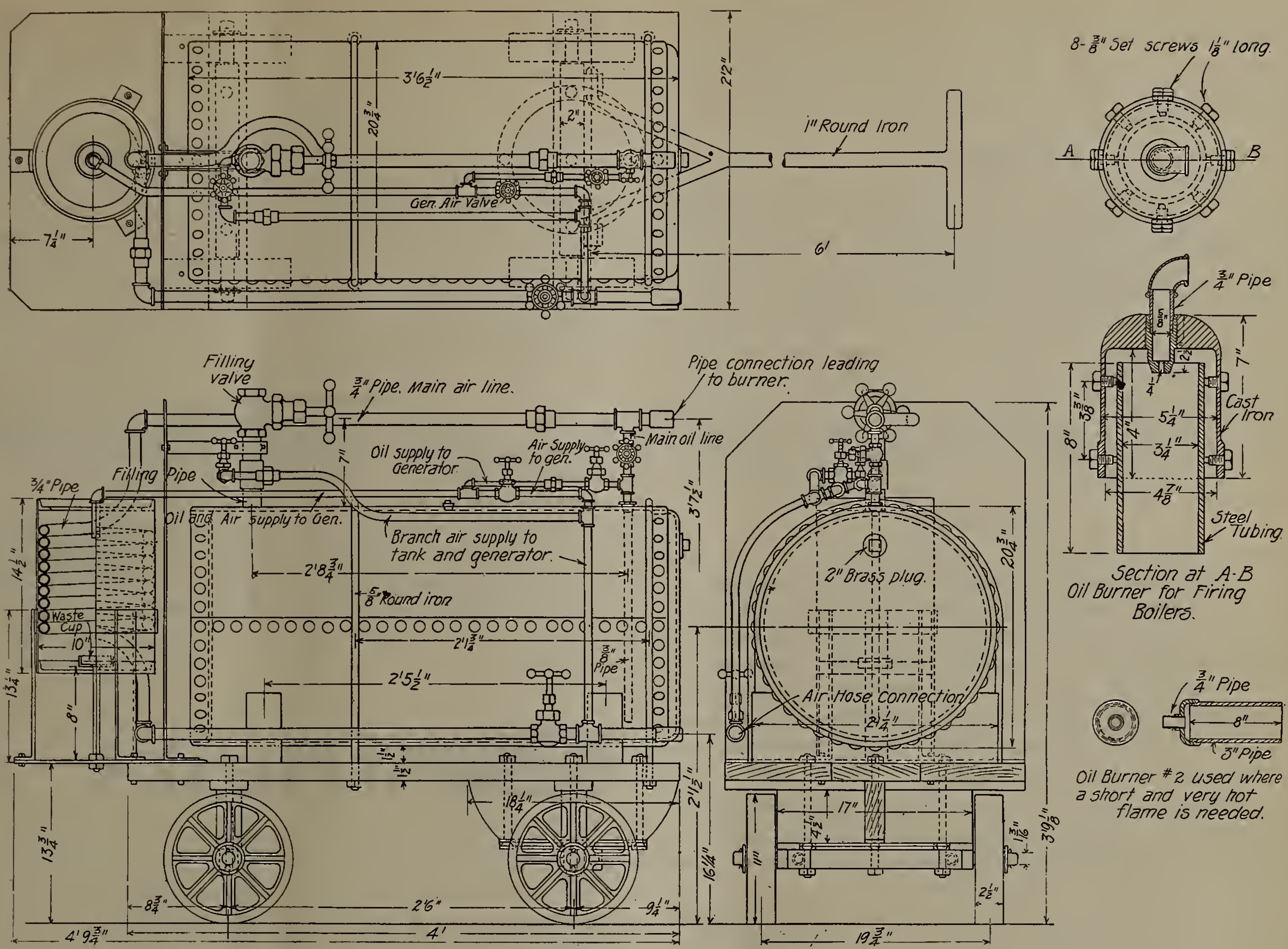
As shown in the drawing, the Robinson connector is supported in normal coupling position solely by a tapered buffer spring having the metal of its coils gradually decreasing in thickness towards its apex, and positively secured at its apex and base to the head and support respectively, the head being provided with integral diverging tubular members for convenient attachment of hose. The connector is thus yielding supported for universal movement from its normal coupling position, in a manner presenting a minimum resilient resistance upon initial engagement of the guides or heads, and a rapidly increasing resistance upon their continued movement to the coupled and interlocked position. Thereby eliminating the distorting, battering, and deteriorating tendencies due to "jamming", etc., found to occur in coupling operations; minimizing the strain to which the guides are subjected (especially in freight service); presenting a flexible oscillation and expediting the maintenance or perfect coupling under all practical conditions.

The connector head is mounted slidably, for universal movement, in a flared socket of the one-piece supporting bracket to which the base coil of the spring is rigidly secured in a manner eliminating distortion and unequal localization of stresses upon the several supporting coils, and is provided with an approved form of collectors, or guides, which set at points diagonally across the face as shown.

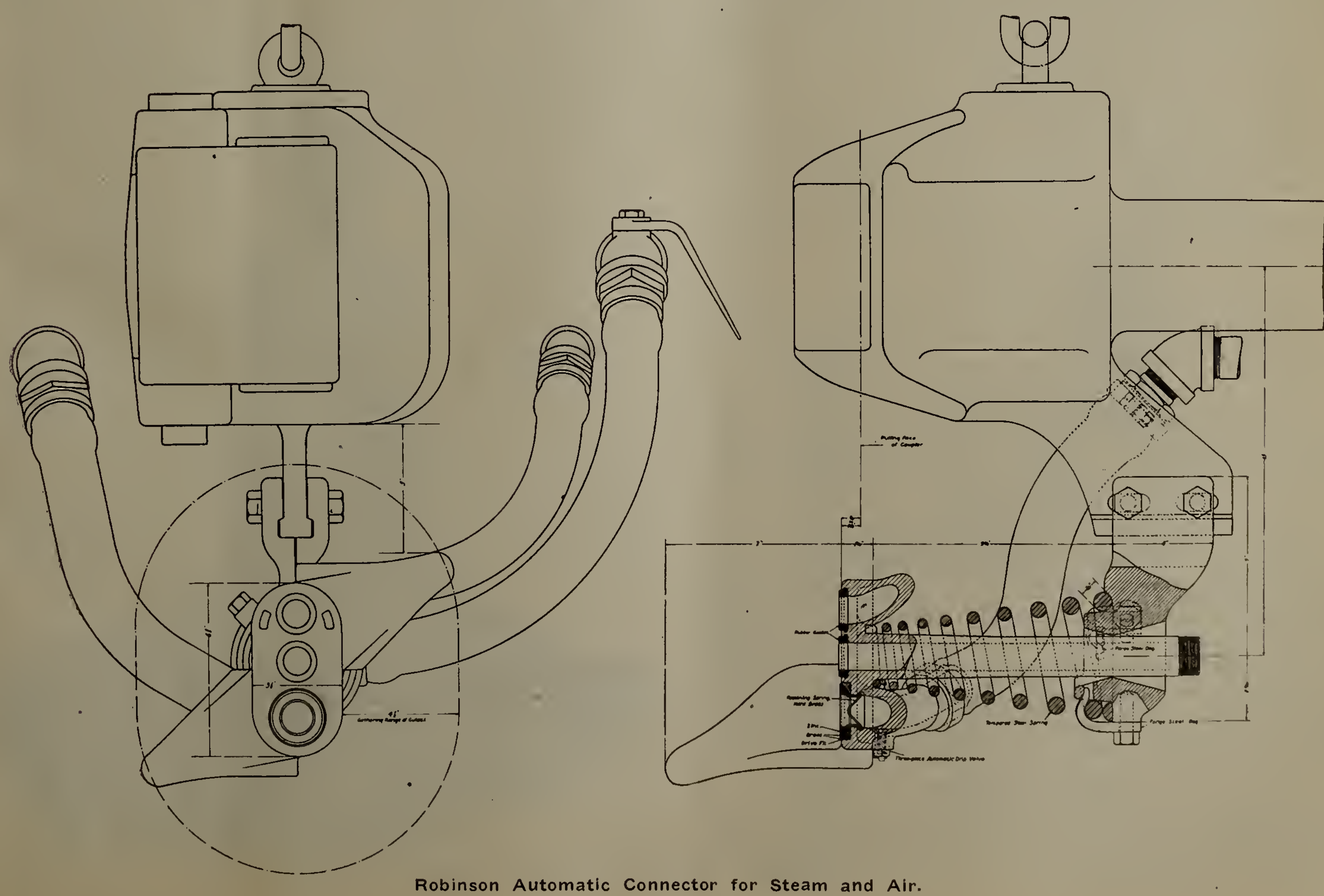
The steam-heat seat forms one of the three bearing points of the coupler faces assigned to preserve the resiliency of the gaskets and prevent foreign substances interfering with a perfect coupling. The seat is free from threads and pivotally mounted for accommodating itself to any angle that might develop between the faces. All gaskets can be removed and replaced by hand without separating the cars, and no part of the coupler is affected by climatic conditions.

The Head.

The head, guides, and pipe connections are made in one powerful, simple casting of considerably less face area and greater strength than obtained in automatic air and steam hose connectors designed up to this time. The integral tubular members diverge rearwardly and angularly to the axle plane of the spring in a manner bringing the face openings of the ports nearest the head's center, and within a radius practically coverable by the outside diameter of the base



Portable Oil Burner for Firing Locomotives.



Robinson Automatic Connector for Steam and Air.

spring coil, thereby reducing the degree of surfaces exposed to the distorting tendency of buffing cars, keeping down the weight, and bringing the connector nearest the draw-bar for efficient operation with minimum stress and vibration on the supporting means and other members as a whole.

The Spring.

The special advantages of the spring lie more particularly in the taper of the metal from which it is coiled. By this new construction a graduated distribution of resilient resistance is obtained which affords a cushion so to speak to ease the shock and strain of first impact, but that multiplies rapidly as the heads seek their coupled and interlocked position. The efficiency of the spring for reducing the "jamming" tendencies of coupling on a sharp curve and insuring a flexible oscillation thereby easing the alignment of the heads and increasing the life of the connector as a whole, highly commends its use. It is so constructed and supported as to insure absolute freedom from the danger of a permanent set.

The Bracket.

The supporting bracket is a single casting provided with a flared socket in which the connector head is mounted slidably for universal oscillation, and has a special seat in which the base coil of the buffer spring is rigidly secured against distorting tendencies in a manner permitting ready movement of the connector head in any direction, resisted only by the spring's varying force which always returns the same to normal coupling position when stress is relieved.

The Guides.

The gathering range of the guides encompasses an area greater than coverable by the draw-bar; they are curved to afford the greatest strength and gathering effect where most needed, and as shown, sets at points diagonally across the face of the heads and extended forwardly thereto a short distance forming a socket in which the opposing head seats itself firmly against angular movement, with respect to the other head. Destructive battering upon initial engagement is thus avoided and all ports under all conditions are kept at a true bearing.

Ports.

These are of the straight port type which mean the elimination of all avoidable friction, and permit an unobstructed flow of air and steam through virtually straight conductors, unbroken by excessive angles or curves. The hose are attached direct without the use of threads, thereby eliminating machine work and increasing efficiency by simplification.

Spring Dogs.

These are drop forged from steel and rigidly secure the base coil of the buffer spring within its seat of bracket in the manner shown, and to the back of the connector head.

Gaskets.

These are of the same general configuration as those used in ordinary hand hose couplings but of greater dimensions. The air-brake and air-signal gaskets are interchangeable.

Interchange.

Means have been provided whereby the Robinson coupler is capable of easy and reliable interchange with any car fitted with the present hand-type of coupling. Short sections of hose, with nipples, are attached to the tubular connections and in turn coupled to the present hand hose attachments. This produces a simple and flexible joint which is free from possible leakage due to abrupt movement of the connector heads when cars are in motion, and does not, in the slightest degree, impair the efficiency of either device.

Pipe Connections.

Rubber hose or metal pipes with any well-known form of flexible joints may be used to connect the coupler with the air-brake pipes. The former, however, are subjected to much less bending and jerking when used with the connector than when employed in hand coupling, and the corresponding increase in life renders them the most desirable form of connection.

Installing.

No change is required in any car to receive the Robinson coupler. A simple lug attached to the draw-bar and the connector is ready for service. It operates in less area than any connector designed, eliminating the necessity of changing the location of the pipes, rods, etc., surrounding the draw-bar, and owing to the new form of construction and support is particularly adapted for freight service. It has but one thread; two movable parts; the powerful, simple "head" casting, the new special spring.

Future Requirements.

In designing the Robinson connector future requirements, so far as can be safely predicted at this time, have not been overlooked. Special arrangements have been made for electrical connection or interchange between steam roads and electrically operated interurban lines, and the application of the special provisions can be readily made without alteration of the connector head, as herewith illustrated, requiring only an ordinary wrench and a few moments to make the addition. The device is manufactured by the Robinson Coupler Co., Washington, D. C.

New Books

KENT'S MECHANICAL ENGINEERS' POCKET-BOOK. By William Kent; 1461 pages, morocco, 4¼ x 7; 8th edition; published by John Wiley & Sons, New York (London, Chapman & Hall). Price $5.00 net.

No student of mechanical problems is unfamiliar with and unsupplied with a copy of this authoritative reference work. A review of the book itself is therefore unnecessary. The headings under which are included the more important of the changes are: Mathematics, Strength of Materials, Alloys, Iron and Steel, Malleable Cast Iron, Steel, Heat, Heating and Ventilating, Water, Steam Engines, Machine Shops, and Electrical Engineering. It appears, by actual measurement, that of the 1416 pages of text in the new book, not including table of contents and index, 485 pages are new matter, while the text is increased only 326 pages as compared with the old book. This indicates that 159 pages of the old book were abandoned, but this is not exactly the case, for part of the 159 pages represents space saved by condensation of formulae and rearrangement of tables. In a very few cases space was lost in the resetting, as indicated by the minus sign in the last column. Fractions of pages were taken account of in the measurement, but are omitted in the table.

Mr. Kent acknowledges the assistance of many manufacturers and engineers and especially that of his son, Robert Thurston Kent, M.E., who has done the work of revising manufacturers' tables of materials and has done practically all of the revising of the subjects of Compressed Air, Fans and Blowers, Hoisting and Conveying, and Machine Shop.

Personals

F. H. Murray has recently been appointed a master mechanic of the Erie R. R. with office at Port Jervis, N. J.

L. L. Wood, formerly general shop foreman of the Evansville & Terre Haute and the Evansville & Indianapolis, has been appointed superintendent of motive power with office at Evansville, Ind., succeeding G. H. Bussing, who resigned some time ago.

C. L. McIlvaine was recently appointed assistant engineer of motive power of the Erie division of the Pennsylvania R. R. with office at Williamsport, Pa.

H. S. Bryan, superintendent of motive power of the Duluth & Iron Range R. R., died October 2nd at Rochester, Minn.

Garret Vliet has been appointed master mechanic of the Grand Trunk Ry. at Battle Creek, Mich., vice W. Hamilton, resigned.

W. H. Evans succeeds R. C. Taylor as superintendent of motive power of the Indiana Union Traction Company.

W. E. Looney has been appointed general foreman of the car department of the Iowa Central Ry. at Marshalltown, Ia., to succeed W. H. Samuels.

J. E. Muhlfeld has been appointed vice-president and general manager of the Kansas City Southern Ry. in charge of the transportation, engineering and purchasing departments.

W. H. Erskine has been appointed general foreman of the Minneapolis & St. Louis R. R., vice A. H. Cairns.

G. W. Lillie has been appointed an assistant superintendent of the Idaho division of the Oregon Short Line at Pocatello and will have charge of mechanical matters on the division as well as supervision over the Pocatello shops and roundhouse.

Among The Manufacturers

New Literature

"The Difference between Albeco Laminated and Multi-Lap Leather Belting" is the title of a booklet being distributed by the American Laminated Belting Co., 113 Hudson St., New York. This booklet is especially interesting in that it gives close comparisons of the operating principles, power transmitting qualities and ultimate economy of both types of belting.

The North Western Expanded Metal Co. of Chicago has issued a booklet of designing data for the reinforcing of concrete culverts, sewers and bridges. It contains much of interest and value for one engaged in this work.

The Carnegie Steel Co. of Pittsburg has issued a pamphlet of the standard specifications for various sorts of steel, axles and wheels. It is divided into sections and is arranged for easy reference.

Allis-Chalmers Co. of Milwaukee, Wis., has issued two leaflets on the respective subjects of "Clutch Economy" and "Transformers for the Central Station." They take up briefly the strong points of the Allis-Chalmers clutches and transformers.

The 1910 loose-leaf catalogue of the Osborne High Pressure Joint & Valve Co. of Chicago is off the press and is descriptive of the products suggested in the firm name. Two of the special features are a protected valve seat and a pipe joint of such construction that it allows the engineer to stop leaks without shutting down.

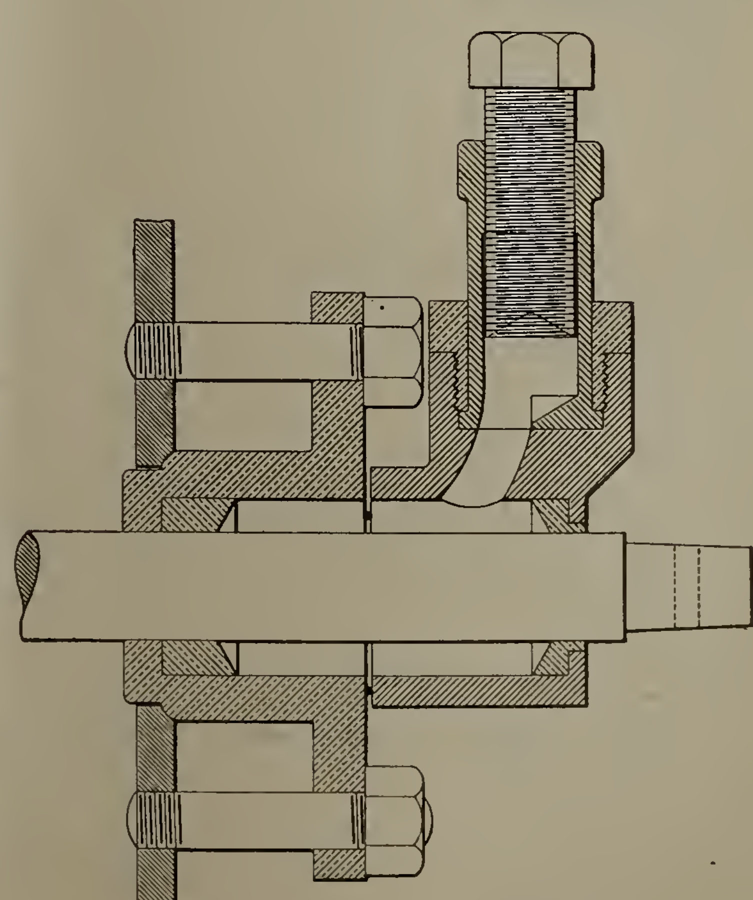
"Emery Wheel Machinery" is the title of a catalogue recently issued by Joseph T. Ryerson & Son, of Chicago, and as usual with Ryerson publications, it takes up its subject in a clean-cut, concise manner.

D. & L. THROTTLE ROD STUFFING BOX AND PLASTIC PACKING.

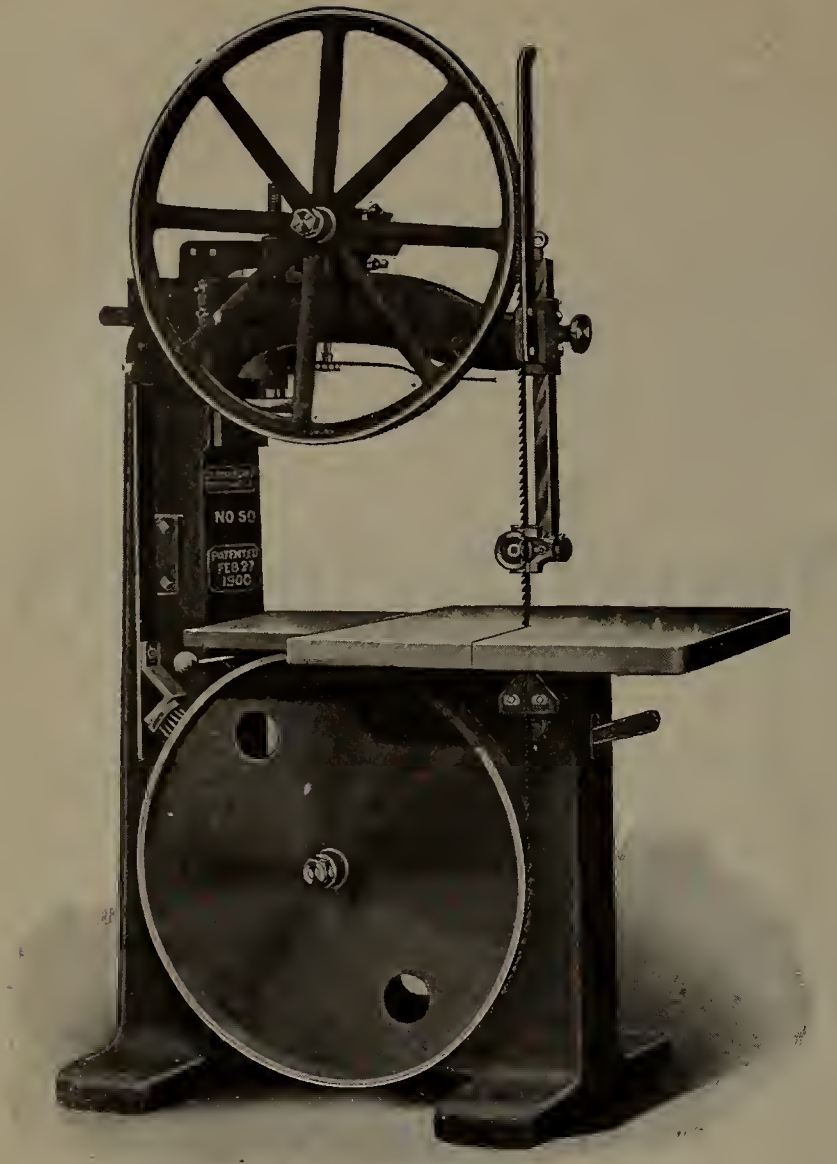
The accompanying illustrations show a new design of throttle rod stuffing box, with which a plastic packing is used.

It is claimed that this plastic packing, as used in this stuffing box, is leak proof, and that the box can be repacked when the boiler is carrying a full head of steam. When applied for the first time, however, the engine should be dead. Reference to the illustrations show that a brass nut is screwed down after the storage chamber is put in place. This chamber is held in

D. & L. Stuffing Box.



Cross-Section of D. & L. Stuffing Box.



Fay & Egan Band Scroll Saw.

position by the shoulder, and is made a snug turning fit with the nut. A port in the bottom of the chamber may be made to coincide with the port in the main casting, or, by giving the chamber a half turn, the port is closed. When packing for the first time, the port is turned to the open position and the packing forced in by aid of the plunger. About four tubes are required to fill the stuffing box.

In repacking, it is necessary first to close the port in the storage chamber so as to prevent any escape of steam. The chamber is then filled, the plunger replaced, after which the port is opened and the packing forced in by screwing down on the plunger. It is suggested that about a teaspoonful of valve oil should be added with each stick of new packing and that the packing should be oiled about once a month to assure an easy working rod.

The stuffing box conforms in design to those generally used, so that replacement is easily accomplished. For new or old power with throttle rigging of odd design, the D. & L. stuffing box can be especially made.

Following are claims made for this stuffing box and packing:

Adaptability to old as well as new power without any change in throttle rod or connections.

Saving of time required to pack throttle, both in labor and by retaining the engine in service. The engineer can carry packing in the seat box and pack throttle when necessary.

Throttle handles operate 50 per cent easier than with other throttle packings.

Long life of packing due to thorough lubrication.

Minimum wear upon throttle rod.

The complete avoidance of delays to motive power caused by an occasional oversight of the condition of the throttle packing.

One size packing for all size throttle rods.

This stuffing box and packing is sold by the Union Machine Company, St. Paul, Minn.

NEW PATTERN SHOP BAND SAW.

The pattern shop tool shown in the illustration is manufactured by J. A. Fay & Egan Co., 145-165 W. Front St., Cincinnati, Ohio. The fact that the manufacturers designed this band scroll saw for use in shops having a considerable amount of plain or intricate scroll sawing to do, makes it especially adapted to the pattern shop where this kind of work is turned out daily. For pattern shop work, the manufacturer arranges the table with a tilting device having micrometer adjustment, which enables the operator to instantly adjust the table to any angle up to 45 degrees to the right and 10 degrees to the left. This device is said to combine quick and accurate angling of the table which will be found of great important to the pattern maker.

The most important feature in the construction of this machine is the straining device which is known as a knife-edge balance. The upper wheel is hung solely on a knife-edge, and the tension on the blade is given by a compound lever arrangement. This is an excellent device for straining the blade. Its action under all conditions is instantaneous, it enables the machine to run at a high rate, with no danger of breaking the blade, no matter how fine it is.

AN EFFICIENT SAND DRYER.

An interesting and efficient sand dryer has recently been placed on the market by the Thomas W. Pangborn Company, 90 West St., New York. The illustration, herewith, shows clearly the construction of the device. The wet sand is shoveled into the hopper and is supported by the cone-shaped screen. As the sand dries, it falls through the perforations to the floor.

To secure greatest fuel economy the inside of the firebox is constructed with a number of concentric rings projecting toward the fire and radial ribs on the outside radiate the heat under the perforated screen. As the sand is supported at all times away from the firebox, coming in contact only with the heated air, it is impossible to burn the sand, even with the firebox red hot. This fact will at once demonstrate the greater rapidity with which sand can be dried by bringing the firebox to a higher heat than is allowed by some other

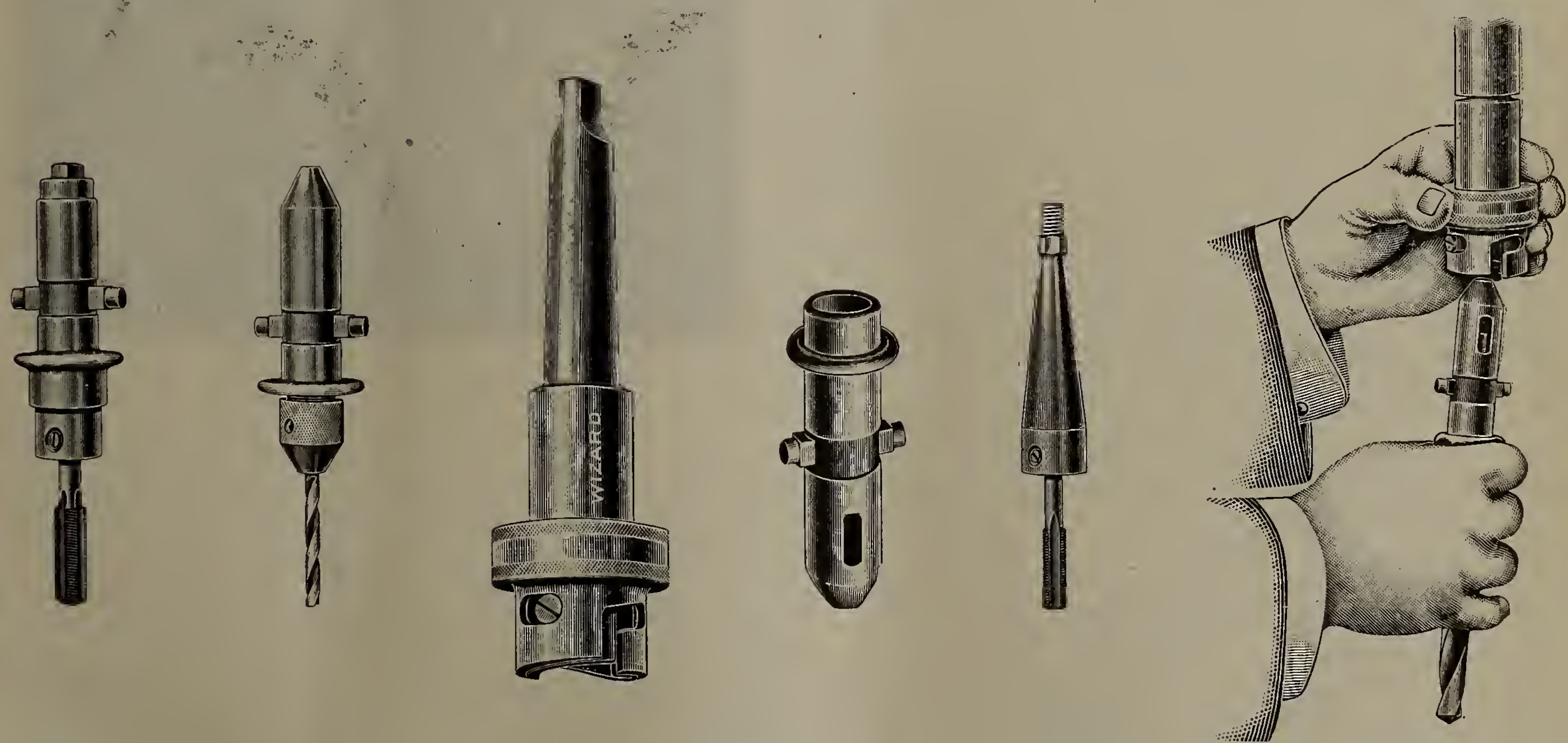
Pangborn Sand Dryer.

constructions. The heat being transmitted to the sand without contact with solid surfaces, prevents it baking or caking. Small doors in the hopper allow for readily removing material that will not pass through the perforated screen.

The dryer stands 4 feet from floor to top of hopper. The hopper is 4 feet in diameter at the top, 37 inches at the bottom. The base is 30 inches in diameter; height from floor to top of firebox, 18 inches. The outfit weighs 1,400 pounds.

QUICK CHANGE DRILL CHUCK.

An interesting device for making possible and practicable the use of different sizes and kinds of tools in drill presses and lathes is manufactured by the McCrosky Reamer Co., Meadville, Pa. The accompanying illustrations plainly show the details and method of use. The "Wizard" chuck operates in a simple way. A slight resistance to the outside collar with the hand while the spindle is in motion overcomes the tension of the spiral spring within and throws the key slot in the chuck open so that the collet will either fall out or slip into the slot. The spring then throws the collar back to closed position, closing the key slot and securely locking the collet in place. Thus a touch to the collar releases one tool and another tool is inserted with another touch. The motion of the spindle itself does the work.



Wizard Chucks and Collets, Showing Methods of Use.

The outfit consists of the stand, chuck and one collet for each tool in the series of operations. The collets and their uses are also evident by reference to the illustrations. The collets can be ordered already fitted for any size straight or special shank, such as taps, straight shank drills, etc. The method of driving straight shanks in such collets is very simple and powerful.

THE CHICAGO CAR DOOR.

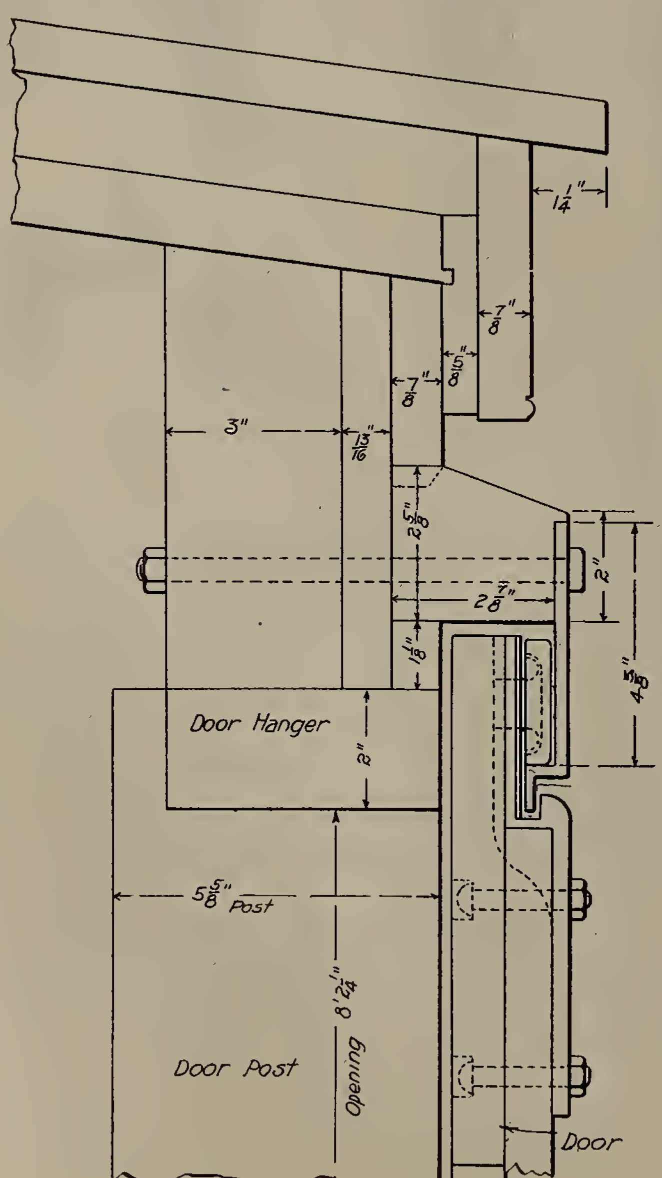
A decided advance in the construction of freight car doors is exemplified in a new door just now being put on the market by the Chicago Grain Door Co., 931 Monadnock Block, Chicago. In general, the design may be said to embody the advantages of the flush door with the greater simplicity of construction possible in the outside door. The principal features are a construction of the track and trolley such as to make the door inseparable from the car except in a complete wreck, and to afford a complete protection, without the use of a hood, against the entrance of rain, snow or sparks at the top of the door. Minor features of construction provide similar protection at the side and bottom; for the effective stopping of the movement of the door both in opening and closing; for the wedging of the door in either open or closed position; and for an unusual degree of strength in the fastenings of the guide and stop brackets at the bottom. The entire construction is characterized by great simplicity and ease of repair, while in case of breakage of an important part, the trolley, for instance, the door is still supported in operative position and cannot swing loose from the car at any point. The door overlaps the entire opening three inches at the top and is itself overlapped for the same distance by the sheet metal trolley track which forms an effective hood. At the bottom, the door is flush with the lower edge of the siding and affords no opportunity for sparks to strike the siding below the door and be drawn by suction through the crack into the car in case of the door bulging.

The trolley track is an L-shaped strip of steel bolted through a 3-inch block or filling piece and the siding to the plate of the car and depending therefrom about the same distance. The short arm of the L turns inwardly and forms the tread on which the trolley runs. From the extremity of this arm is a downward lip of about ¾ inch in width which, in connection with corresponding lips on the trolley hangers, constitutes the interlocking feature, as will be explained later. There is thus formed a recess between the trolley track and the door header open only downwardly and closed at both ends by stop blocks into which the door extends for about 3 inches, affording a complete weatherproof and spark-proof seal along the entire upper edge of the door opening and serving effectively the end sought to be secured by the use of an extra hood. The latter, aside from being an extra expense, is usually of a less substantial construction than the body of the car and is liable to be ripped off because of its projection beyond the line of the fascia and eaves.

The trolley wheel and hanger are both of novel construction. As is shown clearly in the accompanying illustractions, the fastening of the hanger is made to constitute the slightest possible projecion from the surface of the door, as the strengthening ribs are upon the inside face of the bracket, let into the material of the door and extending into the recess above described between the trolley rail and the door header. At the top of the door hanger the hanger is offset to an amount a little less than the thickness of the siding and in this offset is formed a groove into which the depending lip of the trolley rail is received when the door is in place, forming the interlocking feature above mentioned. The offset in the track underneath the tread, the trolley and the top of the door itself all serve as stops to prevent the door from being raised so as to be thrown from its bottom guides.

On the outer face of the upper part of the hanger there is an annular bearing for the trolley sheave, formed by a boss cast on the hanger and with a slightly tapering hole to receive the stem of the trolley sheave. The latter is a plain cast sheave with a projecting stem upon one side tapered to fit loosely the hole in the hanger and having a wearing button upon the other side to reduce the friction of contact with the vertical part of the trolley rail. Around the base of the stem in the inner face of the sheave is a circular groove corresponding with the circular projection on the face of the hanger and into which the latter is received when the sheave is in place. There is thus a double bearing between the sheave and the hanger, and because of the great relative area of bearing surface and the looseness of fit made possible by this construction, no machining is required upon either part and the sheave may be so solid that there is no reasonable probability of breakage. The circular boss upon the hanger, however, serves another purpose. The thickness of the hanger, including the height of the boss, and of the door batten to which it is secured, is greater than the width of the opening between the trolley rail and the door header. In case of breakage of the trolley sheave, the door can only settle until the circular boss strikes the tread of the track—about a half inch—and the boss will then serve as a temporary substitute for the trolley sheave without interfering seriously with the operation of the door. A new sheave may be inserted by simply sliding the door beyond the end of the track and dropping it into place.

Chicago Car Door—Details of Hangers.



Chicago Car Door.

It is apparent that a door having this form of trolley and track cannot be hung or unhung except by removing the stop block and sliding in or out from the end of the track. This is incidental to a construction which makes the door and its supports permanent parts of the car. The strength and freedom from liability to accidental dismounting or dislocation of doors is measured definitely by the strength of the trolley rail and its fastening and these can be made as substantial as any part of the car body.

There are features of considerable importance in the mounting of the door at the bottom and the protection at the sides. The door extends down so that the lower edge is flush with the car siding, as has been said. The shunting stop brackets at each end of the run and the guide bracket between, are all bolted directly through the sill of the car with two bolts and safety lag screw. These stops are duplicates except that one is the reverse of the other. The construction enables the use of a short bracket which affords only small leverage against attempts to pry the door open from the bottom and the opening of the crack between the door and the car body is about seven inches below the level of the floor. It is, therefore, a practical impossibility for sparks to be sucked into the car through this opening even though the door has bulged, since the stronger suction is always under the car rather than into it.

The intermediate guide bracket has a curved bearing surface toward the door and acts as a guide toward the body whether the door is opening or closing. The shunting stop brackets at the ends of the run have guiding surfaces inclined toward the car according to the direction of movement of the door, and the stop is inclined at right angles to the guide bearing. The wedge attached to the door has corresponding inclinations and a rounded nose between the inclined sides. The effect in opening or closing is for the door, through its wedge, to deliver a slightly glancing blow upon the two inclinations in succession, one blow acting against the other and relieving the shock, though still retaining the door close against the side of the car. One important result of this construction is that the wooden spark protection strip at the front edge of the door opening to which the hasp is attached is not struck by the door however violently it may be closed. When this strip is in position to act as a partrial stop to the closing door, not only is its usefulness as a protection interfered with by its being driven away from the opening it is intended to cover, but the hasp is thrown out of position to such an extent as to make it impossible to fasten the door.

The weather and spark protection at the rear edge of the door is by a plate attached to the door post and projecting about one inch beyond the side of the post, and an angle shoe on the edge of the door with rounded projecting leg which engages in the recess behind the door post plate when the door is closed. This also serves as a door stiffener. With the exception of the trolley track and the protection strips the entire construction is of malleable iron and requires no machining.

Industrial Notes

The Ford & Johnson Co. have recently received, among other orders, a contract to equip with seats 25 cars of the Erie R. R., which are building in the Wilmington shops of the American Car & Foundry Co. This company has also received an order for the equipment of 50 cars of the New York, New Haven & Hartford R. R., being built by Osgood, Bradley Co., of Worcester, Mass.

On November 1st, the firm of Crerar, Adams & Co. removed to their new warehouse and office, 239 to 259 East Erie Street, corner Fairbanks Court. The removal from the corner of Fifth Avenue and South Water Street, which premises have been occupied by them continually since 1858, with the exception of one year following the Chicago fire—takes from that vicinity a firm long recognized as the leader in the distribution of railroad supplies in the United States. Their new warehouse is a large one, absolutely fireproof, equipped with every known device for the prompt handling of supplies and will allow them to carry a very much larger stock for the transaction of their growing business.

The National Bolt & Nut Co., Pittsburg, manufacturers of "National" hot pressed nuts, has awarded contracts for buildings, machinery, etc., for the manufacture of cold punched nuts. Equipment will consist of a 150 h. p. Miller improved gas engine, Pawtucket nut presses, National nut tappers, machine shop tools, etc. This plant now has a capacity of 75,000 kegs "National" hot pressed nuts annually and the new improvement will make it the largest nut works in Pittsburg.

The T. H. Symington Co., of Baltimore, Md., has moved its Chicago offices from the Railway Exchange to Suite 623-625 Peoples Gas building. The Symington company, in addition to handling journal boxes, center and side bearings and other products, also manufactures and sells the Farlow draft gear.

The American Locomotive Co. is reported to be preparing plans for the construction of a new power plant and special equipment for its works on the lower north side of Pittsburg. It is proposed to equip the plant, as far as possible, for electric motor drive. The estimated cost is about $500,000.

Mr. George Bell has severed connection with the Westinghouse Electric & Manufacturing Company to accept the position of general manager of the Shelby County Water, Gas & Electric Company, of Shelbyville, Ind. Mr. Bell was with the Westinghouse company for about nine years. He took up his new duties November 1.

The new wire and rod mill of the American Steel & Wire Co. now under construction near Corey, Ala., will be 480x 1,600 feet. It is estimated that when completed it will be operated by electricity, and have a daily capacity of 450 tons of finished product. The plant will cost about $4,000,000.

Mr. W. L. Reid, formerly superintendent of the Brooks plant of the American Locomotive Co., has been appointed general manager of the company with headquarters at Schenectady, N. Y.

The Chicago & Northwestern recently ordered 30 consolidation locomotives equipped with superheaters manufactured by the Locomotive Superheater Co., 30 Church St., New York.

C. H. Peterson, hitherto connected with the Chicago office of the Baldwin Locomotive Works and the Standard Steel Works, has been appointed southwestern representative of these companies, with office at 914 Security Building, St. Louis, Mo. Edward B. Halsey, who has been in charge of the St. Louis office, has been transferred to the sales department of the Philadelphia office.

The Malcom Brake Shoe Co., Charleston, W. Va., has been incorporated to manufacture brake shoes. The incorporators are: C. A. Malcom, of Mindon, W. Va.; T. Mairs, S. B. Avis, Waller Hardy and A. E. Scherr, of Charleston. Capital stock, $25,000.

At the annual stockholders' meeting of the American Locomotive Co., New York, held on October 18, the former directors of the company were re-elected.

The Westinghouse Electric & Manufacturing Co., Pittsburg, Pa., has received from the Boston & Maine a contract for the entire equipment for the electrification of the Hoosac tunnel under the Hoosac Mountain in Massachusetts.

Judge Kohlsaat, of the federal court at Chicago, has issued an injunction restraining the Ryan Car Company and the Lemack Carriers' Company from infringing on patents obtained by Frank X. Mudd, general manager of the Live Poultry Transportation Company, for improvements on poultry cars. The title to the patents is now in the name of the Live Poultry Transportation Company, and bears the number of 539,229. The ascertaining of what damages the defendant companies shall pay to the plaintiff was delegated to James S. Hopkins, as master in chancery.

The Rostand Mfg. Co. advises that it has recently completed a factory addition costing $12,000. The foundry and finishing departments are greatly enlarged.

An association of interests in the manufacture and sale of machinery and machine tools has been announced by the Gisholt Machine Company and Joseph T. Ryerson & Son. This announcement is of particular interest as representing the establishment of a relationship which is understood to be intimate between one of the leading machine tool builders and one of the strongest general machinery organizations in the country. In furtherance of the plans formulated by the interests thus combined, extensive additions will be immediately made to the Gisholt plant at Madison, Wisconsin, which will greatly increase the output and scope of that concern and permit of a development which the association of these two concerns would seem to prophesy.

The H. W. Johns-Manville Co., whose main office is at 100 William street, New York, has recently opened new branch offices at Atlanta, Ga., and Rochester, N. Y., for the convenience of its customers and to meet its growing business in those sections. The Atlantic office is located in the Empire building, in charge of Mr. W. H. Johns, who has been traveling in that territory for the company for a number of years, and the Rochester office is located at 725 Chamber of Commerce, in charge of Mr. H. P. Domine, formerly with the

Buffalo branch of the company.

Mr. James E. Miner, who was in charge of the Nathan Manufacturing Co.'s interests in the southern territory of the United States, Mexico and Cuba, died on September 27. He was 67 years old and had been in the employ of the Nathan Company for the past 28 years.

The Westinghouse Electric & Manufacturing Co. has completed plans for building a foundry at Trafford City, Pa., on a site of 70 acres near the foundry of the Westinghouse Machine Co. Work will begin at once. The plant will cost $3,000,000 and will consist of two foundry buildings, a pattern shop, a 6-story pattern storage building of brick, steel and fireproof. Shipping yards, having a complete system of crane runways, will also be constructed, each runway to have two electric cranes.

The Northern Engineering Works, Detroit, Mich., report recent shipments of two 10-ton, 60-ft. span electric traveling cranes to the Detroit Bridge & Steel Works and two 7½-ton cranes to the Lenoir Car Works. The company also reports that, in connection with new additions to its plant, the Kewanee Boiler Co., Kewanee, Ill., are installing four electric traveling Northern cranes. These cranes are of alternating current Northern type "E" design, ranging from 5 to 15 tons and with 55-ft. spans.

The Union Switch & Signal Co. has called a special meeting of the shareholders for December 14 to vote on a proposition to increase the capital stock of the company from $2,-500,000 to $5,000,000, all the new stock to be common. If the proposed increase in stock is approved by the shareholders, a stock dividend of 60 per cent will, it is understood, be declared, which will be distributed pro rata to both common and preferred stockholders. Out of the remaning 40 per cent of the new stock the directors will issue sufficient to increase the working capital and meet the demands of the company from time to time.

The directors of the Westinghouse Machine Co. have called a special meeting of stockholders of the company on December 8 for the purpose of voting on the proposed increase of the indebtedness of the company, and if such an increase is authorized, to approve the execution of bonds or other securities of the company, secured by mortgage or otherwise, "and the sale, exchange, or other disposition of said securities, at such a price upon such terms, and in such manner as the board of directors shall deem proper." In the formal notice of the meeting no mention is made of the amount of the proposed increase in the company's indebtedness.

The Browning Manufacturing Co., Mansfield, Ohio, has been incorporated to manufacture cranes, shovels, etc. The incorporators are L. C. Pelott, Geo. F. Stalley, Jr., and A. S. Meyer, all of Columbus. Capital stock, $200,000.

Report of the Eleventh Annual Convention, of the Chief Interchange Car Inspectors', and Car Foremen's Association of America

The October issue of the Railway Master Mechanic contained the papers read at the eleventh annual convention of the Chief Interchange Car Inspectors' and Car Foremen's Assn. The full report of the proceedings is published below.*

President H. Boutet called the meeting to order on September 6 at 9:30 A. M. and introduced William F. Gude, president of the Chamber of Commerce of Washington, who welcomed the association as follows:

Address of William F. Gude.

Mr. President, Ladies and Gentlemen:—

I was hardly expected to address you this morning, but I want to express my extreme pleasure at seeing so many of you here on so warm a morning. I do not not know whether it is so warm in order to emphasize the good, warm, hearty welcome that the City of Washington wishes to extend to you today. I want to say that the Hon. Cuno H. Rudolph, who is president of the Board of Commissioners of the District of Columbia and acts as a Mayor or Governor, was to be here but unforunately he has been called out of the city to attend a funeral of a near relative in Pennsylvania, and left instructions that if I got back in time that I was to come here and give you a welcome on behalf of the Washington Chamber of Commerce.

You know that our city is differently governed. I say "our city," that includes all of you. We are governed by three commissioners who are appointed by the President of the United States, and they act as our Mayor or our Governor; but we will not go into that.

One of the pleasantest duties of the president of the Chamber of Commerce is to meet the stranger within our gates and persuade him that he is really at home; that as a matter of fact the Capital belongs quite as much to the man from Cincinnati as to the man from Georgetown. You all bear a modest share of the expense of maintaining the parks and building up the capital city of our country and we who live here feel that we are, in a manner accountable to you when you come to look over the property. We trust you will approve of our stewardship and remind the legislator when next you encounter him that the American people deserve the most beautiful capital in the world, and that the said legislator need fear no criticism for generous appropriations for the District of Columbia.

I am told that your convention lasts but three days, so I venture to suggest that you allow yourself about ten days more for sight-seeing, although even that time is too limited to do the city justice. The capitol, the library of Congress, the great departments, the national museum and the other great buildings of the city alone need time to appreciate. Near by, Great Falls, Cabin John, Annapolis, Mt. Vernon and Arlington demand a day each, so you might safely wire home that your visit will be prolonged and that if some one will feed the cat and look out for the canary they need not expect you until the 15th. If you are in need of assistance at any time, you will find our citizens never to hurried to advise and guide you. The Chamber of Commerce is always ready to render help to the stranger and to the city.

In conclusion, let me say that speaking for the city, we are heartily glad to have you with us, we hope that you can stretch the three days into three weeks, and that this convention will be but the first of many of your splendid organization meeting in the capital of the country we are all so proud to claim. I thank you. (Applause.)

President Boutet:—We have with us this morning a man who is more responsible for the meeting being held in Washington than any one else. When I came over in April to see about the convention being held here, I came as a stranger and I visited the hotels. After we got through I was requested to call on Mr. Thomas Grant, secretary of the Chamber of Commerce, and through his influence the meeting was held in this hotel. I think you will agree with me that we are all glad to be here. We would like to hear from Mr. Grant.

Address of Thomas Grant.

Mr. President, Ladies and Gentlemen:—

If I had known that your genial and good president had intended to call on me I should have made a bee line for the Chamber of Commerce, because being a mere man I have the greatest timidity in addressing a mixed audience. I believe that ladies control things as a general proposition. I know that is true in one particular case. A friend of mine who got married said he wanted to go to the mountains and his wife wanted to go to the seashore. I said:—"What did you do?" He said: "We compromised." I asked how he could do that and he replied: "We went where the wife wanted to go."

I know it is the duty of a secretary, particularly a private secretary,—and I had held that position for a good many years,—to keep his head closed rather than open. My training has been along that line and it is with great difficulty that I can express myself. I can write speeches. This little talk that Mr. Gude has given you I wrote. At least he is good enough to let me say

*Two mistakes occurred in the printing of the addresses and papers in the October issue. The name of the author of one of the papers, Mr. J. J. Gainey, was spelled "Gainer," while in the first line of the article the name of the association is wrongfully printed "Chicago Interchange and Car Foremen's Assn." These are inexcusable typographical errors.

that at all these meetings and side step into some of the glory that comes to him as president. I might as well be honest: He did get that speech up himself but it was the worst one that he ever made,—worse than the ones I get up.

I hope to see you later in the day and have the automobile ride and attempt to show you something of the city. All that he has said to you about time is true. You had better wire home to have the cat and canary farmed out for a month. We cannot show you in twice ten days how mighty glad we are to have you here. I thank you. (Applause.)

Address of President Boutet.

Gentlemen and Members of the Chief Interchange Car Inspectors and Car Foremen's Association of America:

It is with great pleasure that I again address you, as your president, at this, the Eleventh, annual meeting of this association, and in this beautiful city, the capital of our country. I trust that this meeting will be as interesting and instructive as our previous ones have been, and I feel sure it will be if our members are as attentive as they have been at former meetings.

The past year has been another busy one for all of us. Quite a number of meetings have been held in different parts of the country concerning car interchange. "Run, Repair or Transfer" has been warmly advocated by quite a number and as bitterly opposed by others. It appears to the speaker that this is as important a subject to those interested in railroad transportation as can be brought up. It is estimated that the railroads of this country are interchanging with one another 250,000 cars per day. The major portion of this interchange takes place in the middle West, the West and the South. Outside of Buffalo, it is comparatively light in the East.

There are employed in this interchange work about 4,500 inspectors, of different nationalities and different temperaments, to inspect and pass upon these cars. It does not require a very bright man to see the results we will have if we permit the inspectors to set back cars to the delivering lines at some of our large interchange points where it is almost impossbile to enlarge the terminals on account of the cities being built up around them and naturally increasing the price of land to figures that are almost prohibitive.

Before condemning "Run, Repair or Transfer," it is only fair to ask its opponents to spend a week at some large terminal where this system is in practice. I feel safe in saying to the opponents they will leave that point feeling that it is an improvement over any other system that can be inaugurated, and that it in no way conflicts with the M. C. B. rules.

Your Executive Committee held a meeting at Chicago and made several recommendations for changes in the rules of the Master Car Builders' Assn. These recommendations were considered by the Arbitration Committee of the M. C. B. Ass'n., but it did not see fit to adopt them. This should not prevent this association from continuing to recommend any changes that it feels would be beneficial. I feel sure that if we can convince the Arbitration Committee that our suggestions have merit they will be given consideration. We should, however, bear in mind that the M. C. B. Association is the authority and that it is also anxious to have rules that will cause the least conflict and will get the cars to destinations with the least delay possible, consistent with safety, and with the least friction between owners and handlers. It has occurred to the speaker that it would be a good plan to have the Arbitration Committee spend a week in discussing the rules and changes and to have some of the men employed in the actual interchange appear before them and go over the rules together.

We have the promise of some very interesting papers to be read at this meeting which I am sure will be of interest to all of you.

I desire to thank the members for the interest and part they have taken in our association in the past and I feel sure that this meeting will not differ in this respect from past meetings. Our sessions will be from 9 A. M. to 12 noon and from 2 P. M. to 5 P. M.

I would ask that you be on hand promptly at the opening of the sessions and that you remain to the close. If you are absent at any time I feel that you will miss something of interest to yourselves and the companies you represent.

I desire to express my thanks to the members of the Entertainment Committee and the friends that have contributed for our entertainment. I feel sure that none of the members need worry about the ladies while they are attending the meetings. The members of the Entertainment Committee have assured me that such complete arrangements have been made that by the time the meeting has adjourned the ladies will have seen all the points of interest in and about Washington.

I wish to thank the members of the Executive Committee, especially our secretary, Mr. Skidmore, Mr. O'Donnell of Buffalo, Mr. McMunn and others, who have been untiring in their efforts to make this meeting a success.

I trust that when we leave Washington, we will feel, and our superior officials also will feel, that the results of the meeting have been very beneficial to the members in attendance and to the roads which they represent.

President Boutet:—Mr. Slack of McCord & Co., Chicago, has something to say.

Mr. Schlack:—As a member of the railway supply concerns part of your entertainment committee, a very pleasant duty has been imposed upon me.

Mr. O'Donnell:—Louder.

Mr. Schlack:—I have a very bad cold and cannot speak any louder.

President Boutet:—Some of the members of the railway organization kept Mr. Slack up last night and then he slept in a draft, so we will call on Mr. O'Donnell to read off the program. He has been one of our most active members for the past three years.

Address of T. J. O'Donnell.

Mr. President, members of the entertainment committee and gentlemen representing the District of Columbia:—

This gentleman whom we have known for a number of years seems to take an especial delight in calling out the man from Buffalo to do something difficult. I did not intend to come here and take Mr. Slack's place, but Mr. Slack stated that he only slept about 38 minutes, so tried to get him to speak louder. However, I will do the best I can.

I am going to thank these gentlemen from the Washington Chamber of Commerce briefly for what they have said. We are all common ordinary mortals and we appreciate the fact that there are very few busy men in positions such as you occupy who would come here and spend a couple of hours to give us the greeting you have extended. However, on behalf of the Chief Interchange Car Inspectors, I think I voice the sentiment of each and every individual in the room, in saying that we heartily appreciate your kind greeting, and, while we are all warm, we have the cafe near and I understand that the ladies have the privilege of going in there as well as the men. Inasmuch as you have given us the freedom of your city, when we go home we will gladly take back the sentiments that you have expressed to our respective Congressmen.

Mr. O'Donnell read the report of the entertainment committee.

The report of the secretary was read by Mr. O'Donnell as follows:—

Report of Secretary.

On hand Sept. 15th. 1909	$ 9.46
Received from active members	353.00
Received from social members	125.00
Total amount on hand	$487.46
Disbursements.	
Subscriptions to the Railway Master Mechanic	$170.50
Photograph of Convention	1.00
Printing, envelopes and Letter Heads	40.00
Postage	22.45
Two months' rent of typewriter	5.00
Stenographer	92.00
Secretary's salary, Sept., '08, to Sept., '09	30.00
A. Berg's expense attending Executive Committee meeting	7.00
Receipt books	.75
Total	$368.70
Total amount received	$487.46
Paid out	368.70
Total on hand	$118.76
184 active members in good standing, increase over last years	54
24 active members delinquent, decrease over last year	6
47 social members, decrease over last year	2
255—Total Membership.	

S. Skidmore,
Secretary & Treasurer.

We your Executive Committee have examined the books of the secretary and find them correct in every detail.

Chas. Waughop,
Chairman.
T. J. O'Donnell.
F. W. Trapnell.

It was moved that the report be received and referred to the executive committee. Carried.

President Boutet:—An invitation was sent to Edw. A. Moseley, secretary of the Interstate Commerce Commission, and his reply will be read:

Aug. 22. 1910.

Dear Mr. Boutet:

I am in receipt of your kind invitation to the meeting of the Chief Interchange Car Inspectors' & Car Foremen's Association of America to be held at the Arlington Hotel, Washington, Sept. 6th, 7th, and 8th, next.

The delay in my reply is owing to the fact that I am on my vacation and mail only comes to my attention at irregular intervals.

As I will be away from Washington upon the date named I regret that I will not be with you; but undoubtedly Mr. Watson and several of the Inspectors will be present.

Wishing your meeting all the success which the excellent purposes of your Association entitle it to

With best wishes to all the members, and with high regard to yourself.

Sincerely yours,
Edw. A. Moscley.

Mr. H. Boutet, President C. I. C. I. & C. F. Assn., Cincinnati, O.

President Boutet:—It is requested that every member will register, as we wish to furnish the entertainment committee the exact number here.

We have here a lot of constitutions of our association, which can be had by coming up to the desk and getting them. If the executive committee will take my advice in this year's proceeding, we will print the constitution and by-laws.

We are ready to commence on the discussion of the rules, which is the first business before the session.

Mr. O'Donnell:—I think that inasmuch as there have been so many rearrangements of the old rules to the new rules that it is absolutely necessary that we read them rule for rule. I move you that such a procedure take place.

Carried.

Mr. Stark was called upon to read the rules.

President Boutet:—We would like to have every member express his views as to his interpretation of the rules, and we would like to have you give your names, as we want to quote you correctly.

Mr. Waughop:—I would suggest that all the Democrats come up front.

Preface.

Mr. Barker:—I would like to find out what is fair usage. It is assumed that slid-flat is not, journals cut and hot are not, and it is also assumed that no grab handles bent or broken ladder steps, or sill steps can be injured by fair usage.

President Boutet:—Are not all of these defects specified throughout the rules as delivering line defects, or defects for which the delivering line should care?

Mr. Barker:—That is not the point at all. The point is, are they to be considered fair, or unfair usage? We know what the rules say about them. If the air brakes are properly attended to, will wheels slide; if the oil box is attended to before they start, will they run hot?

President Boutet:—It would be almost impossible for the association to answer the questions unless you take them one at a time. Will you specify one?—take the slid flat wheel; if you embody them all in one you can see there will be a diversity of opinion.

Mr. Barker:—I will withdraw the question.

Mr. O'Donnell:—We all know what Mr. Barker is trying to arrive at. Wouldn't it be better if we would take the rules and consider them, and then set aside an hour for just such topical discussions as come up. Keep three or four of these questions before us and discuss them later on.

Rule 2.

I would like to ask if a return card does not prove very beneficial also if it is complied with by all roads, if all roads are using them.

Mr. Waughop:—We do not return any cars, hence we do not use them.

President Boutet:—Cincinnati uses them. We return a few cars and we use the M. C. B. return card.

Mr. Stoll:—We return a few cars and we use the M. C. B. cards strictly.

Mr. O'Donnell:—The rule says you must use the card. The man is entirely out of order.

Mr. Barker:—That rule is very embarrassing. They cannot pay $10.00 a day for an ordinary inspector, and the rule says that the defects shall be specified on the card. Sometimes one card is not large enough. There are some joint inspectors who do not have any cards and they work very harmoniously without them.

Mr. Berg:—I do not know why a return card should not be used the same as a repair card. If there isn't room on one, use two.

Mr. Schultz:—We do not return any cars at all unless it is absolutely necessary for leaky tanks, but we have made it a rule to use M. C. B. return cards. There are a few roads that have not complied with that. The real good of a return card is to give the information to the delivering line. There may be a half dozen defects on a car, and the defects for which the car is returned ought to be enumerated on the card.

Mr. Campbell:—We do not return any cars whatever, but the Twin City returns cars for some defects. Several roads use the return card and others do not, and I do not know of any of them having any trouble on account of not using them.

Mr. Stark:—In Columbus they do not return cars to any great extent, and as far as the use of the return card is concerned, I am satisfied it is not used because so few cars are returned.

Mr. Milburn:—We use M. C. B. return cards. Our cars are returned but such a short distance that we do not have to use cards except in wet weather.

Member from Cairo:—We return cars if they are unfit to load.

Mr. Livingston:—He does not state whether he applies an M. C. B. card or not.

Answer:—We are not using the M. C. B. return card.

Rule 5.

Mr. Hall:—I would like to ask if it would not be a good policy for all the members of the association to submit to their superiors and have them marked "Journal box B 1, or B 3," as the case may be, as they pass through the shop. I make that as a motion.

Seconded by Mr. Waughop.

Mr. O'Donnell:—With all due respect, I think you make a mistake in making such a recommendation. The railroads throughout the country are trying to make the card as simple as can be and they are omitting a lot of stenciling. We all know what the designation means. I think it is wrong.

Mr. Mitchell:—I agree with Mr. O'Donnell. I am well satisfied that it can be omitted and it is only a bill of expense. I do not see where we derive any benefit.

Mr. Forrest:—I feel as Mr. O'Donnell does about that. It seems to me that there is entirely to much stenciling on the cars already and it is not necessary by the rules. It is hardly probable that a man would draw a picture of a horse and then write "horse" below it.

Mr. Gainey:—I agree with Mr. O'Donnell. You take any man in the car business and he knows how to make out a report for his wheels without all that stenciling.

Mr. Waughop:—I did not quite understand Mr. Hall's motion. I presumed he referred to the marking of the ends, and that would save a great deal of time.

Mr. Berg:—That is already done.

Mr. Hall:—My object in recommending that was for the purpose of facilitating the movements of the car inspector. He can see that the passenger equipment is all done that way. And what trouble and expense would it be to put it on the truck of the car? L 1 and L 2 and R 1 and R 2. It would facilitate the work of the men in the yards.

President Boutet:—Do I understand you to say you withdraw your second.

Mr. Waughop:—Yes, I withdraw.

Mr. Barker:—I second that motion. I meet Mr. Hall occasionally and his desire has been to speed the freight through. He wants the car inspector to be so quick and have it so plain that a man does not have to take a false step; but as I am reading of the trend of events, as the inspector rides with the train, he is supposed to look at the end of a car and take in at a glance whether it is A or B end. There is entirely too much stenciling. What stenciling there is on a car should be plain. A great many mistakes are attributable to stenciling which is not plain.

Mr. Bradley:—If we ask to recommend anything of that sort, it would be recommending a bill of expense on the railroad companies. We have an A and B end of a car. The brake staff indicates the brake end of a car. He has got to pass by both ends of the car when doing the work.

Mr. Smith:—I cannot agree with Mr. Bradley in that the brake staff end would indicate the end of the car.

The question was put upon the motion and lost by a large majority.

Rule 7.

Mr. Berg:—How are you going to get the location of the side stakes on a gondola.

President Boutet:—Cannot you get them as well as you could if it would be 16 R or 16 L?

Mr. Smith:—I suggest that we wait until we arrive at Rule 14 before we discuss that.

Mr. Jones:—My interpretation of Rule 14 is that the only thing it covers is the journal box and contained parts.

Voice:—That was my interpretation of Rule 14, and we have issued instructions that it be interpreted as applying to all parts of cars and not merely journal boxes; and contained parts shall be known as so and so.

Mr. Rearden:—Did I understand you are discussing Rule 7 or Rule 14?

Mr. O'Donnell:—We are seven rules ahead.

President Boutet:—The wording is somewhat changed, but the ending does not give any different meaning to the rule.

Mr. Barker:—What all roads are after is speed. Wouldn't it be well for the association to recommend to the proper committee that the repair cards be amended to say Bill or No Bill, so that one can be crossed out and save writing.

President Boutet:—That suggestion would come up under the head of changes of M. C. B. rules.

Mr. Fox:—I would like to ask how many are using M. C. B. cards at the present time and nailing them on the cars.

Mr. Barker:—That depends on the local practice. I wanted to speak on that myself and I do not know that we understand what the local practice is. There has been some neglect and it has caused large expense in the clerical department of railroads. Part of my business is to go over the accounts, and I find it has caused quite a bit of expense in not following the rules and attaching them to cars. I could tell you who is attaching a defect card with one tack, and who does not sign his name and who does not make them out.

Mr. McMunn:—We are here to get the correct interpretation of that rule, and I think this is out of order. Let us discuss the interpretation of M. C. B. rules.

President Boutet:—It is the intent to get together to get the proper interpretation of the rules as understood by a majority of the members; when we go home it would follow that we should put it up to the officials and tell them what this association has done and ask them to follow it. We find that that has done a great deal of good. We get the proper interpretation and then we endeavor to have them allow us to carry out what this association had agreed upon. In that way we have become more uniform and it has helped wonderfully to what it used to be. Let us come here and discuss the rules, as to their proper interpretation; after we get that done, let us go home and advocate to our officials that we carry out the rules in such and such a manner. I think this body is perfectly competent to judge what is the proper interpretation of a rule and when we do that we will accomplish more good than any other way. Let the majority rule, and if the majority says that the proper interpretation is one thing, let us go home and carry that out.

Mr. O'Donnell:—Supplementing your remarks, let us tell Mr. Barker we know what he means, and let us help him out if we can. Let us make that a subject of topical discussion. I think Mr. McMunn's idea is perfectly correct. Let us get through with these rules and set aside forty minutes before we adjourn each meeting and talk over these things. We do not want the new members to feel that they are going to be cut off, because we want the views of every man.

Rule 10.

Mr. Barker:—Full information shall be reported to the owner of the car. When you slide a wheel you are using up that part of the metal and it is delivering company's defect, but the delivery company may not be there, and we should furnish that information to the owner of the car.

President Boutet:—If A was to deliver to B one of C's cars with a pair of slid flat wheels he would give B a card for the slid flat wheels. He would also send a card to the owner of the car.

Mr. Barker:—No, sir; one defect card would be all that I would issue, but in the billing the owner is entitled to protection for the loss of metal, and that rule provides that the owner shall receive information as to how much he has lost.

President Boutet:—How is the owner going to get protection unless an M. C. B. defect card is issued?

Mr. Barker:—I will say that there are expense accounts between railroads aside from the defect cards.

Mr. Livingston:—For a car with slid flat wheels he should demand a defect card. And when B bills for that he will send a bill and a defect card to C, and C will send it to A. That is, he will counter-bill against the owner. I will bill A and the owner then will counter-bill against the party issuing the defect card; that way the owner has a check on the loss of material on his wheel.

President Boutet:—As I understand the rule, if A delivers one of C's cars to B, B is entitled to redress for the amount of labor in turning up the wheels, removing the wheel and replacing it again. The only way he could bill on that would be on an M. C. B. defect card. The owner does not know anything about it after they have covered it up, and the only way that the owner could bill for the loss of metal would be on an M. C. B. defect card. Wouldn't it be necessary to give two cards?

Answer:—No, sir; he would not bill the delivering line. The way I understand that is, if you deliver to me a card belonging to some one else, I will ask for a defect card and I will bill the car owner; then he will counter-bill you, because you are responsible, because you said you were responsible.

President Boutet:—There is no rule in the book of rules that is more misunderstood than that particular rule. I would advise you in discussing this rule to bear in mind what you say when you state that there have to be two bills rendered. I hope you are going to arrive at some conclusion.

Mr. Bradley:—I cannot understand why a receiving company can make a bill on a delivering company car and present it to the owner. B delivers a car to A and repairs the wheel. A demands a defect card which B furnishes. He will make a bill against B on a defect card for the loss of metal, and the same time he makes a report to the owner of the car; then the owner of the car will bill B for the loss of metal. The receiving company has no authority to bill the owner on a delivering company defect card, not according to my interpretation of the rule. He must bill the delivering company and notify the owner according to the rule; that puts the owner wise. And he goes back to the delivering company and get reimbursed.

Mr. Barker:—Mr. Livingston, I think, has a good understanding. This is altogether new. It is a good plan to send the entire business to the car owner; he is protected and also the receiving road is protected.

Mr. Hitch:—Wouldn't it be proper for the delivering line to issue an M. C. B. defect card for the slid flat wheels and also issue a defect card for the loss of metal, the receiving line billing the delivering line for the cost of removing and replacing the wheels, and at the same time taking a card for the loss of metal to the car owner?

Mr. Stoll:—It seems to me that we are out of order. I think Rule 101 is the proper rule to discuss when we come to that.

Mr. O'Donnell:—I think he puts the question proper; that will define what we must do; but if we wish to continue the discussion we can have a motion put before the membership, as to the understanding of this rule, or defer it until we discuss 68.

Mr. Waughop:—I move you that as far as interchange is concerned, with a car in case of a slid flat wheel or damage to a wheel for which the delivery company is responsible, it shall be carded with one M. C. B. card.

Seconded.

President Boutet:—That the latter portion of Rule 10 be interpreted to mean by this association that one defect card should be given only, and that no reimbursement to the car owner direct should be taken by the issuing of said card.

Mr. Gainey:—Rule 10 refers only to the repair card, and these people are discussing the M. C. B. card. I think they better wait till they get to the other rules. And I move you that we lay this over for a topic of discussion untill we reach Rule 101.

Mr. Waughop:—I will withdraw my motion, with the consent of my second.

The question was put upon Mr. Gainey's motion and carried.

President Boutet:—I think we reached the point that brought out what I wanted to bring out. I wanted to get some of our members to thinking about protecting the owner for slid flat wheels on delivery. I realized it was not the proper rule to discuss, but it will start them to thinking.

At the opening of the meeting I read you a letter from Mr. Moseley, stating his regrets at not being able to be with us. We have with us Mr. James E. Jones, inspector Interstate Commerce Commission, who has been requested to speak for Mr. Moseley.

Address of Mr. Jones.

This paper appeared in the October issue of the Railway Master Mechanic.

It was moved by Mr. Stark and duly seconded that a rising vote of thanks be given Mr. Moseley and his colleague, Mr. Jones.

Carried unanimously.

Mr. Stark:—I feel that we are all under obligations to the interstate inspectors; they have tried to teach us the way that we should keep up the safety appliances. We have a duty to perform towards the government as well as towards the railroads which we represent. It is our duty to maintain safety appliances and keep them in such condition that they cannot find a case. We have all done what we could to keep the safety appliances in the best possible condition, and I think we are under great obligations to the Interstate inspectors for the courtesy that they have shown.

President Boutet:—I think this represents to you, Mr. Jones, that our association appreciates your address. I wish to thank you on behalf of the association for your courtesy in the matter. We will be glad to have you remain with us and take part in the discussions, if you care to do so. We will now proceed with the rules.

Rule 14.

Mr. O'Donnell:—I move you that the mention of the oil boxes and their contained parts shall be termed the wheels and actual part of the truck and shall not refer to any portion of the body of the car.

Mr. Barker:—I think Brother O'Donnell mentioned axles. That is a new rule that would not work itself out. From the discussion, it is for the protection of the car owner, and it seems that it was intended for the oil boxes. I believe it will eventually mean the whole part. I believe it is the oil boxes and contained parts, but it will control the entire repairs.

Mr. A. Berg:—I think it should show what side you apply the parts and that must be shown on the repair card, and you have got to furnish this information on the repair card.

Mr. Berg:—That will be all right, but suppose you take your reference from the "A" end, and then say right or left and you confuse it.

Mr. O'Donnell:—You have to consider all reference on that part of the truck and its attachments. I think my motion covered that.

Question:—Would that control the truck frame?

Mr. O'Donnell:—It would be either on the right or left side, in one or two, three or four. That would not extend the whole length of the car from the "B" end.

Mr. O'Donnell:—The intent of the change is for the protection of the owner on making repairs, but any foreman or any inspector issuing a repair card or defect card can very easily locate the part of the truck that he wants the item to cover.

Mr. Wagoner:—I would not like to see that motion prevail as it has been read, as we are now passing upon the interpretation of these rules and if we interpret that to apply to truck frames and all parts of the trucks it might express our ignorance.

Mr. Hitch:—This covers the oil boxes and contained parts only and does not pertain to any other part of the car.

Mr. O'Donnell:—That was my understanding. I do not think it carried any further than the rule said. We do not want the truck part and the body part to antagonize.

Mr. Stark:—I cannot support it in its present wording. I think is should be defeated now, and a new motion made.

Mr. Gainey:—I offer an amendment to Mr. O'Donnell's motion that it be interpreted to mean the journal box and contained parts, and no other portion.

Mr. Livingston:—Would that include the wheels?

President Boutet:—No, sir, the oil boxes and their contained parts.

Mr. Forrest:—I do not believe that the majority of the convention understand Mr. O'Donnell's motion, or the purport of it. I take it that Mr. O'Donnell put a motion and tried to carry it through, that the special object of the men in this convention was not to confuse any part of the truck with the body of the car when designating the car.

Mr. Schultz:—The intent of the motion was to construe all parts of the car to establish any portion from the "B" end. My understanding of the rule is that we are to establish the location of any part of the oil box and its contained parts from this end, and no other part.

President Boutet:—My impression was that it would simply carry with it the interpretation that we would try, in making our repair cards, showing what portion of the truck our oil box was, and not confusing it with any portion of the car. The rule is plain on that and I think it is only a step in the right direction I believe we ought to vote for Mr. O'Donnell's motion. I believe it was the intent of the Master Car Builders to locate any particular portion of the truck, to stop any confusion on bills, and it appears to me that we are only going a little further than what the Master Car Builders intended; we are not deviating from the rules in any manner.

Mr. Hill:—It appears to me, in making the matter plain, these bills—whether it be owner's defect or delivering line's defect—in designating the part of the truck damaged, that there would be no good reason to confine ourselves to oil boxes and contained parts. You have broken arch bars, truck bolsters, truck springs, slid flat wheels, defective wheels and all kinds of repairs, and the intent of the rule would be designate the particular parts. The rules give us territory sufficient to designate the particular part of the truck, whichever side it might be on. It gives us the "B" end of the car and the "A" end. Mr. O'Donnell's motion carries with it the dropping of the idea of any defect on the body of the car, but why it should not contain any and all parts of trucks to make an intelligent bill, I do not see. A car foreman would probably make an intelligent bill and he would make it from reading the rules.

Mr. Wlman:—My object in objecting to the motion as read was based on the statement made by the president a few minutes ago to the effect that we were to interpret the rules as they are and not recommend changes to the Master Car Builders' Asociation. This motion as it stands now recommends that we interpret differently from the way it reads. If we are to propose changes, I would like to take up some of the rules we have just passed.

Mr. Hitch:—I would like to ask if it is the practice to include anything else beside the oil boxes and contained parts.

President Boutet:—Everybody knows exactly the wording of the rule.

Mr. Barker:—As I understand it, Mr. O'Donnell's motion was to avoid confusion, so we would all understand that this was for the trucks only, and it is going to make more confusion than a little. They pick them up with the cranes and turn it around until the trucks are stenciled on the "B" end and the "A" end; there is going to be confusion, but it is for the protection of the owner and it will finally protect the owner.

The question was put upon the amendment and carried.

President Boutet:—That means journal boxes and their contained parts.

Mr. Waughop:—You might as well describe the contained parts.

President Boutet:—That is so. It consists of journal boxes, wedges or stops, journal brass and the waste.

Mr. O'Donnell:—In putting on the cards, they ought to use more tacks, and the reverse side should be filled.

President Boutet:—At the opening session I failed to announce that the vice president, Mr. Trapnell, was unavoidably detained, but will arrive later.

Mr. Berg:—In connection with the rule, I understand that on making reports you refer to "A" and "B" and give no other location. I want to know what you are going to do.

President Boutet:—I will try to explain what was the interpretation of the association. If I am wrong, I trust you will call my attention to it. The last rule we voted on was to the effect that it was only necessary, in regard to the oil box, to specify which particular box, "A" or "B"; 1, 2, 3, or 4 R or L. There was nothing in that motion that would prevent any other person from designating any portion of the car in the same manner, if he feels so disposed.

Mr. Bradley:—There would have to be another rule.

Rule 17.

Mr. Schultz:—Some roads request that joint evidence be signed. The case I have in mind was the application of an M. C. B. butt in place of an 8½ butt. This is permissible under the rules and therefore joint evidence is improper and should not be sent to the delivering line. The argument is that the statement, or the joint evidence simply states the fact. I would like to have a ruling on whether or not under these conditions, joint evidence should be signed, admitting to my point of view, that it is of no benefit to the car owner.

Mr. Wyman:—I happen to be familiar with the practice. It is a case in which we are both interested. I would like to correct the statement he made. It is not a case of applying a 9 and 8 inch butt; it was a case of applying a 6½ inch butt and applying liners for an 8½ inch butt.

Mr. Schultz:—The case is just as I stated: The application of an M. C. B. 9 and 8 inch butt in place of an 8½. The contention was that it was made of some use to them, and I refused to sign joint evidence under those conditions for the reason that it was permissible.

Mr. Wyman:—I have the papers in my pocket now where he refused to sign joint evidence.

President Boutet:—Do you think Mr. Schultz came down here to get the opinion of the association to use against you in your particular case?

Mr. Wyman:—We had joint evidence by instructions from the superintendent of motive power.

Mr. Schultz:—What I had in mind was just as I stated, to get an opinion as to whether or not you can compel a delivery line to sign joint evidence.

Mr. Waughop:—I would like to know how you would apply a 9 in place of an 8½?

Mr. Schultz:—You fill it.

Mr. Waughop:—For the benefit of the association, I will say that the arbitration committee has up for consideration the adoption of an 8½ inch butt as a standard. If passed, it will be passed this month.

Mr. Devaney:—If you put a 9 inch butt into an 8½ inch sleeve —an 8½ butt coupler; for instance you take a coupler 8½ inch butt and shim it up, would you apply joint evidence?

Mr. O'Donnell:—You would have to, according to the rule. It is improper repairs. You cannot change the construction of a man's car. You cannot change the height of the oil box to put in a standard. The point is to sign joint evidence or a statement of facts. I think that a statement of facts is all that would be due in that case. You cannot simply issue a joint evidence card to please an individual. I would simply give them a statement of facts.

Mr. Devaney:—Don't a statement of facts mean that the fellow who applied that has to furnish a defect card?

Mr. O'Donnell:—It sustains the fellow who wants the evidence for the other fellow. If you are representing a dozen roads and he says:—"I wish you would give a statement of the case over your signature." They can use that for any purpose they see fit. I give them the information.

Mr. Stoll:—I believe M. C. B. rule 17 is very plain on that. It says M. C. B. standards may be used when as strong. I do not believe that a coupler shimmed up would be as strong.

Mr. Elliott:—I would like to know what you would use in a case of that kind?

Mr. Wymer:—Go over and get an 8½.

Mr. Elliott:—It is not standard.

President Boutet:—I would like to have Mr. Schultz explain. I understand Mr. Devaney brought out something that Mr. Schultz knew about.

Mr. Schultz:—The road I represent has built some cars that had 8½ inch butt; they came back with a wrong coupler in; they were pretty near worn out before we found it out.

Mr. Wymer:—I think this is important because I know there has been a good deal of discussion on signing joint evidence, and I would like to have your interpretation as to whether or not a car equipped with an 8½ inch butt and has had a 6½. The 8½ is not standard and 6½ is—in case a car comes home with a 6½ inch butt to fit an 8½ inch butt; is it against the rule and joint evidence should be signed? I think it is on the ground that the strength of the car has been impaired.

Mr. Barker:—I want to agree with Mr. O'Donnell. Joint evidence is merely a statement of the facts. These two brothers have mentioned one particular point and that is that the rules are specific that the M. C. B. material used must be of M. C. B.

dimensions. A joint evidence card does damage to no one if it is a statement of the facts. It possesses no value unless you haven't a repair card. This association does not want to go on record as being opposed to something that the M. C. B. rules provide for, and they provide that when making repairs you must use material of M. C. B. dimensions.

Mr. Hitch:—I have arbitration case No. 781, Oct., 1909. The decision was as follows:

> The contention of the C. B. & Q. R. R. is correct; the B. & O. R. R. is responsible for the wrong repairs. There are two standard butts for 5 by 5 inch shank couplers, one 6½ inches, the other 9⅛ inches. The proceedings of 1908, page 624, read as follows: "In 1907 a butt 5 by 5½ by 9⅛ inches for friction draft gear (see Sheet M. C. B. 11) was adopted as standard."
>
> The association has recognized the necessity for butts of the sizes mentioned, on 5 by 5 inch shank couplers, and it is presumed each one of these will be used in its proper place.
>
> The C. B. & Q. R. R. contends that its attachment demanded a 9⅛ inch butt, consequently the use of the 6½ inch butt is wrong repairs.

Mr. Devaney:—I am surprised in a way and not surprised in another. A man got up here and said that joint evidence did not mean any harm. It means a defect card for some fellow and that joint evidence is going to get him into trouble.

President Boutet:—If the coupler is wrong, it should get him in trouble.

Mr. Wymer:—I move you that a 6½ inch butt applied in place of an 8½ butt is wrong repairs and that joint evidence should be signed.

Mr. O'Donnell:—A man over there said we would be made a laughing stock if we would try to interpret the oil box and contained parts so as to make them separate from the body of the car; what would it be if we interpreted this on that basis? I think the motion is ill-timed, and it puts us in a bad light before general officers. We know in our own hearts it is wrong.

Mr. Wymer:—I accept the challenge. If the gentleman will read the arbitration decision, he will find it does not cover the situation at all. The question is whether or not it is wrong repairs to change by using an M. C. B. standard where you injure the construction of the car.

Mr. Waughop:—The case referred to is not a parallel case of Mr. Wymer's, as he stated it. It calls for two M. C. B. standard butts. The case he states calls for a 6½ standard, against an 8½ non-standard. Mr. Wymer's contention is correct.

Mr. Barker:—I think this association should be careful not to tread upon the territory of the arbitration committee. Don't you think it would be well to have the executive committee act with the arbitration committee and have them decide which is proper. Is the 9 and 8 wrong?

President Boutet:—The motion is that a 6½ standard coupler applied to a 8½ inch is wrong repairs.

The question was put upon the motion and carried.

President Boutet:—Before we adjourn, our meeting is called for 2 o'clock; dinner is not served until 1 o'clock; there is a move on foot to try to give some time to visit the buildings and I would suggest that we stretch the time now a half hour. The secretary has instructed me to announce that it will be necessary for all of you to register the number with you.

Mr. Wright. We would like to know the attendance immediately after this meeting. We do not want to miss anybody: Arrangements have been made to visit the public buildings, and there will be enough guides to take care of as many as will go.

Mr. O'Donnell:—Is it necessary that we should proceed to business at 2 o'clock? There are a lot of us fellows who do not get to Washington only about once in fifteen years. The ladies are going around to see the buildings; there is nothing in the line of entertainment that we want to see more than the public buildings.

President Boutet:—That is the way I understand the matter. We cannot afford to come down here and loaf. We must have some work. I said that if we would work hard today and extend our evening session and come here Thursday morning, we might possibly take tomorrow. I realize that we would like to see the buildings but we cannot afford to neglect our work.

Rule 20.

Mr. Wilcox:—We have no high or low cars.

Mr. Barker:—We could just as well have one inch or more in variance and they could be moved just as well. If it is raised and he refuses it, what would you do with the car when it returned?

Mr. O'Donnell:—I think we have a man who would tell us where to get off. The government law tells us what to do.

Mr. Wilcox:—We have not had a car returned to us in the last three or four years on account of high or low drawbar.

Mr. O'Donnell:—That means we do not have any cars violating the interstate commerce law. Is that right? We do have drawbars low, but they are not low very long in that vicinity.

President Boutet:—We have some cases where they are loaded in the end and we adjust that before it goes out. We do not let them go with a coupler high or low. We do not allow any deviation from the rules applied by the interstate commerce, which are M. C. B. rules.

Rule 21.

President Boutet:—Suppose a car were delivered with coal or coke; would C be allowed to put a running board on and charge the owner for it?

Mr. O'Donnell:—What would he want a running board for?

President Boutet:—Because the rules call for one. They say so, and they are the judges.

Mr. Peiffer:—If the car had not been originally equipped with a running board, they certainly cannot demand you to equip it. If it is a coal car it will have to have means to get down on the inside as well as the outside to meet the requirements. Ordinary coke cars are of steel construction. The coal cars do not have any means—nothing only side steps to go over, and I do not see why any change should be made, or that a running board should be on a car simply because it is to have coal in it.

Mr. Livingston:—I believe it is intended to cover cars in bad condition; I do not believe it is intended to cover coke cars.

Mr. Schultz:—In case of a necessity a temporary running board should get a car home; in which event it would be owner's defect. If a car was in an accideent and the delivering line should try to get it home, I do not think you could bill the owners, if it is the intention to get the car home.

Mr. Devaney:—The best way to get rid of that would be to let that road that won't refuse them apply one and bill the owner and put it up to that august body.

Mr. Waughop:—I move you that under the provisions of Rule 2 which makes the railroad company the judge whether it is safe, we would be entitled to charge the owner for applying a temporary running board to a car that is unsafe to go over our line.

Mr. O'Donnell:—I do not think any car owner would pay a bill putting $4.00 or $5.00 on a standard car that was not necessary. You cannot compel running boards to be put on. It seems out of line to interpret a rule to convey the idea that it is only for cars going home, with the roof off or otherwise.

President Boutet:—Among general managers and superintendents of railroads it has brought out a great deal of consideration regarding the transfer of cars. They positively refuse to do so, and I do not know as the vote of this association is going to carry a great deal of weight, except to show the understanding of these people that we can or cannot apply running boards.

Mr. Stoll:—No coke cars constructed with running boards ever can go over the tracks at Toledo without being repaired, without half billing. When a car is loaded for pig iron there is as much danger of a man falling in and hurting himself as there is to fall out.

Mr. O'Donnell:—A man is liable to fall down in a self-cleaning hopper.

President Boutet:—I believe that the hopper is far more dangerous, but that is in the construction of the car.

Mr. Gainey:—I do not believe that there is anybody here who has any right to change the original construction of a car and charge the owner for the change, as far as running board and hand rails are concerned.

Mr. Barker:—The rules require that a receiving road shall be the judge as to the condition—of the safety of a car; provided you live up to the rules. There is quite an exception, and I should not like to see this association lay something down that possibly might be governed by the law of the land, if we were going to condemn a lot of equipment. I am very much in sympathy with the other people.

Mr. Schultz:—I would like to offer an amendment, that it is the sense of this meeting that Rule 21 is to govern cases of cars that have become unserviceable on account of roofs blown off, etc., and moving home to owner.

Mr. Chaplain:—I cannot see where a box car with a roof blown off is any more dangerous than a self-cleaning hopper.

The question was put upon the motion and carried with but two dissenting votes.

Thereupon an adjournment was had until 2 o'clock.

Tuesday Afternoon Session.

Rule 22.

Mr. Barker:—That would appear to bring out that the owner could splice sills just as he wanted to. We splice foreign cars in accordance with the rules, but there is nothing in the rules to prevents one from splicing in any manner he sees fit when it arrives at interchange point.

President Boutet:—As I understand it, no joint evidence is to be given except by the delivery of that car to its owner.

Question:—Suppose he does give joint evidence, what can you do?

Mr. Barker:—Joint evidence is of no value unless you can prove that the other fellow spliced his car. If the rules are of any value and it is for the best interests of the equipment that they should be spliced according to the rules, should not everybody do so?

President Boutet:—That is true and I believe should be complied with. Should we not all construct cars of the same kind, according to certain specifications when we get down to it?

Mr. Barker:—The Freight Agents Transportation officials and the officials of the railroads say it is time that the car men arrived at a good car door and hangers; and the American Association is crying for a standard American railroad freight car, and waiting for the car men to get one up.

Mr. Berg:—In reference to Mr. Barker's remarks and in connection with the splicing of cars, we have two forms of splice here. It is optional with each railroad company to splice its cars as it sees fit, as long as it complies with the forms that are given here; but when they splice sills of a freight car they have to comply with the standard M. C. B. splice; that is all that is required. As for any trouble arising at connections, it is not at all likely that any spilce but a butt splice would be accepted unless the road adopted that kind of a splice.

Mr. Devaney:—I would say about splicing a draft sill 12 inches or over—whether a 24-inch or 34-inch splice would be proper on a foreign car.

President Boutet:—I have failed to find draw sills of that dimension.

Mr. Devaney:—I find them every day. I think it is proper to put in a 24-inch, but some people do not understand it that way. I would like to hear from the L. & N. on that question.

Mr. Peiffer:—My understanding of that rule is that all center sills must have a 33-inch splice, and as far as the 12-inch sills—we follow the same plan as shown in Figure 9B. We have a good many cars where the lugs are attached to the sill, and I never had any question about it.

President Boutet:—I do not know that there are any L. & N. men here who could answer your question.

Mr. Barker:—The D. & H. have some 12-inch sills.

Mr. Livingston:—The rules provide that when center sills are spliced the plan shown in Fig. 9A is followed.

Mr. Devaney:—There is nothing here shows a 24-inch splice, no matter how deep the sill. This gentleman here said 33-inch.

Mr. Peiffer:—It says sills of foreign cars should be spliced in that form.

Mr. Hitch:—I move that a 24-inch be a proper splice for a draw sill. Seconded.

Mr. Stoll:—I believe it is all right if the sills are 12 inches, but where the sills are less than 12 inches——

Mr. Forrest:—On page 13 there is an outline of a splice made which tells how a splice to a foreign car must be 33 inches.

The question was put upon the motion and carried.

Mr. Wymer:—I would like to ask if any of the members have found a case where they could not keep 24 inches away from the body bolster as this provides?

Mr. Devaney:—I have found a case of that kind: They have a filling block in the center running 18 or 24 inches behind the transom. I took them out and run out beyond the splice and put in the bolts——I could not keep 24 inches away from the bolster.

Mr. Gainey:—What he refers to is the drop-bottom coal car. We have a great many cars that the splice would come in contact with the outside cross timbers, but we do not count them as cross timbers. We splice right on over them.

Rule 31 (Old Rule 33).

Mr. Devaney:—What is meant by "extraordinary"? What is an extraordinary amount of roofing? By giving an entire new roof you can put some cars in service in 24 hours. What would they consider extraordinary repairs to a roof, the outside sheeting?

Mr. Berg:—The rule says when we get into extraordinary repairs such as sills. It means what it says.

Mr. O'Donnell:—It means excessive repairs, running into from $15.00 to $35.00 or $40.00; the owner must be fully conversant with the repairs done.

Mr. Devaney:—Would you O. K. a bill for an entire new roof on a car for which the bill would not amount to $35.00?

Mr. Berg:—Of an Erie car?

Mr. Devaney:—Whatever road he is with.

Mr. Berg:—Outside roof boards and the running boards—has anyone a right to question anything like that? If you find it necessary to apply a new course of roof boards, you certainly have a right to bill the owner; if it isn't on account of a rough usage you have to. If you should be in doubt as to whether he would want it or not, you probably would procure authority before you tackled it; but I do not know of any road that refuses to O. K. a bill where they knew that the roof was decayed.

Voice:—I think we are getting out of line. The question refers to rule A.

President Boutet:—If we adhered strictly to these things, possibly it would not bring out the point we want. He represents the St. Louis Terminal.

Mr. Devaney:—I am here for my own information, and I represent 14 or 15 traffic lines. I do not think it is proper for you to tell that.

President Boutet:—I thought it was a good chance to introduce you to the members so they would know who you were.

Mr. Barker:—Are you asking if an entire new roof would be extraordinary repairs? It does not make any difference whether the roof is decayed or worn out by fair usage, the owner would probably not be heard to object. If they were receiving new cars and the roof blew off the owner would have to pay for the new roof.

Mr. Waughop:—Probably that interpretation gave the benefit of the doubt to the owner. Forty-nine per cent of missing roofs should be charged to the owner without question.

Mr. Devaney:—My idea for asking that is, I run into cars whose roofs can be put into condition for $30.00. If I have to write to the owner and get home-out cars, it is detrimental to all the roads. I wanted to see how far they would go. I believe they ought to be let go the full limit, if the cars can be put in service and show that they did not handle it roughly.

President Boutet:—I do not believe if you repair the entire top that there would be any objection to the bill.

Mr. Barker:—There are several decisions on extraordinary repairs.

President Boutet:—The only change is adding a water trough.

Mr. Barker:—A water trough on a stock car is a concealed part of a car. In the case of closed horse cars or open slat stock cars it is not outside of the rail.

Mr. Livingston:—Rule 23 defines what parts the owner should be responsible for, and it says water troughs and all inside or concealed parts. It is a separate subject entirely. It would not make any difference whether it was a closed car or an open stock car.

Mr. Barker:—Is that the understanding of this association, that the trough in a stock car is a concealed part?

President Boutet:—From the gentleman's remarks I would take it to mean it was his understanding that the owners were responsible for water troughs, but he did not say it was a concealed portion.

Mr. Livingston:—My impression would be that it did not make any difference whether it was concealed or not; that the owners are responsible anyhow.

Mr. Barker:—I have read a little about this association before and heard some criticism about it. Every rule to which there is no objection made is supposed to be adopted by the association?

President Boutet:—I suppose that we are of the same opinion as to the interpretation. We are not approving or disapproving, but it seems to be a general understanding if we pass a rule that everybody has the same interpretation. But any rule on which there is a discussion, or any doubt as to the proper interpretation, then it is proper to take the vote of the association as to the proper interpretation.

Wheeling Man:—I might ask that it be the sense of this convention that water troughs missing on cars, as per Rule 23, are chargeable to the owner regardless of whether they are concealed or not.

Seconded and carried.

Rule 40.

Mr. Devaney:—I would like to know what is meant by the word "damage." How badly does it have to be damaged before you will card it in connection with a combination?

President Boutet:—If it is damaged bad enough to go in the shop and the owner, under ordinary circumstances, would repair it, it is damaged bad enough to be carded.

Mr. Waughop:—That is the ground I take.

Mr. O'Donnell:—Mr. Devaney does not mean to tell us that the combination here would enter into steel cars. There isn't any combination that would enter into steel cars.

Mr. Devaney:—If there isn't we are all at sea.

Mr. O'Donnell:—The Master Car Builders appointed a special committee to act on all steel cars on combination.

Mr. Devaney:—What are they doing now?

Mr. O'Donnell:—If you have one end sill broken it is a cardable defect; if you have a wooden one broken it is simply owner's defect.

Mr. Waughop:—I will have to throw up my hands.

President Boutet:—So will I.

Mr. Waughop:—The only conditions under which I would card an end sill broken on a steel car is when it is struck.

Mr. O'Donnell:—How are you going to break them? Do you mean to say you would consider it owner's defect?

Mr. Waughop:—We certainly would.

President Boutet:—I realize that the Master Car Builders made the rules, and they set out what they call a combination; they have never made any difference between steel or wooden, and if the end sill were damaged so that when it went in the shop it would be repaired I would consider it a combination. If I am wrong I would like to be set right.

Mr. Trapnell:—We handle it just as outlined by you. We have a great many steel tank cars. We only give a card for a broken end sill when it is necessary to remove the end sill.

Mr. O'Donnell:—That is a different proposition where there is more or less rust and decay in the metal parts, but you take an 80,000 or 100,000 steel underframe car, and tear the end out of it, I do not think it is fair to the owner if you do not run into a combination. I am glad that Kansas City agrees with Cincinnati once in a while, but I am inclined to think that if you asked Mr. Peiffer, or some of the car men to accept them under those conditions, they would simply tell you to be good and give them a card. I have refused cards on a lot of cars that have been in service six or seven years. They are giving out due to rust and decay, but you take a car that is in good shape I do not think a combination should enter into it. You have to use good sense, and I do not think I would accept them home on that combination.

Mr. Barker:—The D. & H. have all new cars and they are receiving their cars when they arrive home with damages under the rules for wooden frame cars. Our understanding of it is that the Master Car Builders have appointed a committee because they considered that has not been fair, and we expect during the year that there will be some modification, but I can look into the faces of some that are passing them home with damaged end sills, and I do not know but what they are blushing about it now.

Mr. Wymer:—It does not say whether wooden or steel. If these combinations do not apply to steel cars we have no rules governing the interchange of steel cars at all, as far as a combination is concerned. We touch the New York Central in different places and I have not had any trouble with them.

Mr. Chapman:—I have had a great deal to do with the interchange of steel cars, and I must say I have never furnished a card for a broken steel sill where it did not show any signs of unfair usage.

Mr. Smith:—I move you that Rules 37 to 43 refer to steel cars as well as wooden cars.

Seconded by Mr. Waughop.

Mr. A. Berg:—I consider steel cars the same as wooden cars. The present rule covers steel cars. We have a decision on that.

The motion was carried with one opposing vote.

Rule 41.

Cairo Man:—If you have an end sill and two draft sills broken at each end, would you card both ends?

Answer:—It is a combination of defects at both ends.

Rule 42.

Voice:—We had a discussion at our place as to how much a sill must be broken under Rule 42 before it will be considered a damaged sill. We have been unable to agree, and I would like to hear from the members as to how they deal with that question elsewhere.

President Boutet:—It has been at Cincinnati a rule that it should be damaged bad enough to repair before it should be carded. It might be well to take a vote on that if you want to.

Voice:—Some roads differ as to how much it would have to be damaged to necessitate repairs, and allow their cars to run longer than others. So it is a hard matter to decide the question on transfer as to just how much it should be damaged. I do not think there is any way of arriving at a conclusion, but I would like to hear a discussion as to what the joint inspectors are doing regarding this question, because it is a question that is pretty hard to settle.

President Boutet:—You realize that a joint inspector is placed over the inspectors as an arbiter. He is supposed to use good judgment. I think that is one of the questions that he has to settle himself. I do not think this association could put any limit or specify any amount of damage, except that we might say that it should be damaged bad enough to repair. A man employed as joint inspector should use his own judgment as to whether it would be proper to give a card.

Voice:—Cannot we ask for an opinion? It has been discussed in other conventions, but I have never heard an opinion expressed regarding this matter. There is room for a good deal of discussion, and if we understand how others do, it would be a great help.

Mr. O'Donnell:—What is the question briefly? Before it should be considered a cardable defect, if a sill is cracked so badly so that it must be repaired—if the owners are taking a car home from us, in many instances they take it without question, but if it is offered me in interchange it is unfair for the receiving company to take chances at the other end. So it is up to us to say whether a card is due or not; we allow them to go forward and see what the owners say first. That is the 40 and 50 capacity; you take the 60,000—those cars should be carded without question.

Mr. Livingston:—Are we to understand that you handle the defect on notation?

Mr. O'Donnell:—Yes, we do.

Mr. Livingston:—The reason I asked is that at Toledo we are under the impression that the Frontier was living up to M. C. B. rules strictly.

President Boutet:—Is there anything in the M. C. B. rules?

Mr. Livingston:—There is nothing to bar it. These things are being considered at Toledo.

Mr. O'Donnell:—It seems as though the Frontier agreement always has somebody who seems out of line as to just how we do business. If that gentleman will come down and stay with me a week or so I will show him we are living up to M. C. B. rules. But if you were a railroad who maintained us men to look after your interest you would not expect us to be rubber stamps and say: "You must make it bad stuff or good stuff," if it is only three-quarters. You do not want to throw away $35.00 or over. It is up to us to protect the delivering line if you can get them home for nothing. I hope the medicine will agree with you.

Mr. Livingston:—This rule says "if a car has defects."

Mr. O'Donnell:—If the receiving road sees fit on their part as a party to those rules, to accept that car, does it hurt the other fellows if they do not put on a card that is simply throwing money away.

Mr. Schultz:—I feel that it was the intention of the framers of these rules that Rule 3 should be lived up to, that a defect card should be placed on a car. In the case quoted by Mr. O'Donnell, if the receiving road and the delivering road get together and pass upon a car belonging to somebody else and they join in and decide there ought to be a decision there that ought to stand and not that perhaps it ought to be removed and perhaps not—I believe leave it to somebody else; it ought to be definitely passed upon at interchange. If it is a cardable defect, they ought to say so; if it is not, they might say, "It is our opinion that the sill is not sufficiently damaged that it should be removed." That ought to settle it.

Voice:—If two or three roads enter into an agreement to run cars on notation. I do not say whether we run a car on notation or a record and I do not say that we ought to put a defect card on. Of course, if we have a wreck and they demand it, we ought to put them on.

President Boutet:—This discussion is out of order. There ought to be a motion before the house.

Mr. Waughop:—I move you that it is in the sense of this meeting that on all wooden cars the damage to a combination shall be cardable where it is subject to renewal; on all steel cars where it is subject to renewal or repairing, such as straightening, etc.

Mr. Barker:—As I understand from this gentleman he wants a crack on an end sill and a crack on the center sill described as closely as chips on a plane, and we will have to have a gauge. Perhaps as they have close decisions in his country he could give us a definition. If they would put a man like Mr. O'Donnell in that territory the trouble would cease.

Mr. Schultz:—I will second the motion. We know there is very little carding done for little damaged stuff, but the running of cars on record, making a notation and then issuing a card providing they ask for it, is wrong.

President Boutet:—The subject is how much damage on any given part shall there be before it is considered a combination.

Mr. Schultz:—A part must be damaged so as to require immediate renewal in order to be carded in interchange.

Mr. Devaney:—I agree with Mr. Schultz. The damage must be such that it must be removed, at that connection or nearest point.

Mr. Barker:—Then we would have to wipe out the defect card entirely.

Voice:—I think it ought to be left to the chief joint inspector.

Mr. Dyer:—We would be taking away the right that the owner has to say whether that car shall be repaired or not, although the defects are the same as when the car was interchanged by two intermediate roads.

Mr. Forrest:—I believe that when this association, or any other association, attempts to say how badly a car shall be damaged before a defect card is given, we are threshing over something that we are not able to arrive at. We see lots of cars running over the roads today that have a mark on the side of the sill caused by the sill riding the wheel; that sill is damaged to an extent and there is a defect card given. It is possible—while I would not say that it is probable—that the owner of that car will bill on that defect card and will bill for that sill and never remove it.

President Boutet:—Your views and mine are entirely different. It is the duty of each and all of us to give information to the inspectors; if we are unable to determine about the amount of damage to any given part, how can that be expected of the inspectors? Every defect card that we give is better than a check on a bank. We ought to be able to say how much any given part should be damaged before we give a card. We do not put on a card for every little sliver. We should use some judgment as to what we consider fair and honest. If I should damage one of your cars so that it should be repaired or repainted, I believe I should be compelled to pay for it, but if I had merely scratched it, I do not think we should be required to pay for it.

Mr. Forrest:—I look at it in the same way that you do. I said that it was possible for these conditions to exist. I feel that a great majority of us are under the chief joint inspector and it is up to him to say whether we should card. He is it; let us stand by what he says.

Mr. Schultz:—The real benefit we can gain is to have a general understanding of the heads here, so if I pass a car through Chicago, it will pass at Buffalo. If the owner will permit a car to go along, I do not believe anybody should pay for it. When a car is received upon our line which has a cardable defect, we give a defect card; if not, we forget it; there is no record.

Voice:—The receiving road is the party to say whether they will receive it or not. I cannot see how a delivering line can tell another road he must take a car, if the delivering road says it must be carded.

President Boutet:—I understood that your position was a joint car inspector. Whom do you represent?

Answer:—I represent the New York Central and Pennsylvania.

President Boutet:—Suppose a car was to be delivered by the New York Central to the Pennsylvania, whom would you represent?

Answer:—I would be their representative at the point where I am located.

Question:—You would represent both companies?

Answer:—Yes.

Question:—If in your opinion you thought best you would tell the New York Central to card it?

Answer:—Yes.

Mr. Schultz:—Providing one of these particular cars was a foreign car, would he still stick to his opinion? That is the point we are getting at.

President Boutet:—I believe you are trying to get back to every point that is making records. We run cars on record, but it is our practice not to make a record of a defect unless it should be carded. For little scratches, we do not make a record.

Mr. Devaney:—I want to ask if under Rule 41 at Cincinnati they will run a car out with that combination bad enough to card?

President Boutet:—Yes.

Mr. Devaney:—I think it is poor railroading.

President Boutet:—I expect you are not the first man to say that. It is often that a combination appears on different classes of cars.

Mr. Devaney:—We are accepting rule 41.

President Boutet:—We will take an eight sill car we find has two draw sills and an end sill cracked. The car is loaded with fruit that it would be injurious to transfer; it is lots stronger than many of the other cars. In the same case if we would stop that car simply because it had a combination, and it was stronger than the other car; is there any judgment in that? There is reason in all things and exceptions to everything. We do run them with a combination of defects. I am talking about the sills. There are often cars with defects bad enough that the owner should receive protection.

Mr. Devaney:—That isn't the point.

President Boutet:—I beg your pardon. They are broken so that a reasonable man should card; I believe it is a combination.

Mr. Stark:—Do you pass on notation?

Mr. Waughop:—It is very apparent to me from the talk that has been going on that it would be well for all the joint points to adopt one rule; that takes away from the foreman and the local inspector the right to say whether a car is safe to run. All cars for which the inspector holds a combination for a defect must be personally inspected by a chief inspector or his assistant, who will card the car if he finds it wants a card. That being true, all cars that are carded should be carded in St. Louis. It reduces to a minimum the men who can make a mistake. There are no willow plumes growing on my shoulders; I occasionally make a mistake.

Mr. Barker:—We are drifting back to passing cars under notation and we are going to receive authority to do that, because we have arrived at the time when we are expected to pass cars on twentieth century inspection; and if we are going to pass cars on run repairs, what is the chief joint inspector going to do unless he makes a notation? As far as we are concerned, part of our interchange is under that system, and part is not. I am free to say that the joint inspector that does not pass them under repair and transfer is doing just as good and with as few delays as the one who runs them. I am watching so as to see which gives the best results. My opinion is that we are coming to repair or transfer, and that means to run cars on notation.

Mr. Bradley:—Mr. Waughop suggests that the joint inspector or arbitrator would inspect that car personally and decide whether it should be carded or not.

Mr. Waughop:—That is correct.

President Boutet:—No, it is not correct. The joint inspector has nine assistants who go around in the yard every day. It is impossible for any one man to see the cars that have a combination on them.

Mr. Bradley:—Even at that, if he were in Buffalo with the nine assistants he would hold up freight and cause considerable delay. My idea would be to accept the car if it were safe to run. The car evidently is in safer condition than a great many cars that are hauled in that same train. Run the car on notation on homeward bound, and if the owners demand a card, trace the car back.

Mr. Waughop:—On all perishable freight?

The question was put upon the motion and carried.

Rule 44.

Mr. Trene:—What would you term improper loading?

President Boutet:—Is that personal to me? I would term anything improperly loaded if it did not comply with the recommended practice of loading long material.

Mr. Trene:—If you found a Big 4 car loaded with a load of any commodity that would reach up over the sides, or the car was spread, would you determine it owner's defect or delivering Company's defect?

President Boutet:—The delivering line. The stakes had not been tied together tight enough?

Mr. Trene:—No, the car itself had stretched out—a gondola.

President Boutet:—I would term that, if it had spread more than a given amount that it was delivering Company defect. The way we interpret Rule 115 American Association, we have taken 10 inches for the open car; if it is out of line more than 10 inches, it is improperly loaded; but if it is less than that the receiving line must take it, and if it does not clear their tunnels, they are responsible for the transfer. Sometimes a broken truck spring will cause it, but often in our country cars loaded with lumber, the load gets shifted more than 10 inches.

Mr. O'Donnell:—This man is trying to corner somebody. He wants somebody to take a steel car. What right have you to determine a limit on a car that is physically weak itself. I think the delivering line should be responsible according to Rule A 15.

Mr. Trene:—If Mr. O'Donnell delivers me a car in good shape and I put in the required number of stakes, and after the load goes on it spreads out; the car goes back to him and he refuses the car and says:—"Take the load out of the car." That is the point I would like to have decided.

President Boutet:—We have had quite a number of cases where cars are delivered from one line to another for loading; they get to the coal mines, the side stakes are broken out and the car goes back; it is bulged out 10 or 12 inches. In such cases where it comes back to them it is up to them to take care of it; but if it is caused by unfair usage, then we give a defect card against the delivering line.

Mr. Barker:—The rules that we recommend for loading material, say that these gentlemen should examine the empty car before they start it out to go to loading, and if it fails on the road they should receive it back. The rules specifically provide that cars shall be examined by a competent inspector before being loaded.

I would move you that this association respectfully suggest to the freight departments of the various railroads of the United States that each local freight agent and each yard master be provided with a copy of the rules for loading long material and see that they are lived up to. Then we shall have no trouble at interchange points or any local point in the inspection of long material.

Mr. O'Donnell:—You might just as well send those out to some country side resort and frame them. They all have these rules and they depend upon the inspectors to see positively that the cars receive due consideration either for rejection or acceptation. But this idea is an excellent one, if they only realized what it meant when they got them. I hope in making these remarks that the freight agents and yard masters will not think I am giving them any knock. There has been a vast improvement in the general condtion for loading long material; it seems to have been due to these rules. You take a mountainous road; they will not take cars with air lines bad. These roads are not so strict. The mountain lines say "We want that car absolutely in accordance with the rules for loading long material." That means taking off the soft wood stakes and putting on the hard wood stakes. Other roads would take the car. We have the same on pipe. The air line road can take the pipe, but the mountainous roads have to be cautious, because it is liable to cause them trouble on the double tracked lines. If we tie up interchange when it is not necessary it is not the spirit of cooperation. We are paid to be one part of the railroads that pay us, and it is up to us to cooperate in getting that freight through just as quick as we can.

Mr. Hitch:—I learn that there are a number of roads throughout the country that have no copy of these recommendations to be governed by. It appears to me that these recommendations should be embodied in this book.

The motion was seconded and lost.

Rule 53 (Old Rule 40).

Mr. Wymer:—There is a question that I would like to ask:—Suppose a car is offered in interchange with one inch train line and 1 inch air hose; how can that be repaired in order to get a standard hose on that car, and what part of it can be chargeable to the owner of the car, if any, and how much would be carded in interchange?

Mr. Gainey:—In answer to him. He can auply a 1⅜ air hose by putting an L on there. Some roads have a restriction that they will not run a car with a 1 inch train line on it. Can they refuse a car with a 1 inch train line on it that has been built previous to Sept. 1, 1910?

Mr. Barker:—If the receiving line is the judge as to the safe operation of their line, they can.

Mr. Waughop:—All cars built after the 1st of September, 1910, should be equipped with a 1¼-inch train line. All built prior must be, as long as they have the proper hose on.

Mr. Trapnell:—There are a good many of them running inch train line, and they have accepted it right along.

Mr. Stark:—We can repair them and charge the owner, is that the interpretation?

Mr. Wymer:—Suppose you get that car and offer it at interchange, and the other fellow rejects it, what can you do?

President Boutet:—Will you show me where the car can be declined under the present rule? We are talking about train line.

Mr. Wymer:—I am talking about hose.

President Boutet:—We are on the matter of train pipe now. If it meets with the approval of somebody I would like to have him make a motion. I understand that if any car is offered in interchange it must have 1¼-inch train pipe, provided the air was applied after September 1st. If the car was applied previously it must be accepted, according to this rule.

Mr. Gainey:—I will move you to that effect.

Motion seconded.

Mr. Hughes:—How are we going to decide when the car was built?

President Boutet:—I do not think there are any new cars that have been built in the last three years but that have 1¼-inch pipe.

The question was put upon the motion and carried.

Rule 55.

Mr. Weal:—This rule appears to be a new rule and makes the delivering company responsible for the price of torn air hose offered in interchange. Am I to understand that I could not accept a car offered from a delivering line at a junction point where it had no air plant to make a test until it was put in a train, and the air hose was found to be bursted, and bill the owner? Would we have a right to apply that bursted or torn hose, or leaky pipe due to seams, and bill the owner; or would we have to make the delivering company responsible for something the owner should be billed in?

Mr. Devaney:—He has already accepted this car and got it in his train.

President Boutet:—If a car is offered in interchange with a bursted hose—there is only one way that I could answer that: That car was offered in interchange and nothing discovered. In testing the air he discovers a bursted hose. He did not know whether that hose bursted before he got it or not; he could not see anything when he got it; then he would certainly bill the owners.

Mr. O'Donnell:—Is that according to the gospel of Mr. Shultz?

President Boutet:—It is not only the gospel in Chicago, but I think it will be the gospel of every car foreman in the country.

Mr. Weal:—I agree to that interpretation; that is why I brought up the point. Could a receiving line take a car with a bursted air hose and apply it and bill the owner under this rule?

Mr. Waughop:—He could but he would be a thief.

Mr. Weal:—After the car had been accepted, where there was no air plant to make a test until it was put into the receiving company's train?

Mr. Barker:—That would change the entire expense for the hose. Suppose the owner is delivering a train and the majority of its cars are his own cars, and he has an arrangement with a foreign line that he shall run, repair or transfer; he runs the train into the other man's yard; he makes a test and finds three leaking train lines and five bursted hose; shall the receiving line pay for this, or shall the owner? We are delivering cars where we do not make any inspection; we do not care what you do with them. We said we did not want any backward movement of freight. They are telling me that the joint inspectors are trying to destroy the freight traffic of the road, and we took a train and moved it into the other man's yard and he inspects the cars and finds a bursted hose; what shall Mr. Weal do? Shall he bill the owner or the other road?

Mr. Gainey:—If an inspector receives a cut of cars from a delivering line and he finds no defects, and he takes these into his own yard, and on a test he finds a bursted hose or a seamy pipe, he should charge it to the owner. He does not know whether it bursted before he got it or when he tested it, or while he was testing it. And it is fair to all.

Mr. Weal:—The point raised by Mr. Barker is a good one. There are a good many agreements in the United States where cars are placed into the receiving company's yard and the inspection is made by the receiving road's. inspector. The hose is found bursted before there is a test. This is going to work a hardship on the delivering company.

Mr. O'Donnell:—I do not think he is going to say that with all sincerity. That rule was in the book last year. While we have many agreements there are only two identical charges: fair and unfair. Take your pick and interpret. If you were going to make your neighbor pay for a lot of defects that were not fair, I would say, it is dishonest. I do not think the rule intends that a delivering line should card a lot of owner's defects. It was put in there to put a penalty on the delivering line. As long as you are making it equitable between you, nobody is going to worry you about any charge.

President Boutet:—If we read the first portion of the preface and Rule 56, you will see that the rule is contradictory.

Mr. Weal:—I am satisfied we are going to meet with more or less controversy with that very little thing.

Mr. Stoll:—I would like to ask the gentleman what he did all last year?

Voice:—I will say that Mr. O'Donnell explained the method that we have followed at Wilkes-Barre last year and we are doing so yet. If the damage is by fair usage we bill the owner, and for unfair usage we bill the line. Certainly a bursted air hose is not unfair usage.

Rule 57 (Old Rule 30).

Mr. Wymer:—I would like to know when you are applying 1⅜-inch air hose to a train line, there are certain repairs needed to make this connection; can you charge them to the owners of the car, these connecting parts—or what part of them are cardable in interchange?

President Boutet:—They cannot deliver that car to you unless it is equipped with a 1¼ air hose, and the same fittings that you would fasten a 1¼ to you would use in fastening a 1⅜ to. I cannot see where there would be any chance. We certainly haven't any inch hose in service now.

Mr. Wymer:—This same thing has happened.

Voice:—As I understand it we certainly have only one M. C. B. standard.

President Boutet:—Here is a car offered in interchange with an inch air hose. The delivering line's cars have inch air hose instead of 1⅜; what portion is chargeable to the delivering line and what portion is chargeable to the owner, if any? If a car is equipped with a 1 inch angle valve, it might be equipped with a 1¼ valve and a reducer put in there.

Mr. Hitch:—Suppose it had inch air pipe, inch angle valves and inch air hose?

President Boutet:—Who would you make the charge against?

Voice:—I believe the delivering line would be responsible.

Mr. Barker:—As I understand it there are two M. C. B. size of hose in service.

President Boutet:—In freight service?

Mr. Barker:—It was so intended by the managers of the railroads that there was to be. The rules state that 1¼ is right and a 1⅜ is all right. We do not want to throw away any good material. The rules state that the intention is not to throw away this good material.

Voice:—1¼ hose was M. C. B. standard before September 1st; but it is not since September 1st.

Mr. Wymer:—Under certain conditions.

Voice:—You cut the date on and we are going to sting you for it.

President Boutet:—It would be my understanding that if A were to deliver to B one of A's cars, that the delivering line would be compelled to charge for 1 inch air hose, which would necessarily compel the receiving line to take the inch angle valve off to make the repairs for that hose, as he cannot run a car with an inch air hose, and the delivering line would either have to take off the hose, or give the receiving line a card against him for doing the same. If I had a case to come up that way, I should decide it in that manner.

It was moved by Mr. Cox and duly seconded that if a car is offered in interchange by A belonging to C, that A should give B a defect card covering 1 inch air hose in place of 1⅜, which should cover the necessary work in putting on 1⅜ hose; or, it would compel him to put on 1⅜ angle valve.

Mr. Barker:—It has been a common practice for years to put a 1¼ nipple into an inch hose, and use a 1¼ angle cock. I made an examination of one last Friday.

President Boutet:—The reason that interpretation that way was that the rules specifically state that no cars built after September 1st could be equipped with anything less than a 1¼ train line. These are repairs made after September 1st, and I am afraid if you make any repairs that do not conform to M. C. B. standard at the present day, the owner would come back at you that they were wrong repairs. The owner would want redress.

The motion was carried.

Mr. Wymer:—That would carry with it the idea that when they come home the owner could not demand joint evidence for wrong repairs.

President Boutet:—He could demand it, but if he got it he would submit it to the arbitration committee.

Question:—How about the information contained on the plate?

President Boutet:—The arbitration committee tells us that this badge plate must contain all the information required. Under these conditions I have decided that any air hose that does not contain this information is not an M. C. B. standard. I did not feel that I was any more technical than the M. C. B. were when they inserted the rule.

Voice:—It reads "the name of the railroad." The arbitration committee submitted, either purchaser or railroad. We run cars on the Monon line, but that is a combination of railroads.

President Boutet:—Are they not the purchaser? I would like to have you interpret what you mean by the Monon or Frisco?

Mr. O'Donnell:—We have a large number of hose that come to us without cards, bearing the purchaser's name, G. H. Wood & Co. I cannot see how we can pass those without cards, if that is a railway.

Question:—Is G. H. Wood & Co. on the badge plate?

Answer:—It is right on the plate.

Question:—Isn't there a private car line by that name?

Mr. O'Donnell:—Not to my knowledge.

Mr. Waughop:—That is a private line; that is the name of a road.

Mr. McMun:—I move you that it is the sense of this meeting that an M. C. B. standard hose means that it have the name of the road or purchaser buying shown on the badge.

Seconded by Mr. Weal.

Mr. Waughop:—The name of the road means the name of the purchaser.

Mr. O'Donnell:—I do not agree with him. You must have the name of the railroad.

President Boutet:—Or purchaser—the purchaser takes down the fence for anything.

Mr. O'Donnell:—You have got to stamp the name of the railroad on there. The intent of the rule is to have the name of the railroad so that they can tell who bought the hose. I should dislike to see this association go on record that way at this late date, with all the great minds that have been working on the air hose question.

Mr. Waughop:—I move you that we amend the motion by making it read that it is the sense of this meeting that it be the name of the road or private car line owning the car.

Mr. Schultz:—There never was anything that caused us so much grief as the air hose question. It seems to me that the private car companies who buy hose and other concerns should be protected, and this motion should include anybody who is in the market to buy hose for the purpose of putting it on equipment.

Mr. Stoll:—The arbitrating committee had an extra meeting on that very thing. They sent out certain letters that when a purchaser's name was shown on the label, it was M. C. B. hose.

President Boutet:—This motion is that any information should have the name of the railroad or purchaser; if it does not appear on the badge plate as shown in the cut, it is not considered M. C. B. hose.

Mr. Barker:—I should not like to see this association go on record as destroying some valuable material which the railroads might use and then have the Frisco or Monon route get another circular out. They will go to the arbitration committee to show that it is 1⅜ hose and they will have to pass it. I think the association should be careful not to run up against the arbitration committee or trespass on their territory.

President Boutet:—I believe this association is proper to define what they consider is the proper interpretation of the rules. They say all information must be contained in this badge plate.

Mr. McMun:—They have an air hose with the name of the railroad outside of the badge plate as shown in this book; that should not be considered?

President Boutet:—There is a Monon hose that has the name Monon, that is separate from the badge plate entirely. The motion was that a hose printed in that manner should be considered as a non-M. C. B. air hose.

Mr. Head:—You take the Armour Co., they have 1,000 refrigerator cars; are they going to pay the Wabash to change them?

Mr. Waughop:—I move you that it is the sense of this meeting that the M. C. B. label as shown on page 24, under Rule 58, the top line where is says "the name of the road," means the name of any railroad company or private line car company owning cars; that it shall mean a proper M. C. B. standard.

President Boutet:—Would you eliminate the air brake company?

Mr. Waughop:—They must own hose.

President Boutet:—There are hundreds of them, and they have air hose manufactured that complies with M. C. B. standard.

Mr. Trapnell:—I would like to amend by saying any purchaser named on hose, when the specifications are complied with, would be considered M. C. B.

President Boutet:—That would include, if this badge had the name of any manufacturer, it would be considered legitimate as long as it was enclosed in the badge plate.

The question was put and the motion carried.

President Boutet:—That would carry with it the sense of this meeting that if the name of a railroad or private car line of air brake company, if stamped, is M. C. B. standard air hose.

Question:—It must be stamped on?

Answer:—Yes, on the original plate.

Mr. Dyer:—It says it shall be in the lower right-hand corner.

Mr. Barker:—The motion that we have passed is that it shall be in the original label.

President Boutet:—Yes, and only one label.

Mr. O'Donnell:—I would like to ask a question. We have run across quite a number of standard hose where the small lettering 1⅜ inch has been obliterated with constant rubbing; should we be technical and card as size missing?

Mr. Schultz:—If it is all right, I believe it ought to be passed.

President Boutet:—The instructions that I give are that they must be positive before carding.

Mr. O'Donnell:—Up in the terminal yards at Buffalo they are not going to cut the trains to find out the air hose. They come in and go out in fifty minutes; we cannot take a photograph of these cars. Any hose that shows originally by its general appearance that it was put on as a standard 1⅜ inch hose, let her go. If the size is dim, you cannot do otherwise or you are going to float a number of hose that are not proper.

Mr. Wymer:—You say in regard to the stenciling that unless you are sure it is not 1⅜, not to card. I am not sure that you mean that as broad as it sounds. There is lots of hose running that is claimed to be standard.

President Boutet:—Unless the inspectors are sure that it is not, they should not card for it.

Mr. Schultz:—I recently made an inspection of a great many cars for this purpose, and I found that a great many more hose met with the M. C. B. requirements that those that are being carded, and I feel that we ought to give the benefit of the doubt where there was a question that the hose was 1⅜ standard hose and not issue a card.

Mr. Devaney:—We received a card for 1⅜ hose which says that east of Buffalo somebody put a defect card on for wrong hose. It shows that the hose had not been removed. The people at Buffalo came back for an off-set defect card. What are you going to do?

Mr. Schultz:—Since August 1st, we have established a rule that we remove every non-M. C. B. air hose, and show the amount right there. We ought to do that at all junction points and the time would come that we would be rid of it.

Mr. Campbell:—I think your practice is what is causing us all the trouble up north. We are living up to the M. C. B. rule; you are passing them up to us where you think they may be 1⅜. We are changing 200 hose a day just on account of this trouble.

Voice:—If you are not positive the hose should be carded.

Mr. Schultz:—We have heard them argue and they say positively that the hose should be removed.

President Boutet:—The rules provide that a car should be equipped with 1⅜ air hose. We should realize something of the expense it would be to railroads and be very careful. Since the 5th of February we have carded over $50,000 worth of air hose. I am satisfied some is carded wrong. We make some mistakes. I watched two inspectors for ten minutes examining a hose to determine whether it was 1⅜ or not. We should not burden the railroad companies with any more expense than possible. I believe this association would take a step in the right direction if they would say if the inspector is not positive it is not 1⅜ to not card. Everybody that is buying hose is buying 1⅜.

Voice:—You may look at the label very closely and imagine you see 1⅜ there. Some other fellow does not see it. Why not card it in the first place. If you are going to take a chance on it; get rid of it.

President Boutet:—Your argument is all right if you are sure, but if you are not sure why should you burden A with the expense of that hose?

Voice:—Why should you burden the other fellow? If you are not sure that it is not an M. C. B. standard, it will not be carded.

President Boutet:—On that same principle, we should examine every journal to see that it is rough.

Mr. Schultz:—I move you that it is the sense of this meeting that cars offered in interchange having, and found to have, non-M. C. B. standard air hose, that the hose should be removed by the receiving line and a defect card requested, and in case of a hose appearing to have all dimensions of a standard, the benefit of the doubt be given to the hose; it should not be removed and no card requested.

The motion was seconded and lost.

Mr. Waughop:—Any hose that comes into the St. Louis territory with 1⅜ not appearing on the label will be carded regardless of whether it is 1⅜ or not. Take a car offered in interchange, if it showed only that it had no doubt been equipped with metal brake beams—no stencil is found with four or less wooden brake beams on it; what would you do with it?

Mr. Schultz:—I would pass the car.

Mr. Wymer:—I think we would pass the car along and it would be up to the owners.

Mr. Barker:—The owner can protect himself by stenciling the car properly.

Mr. Cox:—If a good many ball side bearings were lost out, would that be considered owner's defect or delivering line?

Mr. Schultz:—Rules 46 and 67 say it is owner's responsibility.

Mr. Cox:—These bearings are missing from fair usage, due to faulty construction.

President Boutet:—I would say that it is owner's defect, if done under fair usage.

It is past our usual hour for adjourning, but there are some who desire to take in the trip tomorrow with the ladies, and not have any meeting until Thursday morning. We have got to show our officials that we are doing some work. If you feel that you want to take in the sights tomorrow, you want to come back Thursday morning and knuckle down to business.

Mr. O'Donnell:—I move you that when we adjourn, at 12:30 tomorrow, it will be until 9 o'clock Thursday morning, and when we adjourn at 1 o'clock Thursday, it will be for good.

Seconded by Mr. Cox and carried.

It was decided to continue the session an hour longer.

Rule 68.

Let me ask why a separate defect card is to be furnished in this case?

President Boutet:—As I understand it the New York Central has a Pennsylvania car with a steel-tired wheel—they deliver that car to the Norfolk & Western; give the Norfolk & Western a card for a pair of slid flat wheels, for removing wheels and replacing it again, and a card should be given to the Pennsylvania R. R. covering the loss of metal, and the Pennsylvania could bill against the delivery line for the loss of metal.

Mr. Stoll:—I do not agree with that interpretation. The car owner is being billed in for the defect in this case.

President Boutet:—To get at the facts of the matter, suppose a Pennsylvania had a N. & W. car and they delivered that to the Big 4 with a steel-tired wheel slid flat 2½ inches. The Pennsylvania would give a card to the Big 4, specifying one pair of slid flat, 2½ inches long. They have taken off a certain amount of metal, and where would the owners get any redress for the loss of metal?

Mr. Stoll:—The receiving company gets a defect card against the delivering company. The receiving company bills the car owner for the defects and the car owner counter-bills the delivering company. The rule says: "When the repairs are covered by a defect card, etc.——"

Mr. Brown:—The road that has the car, when he bills the owner, on the strength of a defect card that he got from the delivering company line, he gives a statement of the amount of whatever is taken off of the wheels, and he counter-bills the other road and gets credit for it in that way, for the amount that was taken off.

Mr. Stoll:—I agree with you that a defect card is necessary.

Mr. Gainey:—I will have to agree with this man here, on page 46, it says: "Delivering line defect ———

Mr. Barker:—I supposed we understood that. It is just as the rule reads, and it is very plain. Issued only one defect card.

Mr. Stark:—Do you mean that a separate defect card should obtain to a slid flat?

President Boutet:—If a car is delivered with a slid flat wheel and there is no other defect on the car, we have a separate card. That would undoubtedly cover the turning off of both wheels, if you give a card for the defect.

Mr. Barker:—That would depend upon the practice of the road.

Mr. Stoll:—I move you that one defect card is all that is necessary in case there are no other defects on a car.

Seconded and carried.

Mr. Weal:—Here is a question: A car is offered in interchange where M. C. B. interchange returns a car to delivering line for repairs; the delivering line turns the wheels up and applies them under the car. It is their duty to notify the owner on a repair card and make out no bill. Is it not? That is to be done by a repair card?

Mr. Stoll:—I believe that the fellow who destroys the wheel would be in debt to the extent of 75 cents.

Mr. Dyer:—Would the charge for journal bearings be included to the owner.

President Boutet:—He should pay any bill that is necessary to make the repairs. If it is proper to include any portion of it, it is proper to include all. Mr. Stoll, according to your statement, if the New York Central had a Norfolk & Western car on their line and they slid the wheels 2½ inches; they took the wheels out and notified the owner that they had removed a pair of wheels on such a car, that the owners would be indebted to them?

Mr. Stoll:—No, sir; the party who slid the wheels would be indebted to the owner for the loss of metal.

President Boutet:—And for the removal of the wheels; they have to do it at their own expense, but they do not.

Mr. Stoll:—If it exceeded 2½ inches it would be more.

Rule 84.

Mr. Mahoney:—I would like to ask how much an axle has to be bent to render it unsafe?

Mr. Barker:—I have known of an axle bent so that there was 1¾ difference and it run all right. I should not want to run it at all.

President Boutet:—To enable the gentlemen to get the information asked for, I will tell how I treat it. If I find an axle would vary more than a half inch, between flanges of wheels, I consider it bent. That is a pretty strong limit in cast iron wheels. It would vary from ⅜ to ½ inch of a heavy loaded car. When it does not vary over ½ inch in gauging the wheel all around between flanges, it is not bent so that we would take it out.

Voice:—Rule 38 covers that.

Member:—It isn't the bending of the axle; it is the variance of the flange. We had a rule where I was that the variation should be ⅞ of an inch. We used to run when less than ⅞. We used to run until the flanges were worn down thin. We did not test on top and bottom, but we would go along each side and see that the weight of the car would not make any variation.

Mr. McCormick:—My experience is ⅝ of an inch.

Mr. Huett:—Mine is ⅜ of an inch, but I would like to know if any you have had any experience with steel-tired wheels.

President Boutet:—As far as an axle being bent, with our heavier flanges, the flange takes up about all the room we can possibly spare on the guard rails. The M. C. B. has made a rule whereby if it exceeds a certain limit it is unsafe. I think we better confine ourselves pretty closely to the M. C. B. requirements.

It was moved that the previous motion in regard to adjournment be reconsidered. Seconded and carried.

Moved by Mr. Dyer and seconded by Mr. Censar that when we adjourn, we adjourn to meet at 2 P. M. tomorrow. Carried.

Wednesday Afternoon Session.

The following telegram was read from Mr. Brazier:

New York, Sept. 6th, 1910.

H. Boutet—

Hotel Arlington, Washington, D. C.

Very sorry cannot attend your convention. Hope you will have profitable meeting. Central is well represented in Executive Member McMunn and General Inspector Chabbee.

F. W. BRAZIER.

President Boutet:—If there are no objections the telegram will be received and placed in the proceedings.

Report of Executive Committee.

Mr. Waughop:—Mr. James E. Jones, inspector of safety appliances with the interstate commerce has made application for membership. It is the opinion of the executive committee that our constitution forbids the election to membership any one not connected with the interchange of railroads, or a representative of a railway supply house as a social member. We recommend, however, that any interstate commerce inspector be elected as an honorary member of the association and be admitted that way.

The executive committee has examined the books of the secretary-treasurer and found them correct in every detail, as follows:

On hand September 15, 1909 .... $ 9.46

Received from active members	353.00
Received from social members	125.00
	$487.46
Disbursements	368.70
Total on hand	$118.76

The executive committee recommend that the present meeting's work of the stenographer be taken care of. Also recommend that the secretary, if the funds will permit it, be allowed the sum of $50.00 for his services.

It was moved by Mr. Waughop that the suggestions of the executive committee be concurred in. Seconded and carried.

President Boutet:—That includes with it, if you adopt the secretary's report, an increase of salary of $50.00. We have got to a position now where the association is able to pay the secretary $50.00. That will not pay him for the duties he has to perform, but we have got to get at it gradually.

It was moved that the report be adopted. Seconded and carried.

It was suggested by Mr. O'Donnell that Mr. McMunn relieve Mr. Stark in the reading of rules.

Mr. McMunn:—I would suggest that we dispense with the reading of rules and simply take up the changes.

President Boutet:—We will read the number of the rule and not discuss it unless somebody has an objection.

Rule 100.

Mr. O'Donnell:—Wasn't it understood that we would agree on the loss of service metal on steel wheels; has that been passed upon?

President Boutet:—Yes.

Rule 101.

Mr. Head:—That takes care of the discussion yesterday as to when issuing one defect card, how to render a bill.

President Boutet:—That is where your president was a little lax yesterday.

Rule 108.

Mr. Huett:—Is there any change in old rule 105? What do they mean by no charge to be made for lettering, etc.?

President Boutet:—They charge for so many square feet of paint. Stenciling and everything goes in with that.

Mr. Barker:—If the car is not stenciled, that would be improper repairs and the car would be entitled to joint evidence.

President Boutet:—Yes.

Mr. Barker:—Sometimes it has caused considerable expense in the general office on account of one figure being left off, and the car was not stenciled with that number.

Rule 112.

Mr. Biddim:—I would like to know what they are doing for doors off and in cars when cars are offered in interchange?

President Boutet:—As far as Cincinnati is concerned, we are not issuing any cards for a door off that is all right in a car.

Mr. Vittum:—Our executive committee made this a cardable defect and sent it over the receiving line to have the door applied. I understand that there is a different interpretation put upon this rule at the different points. If we are wrong, we ought to get right.

Mr. Berg:—Has he reference to empty or loaded cars?

President Boutet:—What difference would it make?

Mr. Vittum:—You cannot tell whether a door is in a car or not if it is loaded. We would not know whether the door belonged to that car or not; somebody might stick an old door in the car.

Mr. Waughop:—We do not card them.

Mr. Barker:—There are a number of interchange points that I am connected with that treat a door spoken of by Mr. Berg as improper repairs—a door that does not fit.

Mr. Stoll:—I believe it is very plain that if you have a car that has a door loose you bill for hanging it, one hour. Old rule 94 is for applying a side door, but rule 106 provides for rehanging a side door.

Mr. Gresham:—That is the way we look at it down in Memphis. If the car is stopped at any point on our line, and we find it to be the wrong side door, then it is a cardable defect; otherwise it is chargeable to the owner for the replacing of the door.

Mr. Waughop:—What do you card for?

Answer:—For a side door missing, when the door does not properly fit the opening of the car.

It was moved by Mr. Waughop that it is the sense of this association that where a car moves in interchange with the proper door loose in a car, that no card be given.

Seconded.

Mr. Livingston:—When a car is offered in interchange with a side door lying in the card, and it is the proper door, that you consider it owner's defect, and you would have a right to hang the door and charge the owner for one hour's time.

Mr. Waughop:—It would cost more than you would get out of it to put in a 24 cent bill.

Mr. Devaney:—I wonder if Mr. Waughop means a side door that fits the car?

President Boutet:—It certainly could not be the proper door, if it were a Norfolk & Western door in a Pennsylvania car.

Mr. Devaney:—If some one puts a Norfolk & Western door on and it fits in every respect?

President Boutet:—It would hardly be fair, if, I wore the same shoe you did, for me to accept it, if a mistake was made and your shoe given to me instead of my own.

Mr. Devaney:—We are not interchanging shoes, but we interchange couplers in a car, why not a side door?

Mr. Waughop:—It simply takes joint evidence in putting the fasteners on the door.

Mr. Chapman:—I find a large number of the doors that are laid in the cars, have the rollers missing, and in a majority of cases the hangers are missing; that is the reason the door was not hung. How would you treat the door?

President Boutet:—I would treat it the same as any other missing material. If the hangers were gone, it was not a complete door.

The question was put upon the motion and carried.

Mr. Waughop:—I move you that it is the sense of this meeting that where a car is offered in interchange with a side door that does not belong to the car and will not fit it, that it be carded as a missing door and that the door be returned.

President Boutet:—I do not think we ought to compel the receiving line to return the door to anybody.

Motion seconded by Mr. Trapnell.

Mr. Stark:—Have we any right to take such action?

President Boutet:—I realize that there was a portion of that motion that was not correct, but I think the intent of the motion is all right; that was that where a car is offered in interchange with a foreign door in the car, that it was a cardable defect.

Mr. Stark:—If you say that is the sense of this body, I will agree.

The motion was carried.

Rule 114.

Mr. Head:—There has been a great deal of correspondence in regard to bills for the application of siding on cars and sills. Ordinarily they have never been allowed on side sills, but we have been allowed to charge for end sheeting. The private lines have put it on to the railroads a great deal in the replacing of sills and made a charge for the end sill. This rule is to make the ends the same as the sides.

Rule 107.

Mr. Devaney:—I would like to go back a moment, what I want to find out is, how do we get at that labor. For instance an end sill on a steel car—one man would take three hours and another five. Is there anything in the rules that would keep us in a limit on that? It will likely cause trouble and a complication of bills.

Voice:—Wouldn't ten cents a rivet cover that?

Mr. McMunn:—That is covered by the foot note. It would be put on at a price per hour. 10 cents per rivet.

Mr. Devaney:—How are we going to get at the actual time?

Answer:—The bottom of page 58 answers the question.

President Boutet:—That does not cover the question.

Mr. Devaney:—You take any price of structural steel broken —one of the truck sides—there would be four or five hours labor; there is nothing in here that I can see to cover that.

President Boutet:—He has a car that he received from a connection with a broken end sill with an M. C. B. defect card on. His understanding is that he can charge the actual time consumed. He says he might consume two hours and somebody else would possibly charge for five hours. In my opinion the proper charge would be for the actual time consumed as there is no set rule.

Mr. Wilcox:—I have charged on the basis of 10 cents a rivet. That covers drilling the holes and putting back the end.

Mr. Barker:—What shape would you be in with the railroads that build cast steel end sills, and end sills made out of structural steel? The M. C. B. committee expect to make a report on that next year. I do not think that is covered by the rule.

Mr. Waughop:—It does not mention wood or cast steel.

Voice:—We have been billing them out on a rivet basis where we apply new end sills, which includes drilling out and punching, and cutting out old rivets.

President Boutet:—There is a difference of opinion. Some think it is proper to charge for the new material and labor necessary; others think it should be charged by the rivets.

Mr. Gresham:—I have never applied metal end sills, but I have applied metal truck sides. We charge on a rivet basis for the truck and then regular M. C. B. prices for applying the truck side. Our bill was accepted as correct. I should think that a metal end sill would be considered the same way.

Mr. Wymer:—I move you that it is the sense of this convention that in applying structural steel that the actual cost of the labor necessary for drilling should be charged in addition to the rivet basis.

President Boutet:—Do I understand you to say new material?

Answer:—New parts. Yes.

Motion seconded.

Mr. Huett:—Is that figured on piece work basis? We have always charged for metal end sills, so much a pound for the material and 10 cents a rivet, which covers removal, replacing, fitting and punching. That is our practice.

Mr. Devaney:—They do not seem to understand what I mean. I mean getting it ready to put in. If Mr. Wymer's contention is right, what is this rule for?

Mr. Wymer:—I do not understand this note on this rivet basis refers to punching and drilling holes in new parts—when you are replacing those—putting the part back in. This end sill had never been on that car before.

Mr. Barker:—A distinction is made between renewing and replacing. Replacing is putting back the old part.

Mr. Huett:—We have to drill holes for replacing.

Mr. Hill:—In damaged structural end sills, there are no two damaged alike. One would cause five or six hours' labor, and another but two or three hours. My impression is that they have left it open on that account.

Paragraph 3 on the repair of steel cars was read.

Mr. Devaney:—If I repair a steel end sill and it takes three hours to drill out and fit it, I would charge three hours at 24 cents an hour in addition to the rivet basis. And he gets another end sill and takes five hours; he is allowed to charge five hours at 24 cents an hour in addition to the rivet basis.

The motion was carried.

Mr. Barker:—I do not know whether it is for this association to say what is the proper charge. There is a committee of Master Car Builders working on that, and I do not see why it is proper for us to decide in advance of their decision.

Mr. Waughop:—I move you that it is the sense of this meeting that a proper charge for replacing or renewing structural iron end sills or structural iron parts shall be on the rivet basis, plus the last two lines on end sills on page 56.

Seconded by many.

Mr. Gainey:—I think Rule 107 covers that. It says it should be charged at the current market price, plus the labor.

The question was put upon the motion and lost, 20 voting in favor of the motion.

Mr. Devaney:—I do not understand Rule 107 as this association understands it.

Mr. Rearden:—I move you that it is the sense of this association that that labor charge of seven hours should cover the labor charge for any kind of an end sill.

Mr. O'Donnell:—Inasmuch as the matter is now reopened, why not have Mr. Devaney give us some reason as to why he is so anxious? No railroad would object to that charge.

Mr. Devaney:—If you are repairing a steel end sill, I think Rule 107, if it takes one man 3 hours and another 5; he is entitled to charge for five hours in addition to all the other charges they are talking about. It is left to the man who is making the repairs.

Mr. O'Donnell:—I think any shop should use common sense and good judgment. Some shops have up-to-date appliances while other shops are not in a position to do it. If you are not in a position to repair the steel parts on a good substantial labor basis you could deduct the amount that you have used up in consideration of what appliances you have. I do not think any road would object to a just charge.

Mr. Wymer:—As I understand the vote that was taken, it is the sense of this meeting that no additional charge can be made for repairing end sills. As far as the road I represent, I think we shall make a charge, and would be very glad, if any one would taken exceptions to it, to put it up to the arbitration committee.

Rule 115.

Mr. Lynch:—There appears to be repetition of charges.

Mr. Berg:—In one place it says 35 and in the other 25.

Mr. Wymer:—On one side it in cludes 4 items and the other nine. That is where they get the extra charge.

Mr. Waughop:—I think it would be well for the railroads to call attention to the fact that when home route cards be called for that they do not specify all existing defects on that card.

President Boutet:—If a car is delivered home, down in our territory, and it had been home routed by some foreign line and the home route card called for two decayed londitudinal sills and decayed end sill, and, on examination of the car it shows that the sills are not decayed but broken from unfair usage, we give the delivering line the opportunity to take same up with the line delivering the car to them and request an M. C. B. defect card covering defects.

If they are unable to get defect card, we give a card against the delivering line covering a combination of defects caused by rough usage, which had evidently been misrepresented by the person asking for home route card, claiming that the defects were caused by decay.

Mr. Waughop:—A car may be sent home for general worn out condition; why should we specify them?

Mr. O'Donnell:—Is that the regular standard home route card that outlines that? They are scarce in our vicinity. There is a local card that we use, but we have disregarded those. If it is a wrecked car of course we have to hold the car up and protect the receiving line with a defect card, but we do not receive any cars, to my knowledge, thus covered by defects either for bad roofs or whatever it is for.

(Balance of discussion omitted)

Rule 128.

Mr. O'Donnell:—It is not up to us to put any interpretation on the balance of the rules.

I move you that we simply pass upon the rules as adopted by this body in the manner stated. That is the freight car rules.

Seconded and carried.

Mr. O'Donnell:—If there is any person directly connected with the passenger work, who wants to take up anything in the passenger rules, I think it is only right that we should discuss these points. But if there is not, I would ask that we pass them without discussion.

Mr. Hill:—I am connected with passenger work on our road, but I will say in regard to any of the rules, we keep absolutely within the limit and on the safe side and we have but very little difficulty in adjusting the difference between the private lines. We go to the extreme in adjusting the limit on the passenger cars. We do not allow them to come to any limit on anything. that is questionable.

Mr. O'Donnell:—If we have disposed of the rules I am going to ask the courtesy of this body to a gentleman who has listened to our discussion very patiently for the past few days, and who honors us by his presence,—Mr. Lucore of the American Railway Association,—for a few words of encouragement to this body.

Mr. Lucore:—There is one thing that has occurred to me in listening to your discussions, and that is, it does not matter how perfect a set of interchange rules may be devised, a great deal of the benefit of these rules is wasted if there is any misunderstanding as to what the rules mean. We all know, as railroad men that it is one thing to issue an order and another thing, to execute it. I am very sorry that there are not more members of the Master Car Builders here to listen to these discussions, and to see how earnestly you are endeavoring to arrive at a uniform understanding of what their rules mean. It is of course very desirable that there be perfect rules, and it is quite as necessary that there should be a perfect understanding of how to put those rules into effect, and you appear to be giving that phase of the matter the careful consideration it requires. (Applause.)

President Boutet:—In answer to Mr. Lucore I could only state that this body of men has been meeting for the last fifteen years, and it has been our impression at all times that our book of rules is liable to have a great many constructions. Every point in the country claims that it is working under M. C. B. rules. Some claim one thing and some another, but I believe we all feel that when a defect card is placed on a car, that it should only be placed there when a defect exists on a car of such a nature that it should be repaired the first time it is in the shop at least.

If there is no objection we will now listen to the paper by Mr. Gainey.

Mr. Gainey:—I would like to move that the telegram from Mr. Brazier of the New York Central be acknowledged with the advice that we are having a successful meeting.

Seconded and carried.

Mr. Gainey read his paper, which appeared in the October issue of the Railway Master Mechanic.

It was moved by Mr. Trapnell that the paper be received, placed on file and entered in the proceedings of the association, and that a vote of thanks be extended to Mr. Gainey for the paper.

Seconded and carried.

Voice:—Does that mean that it is the sense of this association to accept running repairs?

President Boutet:—That we accept the sentiments of the letter, that would mean, according to my idea.

Mr. O'Donnell:—That of course will be handled in the receiving Company's yards. It is a breach of rule for running repairs, to eliminate inspection except for safety appliances. I think Mr. Gainey is only putting another nail in the fundamental principle. The thinking man says:—We have got to do away with holding up cars at terminal points. I think Mr. Gainey's paper is one of the matters that is going to prove it to you. We may not all be in the interchange business in the future, but you may be a successful railroad man, and it seems an outrage to hold a loaded car at a terminal point for eight or ten hours on a technicality of interchange inspection. I think 50 minutes at the outside is long enough to hold a car unless it has defects that necessarily must be dealt with before it can pass out. I think Mr. Boutet and all the rest of the men who are on this movement should be complimented. It is no hobby of mine, I am simply carrying out the wishes of the 13 roads that employ me, and it is the duty of all of us to go ahead and devise ways and means of getting the freight through the country, and that is the most practical way. You should look at the lading of a car and let it pass on.

Mr. Wymer:—As I understand the motion it is that this paper be published as a part of the proceedings and not as an expression of the sentiments of this association.

President Boutet:—That is the way I understand it.

Mr. Trapnell:—That is my sentiment entirely.

Mr. Wymer:—I would hate to see that motion prevail because it is a subject that has already had a great deal of discussion, and a paper like that carries with it so much room for thought. It seems to me it would be rather difficult to vote upon the sentiments in that paper without having time to read it over carefully. I should not like to vote in favor of such radical changes, without further time, but I think it should be a part of our proceedings.

Mr. Hill:—The paper read by Mr. Gainey gives a fair exposition of the conditions that exist at Cincinnati and the manner in which conditions are treated. It is not understood that we desire a vote to adopt our methods. We only wish to say that our successful manner of handling the interchange has proved very satisfactory.

Mr. Schultz:—The proper procedure is to vote on the printing of this paper in our proceedings, and then I think the next is to discuss the paper. I want to be understood as wanting to have it printed and discussed.

Mr. Barker:—Does that permit this association to recommend to the railroads that this association recommends running repairs?

President Boutet:—According to the way I stated the motion that is what it would do, but the mover of the motion states that he did not intend it was the sense of this meeting that that was the proper manner.

Mr. Barker:—I am aware of several interchange points where they have forbid that.

President Boutet:—We should not discuss the paper from that point of view. I do not think it is within our province, and I hope Mr. Schultz's motion that we accept the paper will prevail.

Mr. Barker:—The first inspection is the first delay to see that is it safe, and they are inspected afterwards so that they have two inspections. I do not know of any interchange point that has any more. I am acquainted with interchange points that have both. One has the run repair and transfer and the other does not. So far as my records go, one is handled just as well as the other.

The question was put upon the motion that the paper be received, and carried.

It was moved that the paper be discussed.

Mr. Trapnell:—Before we undertake to handle the paper, it should be carefully read section by section.

Mr. Schultz:—As there are other papers, I move you that we read all the papers. Seconded and carried.

Mr. Trapnell:—I move you that the discussion of papers be made an order of business the first hour in the morning.

Carried.

Mr. Devaney read a paper which appeared in the October issue of the Railway Master Mechanic.

It was moved by Mr. Waughop that the paper be accepted, made a part of the proceedings and a vote of thanks extended the writer.

Seconded and carried.

A paper written by Mr. Harvey and published in the October issue of the Railway Master Mechanic was read by Mr. Schultz.

It was moved by Mr. Trapnell that the paper be accepted, made a part of the proceedings and that the secretary be instructed to correspond with Mr. Harvey advising him of the thanks of this association, and a vote of thanks be extended to the reader of the able paper.

Mr. O'Donnell:—The main thing is to carry out what he has told us.

Mr. Devaney:—It is one of the best papers I have ever read. He brings it out in such a nice manner, and we should follow the instructions.

Mr. Schultz:—The idea of this paper is to call attention of the designers to these little things.

The question was put upon the motion and carried.

Mr. Waughop:—You are no doubt aware that the A. R. A. and the transportation departments are very anxious to move freight. In other words, they wish to get the quickest possible mileage out of freight cars in the least possible time. Several of our roads have severely hampered the movement of cars on account of penalty defects, particularly so in large terminals, and I am going to offer a resolution and ask that it be discussed tomorrow.

Resolved that the chief interchange car inspectors and car foremen of America recommend to the Master Car Builders arbitration committee that all cars moving in interchange, with car owners' defects, which could have been repaired and charged to the owner prior to offering in interchange by delivering line, shall be received in interchange without M. C. B. defect card, and when so delivered and repaired by the receiving line shall be charged to the owner.

Seconded by Mr. Trapnell.

Mr. Schulz:—It is certainly a good, practical idea, but the technical point is being used by the M. C. B. to penalize the road in order to bring the equipment up, would stand in the way of the adoption of the resolution. I personally feel that it is the proper way to handle business. It cannot make any difference to the car owner, and I believe that the technical point that is being used to penalize the railroads is wrong.

Mr. Waughop:—The point that Mr. Schultz brings out is just what I wanted brought out. I have followed the M. C. B. rules since 1876. The penalizing of the M. C. B. was made with the object of inducing the delivering line to maintain the equipment of foreign cars while on their system. The object was correct but it has failed in its purpose. No one in our country pays attention to it. I believe that if a car owner defect is chargeable to a car while on a system it should be a car owner defect anywhere. (Applause.) Not hold the car a month for a defect card, but repair it such as you would any other running repair. I think if it were put in the proper light before the arbitration committee that their object has failed and that it is just equalizing itself, they would see it as we do. If you strike a balance at the City of St. Louis on all car owner defects interchanged at that point, there would not be $300 difference on the balance sheet either for or against a railroad in a year. Why cause all this extra expense, passing it through the auditor's office, when it should be charged to the owner direct?

Mr. Gainey:—I could only repeat what Mr. Waughop says. I heartily agree with him. I have always contended that what was an owner's defect at one time should be an owner's defect at all times and under all conditions. I hope the motion will prevail.

Mr. O'Donnell:—I was going to voice the same sentiments as Mr. Gainey. I am pleased that our old war horse is the mover of the motion. The credit should be given to him in a way because he has been with the association so long. The time is coming—I am not a prophet but say this with confidence, that it will come out in the end as we anticipate—that a car owner's defect is a car owner's defect at any stage of the game. I have had lots of trouble, a number of roads simply object to a card for a brake shoe missing on a car a mile and a half distant. In order to help that car load, we see fit to repair the car to the amount of 45 or 50 cents in the receiving yard. It is charged to the owner. He checks it and he says that the car was delivered in interchange and has a defect card. Somebody above us says:—"Obey instructions." The work that we are trying to do to move the car is not appreciated. There are about 7,000 or 8,000 cards a month issued for the little casting that supports the truss on top of the wooden block. It does not amount to 2 or 4 cents, labor and material. We card these to the extent of keeping the inspectors awake nights thinking about what they are doing. They do not know whether they are carding cars or simply doing work for the railroads. I fought for the men on that proposition. The rules say that material missing from cars offered in interchange must be carded for. I believe we should ask them, "Why this fallacy: obey the rules?"

President Boutet:—In answer to Mr. Schultz, who seems to think if we take a vote on this we would be doing something contrary to the M. C. B. rules, I look at that in a different light. This association passes a resolution which is the sense of this meeting that a rule should be changed in such and such a manner. We have been recognized by the Master Car Builders for four or five years. If they do not see fit to adopt our view, it does not prevent the association from still saying to them: "We believe we are right, and we would like to have you consider the rule," giving them our reason.

Mr. Wymer:—The wording of that rule, to my mind, is at variance with the intention of it. That resolution forces the receiving line to accept the car, while, as I understand it, if it is a car owner's defect over in A's yard and he delivers to the other fellow, that it still remains a defect. That says he be required to accept the car.

Mr. Waughop:—This is simply a recommendation to the arbitration committee, if they see fit to take from the M. C. B. rules the penalty defect and force a railroad to take a car which is rotten.

Mr. Wymer:—If that resolution prevails it would mean that if we would offer the car with any car owner's defect—it might have a broken draw sill—we would have to accept it. I do not think that is the intention.

President Boutet:—I believe in my own mind that in the next ten years we will have nothing except safety inspection. All cars will be pooled and we will run our cars as long as safe and the expense will be charged pro rata according to the mileage. Run repair may be looked at by some of you people as bugbear. I expect that I opposed run repair or transfer as badly as anybody. I could not realize anything except that we were going to pile up cars and burden one road with all the repairs of the other line; but after it had been in vogue a short time I realized I was wrong, and after being in vogue since 1902, I am free to say that I have never seen anything that will move freight better than run repair or transfer. The interstate commerce rule says we shall not haul a pound of freight unless we receive revenue. What right have we to make others haul it back and haul it over again without revenue?

Mr. Wymer:—I do not want to go on record that I am against or for "Run, Repair or Transfer." If this resolution means that, let us debate it on those grounds. The resolution means one thing, but it carries more than that with it. I think it might be amended in some way to say that if the receiving road repaired that car that it could be charged to the owner.

Mr. Waughop:—I make the motion just as I read it. We do not want to go back; we are going ahead.

The question was put upon the motion and carried.

Secretary Skidmore:—The interstate Commerce Commission has sent down a large number of proposed new safety appliance acts to be distributed among the members.

President Boutet:—I have kept you here after our hour for adjournment so as to help us in getting through tomorrow morning, but if there is no objection we will now adjourn.

Thursday Morning Session.

President Boutet called the meeting to order at 9 A. M. and called for a paper from Mr. James Reed, general foreman of passenger inspection at Buffalo, after which he requested Vice-President Trapnell to take the chair during his absence while helping to make arrangements for entertainment.

Mr. Reed delivered an address which appeared in the October issue of the Railway Master Mechanic.

Mr. McMunn:—I move you that the paper be accepted, included in the proceedings and that Mr. Reed be tendered a vote of thanks for the very able paper.

Seconded and carried.

Vice-President Trapnell:—A special order of business was the discussion of papers at yesterday afternoon's session, and I suppose will include the one this morning. The first paper was the one by Mr. Gainey relative to run repair and transfer. If there is no objection, we will proceed along that line.

Mr. Shraeder:—In regard to the paper on hot-boxes: I happen to have an opportunity of being on one end of the line and Mr. Reed on the other, about 450 miles apart. I change on an average 350 or 360 wheels a month. On some of the fast trains, after the wheels have been applied we give a car a trial run for about 25 miles and send a man on the train with the car. The man goes as far as Ratzler and leaves the car in fine shape; the car goes into Buffalo with a hot-box, and we are unable to explain the cause. I think a discussion would enlighten us, and we would like to hear what the others say.

Mr. Hill (C. & O.):—We have claimed at different times that we have no hot-boxes. A few years ago we prided ourselves on having so few hot-boxes. We have as heavy coaches as there is. A western road had gotten word from our superintendent of motive power that we were having no hot-boxes, and they sent two experts to the Cincinnati terminal to examine what was the cause of our success. They stayed with us four or five days and went from there to Huntington. They claimed they got nothing from us.

In the first place we run absolutely on soft metal. In the second place, we have not discarded the free oil. We have picked one of the old practical men to give them his undivided attention. In applying journals to the fast passenger trains: In the morning our inspector goes over the cars to see if the wheels are to changed; they jack up a car and put them right in and out they go. There is no trial trip. Some of the peole object to the method that we take in dressing our brasses. They are made in the Huntington shop, strictly for passenger purposes. This oiler takes the brasses and dresses them up. What we want is success. Before the oil is put in I examine the journal personally and we never call good, enough. Good enough is a poor job. It has to be just as near absolutely perfect as we can get it. If not, we go to work on it. Since the 1st of March on No. 2 of our fast passenger trains, we have had one hot box and we found that the babbit was broken. We go over our train carefully and if any of the brasses are down to the hard metal, we take them out.

Mr. O'Donnell:—I want to inquire the length of the division over which he has charge and the physical condition of the track.

Mr. Hill:—We have 162 miles in the division, but our train runs direct to Jersey City. From Cincinnati to New York, and we are accountable for the journals down there and return. Our superintendent has said to us: "You are well aware that a car can be oiled so it will run 1,600 miles; I never want the box lid raised until it gets back." The round trip to New York is our division. I am speaking of our heaving passenger Pullman and C. & O. 6 wheel truck. Occasionally we have a heavy express car 5 x 9 journal—there is occasionally a hot box on that, but I am speaking of the passenger equipment. We have them occasionally on the heavy express because we cannot tell how heavily they will load the car and we account for the hot box by the extreme pressure.

Mr. O'Donnell:—I think Mr. Reed brings out many valuable points. Mr. Shraeder says he is at the New York end and he is at the Buffalo section. I have had more or less conversation with Mr. Reed and those directly connected with him, on the conditions be brings out, and I want to say—being acquainted with the work that he is up against—I do not think there is any line in the country that is more zealous for the welfare of the passenger equipment in regard to delays, than the line he represents. His chief superior is very zealous to see that the hot-box question is kept down. I think Mr. Reed should be given some points by those directly interested to help him along. He has brought a paper here with that end in view at the request of the president. The Buffalo terminal is one of the heaviest terminals and they have some pretty fast service going through those points. That is the reason I would be very glad to have as much discussion as possible.

Mr. Gresham:—I was in the passenger service at a point just about half way between terminals. It was the practice of that road to send a man out with new wheels during the winter time, but not in the summer. I have found one thing that obviates the hot-box question and that is having a thoroughly clean journal. I am not very particular about the brass being cleaned out, but you should have a little bit of pin grease and put a coat of that in the brass before you put it in the journal. It is very seldom that it will give you trouble. I had occasion to remove a brass from a chair car that came out of New Orleans. It run 395 miles with a Cook cooler on it. The conductor advised me if he were in my place he would not take it off. I put a new brass in with the pin grease and it run 392 miles more. Pin grease doesn't cost very much and I think car men ought to have it.

Mr. Barker:—I have heard a lot about oil. The acme of success is a bath of free oil, but we are under such conditions that we cannot supply our bearings with a bath of free oil. Take cotton or wool and soak up the oil. It is largely a matter of shop practice. It takes careful analysis each month to ascertain the cause of delays to trains. One of our causes of delays to equipment is hot boxes. We are very careful to have the surface of the journal smooth and in a number of cases polished, and we will leave the inside of the collar as a file. There are times when the filling of the journal is not properly finished.

We are provided with a dust guard for the oil boxes, and we have been instructed to have a row of waste. We are supposed to have tight box covers to keep out the dirt. We have the lead lined journal bearing, which is soft metal, as Mr. Hill spoke about. Passenger cars in fast service run hot as soon as they get off of the soft metal, if it is only a quarter of an inch of the surface of the journal bearings that are exposed.

We have a superintendent who does not accept anything doubtful; he is after the primary cause. We simply accept the journals from the shop and the journal bearings as furnished by the contractor and the oil and waste from the supply department, and apply them in the shortest time possible and send the car out on the line. You must not have the box run hot. That is the service we are supposed to give, and we are to have no hot boxes from the application of new wheels. Our superintendent of machinery said, "Trace the primary cause." I said, "The primary cause may take me into the machine shop." He said, "Go to the primary cause; never mind where it is." I went to the machine shop and I showed the general foreman where he was not furnishing us journals properly finished inside the collar. The surface of the journal was planed-surfaced over so that you could not find a fault, but the fillet I did not consider properly finished, and the inside of the collar was neglected in some cases. As soon as we wiped out this cause we did not have any further trouble and we did not have to send a man out. We found that when we picked out our soft bearings, we took them from the ordinary stock, but we found that where we got the soft metal it run through the end of the journal bearings. For passenger boxes, they should have soft metal on each end as well as on the surface. They used to say we were running larger, heavier cars and longer cars at greater speed. As far as the greater speed—we did not run on such great speed only when a train was late once in a while. The weight of the car has nothing to do with it. The length of it may have something to do with it. The journal has been increased in size, so that the area of the bearing surface has the same weight per square inch as the lighter cars. We have had it illustrated to us by saying the ship owners buy new vessels; They put a vessel out on its first trip of 3,000 miles and they must run on this initial trip without running hot. And if the marine department could do that in the new vessels, it was expected that an ordinary railroad man could run a car over a 150 mile division without running hot. We could have no excuse. We should give the primary cause. We have eliminated largely the hot-box troubles. They are not all wiped out, but there has been a vast improvement.

Mr. Cox:—I have had quite a little experience with new wheels. I had a derrick car turned over to me Thanksgiving week that had too much waste in the box before. I removed the waste the car rode about 4 car lengths when I noticed that the box lid was open. I found that the journals were revolving, taking all the waste and rolling it up in the box. I put it in place and it run around the belt in the Bay City yard, and that derrick was the first one that had landed in the yard that had run cool. I was up there just about a year before that and got the same wrecker out of there. The car inspector told me that all cars run hot. I found that my greatest trouble was in keeping the dope in the right place. I went out with a new wrecker, and from Bay City to Sagmore, 16 miles, they were going to put me on a train that run the 16 miles without a stop, but I told them to put me on a jigger. The journals were so hot I was afraid. We stopped at every station and I got the journals warmed up in good shape. I found that the oil was not lubricating right and did not keep the waste in the right place. After I got to the end of the terminal it was fit for a passenger train. If there was some kind of a device gotten up so that the dope could be kept up to the journal, I think we would get results.

Mr. Brown:—I will say that within the last few years we have had scarcely no trouble with hot-boxes, and we feel that our success along this line is due to the personal care that we have given our journals before they were placed under the car. The primary cause is the first thing you should look for. If you find they are not properly fitted up, that is the place to start in. Be sure that the fillets are all right and the collars in good condition. When we get a wheel ready to put under a passenger train, in order to know beyond a doubt that we have a good bearing before we let the car go, we take the bearing and place it over the journal and take a piece of emery paper, and place that with the emery up next to the bearing, and we clamp the paper down and take the bearing on the top and work the bearing until it is perfect. The soft metal will indicate at once when you have all parts covered. All we have between the journal and the bearing is the emery paper. It is so thin that you know when the bearing is in condition to place on the journal. That is one thing that we do.

Another thing is that we never apply a pair of wheel but what we change our dust guards. If there is anything wrong with them we put in new dust guards. We are all running old cars and we have a number that the box lids are loose. As a preventive from dirt getting in the front part of the box, we have a device that we are using in the way of a false dust guard. It is just a block large enough to fit the different sized boxes. It may be covered with a piece of carpet. We place that on the outside and have a little handle on the outside. When you place it in the box the carpet acts as a cushion and you have a tight fit, and you are going to have a clean box when you get to the other side of the division. You will find the dust packed up against the lid, but the condition of the box on the inside is perfectly clean. We have a good dust guard in the back and preventive in front.

We have not used the oil can for a long time, possibly three years, and I would say that in the month of June we did not have one hot box on passenger trains.

When the journal is taken out of the machine shop, if it is not right, send it back, and if everything is followed up by a man in charge, I do not think we will have so many hot boxes.

President Boutet:—The paper has brought out a good deal of discussion, and I believe the fact that it is necessary to give your journals a good deal of attention, and in that manner avoid trouble. If there is nothing further we will pass to the discussion of the next paper.

Mr. Waughop:—Your executive committee wishes to call your attention to the rules requiring that you go into the election of officers at 10 o'clock.

Mr. O'Donnell:—I think at this time it would be somewhat out of line to discuss Mr. Gainey's paper. We should digest it and read it carefully. If it is agreeable I would ask the membership to kindly accept it on the motion yesterday afternoon, without discussion.

President Boutet:—That motion will take with it the same action as to the other papers, if it is agreeable with the authors of the papers.

The motion was seconded and carried.

Election of Officers.

President Boutet appointed Messers Hitch and Devaney to act as tellers.

Mr. Waughop:—By way of explanation to the new members, before I make a nomination I wish to say a few words. The present president has served you faithfully for the last five or six years. That is a long term of office, it is true, but to your president there is much credit due for the inerease in membership from twelve members, when I was president to the 150 or 200 members enrolled at present. The executive committee, in talking over the matter, think it very desirable that we punish the present president for a least one more year. The association has gotten to such a point that we cannot go back, and we have a man at the head of it at the present time who will make it progress; that being true, I think personally, and the committee thinks too, that it would be the proper thing to put in nomination for president for the ensuing year the present encumbent, Henry Boutet. (Applause)

President Boutet:—It is hardly fair for one man to occupy the chair when there are other members of the association entitled to the honor. I stated last year at Buffalo that I was serving my last year as president. I feel that there has been a great deal of work done in getting the association up to where it is; I believe I am entitled to some credit, but I am only entitled to that part that is properly due me. As president I have been enabled to get the good will of the members. The meetings have been conducted in such a manner that they have been made interesting to all. I do not want to go back on my word last year, and I do not want to see the association go back. It is customary in all associations that your vice-president be elected president, but I am going to leave that with you.

I ask the past president Mr. Waughop to take the chair.

Mr. Forrest placed in nomination the first vice president, F. W. Trapnell.

It was moved by Mr. Schultz that the nominations close. Seconded and carried.

The ballot resulted in the election of Mr. Boutet.

Mr. Schultz:—As a member of the executive committee I have no recollection of any scheme being devised, and I would not want to be understood that the executive committee had taken away from you your rights in choosing a president.

Mr. Waughop:—The executive committee when called is not responsible for the absence of any member.

Mr. Schultz:—If the chairman is having a meeting it is the duty to call the members.

Acting President Waughop:—By the action of this association, you have been elected president of the association for the ensuing year; do you accept the position?

President Boutet:—I certainly do.

Acting President Waughop:—I declare you president of the association.

President Boutet:—I thank you for the honors conferred upon me again. I assure you that I will do in the future as I have in the past in an endeavor to make your meetings and the association a success. In conducting the election—we came down to a city that abounds with interest and sight-seeing trips. I have no doubt you are all very anxious to see everything. I congratulate the members upon their attendance at the meeting, but some are prone to go out. We came here to work and it is presumed we should work. One of the members of the executive committee got in yesterday morning; he would not miss seeing the White House this morning, for he might never have a chance to see it again. I think when we have a member of that kind on our executive force, he is not giving the association the attention he should. I would ask that in your selection of officers, you select people who have the interest of the association at heart, and will give it their time at least while they are at the meeting.

President Boutet takes the chair.

Mr. Waughop:—I think that one good turn deserves another. Our present vice-president has served us faithfully, and is thoroughly capable of handling both the presidency and the president. However your action has shown that it is desirable for at least another year to give him further experience. I would, therefore, place in nomination our present vice-president, F. W. Trapnell, of Kansas City.

Seconded by many.

Mr. O'Donnell:—While we are all working in harmony—pardon me for antedating, as it were, my nomination—our worthy past president over there stated that for the best interests of the association, Mr. Boutet was required for another year; while he did not have any skeleton arrangement with myself as a member of the executive committee as stated, still he outlined the reasons, and inasmuch as Mr. Trapnell has been given an opportunity to secure the presidency at the expense of a man who has worked so hard, I am going to nominate Mr. Charless Peiffer, of the B. R. & P., for vice-president.

The name of J. L. Stark was placed in nomination by Mr. Cox.

The ballot resulted in favor of Mr. Trapnell and he was duly declared elected.

Mr. Trapnell:—I can only reiterate what I said the last time that I received this honor from your hands: that I will do all within my power for the up-building and advancement of this association, which is one of the associations, in my opinion, which will be of paramount importance in the railroad service in the near future. I will give it my very best efforts and do all in my power for its up-building I thank you.

Mr. O'Donnell:—For secretary and treasurer, I do not think it is necessary to make any statement as to who we have in mind to nominate for this position. You know his disposition and his nature I take great pleasure in nominating for the ensuing year, Stephen Skidmore, general foreman of the car department of the Big Four.

It was moved by Mr. Trapnell that the rules be suspended and that Past President Waughop cast the vote of the association for Mr. Skidmore.

Seconded and carried.

Mr. Waughop:—I cast the vote of the entire association for Mr. Skidmore as secretary and treasurer.

President declared Mr. Skidmore's election.

Secretary Skidmore:—I do not know that I can do more than thank you for the honor you have conferred upon me. I will endeavor to serve you the coming year as I have done in the past, but my shortcomings heretofore I hope will be excused. I have done everything possible that I thought would be for the best interests of the association, and what I had time to do. You all know that a railroad man when at work is busy attending to his company's business, and it is pretty hard to look after side issues. I do not know whether the members realize the amount of work connected with the position of president and secretary in this association. It is not to go home from this convention when it adjourns and let things remain as they are until we start to our next convention, but we have to begin and work from the time we leave until the next annual meeting. We have a number of concessions this year and other advantages that we never had before and we can get started a little earlier this year; the members will be benefited, will have a better understanding and more time for consideration than in the past year. Our association is growing every year, and the members take more active interest in it I see no reason why it should not become one of the most active associations in railroad service, especially in the car department. I thank you. (Applause.)

President Boutet:—You spoke about your short-comings. Do you refer to a shortage in the finances of the association?

Secretary Skidmore:—I do not know as there is very much shortage of the finances. There wasn't very much capital to work on. I suppose the members realize that one-half the dues goes to the Railway Master Mechanic for one year's subscription. There are some other expenses connected with running the association; postage, invitations and things of that kind, that eats up the remaining dollar. We did not start with much and we did not wind up with much on hand. So far as the capital is concerned, you must not expect anything out of the ordinary.

President Boutet:—One of the concessions we might mention was from the Pullman people. The second Monday before the convention we received a circular from them stating that they would grant half rates to the members if the secretary would certify that they were members. It made it necessary to send out two circulars to all the members, and the circulars were gotten out the same night we received the notice; so if you did not get your transportation all right it was not because of any neglect on the part of the officers.

For members of the executive committee the following names were placed in nomination:—F. C. Schultz, of Chicago; T. J. O'Donnell, of Buffalo; E. R. Campbell, of St. Paul; W. R. McMunn, of New York; A. Berg, of Erie, Pa.; J. L. Stark, of Columbus.

The ballot resulted in favor of W. R. McMunn, F. C. Schultz. T. J. O'Donnell, A. Berg and J. L. Stark.

Mr. McMunn:—I am not going to make a speech as the time is too short. Of course we expect a lengthy address from the newly elected members of the executive committee, so we want to allow as much time for that as possible. I want to thank you for the confidence you have shown in me in giving me such a handsome vote, and I assure you I will do everything in my power to up-build the association.

Mr. Berg:—I do not know that I have anything to say any more than that I thank you for the courtesy you have shown me. I assure you that I will do the best I can to promote the interest of the association in the future as I have in the past.

Mr. Schultz:—I want to thank you for the honor you have shown me in electing me a member of the executive board. There is a great deal that each one of us can do around our home town, as there are a great many car men who would be interested in this providing they were properly approached. If we would bring the matter before them, I think we could double our membership. I know from personal experience that car men are interested, and if it is called to their attention a great deal can be done to build up the association. It is up to the members to do that. You cannot expect to build from the top down; you will have to work from the bottom up.

Mr. O'Donnell:—It is useless for us to say that we appreciate the vote given us, for you know we do, but I want to reiterate that I do not come down here and waste 12 or 15 shirts in this warm weather for O'Donnell. I do it for the railroads for which I work. In honoring the railroads you naturally honor the person individually. The main reason why I am glad to continue as your executive officer is because you have elected, and he has accepted the obligation of serving another year, Mr. Boutet. There is something about Boutet that looks good to me, and I am not ashamed to say it, and while I say it here publicly before all you boys, I want you to understand why I say it. It is because I think you will go a long ways and look over a large amount of territory before you would be able to fill the bill.

In regard to Mr. Campbell of Minnesota, I would ask your indulgence to say that Mr. Campbell is known in the west; he is quiet and reserved, and I hope he will be heard in the future.

I am going to suggest that no member of the executive board shall serve over two terms. I was intending to resign this year, but I will continue to serve the two terms. This is done with the intent of giving your 250 members a chance to serve in this honorary position as well as ourselves.

Mr. Stark:—Being the newly elected member of this august body, I am not supposed to say very much. I say, however, I am on probation. I am not going to try to tell you what I am going to do, but I am going to try to show you what I will do. I thank you for the honor.

President Boutet:—There is another important matter—we all realize, or I think the majority of you do, that the matter of entertaining is one that calls forth a great deal of consideration and the sacrifice of many dollars from our friends. I am going to read over to you a list of the names of the subscribers to the entertainment fund. I trust the members will take some action suitable in acknowledging to these members that we are thankful for the courtesies extended.

American Malleable Co.
American Steel Foundry Co.
American Brake Shoe & Foundry Co.
American Car & Foundry Co.
Bruce V. Crandell, care Chicago Ry. Equipment Co.
Bingham & Taylor.
Bettendorf Axle Co.
Columbia Brake Shoe Co.
Columbus Steel Foundry Co.
Crane & Co.
Galena Signal Oil Co.
G. & C.
German-American Tank Line.
Joyce, Cridland Co.
Geo. W. Jennings.
The Lehon Co.
W. H. Miner.
B. A. Magurn, Grip Nut Co.
McCord & Co.
McConway, Torley Co.
Mowbray & Robinson.
National Malleable Casting Co.
Strong Carlisle, Hammond Co.
Symington Co.
Scullin & Gallagher.
West Disinfecting Co.
Ward Equipment Co.
B. F. Bilson.
Gilford S. Wood
Westinghouse Air Brake Co.
Union Draft Gear Co.

Mr. O'Donnell:—I would move you that the firms and the gentlemen representing them who have so generously taken care of this body socially, honorably and justly, receive a rising vote of thanks which in a small measure voices our appreciation and the thanks of the ladies, for the good time they have given us while we are in the national capital of our glorious United States.

Seconded by many and carried.

Mr. McMunn:—Before we adjourn, I think a vote of thanks should be extended to Miss Unkenholz for her faithful service here during this session; also to the management of the Arlington Hotel for the accommodations they have furnished us in the use of this hall and other matters, and also to the Chamber of Commerce, to Mr. Grant and Mr. Gude.

Seconded and carried.

Mr. O'Donnell:—I move you that no officer of this association be permitted to serve over two years, beginning with this convention. I am not thoroughly acquainted with the constitution, and it may require certain preliminaries to bring that about.

President Boutet:—Article 8 says the by-laws may be amended by a two-thirds vote, provided said amendment is presented at the opening session, etc.

Mr. Schultz:—Any suggestion of that kind should be printed in the minutes in order to convey the intent or the desire of the members for their guidance next year. If we pass a resolution here expressing the desire of the members in regard to the proposition Mr. O'Donnell brought up, wouldn't that be proper at this time?

President Boutet:—Yes; it would be well to state that.

Mr. Schultz:—I move you then that it is the sense of this meeting that in the future no officer should serve more than two consecutive years.

President Boutet:—Any amendment to that constitution that you see fit to adopt or pass, remains with the members. Your president is only a presiding officer. If you see fit to put up anything in the way of a motion he is compelled to submit it to the members.

Mr. O'Donnell:—With Mr. Schultz's permission I would ask to amend that to read "the executive board," or whatever you may call it, shall not serve more than two years. I think it is wrong to cut out the secretary and treasurer, if you see fit to carry him on. You should make up your executive officers from members who are entitled to represent you on the floor.

Seconded and carried.

Mr. O'Donnell:—I think we ought to get the sentiment of the membership as to where we shall hold our next meeting. I think it is placing a burden on the executive committee that we should not carry out.

Mr. Forrest:——I would like very much to suggest to your executive committee that the next meeting of this association be held in Toledo, Ohio.

President Boutet:—I want you to state the advantages. If we go to Toledo what can you promise us in the way of a benefit, especially in an increase of membership.

Mr. Forrest:—We have a number of car foremen and car inspectors who will undoubtedly become members of this association if you bring about a meeting at that place; I believe I can safely say that we could increase our membership 30 members. As far as the entertainment is concerned the board of committees of the city is ready at all times to take upon their shoulders a portion of the entertaining. Toledo is located at the mouth of the Maumee river, near the Michigan boundary, or at the extreme west end of Lake Erie. We are sixty miles from Detroit either by rail or boat. The scenery about Toledo is about what you would find in any lake country. Our parks are second to none. Our buildings are nearly all grouped and are of magnificent architecture, and I believe the committee would make no mistake in going to Toledo.

Voice:—I was going to suggest Memphis. It is a very nice city in which to spend several days, and I believe it would be an inducement to some people up there to join us.

Mr. Gresham:—I would suggest that you come down to the land of cottom, to Memphis. I hope to be able to prove that it will be for the benefit of this association to go to Memphis.

Mr. O'Donnell:—I think the executive committee should take the voice of the other people.

Mr. Campbell:—We have a population of over a half million people. We have 11 railroads. We have an active railroad association of over 150 members, car men, and they take great interest in car matters. Of course, it is far north, but very few of the railroads west and north are represented in this association. As to holding the convention in Minneapolis, I can say that there isn't a city in the world that will do any more for a convention than Minneapolis. We have commercial clubs in both cities; the finest lakes in the world and fine interurban service. I can guarantee you if you come to Minneapolis we would increase our membership from 40 to 50 members. I heartily recommend Minneapolis for the next meeting place.

Mr. Stoll:—I came from the town of which Mr. Forrest has spoken, Toledo. We are a little behind Columbus since the census was taken, but we expect to take in Detroit in the near future. The town is especially fitted because of its advantages, to entertain us. I understand that the secretary of the Chamber of Commerce has sent an invitation, and would like to ask if the secretary has received it.

Secretary Skidmore read the following invitation from Toledo:

President Boutet:—I received a letter some time since from Rochester, asking us to go there. Last night a gentleman from the south said if we would go to Alabama, Montgomery or Nashville, that he was satisfied we would get nine-tenths of the members from the south.

Voice:—We of the South have not been interested in the interchange of cars, consequently our people have not been as active in the work as we should be, and we think to get a meeting down in the territory where we can secure the largest attendance from the South would be of vast interest to the movement of freight from the North and West. Atlanta is one of the most hospitable towns of the South, and I am satisfied you will increase your membership more from holding a meeting down there than by anything else.

Mr. Reed:—I think a beautiful spot for this convention would be Montreal. There is no prettier city than Montreal. We have Mt. Royal, the St. Lawrence; we could take a trip through the Thousand Islands, and I am quite sure we could increase our membership, and I would like to see the convention go to Montreal.

Mr. O'Donnell:—While I suggested that we should not butt in on this, I would like to have Mr. Reed explain the distance Montreal is from different locations, climate, etc.

Mr. Reed:—The climate there is much cooler. The railroad men are a fine lot of fellows, and the city of Montreal is the finest in Canada. There are a lot of Canadians who ought to come into this association. I cannot answer the distance, but I think it is about 400 miles from Buffalo and Detroit is 136 miles from Buffalo.

President Boutet:—I wanted to ask what is the disposition of the Canadian Pacific and Grand Trunk to grant passes in Canadian territory?

Mr. Reed:—It is about as easy for a man to get transportation on the Canadian Pacific as any other road I know of. I do not think there would be any trouble in securing transportation.

Voice:—I think passes could be secured to Minneapolis, and while it is a long trip from here, we do not all live here, and you could stop off in Chicago or St. Louis and spend a few days very pleasantly in either city. I think the association would be benefited by meeting at some place more centrally located in the United States.

Mr. Schults:—The disposition of the C., B. & Q. is very favorable toward issuing passes, and I know of no instance but what the association has been encouraged. I do not want to butt in on the location, but I feel safe in saying that the holding of a convention in such cities would bring results in membership. I am not soliciting business for the C., B. & Q.

Mr. Brown:—While I am not from Toledo, I am from a nearby town, and I think we should bear in mind that Toledo is the only town that has sent us an official invitation. I think we should ask our executive committee to consider this matter carefully. In Cleveland we have a number of car men who are not members who would be glad to go 60 or 80 miles to attend such a convention, and it would be the means of taking in a number of new members to have a meeting in Toledo. Our friend from Minneapolis said we should be located more centrally. I do not know of a place more centrally located than Toledo. I think I speak the sentiments of our Cleveland members that Toledo would be the best point.

Mr. O'Donnell:—I would like to see the discussion close, as the hour is growing late and we have some trips planned.

Mr. Hewitt:—I think we ought to get in touch with the Canadian roads. There are a great many men down there who do not know what we are doing. I would like to go up there and show them what we are doing. I do not know what inducement we could offer, but would like to see you get the Canadian boys.

Mr. Waughop:—I have something to say about Minneapolis. You should consider the place that will do the most good for our association. We have never been in the Northwest further than Chicago. While I have never been in Minneapolis, I have been told that it is a place adjacent to such cities as Omaha, St. Joe. It would be no greater hardship for the members at Buffalo to reach Minneapolis than it would for St. Louis to reach Washington. Personally I am in favor of Minneapolis.

President Boutet:—It is all well enough to extoll the benefits of the different cities, but I do not know but that it would be a good thing in selecting a meeting place that we go to one that hasn't so many points of interest. A number of our members have been prone to take advantage of the outside amusements when they should be here attending to business. It is true that we selected Washington on account of the other attractions and we should have time to take in a certain amount of amusement, but the railroad officials are watching; we came here for work, and it is the duty of each and every member to put in his time at the meetings.

The entertainment committee sends word that Mr. D. P. Hopkins has been very energetic in work connected with the entertainment of the members, and that his name should appear on the entertainment committee.

We are under obligations to these people and when they visit the different localities we should give them a fair show, and if their appliances are as good, they should be favored.

Thereupon the convention adjourned to meet at the call of the Executive Committee in September, 1911.

CONSTITUTION AND BY-LAWS OF THE CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION OF AMERICA.

Constitution.

Article 1. The name of this association shall be the Chief Interchange Car Inspectors' and Car Foremen's Association of America.

Article 2. Objects.—The object of this association shall be to promote uniformity in the interchange of cars throughout America by recommending from time to time, to the M. C. B. Association such changes in their rules as we deem necessary to expedite the movement of traffic and to make such recommendations as in our opinion will be advantageous in the construction and maintenance of cars.

Article 3. The membership shall be composed of the chief interchange car inspectors and car foremen of any steam railroad of America, as active members, and the representatives of any railway supply firms, handling car material, as honorary members.

Article 4. Officers.—The officers of this association shall be a past-president, president, vice-president, secretary-treasurer, and five (5) elective members, who shall form the executive committee.

Article 5. Duties of Officers.—The duty of the president shall be to preside at all meetings of this association, attend all executive committee meetings; he shall be an ex-officio member of all committees.

Section 2. The duty of the vice-president shall be to perform the duties of president in case of absence or disability, in case of absence of both president and vice-president, the chair may be filled by pro-tem appointment.

Section 3. The duty of the secretary-treasurer shall be to keep the record of all meetings of the association, to compile information for the use of the association and committees thereof, which he may from time to time be directed to obtain; to act as secretary of the executive committee; to take charge of all finance, and to keep the accounts of the association under the direction of the executive committee, and to perform such other duties as may be assigned to him from time to time.

His salary shall be fixed at each annual meeting; he shall furnish bond in the sum of $1,000.00, in a reliable surety company, the association to pay for the bond.

Section 4. The duty of the executive committee.—The executive committee shall have general management of the affairs of the association, in conformity to the rules under which it is organized; it shall act upon applications for membership, it shall also audit the accounts of the secretary-treasurer annually and report the results to the association.

Article 6. Elections, When Held.—Officers shall be elected at the annual meeting of the association held in September of each year on the last day of the session, commencing at 10 o'clock a. m.

Section 2. Officers of this association shall be elected by written ballot, by a majority of votes cast, and shall hold office for one year, or until their successors are elected and installed.

Article 7. Dues.—The dues of members in this association shall be two dollars ($2.00) per year, payable in advance, for active members, to meet the necessary expense of the association.

Article 8. Amendments.—This constitution may be amended at any annual meeting, by a two-thirds vote of the members present.

By-Laws.

Article 1. This association shall hold meetings annually, in the month of September, time and place to be set by the executive committee, at least three (3) months before the meeting.

Article 2. Hours of Sessions.—The regular hours of sessions shall be from 9:00 a. m. until 12 noon, and from 2:00 p. m. until 5 p. m.

Article 3. Quorum.—At any regular meeting of the association nine (9) or more members shall constitute a quorum for the transaction of business.

Article 4. Order of Business.—The business of this association shall, unless otherwise ordered, by vote, proceed in the following order:

1. Roll call
2. Reading of the minutes of the last annual meeting.
3. Address by president.
4. Admission of new members.
5. Report of secretary-treasurer.
6. Assessment and collection of annual dues.
7. Unfinished business.
8. New business.
9. Report of committees.
10. Election of officers.
11. Adjournment.

Article 5. Voting.—A majority vote of the active members present shall be required to decide any question, motion or resolution which shall come before the association, unless otherwise ordered.

Article 6. No members shall speak more than twice in the discussion of any question, until all members who desire to do so have had an opportunity to speak.

Article 7. The proceedings of this association shall be governed by Robert's Rules of Order, except as otherwise herein provided.

Article 8. These by-laws may be amended by a two-thirds vote, provided, the said amendment is presented at the opening session, signed by two active members, and voted on at the last day of this session.

LIST OF MEMBERS OF THE C. I. I. & C. F. ASSOCIATION OF AMERICA.

Adams, C. S.—Joint car foremen, N. Y. O. & W. and West Shore R. R., Weehawken, N. J.

Anderson, C. G.—Gen. car foreman, D. L. & W. R. R., Buffalo, N. Y.

Acker, Chas. L.—Master mechanic, Toledo Terminal R. R., Terminal Sta., Toledo, O.

Allen, C. W.—F. C. I., N. Y. C. & H. R., No. 427 Potomac Ave., Buffalo, N. Y.

Adreon, E. L.—Westinghouse Air Brake Co., Broadway & Tyler Sts., St. Louis, Mo.

Boutet, H.—C. I. I., No. 11 Carew Bldg., Cincinnati, O.

Bunting, G. M.—F. C. R., Penn. R. R., No 6113 White Ave., Cleveland, O.

Burns, L. J.—Traveling Car Inspector, C. & O. Ry., Covington, Ky.

Brady, J. L.—F. C. D., L. & N. Ry., No. 1708 Greenup St., Covington, Ky.

Burke, J. C.—Foreman, Mo. Pac. R. R., St. Louis, Mo.

Berg, A.—F. C. D., L. S. & M. S. Ry., No. 920 E. 25th St., Erie, Pa.

Becherer, F. H., Ass't. Fore. Insptr., Penn. R. R., No. 29 Fairview Ave., Buffalo, N. Y.

Benson, F. A.—C. J. I., Erie, D. L. & W. and P. R. R., Elmira, N. Y.

Baldwin, H.—F. C. R., M. C. R. R., Niagara Falls Center, Ontario, Can.

Baltz, V.—C. J. C. I., No. 2810 Myston St., Wheeling, W. Va.

Bradley, J. A.—F. C. R., N. Y. C. & St. L. R. R., No. 187 Babcock St., Buffalo, N. Y.

Barnaby, R.—F. C. I., D. L. & W. Ry., Cloan, Erie Co., N. Y.

Barnwell, Jno.—Ass't. C. I. I., No. 1010 St. Louis Ave., Kansas City, Mo.

Boutet, B.—A. C. I. I., Nó. 809 Carlysle Ave., Cincinnati, O.

Black, F. P.—Gen. Foreman, C. & O. Ry. of Ind., Brighton, Cincinnati, O.

Brannon, J.—A. C. I. I., No. 2166 W. 6th St., Cincinnati, O.

Brazier, W. F.—Supt. Rolling Stock, N. Y. C. & H. R. Ry., New York, N. Y.

Brown, H. G.—Brown Car Wheel Co., Buffalo, N. Y.

Brown, I. H.—Westinghouse Air Brake Co., No. 1102 Traction Bldg., Cincinnati, O.

Bush, S. P.—The Buckeye Steel Casting Co., Columbus, O.

Bendixen.—Vice-Pres. Bettendorf Axle Co., Davenport, Ia.

Brady, John—Bettendorf Axle Co., Davenport, Ia.

Bower, R. M.—A. B. S. & F. Co., No. 30 Church St., New York, N. Y.

Berg, J. V.—Clerk, L. S. & M. S. Ry., Collinwood, O.

Berg, R. M.—L. S. & M. S. Ry., No. 920 E. 25th St., Erie, Pa.

Burkhard, A. A.—Ass't. Gen. Foreman, N. Y. C. & H. R., West Albany, N. Y.

Barker, W. E.—T. C. I., D. H. Co., Sidney, N. Y.

Brown, F. M.—F. C. R., Erie Ry., No. 1435 Kennilworth Ave., Cleveland, O.

Coleman, John A.—A. C. I. I., No. 758 W. 9th St., Cincinnati, O.

Campbell, E. R.—G. C. F., Minn. Transfer Ry. Co., St. Paul, Minn.

Chaffee, F. W.—Gen. Car. Insptr., N. Y. C. & H. R. Ry., N. Y. C. Sta., Albany, N. Y.

Charlton, G. J.—F. C. D., D. L. & W. Ry., No. 520 1-2 Lake St., Elmira, N. Y.

Costley, C. M.—C. J. C. I., Cairo Terminals, Cairo, Ill.

Cleary, F.—C. C., D. L. & W. Ry., Car Dept., No. 114 Schiller St., Buffalo, N. Y.

Chilton, W. W.—Gen. C. F., N. Y. C. & H. R. Ry., Watertown, N. Y.

Chapman, Wm.—F. C. D., N. Y. C. & H. R. Ry., Canandaigua, N. Y.

Calkins, A. E.—C. C. to Supt. R. S., Room No. 610 Grand Cent. Sta., New York, N. Y.

Cramer, W. M.—Car Foreman, N. & W. Ry., Portsmouth, O.

Covert, M. F.—Ass't. M. C. B., Swift's Car Lines, Chicago, Ill.

Copland, D.—Ass't. Gen. Mgr., G. A. C. Co., Chicago, Ill.

Chamberlain.—Chairman Frt. Car Repairs, N. Y. C. & H. R. Ry., New York, N. Y.

Coffin, W. E.—National Mall. Casting Co., Cleveland, O.

Cardwell, J. R.—Union Draft Gear Co., No. 544 Monadnock Bldg., Chicago, Ill.

Case, T. G.—F. C. I., N. Y. C. Lines, Grand Central Terminals, New York, N. Y.

Culver, Geo. B.—Ward Equipment Co., No. 139 Cedar St., New York, N. Y.

Cox, W. D.—F. C. I., W. & L. E. Ry., Toledo, O.

Calderwood, H. N.—G. C. F., A. T. & S. F. Ry., No. 1641 Woodlawn Ave., Kansas City, Kan.

Denne, Arthur.—C. J. C. I., D. L. & W., D. & H. Co. and Erie Rys., Binghamton, N. Y.

Dischinger, H. F.—Foreman, N. Y. C. & H. R. Ry., Exchange St., Buffalo, N. Y.
Dixey, J.—M. C. B., D. S. D., No. 6340 Ingleside Ave., Chicago, Ill.
Demint, S.—Ass't. C. I. I., No. 1010 St. Louis Ave., Kansas City, Mo.
Donahue, T. J.—Foreman, N. Y. C. & H. R. Ry., No. 218 Hauge St., Rochester, N. Y.
Diebert, J. H.—F. C. R., L. V. R. R., No. 316 Fenton St., Buffalo, N. Y.
Dunkin, J. B.—Foreman, L. S. & M. S. Ry., Collinwood, O.
Dyer, Jos.—C. I. I., P. & L. E. and Erie Rys., Youngstown, O.
Deyot, Frank.—Ass't. Gen. Foreman., N. Y. C. & H. R. Ry., No. 1002 Fillmore Ave., E. Buffalo, N. Y.
Dunn, P. T.—M. M., Penn. R. R., Chicago, Ill.
Devanney, J. J.—Foreman Car Dept., T. R. R. Assn. of St. Louis, No. 410 Union Station, St. Louis, Mo.
Dunham, W. G.—Mech. Ex., McCord & Co., Brantford, Ont., Can.
Dickinson, J. J.—Salesman, Richard Didgeon, Pt. Colbourne, Ont., Can.
Dunham, F. C.—U. S. Metal Mfg. Co., No. 25 Broad St., New York, N. Y.
Dowell, W. H.—Foreman, C. H. & D. Ry., Morefield Shop, Indianapolis, Ind.
Eicher, Frank.—F. P. C. R., C. C. C. & St. L. Ry., No 749 W. 3rd St., Cincinnati, O.
Egan, J. W.—Foreman, Erie R. R., Nillson Ave., Cleveland, O.
Edwards, J.—No. 9328 Llewellyn Ave., Chicago, Ill.
Edmonds, B. F.—F. C. I., St. L. & S. F. Ry., No. 1815 Booneville St., Springfield, Mo.
Ewing, J. M.—F. C. R., C. & O. Ry. of I., No. 2604 Beackon St., Cincinnati, O.
Elliott, W. P.—F. C. R., Wiggins Ferry Co., No. 804 Exchange Ave., St. Louis, Mo.
Eubanks, O. G.—Chief Inspector, A. C. L. Ry., Montgomery, Ala.
Epstein, Max.—Pres., G. A. T. L. Co., Chicago, Ill.
Ensigm, J. W.—Dist. Mgr., A. C. & Fdy. Co., Huntington, W. Va.
Farran, J.—F. C. R., Penn. R. R., Sutton Ave., Mt. Washington, Cincinnati, O.
Fox, F. L.—Gen. Car Inspector, P. M. R. R., Union Depot Bldg., Detroit, Mich.
Forrest, J. H.—Foreman, T. & O. C. Ry., No. 816 Wallbridge Ave., Toledo, O.
Fryer, H. H.—Rep. S. C. L., No. 29 Live Stock Exchange, Buffalo, N. Y.
Faeber, A.—Foreman, N. Y. C. & H. R. Ry., Buffalo, N. Y.
Fish, A. T.—Gen. Insptr., N. Y. C. & H. R. Ry., No. 94 Oxford Ave., Buffalo, N. Y.
Ferguson, G. W.—Supt. Lake Terminals, Lorain, O.
Fehl, N.—Foreman, Penn. R. R., No. 3426 Golden Ave., Cincinnati, O.
Fox, Geo. P.—Gen. Foreman Car Dept., N. Y. C. & H. R. Ry., No. 430 Elk St., Albany, N. Y.
Farlling, E. S.—Gen. Foreman., J. S. Shops, Jersey Shore, Pa.
Frey, W. J.—Gen. Car Foreman., L. E. & W. Ry., Lima, O.
Gainey, J. J.—G. F. C. R., C. N. O. & T. P. Ry., No. 16 Davies St., Ludlow, Ky.
Getzen, J. M.—Clerk, Arbitration Dept., Niagara Frontier Agreement, Buffalo, N. Y.
Granstaff, C. F. B.—J. C. I., B. & O. R. R., Wheeling, W. Va.
Greene, C. R.—C. J. C. I., all lines, So. St. Joseph, Mo.
Goolsby, A. G.—Foreman, M. & O. R. R., No. 509 10th St., Cairo, Ill.
Givans, P. S.—Foreman Car Dept., L. & N. R. R., Cincinnati, O.
Graeber, Geo.—Foreman Car Painters, D. L. & W. Ry., No. 213 Grey St., Buffalo, N. Y.
Gallary, Thos. F.—Piece Work Insptr., N. Y. C. & H. R., No. 20 York St., Buffalo, N. Y.
Gresham, J. D.—F. C. R., Union Ry. Co., No. 1063 Royell St., Memphis, Tenn.
Gould, J. O.—Gen. Supt., Gould Coupler Co., Depew, N. Y.
Groobey, Geo.—Gen. Sales Agt., Buckeye Steel Casting Co., Columbus, O.
Golbert, E. A.—Rep., W. H. Minor Co., No. 667 Rookery Bldg., Chicago, Ill.
Gregory, E. A.—A. B. S. & Fdy. Co., Chattanooga, Tenn.
Hitch, C. M.—G. F. C. R., C. H. & D. Ry., Cincinnati, O.
Hitch, G. F.—Foreman, Ill. Cent. R. R., No. 818 Rayburn Bldg., Memphis, Tenn.
Hitch, C. A.—F. P. C. R., C. & O. Ry., No. 9 W. 15th St., Covington, Ky.
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Hogsett, J. W.—C. J. C. I., Ft. Worth R. R., Ft. Worth, Tex.
Halleen, C. A.—F. C. D., L. S. & M. S. Ry., Ashtabula, O.
Head, E.—C. C., Car Dept., Wabash Ry., Springfield, Ill.
Howe, E.—Foreman, Mich. Cent. R. R., Bridgeburg, Ont., Can.
Hoffman, M.—F. C. R., D. L. & W. Ry., No. 133 Millburn St., Buffalo, N. Y.
Hall, W. H.—Gen. Car Insptr., C. R. R. of N. J., Jersey City, N. J.
Hodson, H. A.—F. C. D., C. C. C. & St. L. Ry., Brightwood, Ind.
Harvey, H. H.—Gen. Car. Insptr., C. B. & Q. Ry., No. 1123 S. Cent. Park, Chicago, Ill.
Hanson, F. H.—Div. Gen. Foreman., L. S. & M. S. Ry., No. 639 E. 101st St., Cleveland, O.
Honeycutt, Wm.—Chief Car. Insptr., Santa Fe Ry., Clovis, N. M.
Hill, C. C.—G. F. C. R., C. & O. Ry., Covington, Ky.
Hunistob, J. C.—C. J. I., L. S. & M. S. and B. & O. Rys., Elyria, O.
Howe, S. C.—Div. Acct., N. Y. C. & H. R. Ry., No. 990 Lovejoy St., Buffalo, N. Y.
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Iseringhausen, F. J.—Joint Car Insptr., No. 424 Bilbo St., Lake Charles, La.
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Jones, E. H.—Sec'y Lackawanna Storage Yds., Lackawanna, N. Y.
Jolley, C. L.—Joint Car Insptr., Himrods, N. Y.
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Jones, W. E.—Supt. G. A. C. Co., East Chicago, Ind.
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Keorner, A. H.—F. C. R., Penn. R. R., Columbus, O.
Koehlop, A.—F. C. R., C. A. & C. R. R., P. O. Mile, Columbus, O.
Kipp, A.—Gen. Car Insptr., N. Y. O. & W. R. R., Middletown, N. Y.
Kyle, Thomas.—Foreman, N. Y. C. & H. R. Ry., High Bridge, N. Y.
King, Z. F.—C. C. I., A. C. L. Ry., Savannah, Ga.
Kennett, M. A.—Gen. Car. Foreman, C. R. R. of N. J., Ashley, Pa.
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Long, Wm.—C. C., C. J. C. I. Office, Box 5, Exchange Sta., Buffalo, N. Y.
Lynch, Geo.—C. J. I., All Lines, Erie Depot, Cleveland, O.
Lucore, F. M.—Ass't. to Gen. Agt., American Railway Assn., 401 Grand Central Sta., Chicago, Ill.
Livingston.—Foreman, H. V. Ry., No. 1020 W. Broadway, Toledo, O.
Lawrence, W. C.—Foreman, C. & O. Ry. of Ind., No. 2210 Gest St., Cincinnati, O.
Larrick, A. J.—Foreman Car Repairs, B. & O. R. R., Stock Yards, Cincinnati, O.
Law, Geo. R.—A. B. S. & F. Co., Room No. 230 Sou. Station, Boston, Mass.
Lindman, S.—F. C. R., L. S. & M. S. Ry., Ashtabula, O.
Lightner, H. A.—Gen. Car Foreman, I. C. Ry., E. St. Louis, Ill.
Llewellyn, Geo. W.—Sec'y, The Joyce-Cridland Co., Dayton, O.
Monning, W. L.—Storekeeper, C. & O. R. R., Covington, Ky.
Merriss, E. E.—C. J. C. I., Lexington Rys., Lexington, Ky.
Marea, Jas.—Gen. Foreman, T. St. L. & W. Ry., Toledo, O.
Marlow, G. A.—Car Insptr., Penn. R. R., 16th and Wayne Sts., Erie, Pa.
Millburn, W. G.—C. J. C. I., No. 562 North Main St., Fostoria, O.
Mahoney, J. P.—Foreman, Penn. R. R., No. 682 Elk St., Buffalo, N. Y.
Myers, F. L.—Foreman, Vandalia R. R., East St. Louis, Ill.
Mann, J. F.—Gen. Car. Foreman, P. M. Ry., Saginaw, Mich.
Messeroll, E.—Foreman, G. T. R. R., Bridgeburge, P. O., Ont.
McMunn, W. R.—Special Insptr., N. Y. C. Lines, Room No. 1514 Grand Central Sta., New York, N. Y.
Martin, H. A.—Gen. Car Foreman, B. & A. R. R., Milo Junc., Maine.
McDonald, Geo.—Dist. Car Insptr., C. R. I. & P. Ry., Kansas City, Kansas.
Malone, B. B.—F. C. R., C. H. & D. Ry., Ivorydale, O.
MacNeill, J. A.—Wheel Insptr., A. C. & Fdy. Co., No. 1510 Syndicate Trust Bldg., St. Louis, Mo.
Martin, Geo. V.—National Malleable Casting Co., Cleveland, O.
Madill, Thos.—Mgr. Ry. Sales, Sherwin-Williams Co., No. 630 Ry. Exch. Bldg., Chicago, Ill.
Macpherson, A. F.—Vice-Pres., Bettendorf Axle Co., No. 1590 Old Colony Bldg., Chicago, Ill.
McOsker, D. J.—McCord & Co., Old Colony Bldg., Chicago, Ill.
McIntyre, J. N.—Ponderary, Idaho.
Martin, P. A.—Supt. of Eqpt., N. C. L. Co., 42d St. and Hermitage Ave., Chicago, Ill.
Mooney, W. D.—F. C. R., L. S. & M. S. Ry., No. 15242 Plato Ave., Cleveland, O.
McGreevey—F. C. R., B. & O. R R., Cleveland, O.
Mitchell, Geo. E.—M. C. B., clerk, C. A. & C. Ry., Mt. Vernon, O.
McCormick, J. E.—General car foreman, Sou. Ry., Box 59, Spencer, N. C.
McFadden, C. J.—Foreman, C. C. C. & St. L. Ry., East St. Louis, Ill.

Nelson, G. H.—Inspector, N. Y. C. & H. R. Ry., No. 113 Peabody St., Buffalo, N. Y.
Nihill, P.—C. J. C. I., all lines, No. 18 Bank St., Westfield, N. Y.
Niehaus, R. H.—Foreman, Wabash Ry., No. 4135 Flad Ave., St. Louis, Mo.
Newman, P. J.—C. C. to general car inspector, N. Y. C. Lines, Union Station, Albany, N. Y.
Neary, Wm. E.—Shop foreman, A. C. & Fdy. Co., Detroit, Mich.
O'Donnell, T. J.—Arb., N. Y. C. & H. R. Ry., East Buffalo, N. Y.
O'Dea, R. J.—General car inspector, Erie Ry., Meadville, Pa.
Orchard, J. H.—Foreman car department, D. & H. Co., Carbondale, Pa.
Owen, W. N.—New York Air Brake Co., Buffalo, N. Y.
Olberding, A. G.—President, Columbia Brake Shoe Co. & Foundry Co., Suite No. 1310 Traction Bldg., Cincinnati, O.
O'Neil, Robt.—Foreman, C. H. & D. Ry., Dayton, O.
Pearse, E. C.—General car foreman, Big Four Ry., No. 8701 Clark Ave., Cleveland, O.
Pigeon, Wm.—F. C. I., D. L. & W. Ry., No. 508 Fillmore Ave., Buffalo, N. Y.
Payne, G. C.—Foreman, B. & M. and N. Y. C., Rotterdam Junc., N. Y.
Passmore, H. E.—M. M., T. & O. C. Ry., Kenton, O.
Phipps, D. L.—Manager Chicago Ref. Car Co., No. 1303 First Natl. Bank Bldg., Chicago, Ill.
Powell, H. G.—Foreman car repairs, N. & W. Ry., No. 3632 Brooks Ave., Cincinnati, O.
Parker, Pearl—General foreman, C. I. & S. R. R., No. 284 Chicago St., Kankakee, Ill.
Pfister, J. G.—General car foreman, N. Y. C. Lines, No. 830 Butternut St., Syracuse, N. Y.
Pearce, H. C.—F. C. Dept., I. C. Ry., No. 24 Pleasant St., Freeport, Ill.
Peiffer, C. E.—General car inspector, B. R. & P., DuBois, Pa.
Ryan, W. A.—F. C. R., C. H. & D. Ry., East Toledo, O.
Rudowsky, Chas. A.—Foreman of inspectors, N. Y. C. & H. R. Ry., P. O. Box No. 383, White Plains, N. Y.
Reilly, T.—General yardmaster, C. C. C. & St. L. Ry., 6th and Millcreek, Cincinnati, O.
Reed, J.—C. J. C. I., N. Y. C. Lines, Buffalo, N. Y.
Riordan, C.—Foreman, N. Y. C. & H. R. Ry., No. 2340 Lockport St., Niagara Falls, N. Y.
Rippley, W. H.—Foreman, N. Y. C. Lines, 47th St. and Center Ave., U. S. Yards, Chicago, Ill.
Roem, Otto—C. C. to M. C. B., N. Y. C. Lines, Mott Haven Car Shop, N. Y. C. Lines, New York.
Rice, Edmond—C. C., B. & A. Ry., Boston, Mass.
Ronneberg, T. J.—Foreman, M. & St. L. Ry., No. 1327 Eleventh Ave. S., Ft. Dodge, Ia.
Schaefers, N.—Car Fmn., Cincinnati Equip. Co., Ludlow. Ky.
Skidmore, S.—F. C. R., C. C. C. & St. L. Ry., 6th and Millcreek, Cincinnati, O.
Stark, Chas.—F. C. D., H. V. Ry., Columbus, O.
Stark, J. L.—General car inspector, H. V. Ry., Columbus, O.
Schultz, F. C.—Chief car inspector, C. B. & Q. Ry., No. 1625 South Western Ave., Chicago, Ill.
Schrader, J. R.—General car foreman, N. Y. C. & H. R. Ry., Mott Haven Car Shops, New York, N. Y.
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Smith, H. J.—C. J. C. I., C. R. R. of N. J. and P. & R. Rys., Allentown, Pa.
Sims, John—Foreman, A. R. L., No. 85 Liberty St., Columbus, O.
Stroke, C. J.—Foreman. N. Y. C. & H. R. Ry., No. 39 Manitoba St., Buffalo, N. Y.
Stock, S.—F. C. R., D. L. & W. Ry., No. 421 Gold St., Buffalo, N. Y.
Shreeman, M.—General foreman car department, So. Buffalo Ry., Buffalo, N. Y.
Sutton, W. E.—Foreman, L. V. Ry., No. 445 Broad St., Waverly, N. Y.
Schultze, R. W.—General car foreman, G. C. & S. F. Ry., Cleburne, Texas.
St. Cye, A. T.—Assistant foreman car inspectors, L. S. & M. S. Ry., Ashtabula, O.
Shaver, C. B.—General car foreman, T. St. L. & W. Ry., Frankfort, Ind.
Setzkorn, C.—District car inspector, C. R. I. & P. Ry., El Reno, Oklahoma.
Shoemaker, C. A.—Supt., G. A. C. Co., Warren, O.
Sanford, W. H.—American Car & Foundry Co., Buffalo, N. Y.
Schlack, W. J.—McCord & Co., No. 1435 Old Colony Bldg., Chicago, Ill.
Silk, E. E.—Bettendorf Axle Co., Davenport, Ia.
Stuff, H. B.—Foreman, Penn. R. R., No. 3462 Linwood Ave., Cincinnati, O.
Smyth, T. P.—General car foreman, O. S. L. R. R., Pocatello, Idaho.
Shuler, Frank—J. C. I., Auburn, N. Y.
Scott, James—J. C. I., No. 86 Andes Ave., Geneva, N. Y.
Shearer, R. D.—General foreman, N. Y. C. & H. R. Ry., Lyons, N. Y.
Stoker, J. W.—General foreman car cleaners, Mott Haven Car Shops, New York, N. Y.
Scheibel, P. C.—Clerk, car department, N. Y. C. & H. R. Ry., East Buffalo, N. Y.
Shyne, J.—F. C. I., N. Y. C. & H. R. Ry., No. 17 Littlefield Ave., East Buffalo, N. Y.
Stack, J.—Foreman, B. & O. R. R., East St. Louis, Ill.
Schaffer, J.—No. 404 Wilson St., Buffalo, N. Y.
Turney, E. E.—General car foreman, C. H. & D. Ry., Lima, O.
Trapnell, F. W.—C. I. I., all lines, No. 1010 St. Louis Ave., Kansas City, Mo.
Totten, E. C.—Special inspector, N. Y. C. Lines, Room No. 610 Grand Central Station, New York City.
Thompson, C. W.—General car foreman, N. Y. C. Lines, East Syracuse, N. Y.
Taylor, W. H.—Foreman, Santa Fe R. R., Clovis, N. M.
Thompson, W. O.—M. C. B., N. Y. C. & H. R. Ry., East Buffalo, N. Y.
Vittum, J. E.—C. J. C. I., all lines, No. 396 North High St., Columbus, O.
Verran, J.—Foreman, Ill. Cent. R. R., No. 6845 Throop St., Chicago, Ill.
Van Atta, S. A.—Foreman, C. & O. Ry., Ind., Peru, Ind.
Williamson, W. D.—J. C. I., L. S. & M. S. and B. L. E. R. R., R. F. D. No. 43, Greenville, Pa.
Weber, G. A.—Clerk car department, L. S. & M. S. Ry., No. 539 W. 17th St., Erie, Pa.
Weale, J. H.—C. I. I., D. & H. Co. and C. R. R., of N. J., Wilkes-Barre, Pa.
Waughop, Chas.—C. I. I., all lines, No. 5157 Fairmount Ave., St. Louis, Mo.
Westervelt, J.—General foreman, N. Y. C. Lines, Rochester, N. Y.
Wilcox, A. F.—M. C. B., Spencer-Kellogg Co., Buffalo, N. Y.
Wertschorck—C. C. car department, Ill. Cent. R. R., Central Sta., Chicago, Ill.
Weight, G. C.—Foreman, P. R. R., No. 856 E. 23rd St., Erie, Pa.
Westall, W.—General foreman, L. S. & M. S. Ry., No. 748 East 105th St., Cleveland, O.
Wright, W. S.—Foreman car department, St. L. & B. E. R. R., No. 3604 State St., East St. Louis, Ill.
Wymer, Chas. J.—General car inspector, C. & E. I. Ry., Danville, Ill.
Walsh, W. E.—Galena Signal Oil Co., Ry. Ex. Bldg., Cleveland, O.
Wright, L. S.—National Malleable Casting Co., No. 311 Ry. Ex. Bldg., Chicago, Ill.
Wurtz, Julius—Transfer agent, Grand Trunk Ry., Buffalo, N. Y.
Wood, G. S.—No. 209 Great Northern Bldg., Chicago, Ill.
Wilson, James—General superintendent, National Car Wheel Co., Rochester, N. Y.
Whitridge, J. C.—Buckeye Steel Casting Co., Columbus, O.
Waughop, C. W., Jr.—Scullen-Gallagher Steel Co., St. Louis, Mo., No. 1401 Syndicate Trust Bldg.
Wallace, W. G.—A. S. Fedries, No. 1600 Commercial Natl. Bank Bldg., Chicago, Ill.
Zacher, C. J.—Buffalo Brake Beam Co., No. 67 Norwood Ave., Buffalo, N. Y.

The Chicago Steel Car Co has recently received a number of orders aggregating 2,500 underframes. Among the lot were 1,000 steel underframes for Swift & Company, of Chicago.

The Delaware, Lackawanna & Western Railroad has placed an order for 500 forty-ton box cars and 250 forty-ton steel hoppers with the American Car & Foundry Co., and an order for 250 forty-ton steel hoppers with the Pressed Steel Car Co.

The Hawley Lines, which issued specifications with requests or bids on the construction of 6,750 cars of various types early in the summer, but withdrew their inquiries the latter part of August, are again in the equipment market with a request of bids on 4,250 cars, of which 3,000 are all-steel hoppers of 100,000 lbs. capacity, 250 steel-underframe furniture, 250 automobile and 750 box cars. Most of this equipment is to go to the Western lines, the 750 box cars being intended for the Chicago & Alton and the rest divided betwen this road, the Minneapolis & St. Louis and the Iowa Central.

Railway Mechanical Patents Issued During October

Nut lock, 971,023—Arthur B. Cornelius and Daniel C. Dean, Alton Park, Tenn.
Tank car, 971,102—Louis E. Allyn, Pekin, Ill.
Turn table, 971,115—Gaston A. Bronder, Brooklyn, N. Y.
Train pipe coupling, 971,147—Thomas Reynolds, Baraboo, Wis.
Pressure regulator for automatic brakes, 971,207—Joseph Edouard Alexandre Michel, Paris, France.
Furnace door, 971,266—Gustav de Grahl, Zehlendorf, near Berlin, Germany.
Rotary snow plow, 971,289—Charles B. Mann, San Diego, Cal.
Air brake protection valve, 971,326—Walter V. Turner, Wilkinsburg, Pa.
Triple valve device, 971,327—Walter V. Turner, Edgewood, Pa.
Means for automatically adjusting locomotive exhaust nozzles, 971,339—William Charles Allison, Moose Jaw, Sask., Canada.
Berth lamp, 971,351—William J. Bohan, St. Paul, Minn.
Graduated release triple valve, 971,421—Walter V. Turner, Wilkinsburg, Pa.
Head-rest for car seats, 971,428—Henry W. Bowman, Barbourville, Ky.
Logging car, 971,444—William T. Harding, Raleigh, N. C.
Refrigerator car, 971,478—Anthony W. Watson, Jersey City, N. J.
Superheater, 971,522—William F. Buck, Chicago, Ill., and Henry W. Jacobs, Topeka, Kan.
Dump car, 971,603—John M. Goodwin, Mount Vernon, N. Y.
Mold for casting car wheels, 971,604 and 971,605—Jacob K. Griffith, Latrobe, Pa.
Nut lock, 971,637—Charles Calhoun Rankin, Louisville, Ky.
Car coupling, 971,640—Frank C. Reynolds, Columbus, O.
Nut lock, 971,784—Charles Pfister, New York, N. Y.
Manufacture of stay bolts, 971,085—George S. Thompson, Hockessin, Del.
Combined automatic and straight air brake, 971,806 and 971,-807—Walter V. Turner, Edgewood, Pa.
Straight air emergency brake, 971,808—Walter V. Turner, Edgewood, Pa.
Car seat, 971,822—Fred M. Billhime, Espy, Pa.
Spark arrester, 971,823—Erastus A. Bishop, Wallowa, Ore.
Ash pan, 971,845—Evan Frank Jones and Charles Adrain Barnes, Chicago, Ill.
Railway car coupling, 971,882—Richard D. Gallagher, Jr., New York, N. Y.
Compressed air system for railway cars, 971,896—Oscar Johnson, Chicago, Ill.
Car truck, 971,929—Gustave Rouy, New York, N. Y.
Radial draft gear, 971,930—Ernest H. Schmidt, Cleveland, O.
Pressure reducing valve, 971,982—Thomas P. Ford, New York, N. Y.
Car seat, 971,983—Charles W. H. Frederick, Melrose, Mass.
Buffing mechanism for railway cars, 971,985—Richard D. Gallagher, Jr., New York, N. Y.
Dump car closure, 972,018—John W. Moore, Bartow, Fla.
Pressure regulator for air brakes, 972,347—David H. Downey, Basalt, Colo.
Car wheel lathe, 972,348—Charles G. Draeseke, Dundas, Ontario, Can.
Car frame, 972,467—William R. McKeen, Jr., Omaha, Neb.
Grain door, 972,505—Rado B. Catton and Ira C. Catton, Brimfield, Ill.
Device for braking tram cars and electric railway carriages, 972,514—Charles Degoumois, Berne, Switzerland.
Car truck, 972,581—John E. Simpson and William D. Puckett, Portsmouth, O.
Spark arrester, 972,583—William P. Steele, Palisade, N. J.
Journal box lubricating device, 972,659—Luther K. Smith, Moberly, Mo.
Automatic brake applying device for railway trains, 972,671—Harry P. Zackey, Martinsville, N. Y.
Combined door hanger and track for box cars, 972,679—Stephen J. Cleveland, Mansfield, Pa.
Device to fasten grain doors in freight cars, 972,688—Charles R. Frye, East St. Louis, Ill.
Car unloader, 972,700—Thomas Lightbody, Youngstown, O.
Car structure, 972,708—William R. McKeen, Jr., Omaha, Neb.
Journal lubricating device, 972,719—Ivar A. Randel, Chicago, Ill.
Lock for journal box lids, 972,749—Leonard L. Brown, Clifton Forge, Va.
Bolster, 972,768—Harry T. Krakau, Cleveland, O.
Side frame for car trucks, 972,770—William D. Lowry, St. Louis, Mo.
Steam locomotive, 972,790—Sylvester A. Barrickman, Richwood, W. Va.
Car brake, 972,899—Ira D. Morrison and Louis J. Andrews, Savannah, Ga.
Roller side bearing for railway cars, 972,902—John F. O'Connor, Chicago, Ill.
Car truck, 972,921—Gilbert P. Ritter, Chicago, Ill.
Car door fastener, 972,978—Julius J. Acker, Horton, Kan.
Car truck, 973,024—George G. Floyd, Granite City, Ill.
Grain door for cars, 973,060—Elisha E. A. Martin, Union City, Tenn.
Oil burning locomotive furnace, 973,112—Charles A. Hammel, Los Angeles, Cal.
Valve gear for engines, 973,137—Charles F. Prescott, Philadelphia, Pa.
Automatic brake shoe machine, 973,167—Frederick K. Caswell, Los Angeles, Cal.
Process for making brake shoes, 973,168—Frederick K. Caswell. Los Angeles, Cal.
Brake shoe machine, 973,169—Frederick K. Caswell, Los Angeles, Cal.
Air brake system, 973,179—Arthur Doan, Elmhurst, Cal.
Dump car, 973,208, 973,209 and 973,210—Gustav A. Rakowsky, Duluth, Minn.
Dump car lock, 973,229—Adger C. Stansill, Charles H. Doty and Fred Whiton Hubbard, Columbus, O.
Freight car door, 973,244—Julius Wirkus, Minto, N. D.
Smoke conveyor for locomotives, 973,256—Arthur Lester Bridgham, Boston, Mass.
Means for operating the steps of passenger cars, 973,261—Samuel M. Curwen, Haverford, Pa.
Indicator for cars, 973,334—William D. Baldwin, New York, and August Sundh, Yonkers, N. Y.
Draft gearing, 973,451—Hubert L. Miller, Cumberland, Md.

THE WOOD CORRUGATED FIRE BOX.

A recent report on the action of the corrugated fire boxes manufactured by the Wm. H. Wood Locomotive Fire Box & Tube Plate Co., now in use on the New York Central & Hudson River, shows that after a road service of twelve to thirteen months, the fire boxes were in good condition and not in need of repair. It was noted that there was no distortion of the plates due to the expanding of the tubes, as is usual with the ordinary flanged sheets. The only distortion noted was an expansion of a corrugation due to the fact that the sheet had been cut scant and was brought up by the riveter when riveted. It is stated that there was no evidence of leakage about the mud ring or stays and that the engines are now in service in good condition.

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FLUE FAILURES.

At a recent meeting of the Western Railway Club, a paper on "Flue Failures," by J. W. Kelly, foreman boiler maker on the Chicago & North Western Ry., was presented and is published elsewhere in this issue. During the discussion which followed the reading of the paper considerable was said on the difficulty of impressing the importance of right practice on the men who handle the engine. A number of experiences were cited where one engine man would be continually having trouble with leaky flues while another would rarely have such trouble and pooling of engines was given a large share of the blame for this condition of affairs. Under the old system the engineer and fireman took a certain amount of pride in their engine for it typified to them the results of a month's or year's work and necessarily if it had to be shopped often it reflected on their work. Under the modern system this responsibility is gone; the engine man is to a greater degree responsible only to his conscience for the faithful carrying out of his duty. So when he comes in tired at the end of a long run it is not surprising that he does not always pay enough attention to the condition of the fire and water. This attitude of moral responsibility is hard to create but if it can be done it will do much towards the reduction of flue failures.

Another point not mentioned in the paper was brought out during the discussion as a cause of flue failure—the increasing use of the blower in endeavoring to abate the smoke in large cities. One gentleman stated that while formerly a ¾-in. blower was considered sufficient, a 1½-in. blower was now demanded on the engine man's side as well as the fireman's. No matter if the fire was light, the blower would be drawing in the cold air against the flue sheet while running in the city and flue failure eventually resulted. Of course we shall always have flue failures and it is a case of guarding all points of attack, so as to keep the number down to a minimum.

RAILWAY ELECTRIFICATION IN ENGLAND.

About the middle of 1909, General Manager Aspinall, of the Lancashire and Yorkshire Ry. (the first company in England to convert any part of its line from steam to electric traction) delivered a presidential address to the Institution of Mechanical Engineers on the electrification of the Liverpool Southport Ry., and although disclaiming any intention to deal with the general problem of railway electrification, he took the opportunity to express his ideas on the wider aspects of the question. He urged that the object of railway electrification should be "to make money, not to save money." Although this view was not new, yet its clear enunciation as a general policy served in a remarkable degree to clarify British railwaymen's ideas on the subject and to provide a common basis of agreement for many subsequent discussions of the subject. This year the Institution of Mechanical Engineers, at their joint meeting in Birmingham with the sister American Society, again tackled the problem of railway electrification; no less than five papers being read upon this topic.

The electrical engineer of the Midland said, that in England circumstances favored the adoption of electric traction. A large amount of shunting and branch line work offered a special field for this method of traction, and a cheaper class of coal could be employed than would be suitable for burning in steam locomotives. So far as his line was concerned, he thought that on the Midland main line, where a heavy traffic was handled, more could be effected by adopting electric traction than by adding tracks for steam traffic. Another speaker pointed out that on the Lancashire and Yorkshire and the North Eastern Railways the increase in traffic due to electrification had exceeded the most sanguine estimates, while the increase in passengers on the South London electric section of the Brighton Ry. amounted for the first two months of electrical working to 63 per cent, in comparison with the corresponding period of the previous year. The same speaker gave a very interesting example of the problems to be worked out when considering the electrification of a section of steam railway. The railway line between Birmingham (New Street Station) and Sutton, Coldfield and Four Oaks is a little over eighty miles in length, and there are at present about 30 trains a day in each direction, whose speed, including stops, is about 18 miles an hour. This line runs through a populous residential district, but traffic seems to have decreased since the opening of a tramway, which parallels the line for a considerable distance and gives a more frequent service at lower fares. If the railway were electrified, the speed might be increased by 30 to 50 per cent, and trains run at 15 minute intervals throughout the day, trains of only two cars running during the slack hours. This would undoubtedly bring back traffic from the tramways, besides increasing it in other directions, but the problems for railway boards in such a case is that of estimating the increase in receipts that would result from the increased facilities which is a more elusive calculation than estimating the capital of electrification.

Philip Dawson, in a paper before the British Association, described the main features of the Victoria to London Bridge electricfication carried out by the London, Brighton and South Coast Co. Many objections, he said, had been urged against the single phase system, including low acceleration, low efficiency, and weight of plant, these characteristics being, it was alleged, reflected in a greater energy consumption per ton mile. It was also asserted that repairs and maintenance would be a heavier charge than with continuous current systems. Experience has demonstrated that these criticisms were ill-founded. It had been demonstrated in practice that the acceleration was as high as that of the District Railway and other underground lines in London, and was superior to that obtained on some other continuous current systems. It had also been shown that the increased weight was only 10 per cent at most, while the energy consumption had come out less than with continuous current working, being 70 to 80 watt hours per ton mile, compared with from 100 to 125 with continuous current. The commutators of the motors had run 50,000 miles without repair, and the power factor of the whole system was about 80 per cent. The trolley wires had stood eight monhts' service without sign of wear, and the aluminum strips had a life of 15,000 miles. No trouble had been experienced with the transformers on the trains, notwithstanding that the circuit was made and broken 3,000 times each day. The difficulties in installing the overhead work had been very great, and in the Denmark Hill tunnels in one instance there was only 1½ in. between the collector bow and the tunnel roof. The repair shed equipment included a petrol-electric coach. In spite of the unfavorable character of the gradient, the acceleration was as high as one mile per hour per second. There had been no trouble of any sort with the equipment since the opening of the line to traffic.

One of the most hopeful features of these discussions is the clearly evident disposition of those taking part to agree on certain fundamentals, and to agree also on some particular aspects as being of paramount importance. Last year Mr. Aspinall secured such general agreement on one aspect of broad policy. This year there is a general agreement that, for the present, main-line electrification is impracticable, and that attention ought to be concentrated on congested suburban lines or smoky tunnels, at least so far as England is concerned.

There is also apparent a general desire to concentrate discussion upon the question of the proper electrical system to adopt. Until quite recently all English electric railways were worked by continuous current. Then the Midland experimental line at Heysham was equipped on the single phase system and, just recently, the Victoria-London Bridge section of the London, Brighton and South Coast Railway has been opened with the same system. The single phase system has, however, more popularity on the Continent. Although present discussions are turning largely upon the question of system, it must not be imagined that the rival claimants have not been previously pitted against each other. On the contrary, there have been most earnest, not to say acrimonious discussions. The present generally evident desire to concentrate upon this part of the electrification problem suggests the possibility of some systems being chosen as standard in the near future, and hence it is highly desirable that the choice should be made upon properly considered grounds.

There are some who think that because it is only proposed to electrify certain independent suburban districts, it is, therefore, a matter of no importance that each should choose the same electrifical system. It is quite true that there are no serious proposals on foot to electrify main lines, but it is fairly certain that ultimately main lines will be electrified, not so much, possibly, because electricity may in itself be superior to steam, but as a natural extension of a system which will have captured the suburban and terminal traffic at the large centers on the main lines, such as Glasgow, Liverpool, Manchester and district, Birmingham, Wolverhampton, Newcastle, London, and others. It must be fairly obvious that with the terminal and large intermediate stations electrified, with electric mains and trolley wires or third rails on a considerable portion of the route, there are some very potent technical and commercial reasons for extending the system to through trains. Thus it is of the first importance that the congested districts around the large towns should be electrified upon a uniform and interchangeable system. The great practical drawbacks of two "standard" gauges for railways are scarcely yet forgotten, and we certainly ought to avoid having two or more dissimilar electrical systems. Further, and this point is in danger of being lost sight of, in choosing an electrical system, regard must be paid not merely to the need of the suburban lines to be electrified in the near future, but also to the needs of main line electrification, which will ultimately follow. This involves a joint study of the whole railway electrification problem by the more important railways, for if each railway attacks the problem for itself, divergent results may be expected.

Heavy Power for the Hocking Valley Ry.

The Hocking Valley Ry. has recently received twenty freight and three passenger locomotives, designed by the late G. J. DeVilbiss, superintendent of motive power of that line, and built by the American Locomotive Co., which is the first lot of heavy power the road has had built with a view to ultimately replacing its light power.

The freight engines are of heavy construction, consolidation type, and designed for handling the coal traffic on the Hocking from the central and southern parts of Ohio to the lakes. These engines weigh 236,000 lbs., and with 23x30-in. cylinders, 205-lb. boiler pressure, 57-in. drivers, and a maximum tractive power of 48,500 lbs., are capable of hauling 4,800 tons over .3 per cent grades as compared with the heaviest type heretofore on the road weighing 164,000 lbs., with 20x26 in. cylinders, 180 lbs. pressure, 54-in. drivers, maximum tractive power of 29,400 lbs. and hauling capacity of 2,400 tons, making an increase of at least 75 per cent in tonnage handled per train.

The passenger engines are 10-wheel type and of heavy design to handle 6 to 10 cars on a fast schedule, with stops averaging five miles apart. They weigh 188,000 lbs. and have 20x26-in. cylinders, 200-lb. boiler pressure, 72-in. drivers, and maximum tractive power of 24,500 lbs., as against previous largest engines weighing 141,000 lbs., with 18x26-in. cylinders, 180-lb. pressure, 66-in. drivers, and 19,500 lbs. tractive power.

The boilers of both types are radial stayed extended wagon top, which is a departure from the Belpaire, which has been standard heretofore on the line. Tube heating surface has been sacrificed somewhat in square spacing, but there is a large amount of firebox surface, especially in the passenger engines. Flexible staybolts have been used to a large extent.

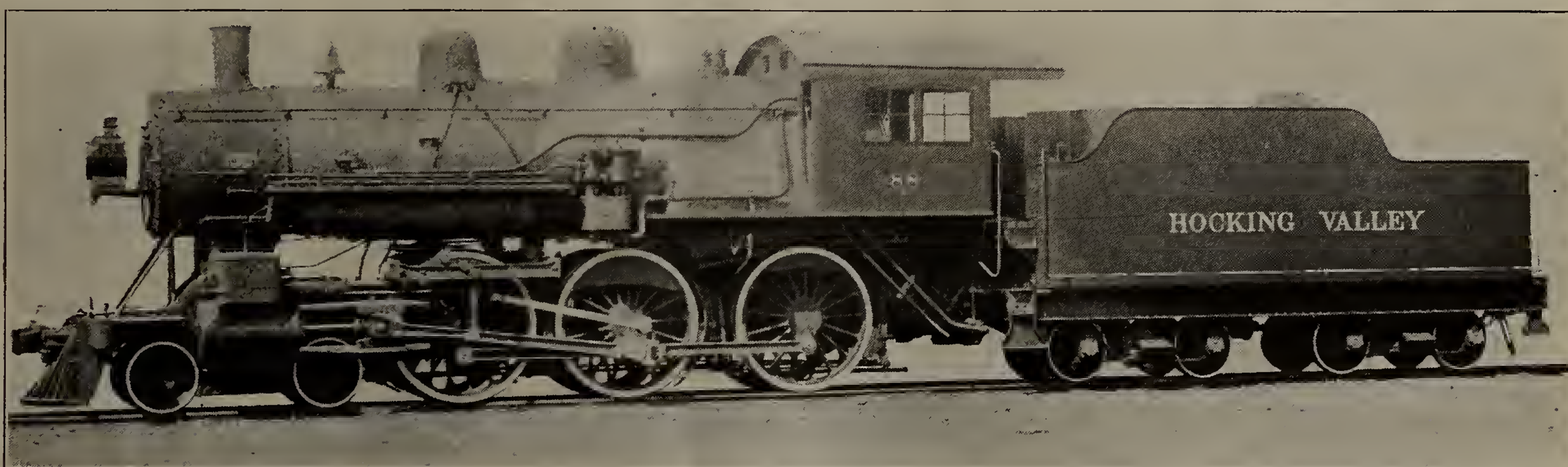
The frames on the freight engines are vanadium cast steel, and the driving springs on both engines are vanadium steel. Shoes and wedges are of bronze, working in cast steel boxes.

All of the engines are equipped with Baker-Pilliod valve gear; the passenger engines and ten freight engines having slide valves, and the other ten having piston valves. Pistons are solid-head type, with gun-iron packing rings, and the cylinders are also bushed with gun iron.

The fire doors are pneumatic and ash pans are Hocking Valley standard drop bottom, which has been adopted by several leading railroads.

The tenders have water-bottom type tanks set on steel frames of 13-in. channels. Tender trucks are arch-bar type with cast steel bolsters and cast steel wheels.

The general design is shown in the accompanying illustrations, and the general dimensions and ratios are given below:



One of the New Ten-Wheelers, Hocking Valley Ry.

One of the New Consolidations, Hocking Valley Ry.

General Data.	Freight	Passenger
Tractive effort	48,500 lbs.	34,500 lbs.
Weight in working order	236,000 lbs.	188,000 lbs.
Weight on drivers	208,000 lbs.	142,000 lbs.
Weight, engine and tender, in working order	390,000 lbs.	332,000 lbs.
Wheel base, driving	17 ft. 3 in.	14 ft. 4 in.
Wheel base, total	26 ft. 5 in.	26 ft. 1 in.
Wheel base, engine and tender	58 ft. 3 in.	56 ft. 0 in.

Ratios

Weight on drivers ÷ tractive effort	4.29	5.79
Total weight ÷ tractive effort	4.87	7.67
Tractive effort × diameter drivers ÷ heating surface	783.14	707.01
Total heating surface ÷ grate area	64.18	47.98
Firebox heating surface ÷ total heating surface %	5.72	6.81
Weight on drivers ÷ total heating surface	58.92	56.91
Total weight ÷ total heating surface	66.86	75.35
Volume both cylinders, cu. ft.	14.42	9.45
Total heating surface ÷ volume cylinders	244.80	264.02
Grate area ÷ volume cylinders	3.81	5.50

Valves

Kind, on ten engines	14-in. piston	....
Kind, on others	Slide	5¾
Greatest travel, piston	5 in.	1 in.
Greatest travel, slide	5¼	116 in.
Outside lap	1 in.	....
Inside clearance	Line and line	Slide

Wheels

Driving, diameter, over tires	57 in.	72 in.
Driving, diameter, centers	50 in.	66 in.
Driving, journals, main, diameter and length	10½x12	9x12
Driving, journals, others, diameter and length	10x12	9x12
Engine truck wheels, kind	Cast steel	Cast steel
Engine truck wheels, diameter	33 in.	33 in.
Engine truck journals, diameter and length	6x12	5½x12

Boiler

Type	E. W. T.	E. W. T.
Working pressure	205 lbs.	200 lbs.
Outside diameter first ring	80 in.	67 in.
Firebox, length and width	73¼x108⅛	73¼x102¼
Firebox, thickness of plates	⅜ and ½	⅜ and ½
Firebox, water space	5 in.	5 in.
Tubes, number and outside diameter	412—2 in.	291—2 in.
Tubes, length	15 ft. 6 in.	15 ft. 4 in.
Heating surface, tubes	3328	2325
Heating surface, firebox	202	170
Heating surface, total	3530	2495
Grate area	55	52

Tender

Tank, type	Water bottom	Water bottom
Frame	13-in. channels	13-in. channels
Wheels, diameter	33 in.	33 in.
Wheels, kind	Cast steel	Cast steel
Journals, diameter & length	5½x10	5½x10
Water capacity	7500 gals.	7000 gals.
Coal capacity	16 tons	13 tons

We are indebted to M. A. Kinney, successor to G. J. DeVillbiss as superintendent of motive power of the Hocking Valley, for the above information.

Shop Extension of the Chicago & North-Western Ry.

The Chicago & North-Western Ry. has for the past months been constructing an addition to its Chicago shops to take care of its rapidly increasing repair work due to the increase in the locomotives now operated—the Northwestern has 1,580 engines, a few of which are narrow gauge.

The present machine and erecting shop was laid out and built in 1873 and 1874. Since that time there has been no addition to the erecting shop proper. It being possible up to the present time to handle the comparatively enormous increase in motive power repair works in the old shop. This is a monument to the foresight of the mechanical and engineering heads at that time. The only mistake in the layout was the failure to allow for a comprehensive building extension. An annex to the machine shop was built in 1899, extending to the west or at right angles to the old erecting shop. This extension of two stories was for the installation of the modern large machine tools which could not be accommodated in the old shop.

Referring to the drawing of the shop layout, it will be noted that the addition, now nearly completed, consists of an erecting shop, a wheel shop and a stripping shop. Owing to the location of the yards it was not possible as first intended, to place the new erecting shop parallel to the old shop in a north and south position. It was therefore laid down at right angles with provision for indefinite extension to the west.

The erecting shop measures 188 ft. 8 ins. by 362 ft. 4 in. and is fitted with fifteen pits reached by a transfer table, with a track 546 ft. long located on the south side of the building. Provision has been made for an extension of ten pits to the west and for a duplicate of the building paralleling it on the north as shown on the drawing of the layout.

What seems to be a serious inconvenience in taking locomotives to the transfer table from the roundhouses will be noticed by study of the drawing. With the original north and south plan it would have been possible to run locomotives directly onto the transfer table and thence to the erecting shop pits. As the shop has been built it will be necessary to place them on a turntable located to the north, thence over a track through the stripping shop, where the engines are completely stripped, thence on shop trucks to the transfer table and then to the erecting shop pits. Adjoining the stripping shop to the east is a wheel shop fitted with a ten-ton crane. In this shop are located the large wheel presses and lathes.

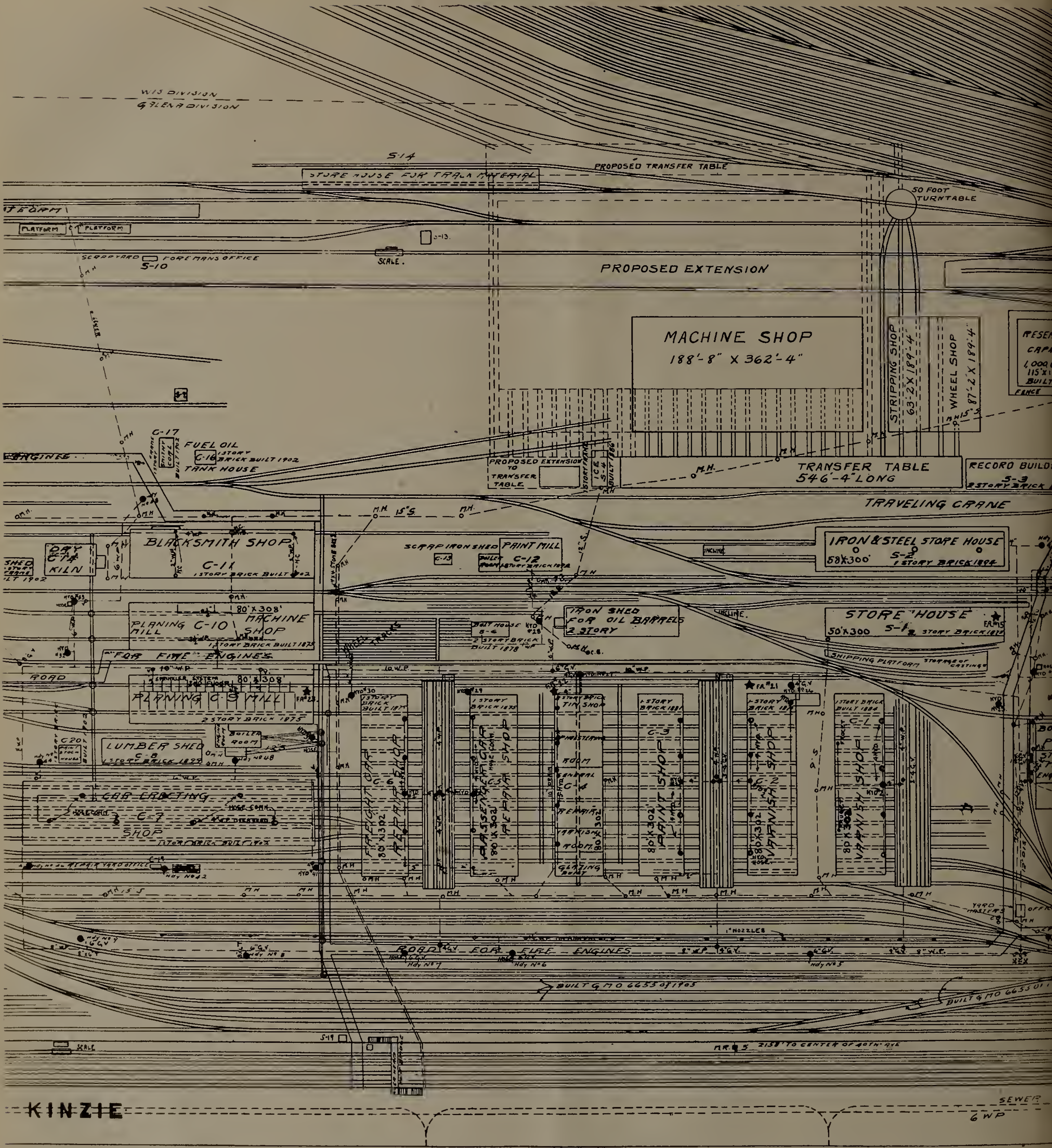
A complete list of new machinery purchased for the new erecting shop and wheel shop is given in the table:

One of the interesting features is the transfer table which is 50 ft. long and is designed to handle Mallet locomotives weighing 200 tons without tender. The working speeds are 250 ft. per minute, with heaviest load, and 600 ft. without load. The engine haul is designed to pull locomotives on or off the table at a speed of 275 feet per minute. All of these speeds may be reduced a little over one-half by running the motors in series. The cable is carried on four rails in the pit, the drive being through a single shaft on one side of the table. This table was made by Geo. P. Nichols & Bro., Chicago.

The turntable, over which all locomotives to be shopped must be taken, as shown on the drawing is of the same length and capacity as the transfer table. It is operated by a heavy duty electric traction capable of turning the heaviest locomotives a full revolution in not to exceed one minute, balanced or out of balance. In addition an electric hauling device is provided for the purpose of pulling locomotives in or off the table at a speed of from 50 to 100 feet per minute. The control of both the turning and hauling appliances is from the operator's cab mounted on the tractor. This tractor and hauling apparatus was also built by Geo. P. Nichols & Bro., Chicago.

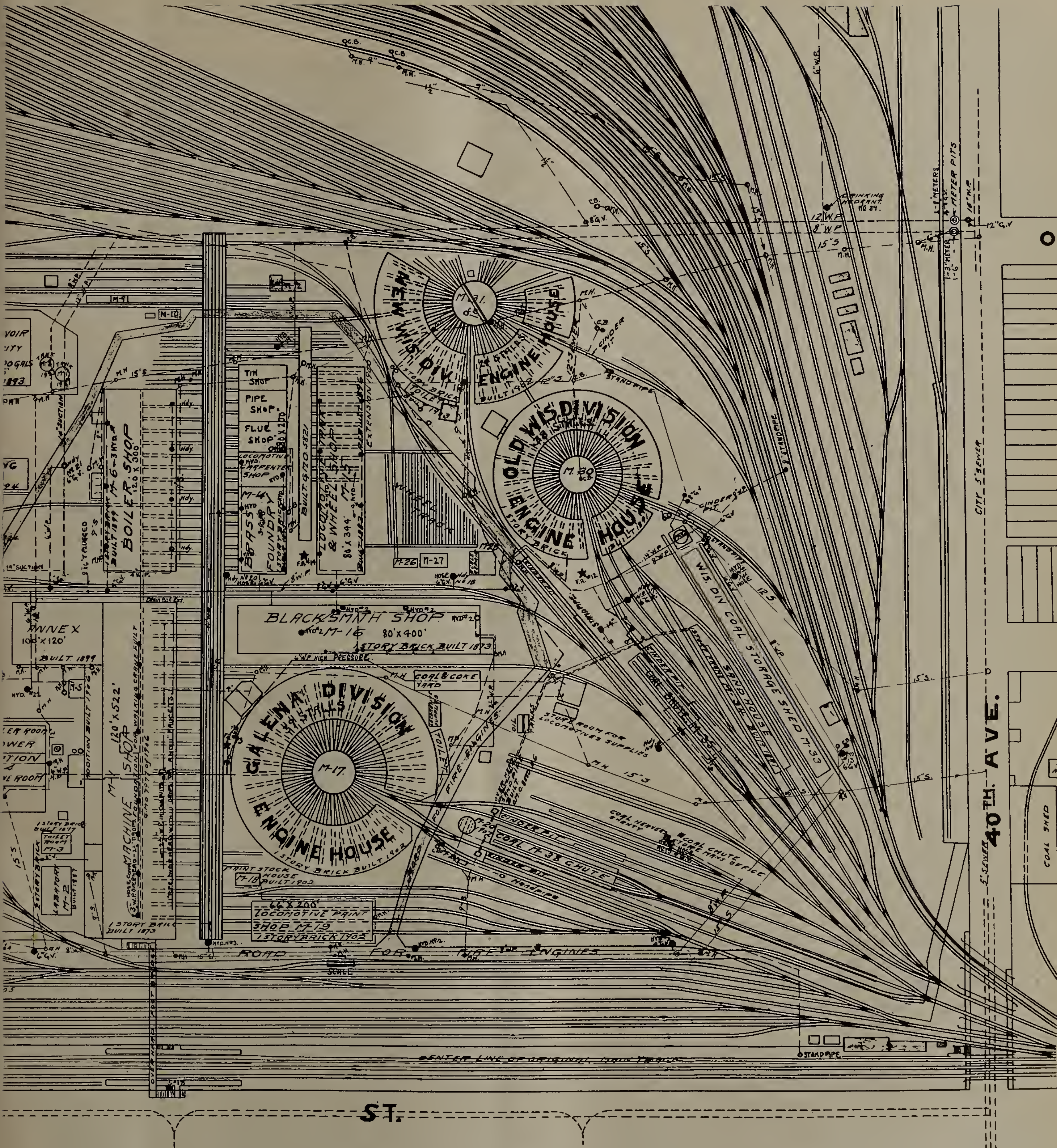
MACHINE TOOLS PURCHASED FOR NEW SHOP, C. & N. W. RY.

No.	Capacity.	Machine.	Drive.	Manufacturers.
1	90" 60 Ton	Wheel Press	Motor	Putnam Machine Co.
1	Extra Heavy	Quartering Machine	Motor	Niles-Bement-Pond Co.
1	32" Swing, 16 ft. Bed	Lathe	Motor	Niles-Bement-Pond Co.
1	28" Swing, 10 ft. 6 in. Bed	Lathe	Motor	Niles-Bement-Pond Co.
1	24" Jaw	Universal Chuck		Niles-Bement-Pond Co.
1	24" Stroke	Shaper and Vise	Motor	Gould & Eberhardt
1	48"x48"x16 ft. Bed	Planer	Motor	Niles-Bement-Pond Co.
1	90"	Drive Wheel Lathe	Motor	Niles-Bement-Pond Co.
1	40"	Drill Press	Motor	Niles-Bement-Pond Co.
1	18"	Crank Slotter	Motor	Niles-Bement-Pond Co.
1	51" Double Head	Boring Mill	Motor	Niles-Bement-Pond Co.
1	28" Swing	Quick Change Gear Lathe	Motor	Niles-Bement-Pond Co.
1	24" Stroke	Crank Shaper and Vise	Motor	Gould & Eberhardt
1	40"	Drill Press	Motor	Niles-Bement-Pond Co.
1	18"	Crank Slotter	Motor	Niles-Bement-Pond Co.
1	Double Head	Boring Machine	Motor	
1	37"	Boring Mill	Motor	Niles-Bement-Pond Co.
1	Double	Emery Wheel Stand	Motor	Ransom Mfg. Co.
1		Turret Lathe	Motor	Warney & Swasey
1	40"	Drill Press	Motor	Niles-Bement-Pond Co.
1	30"	Lathe	Motor	Niles-Bement-Pond Co.
1	38" Swing	Lathe	Motor	Niles-Bement-Pond Co.
1	No. 4	Milling Machine	Motor	LeBlond Machine Co.
1	26" Swing	Plain Grinder	Motor	Landis Machine Co.
1		Guide Grinder	Motor	Bridgeport, S. E. W. Co.
1	40"	Drill Press	Motor	Niles-Bement-Pond Co.
1	21"	Lathe	Motor	Gisholt Machine Co.
1	20"	Lathe	Motor	Niles-Bement-Pond Co.
1	44"x36"x10'	Planer	Motor	Wm. Gray & Co.
1	40"	Drill Press	Motor	Niles-Bement-Pond Co.
1	Double	Emery Wheel Stand	Motor	Ransom Mfg. Co.
1	90"	Radial Drill Press	Motor	Niles-Bement-Pond Co.
1	24"x4"x6'	Planer	Motor	Chandler
1	4 Spindle	Multiple Drill	Motor	Niles-Bement-Pond Co.
1	Double Head	Bolt Cutter	Motor	Acme Mfg. Co.
1	1½" Double Head	Bolt Cutter	Motor	Landis Machine Co.
3	No. 2	Wet Tool Grinder	Motor	Chicago Machine Tool Co.
1		Tower Hack Saw	Motor	Q. & C. Co.
2	14" Swing	Engine Lathe	Motor	Niles-Bement-Pond Co.
1	44"x36"x12'	Planer	Motor	Wm. Gray & Sons
1	16"	Drill Press	Motor	Barnes Mfg. Co.
1	24" Stroke	Crank Shaper	Motor	Gould & Eberhardt
2	30"	Lathes	Motor	Niles-Bement-Pond Co.
1	No. 4	Milling Machine	Motor	LeBlond Co.
1	40"	Drill Press	Motor	Niles-Bement-Pond Co.
1	Double	Emery Wheel Stand	Motor	Ransom Mfg. Co.
1	No. 2	Hexagon Turret Lathe	Motor	Warner & Swasey
12	No. 300	Lever Jacks		Joyce-Cridland Co.
4	No. 9	Corner Motors		Independent Pneumatic Tool Co.
3	No. 2	Corner Motors		Chicago Pneumatic Tool Co.
5	No. 1	Motors		Chicago Pneumatic Tool Co.
3	No. 2	Motors		Chicago Pneumatic Tool Co.
3	No. 4	Motors		Chicago Pneumatic Tool Co.
2	No. 16	Breast Drills		Chicago Pneumatic Tool Co.
2	Double	Emery Wheel Stands	Motor	Ransom Mfg. Co.
1	3"	Drill Grinder	Motor	Wm. Sellers & Co.
1	36"	Drill Press	Motor	Niles-Bement-Pond Co.
1	No. 2	Floor Grinder	Motor	Bridgeport S. E. W. Co.
1	No. 3	Grinding Machine	Motor	Landis Machine Co.
1	24" Stroke	Crank Shaper	Motor	Gould & Eberhardt
1	12" Swing	Speed Lathe	Motor	Niles-Bement-Pond Co.
1		Splitting Shears	Motor	Scully Steel & Iron Co.
1		Wall Radial Drill	Motor	Marshall & Huschart
1	48"x48"x16'	Planer	Motor	Niles-Bement-Pond Co.



General Layout of the Chicago Shops
The New Erecting Shop Will be Noted in the Left Half of

To H. T. Bentley, assistant superintendent of motive power and machinery, and to his superior, Robert Quayle, is due most of the credit for the preliminary designing of the extension. J. C. Little, mechanical engineer, has creditably performed that section of the work which would naturally fall to his share. The structural design was performed in the engineering department under E. C. Carter, chief engineer, with the assistance of outside architects. The assistance of Mr. Bentley and Mr. Little in the preparation of this article is most appreciatively acknowledged.



of the Chicago & North Western Ry.
the Drawing to the North of the Closely Grouped Buildings.

THE RAILWAY BUSINESS ASSOCIATION.

The Railway Business Association held its annual dinner at the Waldorf-Astoria Hotel, New York, on the evening of November 22. The banquet followed the annual business meeting, which was held in the afternoon. At this meeting the present officers were re-elected. The report of the executive committee was as follows:

Report of Executive Committee.

The Railway Business Association has succeeded in disseminating very generally an appreciation that the frequent and serious periods of depression to which the railway equipment and supply industries are subject widely affects also every other line of business, and that these periods of distress in our industries are largely due to uncertainty as to the legislative outcome of controversies between the railways and members of the public.

Such a controversy is at this moment pending. The Interstate Commerce Commission is now holding hearings on proposed advances in freight rates. The railways will not know until the decision shall have been rendered what view the commission is to take as to the resources proper for railway operation, and have been constrained to postpone new projects and cut all outlays to the minimum.

For the railway supply industries this may mean serious distress. While our establishments are now busy, the fact stares us in the face that few of us have booked any considerable orders in several months, and this dearth of orders, if continued a few weeks more, would see factories shutting down and men thrown out of work. We have still fresh in our memories the disaster of 1908, when at one time 600,000 men usually employed making things for railways were walking the streets. A group of industries employing 1,500,000 operatives, with a capital invested of more than a billion dollars and paying freight bills of $250,000,000 annually, cannot face a collapse of business without grave apprehension. Unless there is a change in a short time this immense aggregation, sustaining many great industrial communities, will be where it was two years ago, with all the consequent ramification of privation and suffering.

We earnestly hope that the commission in giving its decsion will indicate with all possible clearness a purpose of considering the needs of the railways in the broadest spirit. Such a decision would, we believe, enable our railways to finance the enormous improvements which must be made if the traffic of the country is to be carried efficiently and safely.

The merchants want, of course, the best rate they can get for the transportation they use, but recently many of them seem to be thinking more about the quality of service and more about the prosperity of the railways and allied industries and less about the rate. We believe this is the broad, American view, and it should be the aim of our association to win converts to that attitude.

It should be advertised to the world that there is in the United States an organized co-operation to the end that the railways may avoid giving offense and that the public may refrain from hasty measures. Let it be known that the American railways are safe investments because the railway men, the business men and the regulatory agencies of the state and nation have determined to make them safe.

The function of the Railway Business Association is to create an amicable atmosphere in which the railways and their patrons may make mutual concessions and avoid litigation. We believe that nothing will tend more to make business conditions more stable than for railway questions to be discussed amicably and dispassionately.

The Dinner.

Addresses were made by Martin A. Knapp, chairman of the Interstate Commerce Commission; Daniel Willard, president of the Baltimore & Ohio and of the American Railway Association; and John Claflin, president of the H. B. Claflin Company.

About 800 members and guests attended the dinner. The following sat at the speakers' table: Albert Allen, John N. Carlisle, John Claflin, E. A. S. Clarke, William E. Corey, Thomas A. Daly, Martin S. Decker, H. Fitzgerald, W. P. Hamilton, A. Barton Hepburn, James J. Hooker, Otto H. Kahn, John Kirby, Jr., Martin A. Knapp, J. V. Knight, Milo R. Maltbie, D. S. Marfield, Wm. McCarroll, P. H. Morrissey, Frank A. Munsey, John B. Olmsted, George W. Perkins, Ralph Pulitzer, Charles M. Schwab, George W. Simmons, John A. Sleicher, John C. Spooner, Frank W. Stevens, Isidor Straus, John Wanamaker, Daniel Willard.

Following are abstracts of the three principal addresses:

Martin A. Knapp.

The question of railway rates, that is to say, of railway revenues, involves vastly more than the direct interest of shippers or shareholders. In a very real sense, in a sense which is fortunately coming to be better understood, it is a great question of national policy second to none in its economic importance. That the compulsion of competition among the carriers is an unwise and mistaken policy I am persuaded. It is out of the question to have the presence of competition and the absence of discrimination. Just so long as competition between carriers is unrestrained, just so long will it result in policies which are dangerous, for to compete is to discriminate. It is a fallacy to condemn discrimination and at the same time to insist upon the very policy which promotes it. For this reason I advocate the legal sanction of co-operative action between railways regarding rates.

Speaking only for myself, and without reference to the pending controversy over rate advances or any other concrete instance, I suggest three aspects of this question which are of immediate and intense public concern. If our country is to grow and prosper as it ought, if its untold resources are to be developed and its swelling numbers find profitable employment, we need and must have railway earnings sufficient for three things:

First, a return on railway investments of such amount and so well assured as to attract and secure the necessary capital—an enormous sum in the aggregate—to improve existing roads and to construct without delay thousands of miles of new lines in fruitful districts now destitute of any means of transportation. It is a matter of common knowledge that the output of traffic for the fiscal year 1907 exceeded our entire carrying capacity on land and water. With the rapid increase of population and of productive efficiency, that is, with a greater army of workers and better industrial organizations, the volume of that year ought to be and will be nearly doubled in another decade if only we can provide for its prompt and proper distribution. And when we think of the rich regions yet unopened because unserved, when we recall, for example, that there is today in the old state of Maine a section larger than the whole of Massachusetts in which there is not a rod of railway, must we not be impressed with a realization of pressing need and of boundless opportunity? Since it is our national policy—and long will be, I trust—to rely upon private capital and private enterprise to provide these great highways of commerce, to improve and multiply them in pace with our requirements, must we not in the larger public interest, whatever may be thought by this or that shipper, make the business of furnishing railway transportation, which shall be up to the best standard of efficiency, convenience and safety, so desirable to the investor that the necessary funds for betterments and extensions will be forthcoming, and so attractive as a vocation that the highest ability will be employed in its management?

Otherwise, if unhappily this is not done, must not our country come measurably to a standstill and face a future of comparative stagnation?

Second, the payment of liberal wages to an adequate number of competent men. This not only to insure increasing skill and reliability in a service which is all the while becoming more exacting, and on which the safety and comfort of the public constantly depend, but also because of the very great influence of railway wages upon the compensation of labor in every sphere and grade of private employment. To my mind the fundamental social problem is to provide, by the wise development of our institutions and without radical action or injustice, for a more equable diffusion of the bountiful wealth which the earth produces. Now, as a large and increasing majority of the able-bodied live, and must live, by working for others in some capacity, a high and advancing standard of payment for service of every sort tends strongly to promote, and is the best practical means to bring about, the degree of equality in social welfare which makes for the satisfaction and happiness of all our people.

Third, the betterment of existing lines so as to greatly augment their serviceableness to the public, as can in varying degree be done everywhere, without unnecessary and undesirable increase in capitalization. Every dollar borrowed to improve a road now in operation involves a permanent addition to the interest charge which the public is required to pay; the improvement from current earnings puts no lien upon the property, but rather augments its value and usefulness, and by adding to the security of the capital already invested tends to a lower rate of interest upon that capital. Broadly speaking, this means a national policy, so to speak, in respect of railway rates and revenues in harmony with our national policy in other matters of public concern, and in accordance with that enlarging spirit of altruism which manifests itself in public as well as in private life, and which impels the present assumption of burdens that might be escaped or deferred in order that another generation may have an easier task and a larger opportunity. Is it not in this particular field a wise and patriotic policy?

Daniel Willard.

The industries represented by your association constitute a powerful economic force, and your organization has for the first time brought that force to bear on public opinion. It was fortunate for the railways of this country, and I believe a fortunate thing for its commercial industries as well, when the Railway Business Association was formed. You have already performed a most valuable service in the way of bringing about a better understanding between the railway managers and the railway users, and your efforts in that direction deserve hearty recognition. I do not hesitate to say that the railways fully appreciate and gladly acknowledge what you have actually accomplished and will welcome a continuation of the same policy.

I am extremely anxious to see a better understanding reached between the railways and those who use them; but I have never seen any substantial or lasting progress made towards such understanding by parties holding views greatly at variance, until they were both ready and willing to accept the truth, if it could be found, and then act accordingly.

The American railway, except in the extreme East, has almost universally gone ahead of the population or even the settler. The building of a railway under such circumstances was a hazardous undertaking. Men could not be found willing to assume the altogether too apparent risk of loss, unless in some manner there was thought to be something which promised large reward. In many instances large reward was realized. Had it not been so there would have been no railways. Similar risks were assumed in other enterprises in a new country and similar expectations of large reward were indulged in and just as frequently realized.

In the course of time complaints began to be made that the railways were showing special favors to some individuals and communities and withholding such favors from others. It was claimed that rebates were being granted the better to cover up the transaction. It was claimed also that the roads charged less in some instances for a long haul than for a shorter haul when the circumstances were substantially the same. It was claimed that the railroads exercised a controlling influence over some of the legislative bodies, such influence resting largely upon the issuance of free transportation and in some cases the actual payment of money. It was claimed that the railways were over-capitalized and that in some instances large fortunes were made by improper, not to say illegal, practices in that connection. Doubtless there was sufficient cause for complaint. To hold otherwise would be to hold that men engaged in railway affairs were not subject to the same human limitations and weaknesses that are known to be the common heritage of mankind. It was claimed that the pooling practice, at that time much in evidence, was inimical to the interest of the shipper and its abolishment was demanded, though so far as I am able to learn, no general complaint was ever made that rates, as a whole, were excessively high. Other minor complaints against the carriers were also registered.

The feeling aroused by these various practices finally found expression in laws, notably the Interstate Commerce Act, with successive acts amendatory thereof.

Granting, for the sake of argument, that the builders, owners and managers of the railways were in common with the rest of mankind subject to all weaknesses and limitations that the human race is heir to, let us see how much foundation in fact there is, or ought to be, at the present time for such distrust as still seems to exist.

The rebate and unjust discrimination have disappeared, or, if not altogether, then the relief is to be found in the enforcement of the existing law. I submit no additional law is necessary in that direction. The long and short haul question seems to be fully covered by the recent amendment. Recognizing, however, the far-reaching effect the so-called long haul practice has had upon the general commercial and industrial development of this country, Congress has seen fit—wisely, I think—to give the commission much latitude concerning it. A strict and literal enforcement of the law would mean commercial disaster to many communities.

The influence of the railways upon legislation has been, I believe, largely if not entirely eliminated. This has come about partly by the people requiring of their representatives a closer accountability and partly by the fact that the railways, recognizing the higher ethical standard concerning such matters today, have endeavored to adjust their practices in harmony therewith.

The claim that the American railways are over-capitalized is still urged in some quarters. In that connection the following comparisons of capitalizations per mile are interesting:

England	$275,040
Belgium	169,806
France	139,390
Austria	112,879
Germany	109,788
United States	59,000

In my opinion to duplicate the American railway system today would cost a sum very much in excess of the existing capitalization, and while I do not believe a physical valuation of the railways would serve any useful purpose, I am convinced that the railways have nothing to fear in that direction.

James J. Hill, whose knowledge of this subject rests upon the most careful thought and inquiry, has well said: "The American railway pays the highest wages in the world out of the lowest rates in the world, after having set down to capital account the lowest capitalization per mile of all the great countries of the world."

While the railways as they stand today have cost nearly $14,000,000,000, as shown by their outstanding capitalization, it is certain that the development of the country will make necessary further large expenditures for additions to and betterments of the existing lines. It has been well stated that one billion dollars a year, for a number of years at least, will be absolutely necessary for these purposes. How will the money be obtained? By offering something in the way of a security sufficiently attractive to make the money forthcoming; for, as one of the honorable members of the Interstate Commerce Commission has well said:

"We can provide by legislation the sort of cars which a railway shall use and the rates which it shall impose; we can not by legislation force one single dollar of private capital into railway investment against its will."

The cost of railway operation has been increasing for some years, and there is no apparent reason for thinking that this upward tendency will cease. It has been due in part to higher prices for material, higher wages paid for labor, to the higher standard of service demanded by the public, and to various legislative requirements, such as the hours of labor law, the so-called "full crew" bill, etc. Please understand that I am not criticising the laws referred to, nor am I complaining because of the higher standards of today; but, whether good or bad, necessary or unnecessary, they serve to increase the cost of operation and to that extent reduce net earnings. During the last ten years particularly, the American railways have spent enormous sums for improvements, such as reducing grades, eliminating curvature for double track, and enlarging and improving terminals, etc., and the economies resulting from such expenditures have gone far toward offsetting the constantly increasing cost of operation. The possibilities of future economies resulting from further similar expenditures, have been very largely exhausted, so that if costs continue to go up, there would seem to be only one way now to meet the situation, and that by an increase of rates.

Under the recent amendment of the Interstate Commerce law it is now impossible for the carriers to advance any rate unless such increase is approved by the commission. This operates, as I view it, to place the credit of the railways in the hands of the commission, for the credit of the railways is dependent upon the net earnings, and the net earnings will depend very largely upon the rate received.

Much has been said about what is a fair and reasonable return on money invested in railway securities. If the railways were finished and no new capital needed, it might then be interesting to discuss what rate of interest or dividend should be paid in the future on money borrowed in the past. That, however, is not the situation; the railroads are not finished and they will need and must have large sums in the future and it will not be obtained by telling the man whose money is desired that he will be paid a fair rate. The man who has money to lend, taking him as a class, will decide, not what is a fair rate, but what is a satisfactory rate to him, and in reaching that conclusion he will be influenced by many elements, not necessary now to refer to, but which taken as a whole constitute credit.

The question of what is a fair and reasonable freight rate is also a difficult one to determine. Certain it is, as I view it, that the sum of all such rates must at least be sufficient, when combined with efficient management, to furnish such net earnings as will enable the individual road to obtain the necessary new capital when needed on a favorable basis, otherwise, because of impaired credit, money could not be raised at all, or if raised, then under such conditions as would probably add to the embarrassment.

What of the future? Speaking for myself only, I believe that the roads (referring to them again in a personal way) should recognize in the future more generally than they have done in the past, that while they represent private investment and on that account are under certain precise as well as implied obligations to their security holders, they are also charged with a public service to perform, and there are also certain clear and implied obligations in that direction, among which are these:

To treat all alike, giving as full consideration as possible to all reasonable requirements. In short, while giving full and proper consideration to the right of the security holders, to give fair consideration also to the rights and feelings of the users—they are partners in the enterprise.

I think the roads should keep out of politics. This makes it necessary to take the public into their confidence so far as possible, so that the public, being fully and correctly informed, may act intelligently and fairly towards railways.

I think the roads, through their proper officers, should cooperate as far as possible with the Interstate Commerce Commission in trying to bring about a better understanding on the part of all.

The commission, newly charged with greatly increased responsibility incidental to increased power, will, I have no doubt, gladly welcome a spirit of co-operation on the part of the carriers. I have confidence in the intelligence and integrity of the commission. It is the duty of the railways to see that the commission is fully informed concerning the roads' necessities. It is of great importance also, as I view it, that the atmosphere of public discussion should be so free from heat and animosity, that the commission may be assisted and not impeded by public opinion so formed, in reaching just and wise conclusions. To this end, I believe, most, if not all, of the railways, by their present policy in dealing with the public, are earnestly endeavoring to avoid needless antagonism or misunderstanding.

I would not like to have it thought, because of anything I have said, that I am opposed to the policy of government supervision of the railways; on the contrary, I am convinced that, under all the circumstances, it is for the best interest of all—railways as well as the public—that there should be effective government regulation; but, it is also equally important that such supervision or regulation be fair as well as effective, and that it be not so extended as to destroy or discourage individual initiative and enterprise. I will even go so far as to say that I am also convinced that the only alternative to such control by the government, as I have indicated, is government ownership.

I assume we are all equally interested in the prosperity of our country as a whole. We can not have such prosperity as we all desire while the second largest industry in the land, measured by capital investment, remains inert. I positively know that there is today in the minds of railway managers a feeling of hesitancy, of uncertainty, as regards the future. Possibly that feeling is not justified by the facts, by the conditions. Possibly the managers are mistaken. None the less, the feeling is there and it is dominating the situation, and the all-important question is—how can it be corrected? How can the feeling of distrust, which now rightly or wrongly so powerfully influences the policy of the railways, be allayed? I should say by removing the cause, and, unless I have altogether failed to make clear what is in my mind, I think the cause, as I view it, should be apparent; but, to be specific, let the people who use the roads and want the roads, now indicate that, having secured the passage of such laws as they considered necessary in order to correct the conditions complained of in the past, they are now willing (as I think they should be) to open a new account with the future. Let them consider each new proposal for legislation with entire freedom from any spirit of retaliation. I do not say that it is necessary to undo anything already done (although experience may show such action to be wise in some instances), but I do say that the railways should be given a respite from further legislation—State or Federal—for a time at least, and until they can work out some of the many problems now confronting them. If such a course should find favor in the minds of the people and reflected in their attitude towards the carriers, I do not hesitate to say that the patient now indisposed would immediately show signs of convalescence.

The remedy suggested is not a serious one. Is not the experiment worth trying?

John Claflin.

How to meet the increased cost of living is a problem of the time. We may partially explain the advanced prices of what we eat by the reduced proportion of food producers to food consumers, and we may to an extent explain the increased cost of other things which we use by the high wages and the decreased efficiency of labor, but these explanations only show us that we may not soon expect any considerable reduction in the cost of living; that as investors and as business men we must face increased expenses, and it behooves us to determine what we can do, if anything, to increase the income of the community in general and of ourselves in particular.

The railways up to a certain point have indicated the way in which increased expenditures can be met. They have been able to increase their business largely, and a similar increase of business is the solution of his particular difficulties that every merchant would welcome. The railways now have reached a point where it seems difficult for them to continue to increase their gross revenue materially without very great expenditures for betterments and for extensions. Under ordinary conditions the money to pay for such extensions and betterments could readily be had by the sale of bonds bearing a moderate rate of interest. At the present time, however, investors are asking larger returns on their capital than in the near past, and foreign investors, especially those who seek only the choicest of American securities, are inclined to be indifferent to the offerings of American railways, because they are doubtful in view of the recent advance in wages by the railways, whether or not the railways now have a safe margin of profit which will enable them to pay interest on all their fixed obligations and to continue reasonable disbursements to their shareholders. It seems to me the solution of this doubt is of the utmost importance to the general prosperity of this country, and its solution may be facilitated or delayed by the attitude of the merchants of the United States in regard to the advances in freight rates which the railways have proposed.

As a wholesale merchant in New York the question to me is partly academic because as a wholesaler I pay but a small portion of the freight which is charged on merchandise shipped from New York, but as an investor in retail stores throughout the country, the question lies within the scope of my personal investigation and may affect my income largely. I ask then, will it be advantageous for the average merchant outside of New York to pay some increase in freight rates to help the general situation? I think it will. Let us take as a unit a retail business of medium size amounting in sales to perhaps a million dollars per annum. If this business is located pretty far West, say beyond the Mississippi river, it may now pay $25,000 per annum for freight and express from the East. If freight rates should be raised 12 per cent on the average it would pay $3,000 additional per annum to the railways. What would such a business be likely to gain? Let any merchant look back carefully over his records and note the fat years and the lean years and then mark the years of general railway extension and improvement on the one hand, and the years of railway retrenchment on the other, and I am sure he will find that his prosperity on the average has increased with the progress of the railways and has waned with their lack of progress.

These facts may not necessarily demonstrate a relation of cause and effect, but they certainly point to such a relation and no one can doubt that to a considerable extent such a relation exists. If the railways should now be permitted to make some such moderate advance as I have indicated and our typical merchant should pay $3,000 additional in freight and express charges, my own investigation leads me to believe that the general activity which renewed railway buying would induce would increase the merchant's business at least 5 per cent and perhaps as much as 10 per cent or 15 per cent. If such should be the case, at a minimum increase of 5 per cent he would get additional sales amounting to $50,000 at slight additional expense except for freight, and it is entirely safe to say that his net gain on these sales before deducting the increased payment to the railways would be at least $6,000, or twice as much as he would pay by reason of increased rates for transportation.

If a typical business should be taken further east, say near the Ohio river, the haul being shorter the increase in the cost of freight would of course be less, while the increase of business would probably be equally great and the net gain to the merchant materially greater.

This solution of the problem for the merchant as well as for the railways seems to me the logical way out. Mercantile expenses cannot be reduced materially without reducing business proportionately, but under the impetus of a general growth of the country, mercantile business may increase in the future as it has increased in the past with sufficient rapidity to keep expenses within reasonable ratio to the amount of sales.

How can the general growth and general prosperity be best promoted? I think the railway will answer this question satisfactorily if by friendly co-operation we give them the power to go ahead.

THE ROTARY SNOW PLOW.

With a view to obtaining from users of the rotary snow plow their opinions of the advantages of this type of snow fighting equipment, the American Locomotive Company addressed a letter to the chief operating official of every road in the United States on which there are rotaries in service. This letter was not a request for testimonials, but contained the following questions:

"Is the rotary snow plow any easier on track and bridges than other types of plows?"

"Is its operation attended with any less danger to equipment and men than the push (or wedge) plows? If so, could you give us an account of any striking instances of comparatively recent occurrence in which this has been particularly exemplified?"

"Can you cite any instance of recent occurrence in which the rotary has demonstrated its ability to remove snow that no other type of plow could handle?"

"Has the use of the rotary on your road made it possible to dispense with other additional and more expensive methods of keeping the right of way open, such as the building of snow sheds and fences?"

Replies were received to 70 per cent of the letters. In the large majority of cases, each question was answered separately, instances in the experience of the official being given to illustrate the point in question.

Without exception, the only correct conclusion that could be drawn from each reply was that the rotary was the only type of snow plow known which could be relied upon under every condition; and which, where other types of plows were unable to remove the snow, was the last resort.

The replies from the officers of a number of the western roads, on which the problem of keeping the "line" open during the winter is among the principal ones which the operating department has to contend with, concluded with unqualified endorsements of the superior advantages of the rotary.

Possibly the strongest of these endorsements were those received from Mr. E. E. Calvin, vice-president of the Southern Pacific Railroad Co., and Mr. E. Pennington, president of the Minneapolis, St. Paul & Sault Ste. Marie Ry., both of whom have had experience with this type of plow since it was first introduced twenty-five years ago.

there followed a fall of sleet and rain which froze, making the digging extremely hard.

On the Northern Pacific Railway on opening up the Linton branch on Feb. 23rd. 1910, the rotary again proved successful where other types of plows would have been useless. The drifts on this occasion were in many instances from 10 to 15 feet deep, and in very narrow and high cuts, out of which it would have been impossible for any type of plow other than the rotary to have thrown the snow. The rotary on this expedition worked continuously throughout the week.

There are numerous similar cases illustrating the acknowledged fact that, whereas other types of plows have their limitations, the rotary has practically none. Up to the limits of the height of its hood, no drift is too deep for the rotary, and no snow too hard or icy.

Late Design of the Rotary Snow Plow.

One instance on the Southern Pacific in which the rotary proved its ability to remove snow which no other type of plow could have handled might be cited. There are several rotaries in service on the Sacramento division of this road. This division runs through a mountainous district and the rotaries are thus called upon to perform some very difficult service. On the occasion in question, the snow had accumulated during the winter to a depth of about 12 to 15 feet over the entire length of a siding 1,200 feet long. Much of this snow had been frozen hard, and the depth was such that it was above the hood of the rotary. Owing to the height of the drift it was necessary, of course, to shovel off the top of it before bringing the rotary into operation. In spite of these conditions, the rotary cleared the snow out of the siding without difficulty, a feat that no other make of plow known could have accomplished.

On the 14th of February, 1910, on the Minneapolis & St. Louis Railroad there occurred a blizzard which the officials state was one of the most severe storms that South Dakota has experienced in twenty years, according to the opinion of people who had lived there that length of time. The road was completely blocked with snow and sand from Watertown to the Missouri River, and to its most northwesterly point, Leola. An attempt was made to open up the line with wedge plows, but it was found impossible. A rotary was then called into service, and the road was successfully cleared without difficulty, in spite of the fact that, after the blizzard,

The dangers to equipment and men attending the use of the wedge plow in deep drifts or hard packed icy snow are well known to railroad men. Numerous cases of serious accidents resulting in the crippling or killing of men and damage to equipment due to the use of the wedge plow, might be given. The great chance of serious accidents and blockades to traffic, and above all the jeopardy to the lives of the crew entailed in sending a wedge plow at full speed blindly into a deep drift, which must of necessity be done with this type of plow, is the most serious objection urged against it.

An accident of this kind recently occurred on one of the large Western roads where four heavy twelve-wheel engines were pushing a wedge plow. On striking a deep drift, occasioned by a snowslide, the plow was ditched, overturning the four engines and injuring a number of men.

A similar instance occurred in the winter of 1910 on the Minneapolis & St. Louis Railroad, although, owing to the vigilance of the men in charge of the pusher, the results were not as serious. In this case, the wedge plow was being used to clear away snow which was very heavy and wet. On the third attempt the plow broke and derailed the cars to which it was attached. Had not the engineer been on the lookout for such an accident the engine would have also been derailed.

With the rotary there is no bucking. It bores through the drift at comparatively slow speed, and with absolute safety to those operating it. No stronger argument in favor of the rotary can be advanced than this: Its use insures against damage to property and injury and death to employees.

Because of the equal distribution of the weight over the front and rear trucks and the lower speed at which it is run, the rotary is operated with less injury to track and bridges than the wedge plow. This latter type must rely on high speed to buck a heavy drift, thereby throwing a great strain on the rail. The acknowledged common danger with even the best makes of wedge plows is the turning over of a rail, especially on curves. In the rotary snow plow, this danger is entirely eliminated.

Because of its ease on the track, the rotary may operate with safety on branch lines or where the track is not in first class condition, where it would be impossible to use any make of wedge plow.

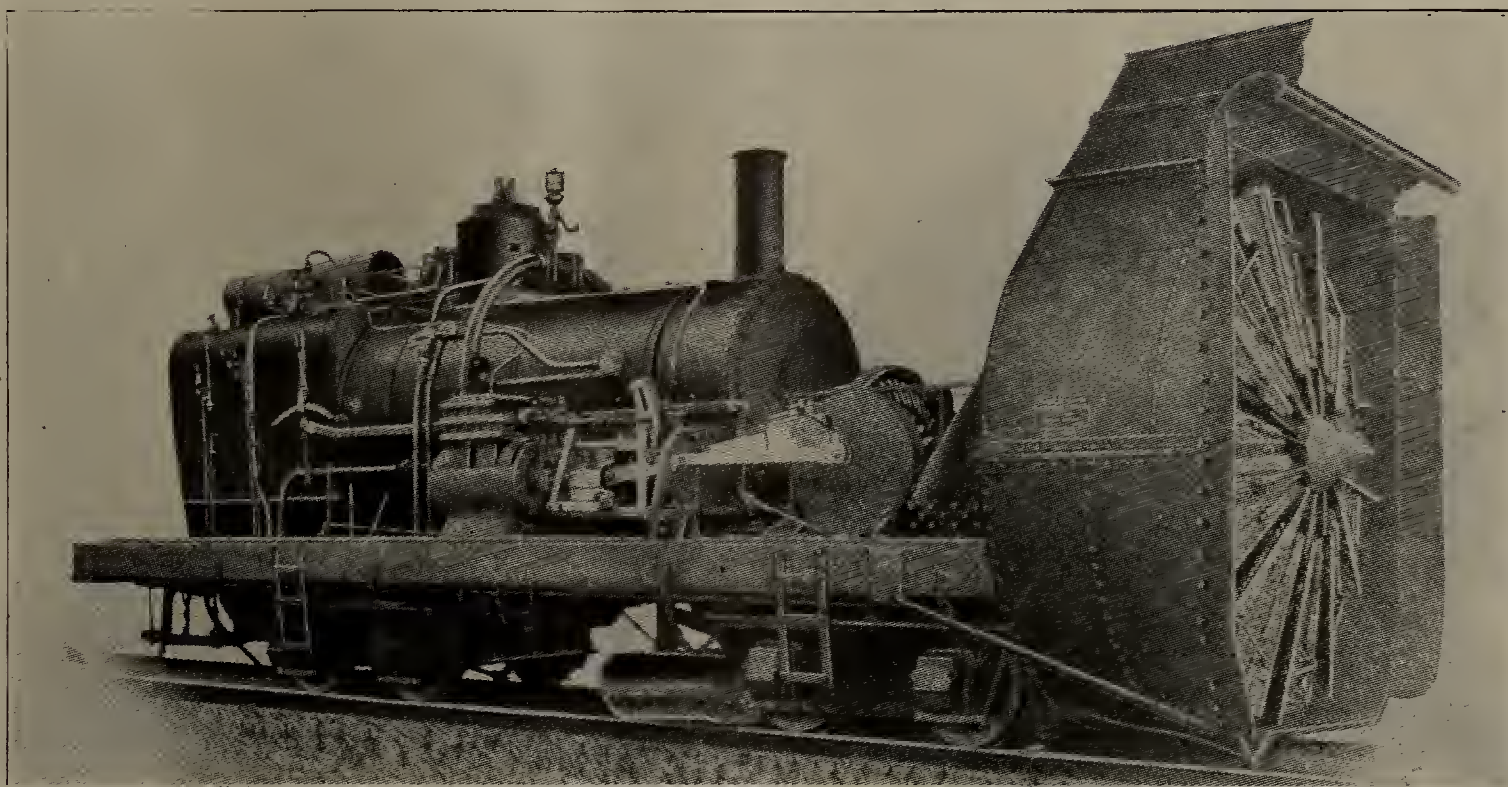
On the Colorado & Southern Railway, a rotary having a width of cut of 10 feet and weighing approximately 148,000 lbs., is used on narrow gauge territory laid with 40-pound steel rails without trouble, according to the report of the railroad officials.

As railroad men know, it often happens during severe blizzards that a train may be snowed in before assistance can reach it. A case of this kind happened in 1909 on one of the large Western roads, where a train was stalled in 6 feet of heavy wet snow, the drift being over 800 feet in length. Although the wedge plow was at hand, there were insufficient men to clear away the snow. With the wedge plow it was impossible to get hold of the rear end of the train to pull it out, owing to the fact that the necessary speed required to buck the drift with that type of plow made a collision almost inevitable. It was necessary, therefore, to wait for a rotary, which, on its arrival, worked up to within 6 feet of the rear of the train, after which the train was handled without difficulty.

Where the snow drifts are deep in a high, narrow cut the wedge plow is absolutely useless, owing to the fact that it must have some space in which to push the snow to one side. No such limitations exist in the rotary. Its wheel revolving rapidly cuts the snow and throws it clear of the embankment. Under these conditions, which often obtain on roads where the depth of the snow does not exceed the limitations of the wedge plow, the rotary is indispensable.

Another distinct advantage of the rotary lies in the fact that it can throw the snow to either side of the track as necessity may demand. Consequently, any plow may be operated over any part of the line, to clear a yard, single or double track, and irrespective of whether it is left or right hand running, giving a flexibility of service which is not afforded by the wedge plow.

In addition to its other advantages, the rotary presents another important one in that in many cases its use of adopting or continuing the use of other addtional and very expensive methods of keeping the "right of way" open, which, where only wedge plows were used, had to be resorted to. On a number of the Western roads the rotary has in some cases made it possible to dispense with the erection of snow sheds and fences, and in others to discontinue the maintenance of those already erected. The expense of building and maintaining snow fences and other protections from snow of a similar character is considerable, and the saving in this item of operating expenses effected by the use of the rotary is, therefore, an important consideration.



Machinery of the Rotary Snow Plow.

On the Rock Island lines, in South Dakota and Minnesota, the use of the rotary has saved the maintenance of two lines of high fences, together with the wide right of way necessary for the second fence.

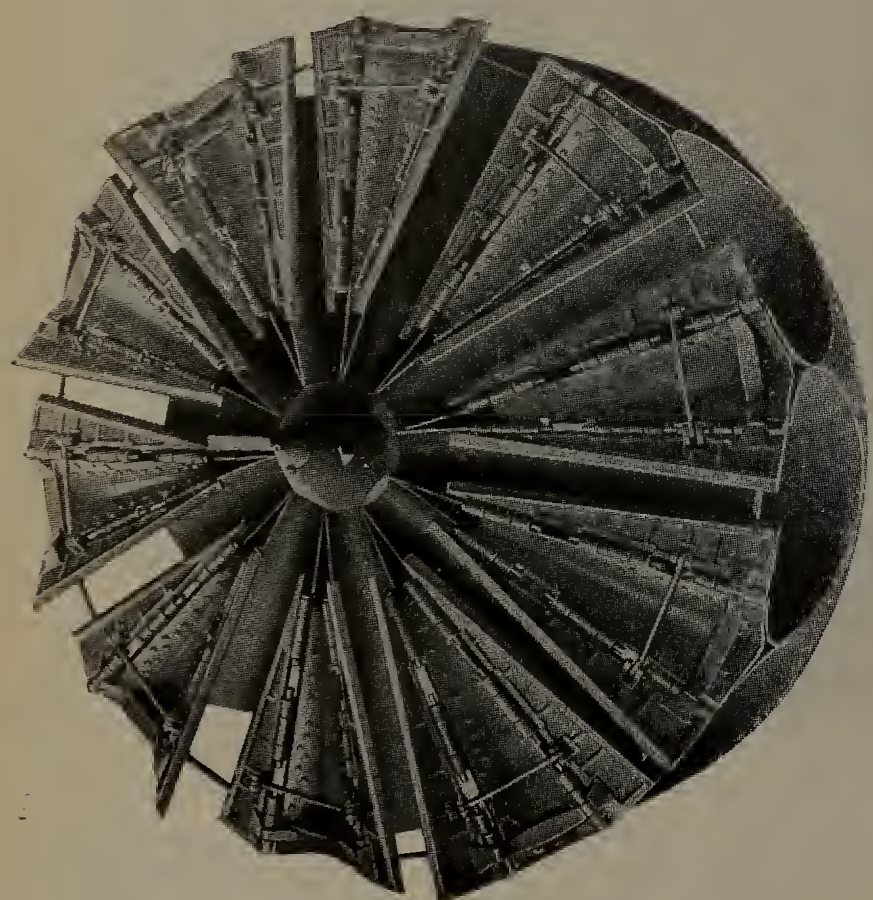
The rotary snow plows on the Sacramento division of the Southern Pacific Railway have made it possible to dispense with about 14,000 feet of snow sheds between Truckee and Tunnel 13, and officials of the road report that more extended use of the rotary would undoubtedly obviate the building or maintaining of snow sheds in certain other bad localities.

On the Colorado Midland Railway, officials state that without the rotary snow plow it would be impossible to operate the line without erecting some 12 miles of snow sheds. As it is, snow sheds are only required at two of the worst points, viz., Windy Point and Busk. Mention might be made of a number of other roads, including the Cregon Railroad & Navigation Co., Colorado & Southern Railway Co., Northern Pacific Railway, and the Denver, Northwestern & Pacific Railway, on which considerable saving in the cost of keeping the right of way open has been effected by the adoption of the rotary snow plow.

The snow conditions on the last of the above-mentioned roads are probably the worst to be found in the United States. This road rises to an altitude of 11,669 feet. The rotaries are in service for about ten out of the twelve months. During the season of 1909, the rotaries ran 18,000 miles. The adoption of the rotary in place of the wedge plow on this road has saved the expense of shedding a considerable number of miles of the line at a high initial cost, to which would have been added a considerable annual appropriation for maintenance. Officials of the road are in consequence very emphatic in their opinions that the rotary is the most efficient and economical device known for keeping the road clear of snow. In fact, without the rotary, this road, as well as a number of others crossing the "Rockies," and the Andes of South America, could not be operated for more than a few months during the year.

Design of the Rotary.

The design of the new rotary is the result of twenty-five years' experience. Every weak point that has developed under all conditions of service has been eliminated, and the design perfected in every detail. The machinery is simple, and of such construction as to stand the hardest use. The construction and arrangement of the machinery is shown in the above illustration of the plow without the cab.



Rotary Scoop Wheel.

The engine consists of two horizontal cylinders, each cast with half saddle, and rigidly bolted together and to the frame. Steam is distributed to the cylinders by slide valves actuated by a simple design of the Walschaert valve gear, so arranged that the pistons of the two cylinders operate in opposite directions. Each cylinder is connected to a cross shaft, on the end of which is a beveled geared pinion which meshes with the beveled gear on the end of the wheel shaft. In the new rotary, machine cut steel gears and pinions are used, thus providing the strongest construction for these most important parts of the machinery, and making a noiseless and smooth running machine.

As will be seen from one of the illustrations, the boiler is of the locomotive type with a Belpaire fire box. It provides ample heating surface to give a good margin of steam capacity to meet all the requirements, and a sufficient grate area to provide for the fuel consumption required with an economical rate of combustion. Steam is conveyed from the dome of the boiler to the steam chests by means of outside wrought iron pipes, one on either side of the boiler. The throttle valve is of the balanced type, so designed that steam enters from the top only, thus insuring the admission of only the dryest steam to the pipes.

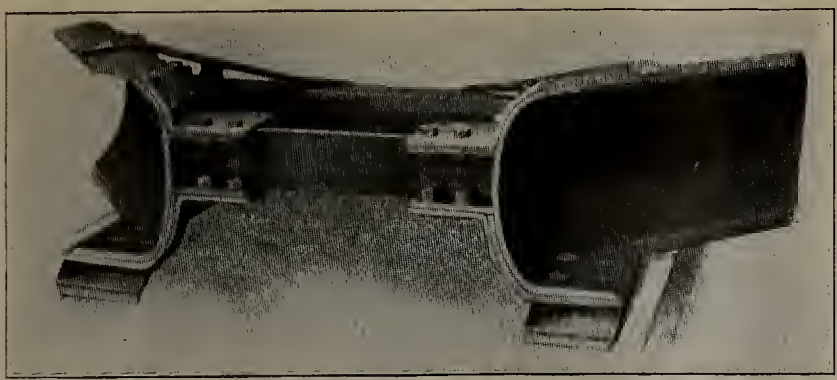
The wheel of the rotary consists of a number of hollow cylindrical cone shaped scoops, usually ten, securely fastened by T-irons to the hub of the wheel and to the steel plate disc which forms the back of the wheel. The scoop of cylindrical section, which is a characteristic feature of the rotaries built by the American Locomotive Co., has been adopted as the one best suited to meet every requirement after years of experience and experiments with other designs, including the scoop of rectangular section. The cylindrical cone shaped scoop possesses a number of important advantages over that of rectangular section. The former type permits of the use of a narrower knife than the latter, thus decreasing the strain on the hinged joint, with a resulting decrease in the possibility of the knife being broken off in heavy snow. It also permits of the use of a stronger design of hinged casting, comprising the hinged joints for two adjacent knives, which are joined together by a bar having a pin connection with each knife. With this construction, the strain on each knife is distributed between the two hinges; while with the scoop of rectangular section each knife has a separate hinge which bears the whole strain on the knife.

Each scoop is open on the front side its entire length, through which the snow is taken in. The openings in the scoops are of ample width to admit the snow cut by the knives, thus preventing chocking or clogging of the wheel. The knives, which are of cast steel, are hinged one on each side of the opening, and so arranged that they automatically adjust themselves into cutting position. Careful attention has been given in the design of the scoop to reducing the friction of the snow, while passing through, to a minimum. Each pair of adjacent scoops are tied together at their outer ends where the force is the greatest by a rod, making the periphery of the wheel practically one solid piece and providing a large margin of strength to resist the contortional strains which are put upon the scoops.

The wheel is encased in a drum with a rectangular front or hood. The bottom of the hood or scoop is cut away in the shape of a V, so that on the sides it projects only slightly in advance of the cutting blades of the wheel; while at the center the knives are the first to encounter the snow. In consequence, the hood presents no dead surface to be forced into the snow; but practically the whole front of the rotary is a sharp cutting edge. The top of the hood is provided with a spout fitted with a moveable cover. The wheel, of course, can be made to rotate in either direction to throw the snow to one side of the track or the other, and the cover of the spout may be turned to suit the direction in which the wheel is rotating. A feature of the new rotary is a pneumatic gear for operating the cover of the spout, which has been added to the hand wheel operating device of the older design, and greatly facilitates handling of the plow.

Another feature in the new rotary which has been successfully applied to a number of recent shovels, further improving their efficiency, is the hood lifting device.

In pulling the rotary back out of a drift, over cleared snow, particularly when the snow is wet and heavy, or at places where the ice-cutters could not be operated, such as in yards where the frogs and switches make this impossible, it sometimes happens that the loose snow will be scraped up and pack up under the hood, lifting the plow. To obviate this difficulty, the hood-lifting device has been applied; by means of which the front end of the shovel can be raised a maximum height of 7 inches by means of power operated ball bearing jack screws. Power is derived from the rotary wheel shaft, the device being thrown in or out of gear by means



Flangers of the Rotary Snow Plow.

of a friction clutch mounted on the wheel shaft and operated by a lever. The power is transmitted by means of a chain from the wheel shaft to a longitudinal shaft which drives the jack screws through a system of beveled gears, worms and worm wheels mounted on a transverse shaft.. A signal is placed in the pilot house operated by a lever fulcrumed on the plow frame, which indicates when the high and low stops are reached, and also the intermediate heights of rise in inches between these two points.

In the standard designs, the plow is carried on two 4-wheel plate frame trucks especially designed to provide the maximum strength with a minimum weight. The side frames are made from a solid 1½-inch steel plate. The trucks are equipped with floating bolsters built up of steel channels and plates, and supported on coiled springs, which are seated on a steel channel spring plank. Wear or rubbing plates are provided between the bolster and the transoms, the latter being of steel plate secured to the side frames by angle irons and reinforced at the top by steel angle irons. Steel plate gussets are also used to tie the transoms and side frames together.

Steel angle irons riveted to the top of each side frame and extending the whole length serve to stiffen the frames longitudinally. The side frames of the front truck, to which the ice-cutter and flangers are applied, are tied together at the ends by bar iron end frames. The journal boxes are of the M. C. B. standard type, and are fitted in cast steel hornblocks, or pedestals, which are provided with a flange on the inner side, through which they are riveted to the frame; thereby relieving the rivets of any tensile stress due to the end thrust of the box.

Among the important and characteristic features of the rotary, which combined result in its exceptional efficiency, are the ice-cutters and flangers. These are the safe-guards against derailments.

With hardly an exception, users of the rotary report that they have never known the rotary to be derailed when working in a drift except by extraordinary causes, such as snow-slides. In the very few instances where derailments have occurred, it is acknowledged to be due to the fact that the ice-cutters had not been kept in good working condition, or that the accident had occurred at a place where the ice-cutters could not be operated. With the ice-cutters and flangers properly performing their functions, it is acknowledged that it is practically impossible for the rotary to be derailed in clearing away ice or snow. The only other possible chance of the rotary being derailed, that is in backing out of a drift, is eliminated by the hood lifting device previously described.

The ice-cutters, which are composed of two parts, the wing and the cutter, are secured to a wrought iron frame supported by bearings on the front of the frame of the forward truck. When in working position, the wing projects over the rail and the cutter point projects down below the rail on the inside directly in front of the forward wheels.

The accompanying illustration shows the design and construction of the flangers. These are secured to a wrought iron frame supported by bearings on the rear axle of the front truck.

A pneumatic operating gear under the control of the pilot is provided by which the ice-cutter and flangers may be simultaneously raised or lowered. Extra ice-cutter points and bolts are furnished in the tool equipment of the rotary, to be used to replace any that may be broken off by striking some obstruction other than ice or snow. By thus making it possible to easily keep the ice-cutters in perfect working order, long delays resulting from injury to these parts are avoided.

The frame is substantially constructed of steel and well braced to withstand all the strains that may come upon it. In the larger rotaries, 15-inch I-beams weighing 80 pounds per foot are used for the center sills, and 12-inch 35-pound channels for the side sills. In the smaller size shovels, 12-inch I-beams and 12-inch channels are used respectively for the center and side sills.

The frame construction is shown in the accompanying illustration. The pillow blocks, boiler saddle and cylinder castings, together with wrought iron diagonal and transverse braces between the center and side sills constitute a very rigid system of bracing.

The frame castings are grooved to embrace the center sills which are machined to fit.

In the design of the cab, especial care has been taken to provide one of strong construction and roomy proportions. It is partitioned off in front of the boiler, the forward compartment being the pilot house and the rear the engineer's cab. All the machinery in the pilot house is underneath the floor and is covered with steel plates, thus securing the safety of the operator. Steel plate doors in the side of the cab give access to the machinery located forward of the dividing partition.

The rotary is equipped with air brakes under the control of the pilot Large reservoir capacity is provided to supply the brake, ice-cutter and flanger and spout operating cylinders.

The Delaware & Hudson has ordered 11 locomotives from the American Locomotive Company. The order includes 5 ten-wheel passenger locomotives with 21 in. by 28 in. cylinders, 63 in. driving wheels and having a total weight in working order of 186,000 lbs.; one ten-wheel superheater passenger locomotive with 23 in. by 26 in. cylinders, 63 in. drivers and having a total weight of 190,000 lbs.; one consolidation superheater locomotive with 24 in. by 30 in. cylinders, 57 in. drivers and a total weight of 202,000 lbs. and 4 Mallet articulated compound locomotives with superheaters and having 26 in. and 41 in. by 28 in. cylinders, 51 in. drivers and a total weight of 450,000 lbs.

Cut 24 Feet Deep, after Passage of Rotary, C., St. P., M. & O. Ry.

FLUE FAILURES.*

The railroads are confronted with a great many failures, and the flue failures are playing their part. I want to say to you that I shall probably refer to a great many things that you all know, but will try to follow the flue and flue sheet from print, repaired and renewal.

Flue failures start in many cases in the designing room of the factories by crowding in too many flues, placing them too close to the heel of the flange, or with too small a bridge, but, providing the blue prints are right, the layerout often uses his own judgment and places the flue wrong. After we have the flue sheet laid out, the driller plays his part by drilling the holes too large. The cause in some cases is that the cutters are not ground right, or that there is too much lost motion in the spindle of the drill press. It is very important to have the holes drilled the exact size and uniform, because it is impossible to keep flues tight in large holes. All holes should be champered on both sides.

The copper ferrules should be expanded by a sectional expander, and never with a roller, because the roller reduces the gauge. Now the sheet is ready for the flues and I want to give you a few figures. I have endeavored to satisfy myself as to the movement that takes place in setting flues and expanding same in roundhouses after being in service. An Atlantic type engine came into the shop for new firebox, and when removed I found the flue sheet had moved upwards in the center about 1 3-8 in., making the crown sheet look as if it was dropping down, but when a straight edge was placed on same, we found that the crown sheet had started to raise up about 18 in. from back flue sheet. So I put a straight edge on the new firebox and found it straight, then I got a tram and trammed it in center of flange on top and lower point between staybolts. Then the flues were set by expanding with section expanders and rolled very light, then beaded with a standard beading tool and inspected before the flue setter left the job, to insure proper work. I then trammed sheet and found that same had moved upwards 3-16 in. This surprised the flue setter very much. I sent the tram with the engine for test and had the men report the movement of sheet every time the flues were expanded. It was as follows:

On Feb. 4, 1910, flues expanded and trammed after work was completed, and found movement of 1-16 in., or total movement of 1-4 in. upward.

March 11, 1910, expanded light, still 1-4 in.

April 15, 1910, expanded light, still 1-4 in.

May 29, 1910, expanded light, moved 1-32 in., total 9-32 in.

*From a paper before the Western Railway Club by J. W. Kelly, foreman boiler maker, C. & N. W. Ry., Chicago.

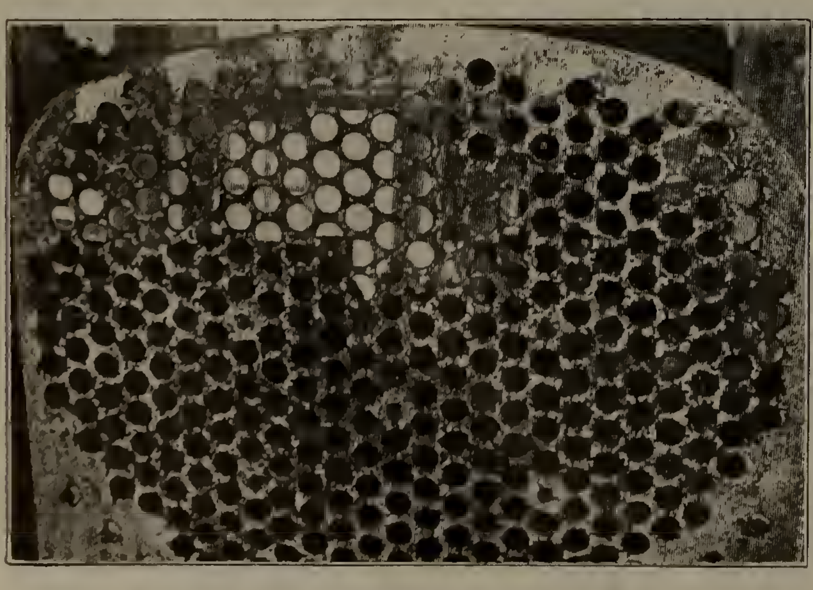


Figure 1.

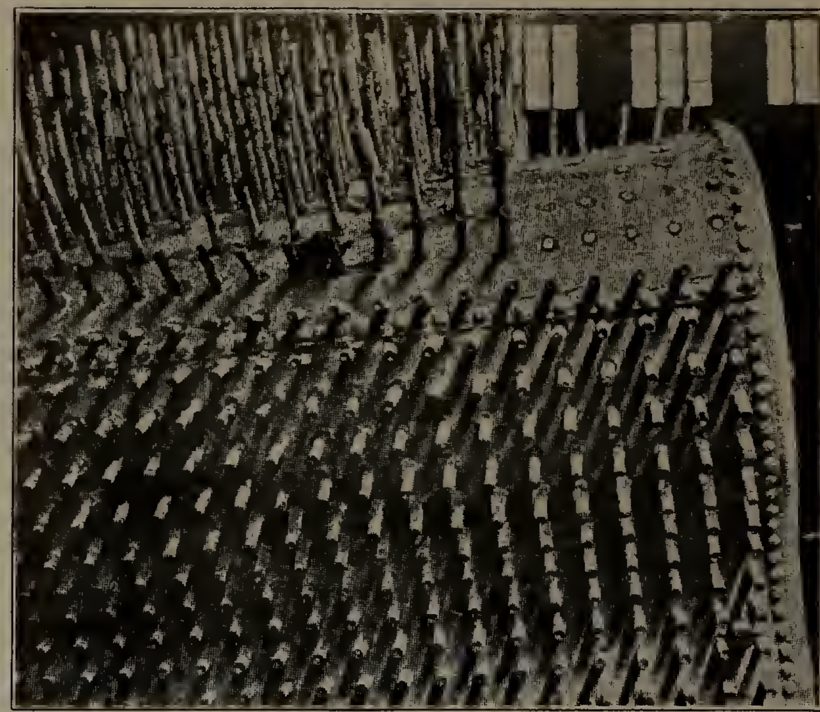


Figure 2.

July 10, 1910, expanded light, moved 1-32 in., total 5-16 in.

July 20, 1910, expanded light, full set moved 3-64 in., total 23-64 in.

Aug. 18, 1910, expanded light, full set moved 1-32 in., total 25-64 in.

Sept. 20, 1910, expanded light, full set moved 3-64 in., total 7-16 in.

Oct. 8, 1910, expanded light, no movement, total 7-16 in.

My object in making this statement is that I want to show what this movement does later. The boiler is tested and if the material is all right no flues have to be renewed, but on the other hand if it is poor material and the lap welds are not properly welded we find the flue fails at this point, as a rule, in the expanding.

There is a wide difference of opinion as to which is the best flue material; one which will not fail from expanding in flue sheet, corrosion, pitting, etc. I have confined my study to the firebox end of the flue, because that is the vital spot requiring attention in service. What we want is material that will not split open when expanding or turning over the bead; that will stand up under ordinary work in roundhouses, because you all know what it means to pull out front end arrangements to remove bad or defective flues.

In regard to the pitting of flues, different methods have been tried to prevent it, with what success I cannot say, but this pitting does mean a great deal to the railroad, for if a set is removed the first time and is found to be badly pitted it means a new set at a total cost of from $600 to $900.

The engine is ready for service and shortly afterward she fails on account of the flues leaking. Now, what is the cause? We know the flue layout is not exactly correct, but the holes are drilled uniform and of correct size, copper and flues properly set and tested 25 per cent excess working pressure. We cannot say it is bad water, even if the engine is running in a bad water district, because she has not been out of the shop long enough to gather enough scale on flues or flue sheet to do any harm and she has been washed out properly every three or four days. This failure is surely due to abuse; feed water not properly applied and improper firing are two of the principal causes. Now, the flues are and must be set back properly to the sheet again and the engine makes successful trips if the engine crew is taken to task by the right party.

Now, we know this engine is perfectly clean and free from scale and we must keep her so by removing all washout plugs, especially those in the front flue sheet, and washing

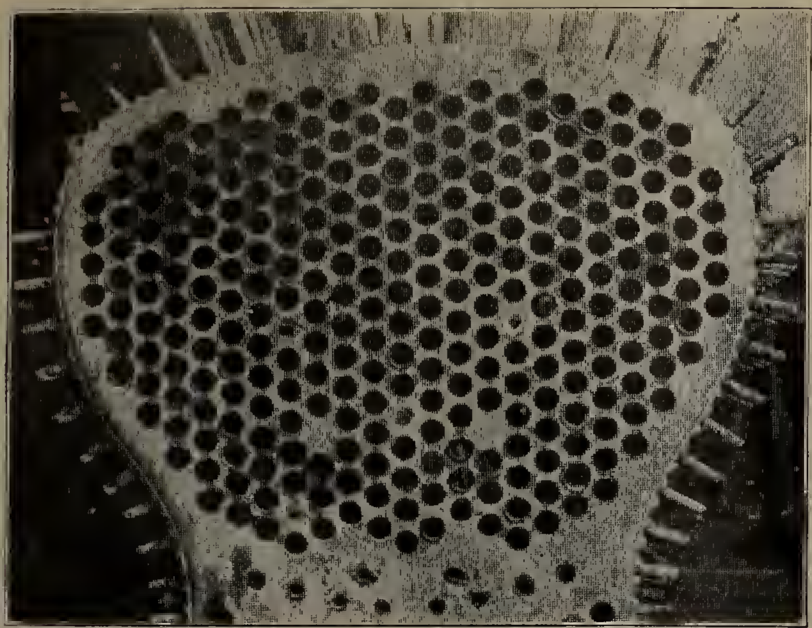


Figure 3.

between the flues, right back to the back flue sheet. Watch and be sure that the long nozzle is used in every hole, becaus if you let it go until the space between the flues is filled up solid you all know what happens—flue failures after flue failures and cracked bridges also for want of water. These flue failures are all up to the roundhouses, but as we are going to keep the engine clean I will try and show why she still fails on account of flues leaking.

The engine arrives at the terminal with only a fair fire, not very much steam and a half glass of water. She is not leaking and is therefore not reported. The hostler gets on engine and finds these conditions, rushes it to the cinder pit, puts on blower and gets fire out quickly so as to get it into the house before the steam is gone—the water is also going fast. When he reaches the table, he starts the injector and fills up the boiler until injector breaks, and what has happened? Every flue has started to leak badly which means the whole set must be expanded before the engine leaves the house. But maybe it is the only engine in and the roundhouse foreman has ordered it out, because he looked at it on arrival and knew it was not leaking. So he takes a chance, tells the boiler maker to calk her up, or dry her up and let her go. The engine goes out on the main line and ties up everything, due to another flue failure. Right here I want to say this kind of a failure can be stopped by compelling all engineers to leave the boilers full of water, a good fire and plenty of steam before stopping The engine is now towed to the nearest roundhouse and the boiler maker is ordered to do the necessary work. He starts by using a mandrel (which is termed pin) and pins out flues, calking them with a beading tool which is altogether too large, and has no bearing on bead but only cuts and grooves flue sheet, thus spoiling the bead. The engine is started out and fails again on account of flues leaking. This pinning of flues and use of improper beading tools have caused a great many failures and every foreman boiler maker should watch this matter very closely and stop it.

Everybody in charge is after this engine now, and the orders are to put her in first-class condition before leaving roundhouse. The flues are again expanded, this time properly, and well beaded and she does good work for a few days when a new hostler forgets the water and puts her in the house with 1 in. of water in the glass.

About two hours later the fill-up man finds no water in the glass and connects up the hose to the blow-off cocks, and as the engine is ordered out, fills her up quickly with cold water, fires up and pulls out of house with heavy fire. The engineer cannot sees the flues, and when the boiler maker inspects them they appear to be tight. At the depot the fireman calls the engineer's attention to the flues leaking, and there is another flue failure. I might say here: Do not allow fill-up men to connect up to blow-off cocks if the fill-up water is cold. Better still, is to have a standard fill-up valve on top of shell or dome and do all the filling through this valve, thus preventing flue failures. This also applies where the engines are waiting for orders or standing on side track for some time. The crew gets careless, allowing the fire to burn down, resulting in no steam; they receive orders to go, on goes the injector and what happens? Flues all leaking and engine soon has given out.

A great many flues failures are caused by careless firemen allowing the fire to get too heavy, so as to have two to three feet of clinkers next to back flue sheet, which stops circulation, causing the flues to contract and leak. Another cause is where engines are tied up and stand outside in the winter. The fires are allowed to burn down and only kept alive at door hole. The injector must be put on, the cold water goes right down to the bottom flues, and we get the same results as above stated, flues leaking.

There are several other causes, such as running with fire door open, leaky steam pipes, poor firing, by having no fire for 10 to 20 in. from back flue sheet and filling up a hot boiler in roundhouse with cold water. In every case flues must be worked over, and by this continuous work I will try to show what it means to the back flue sheet. In every case it gives more or less trouble until sheet is removed from the firebox.

Fig. 1 shows small cracks from top holes on account of flues holes being too close to the top; sheet is moving upward from expanding flues too much. Fig. 2 shows box removed, also shows that the flue sheet has moved up 1 1-4 in. and make crown sheet look as if it had dropped. Fig. 3 shows the right lay out on top, but too small a bridge. Note that the top is not cracked, plugged or patched, but there are several cracked and plugged bridges in the bottom. Fig. 4 shows top of back flue which has raised upward 1⅛ in., and is also badly buckled in bottom. Now, we all know what happens when beads drop off. Flues are plugged from one to forty, especially so if throat sheet is short and flues are too low down. If it is possible to run an engine with the bottom flues plugged and she still does good work, and is light on coal, why not leave these flues out, so they will not be there to contract and leak? So with this point in view, I got permission to experiment with one engine. I plugged up about 40 flues and put a stay rod in center of plugs, generally termed sunflowers. (Shown in Fig. 5.) The engine went into service and did as well or a little

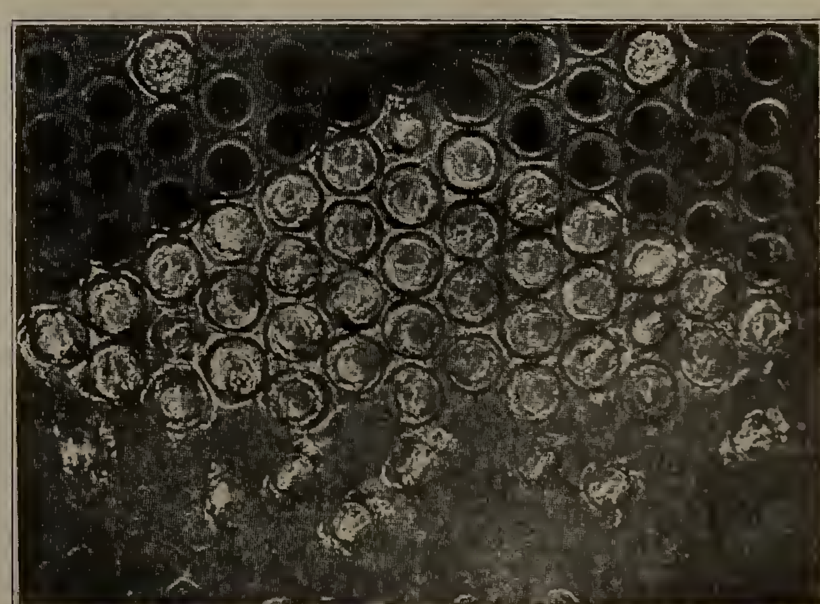


Figure 5.

Figure 4.

better as to coal, and steamed fine. The flues were applied November 6, 1907, and the engine was put in heavy freight service for test purpose. Flues gave very little trouble, and were removed when engine received general repairs to machinery, but they were still in fair condition on April 7, 1910.

The point I want to make is this: Do not crowd in too many flues because you must have the required heating surface. Keep the top flue down say from 4 in. to 4½ in. from the flange to center of flue hole, and all flue holes not to exceed 3 in. from flange. Fig. 6 shows the standard lay out with stay rod holes in bottom center where flues are left out. These engines when received from locomotive works had 342 flues, ⅝ in. bridge. They have, with present lay out, 280 flues, 13-16 in. bridge. Note that the flues are laid out with the taper of sides of the flue sheet, which gives us a wider bridge in the bottom, better circulation and a chance to let the sediment down. I recommend it wherever it can be applied.

We are applying the scheme shown in Fig. 6 to all engines of this class receiving new firebox or new back flue sheet, and are getting good service. You all know there are a great many engineers who never have leaky flues or any kind of a flue failure, and the flues run for several months without being expanded. This is why that some boilers and flues give such good service. Flue sheets do not move upward so fast and cause trouble as shown. While on the other hand, engines of same class with other engineers always leak and have all kinds of failures, doing practically the same work. While the flues and flue sheet must stand for these failures, nevertheless they are men failures.

We know from tests on the New York Central that the flues moved upward as shown by Mr. McBain's paper before the "New Club," also at the last "Boiler Makers' Convention." I have proven that the back flue sheet moves upward when flues are continually expanded.

Now, with the power getting larger all the time, these large boilers must have more attention; we must depart from the old rut and try and grow larger with the boiler, because we cannot expect the same results with the same methods we had when the boiler had 150 flues and carried 135 to 150 lbs. steam pressure. It is my opinion that we must go even farther than Fig. 6 shows to meet this situation by reinforcing the back flue sheet in some manner to help take care of these sudden contradictions of flues and the upward movement of the back flue sheet and flues. But with present conditions, we must hold engines from service when flues become thin and have poor beads and remove them before they make several failures.

The method of taking care of flues at terminals is narrowed down to the sectional expander and beading tool. It is my intention to especially call your attention to the tools and their manipulation, as it is of the greatest importance, and so much depends not only upon the way they are handled, but the time at which they are used. If flues are leaking slightly, use a beading tool that fits the bead properly and calk well. If a set of flues are loose, and leaking badly, they should be properly expanded and calked. The roller expander should never be used, as it rapidly thins the flue and reduces its ultimate life. The mandrel or tapered pin should under no circumstances be used, as this tool shears off the bead in time and only dries up the flues temporarily and they soon become leaky and will fail. The beading tools should be watched very closely and keep them up to standard gauge, as flat tools soon destroy flues. The flue bead fails under mechanical punishment due to loss of vitality.

Brick arches are playing their part in helping to keep flues tight, and should, in my opinion, be placed in all large locomotive boilers, tight against the back flue sheet, with an opening in the corner to allow sparks to go down. The top of the arch should be even with the top of door. There are other reasons why it should be applied, it results in better combustion, reduces the cutting action of sparks on the beads by keeping a large percentage in fire box and stops the small light fire from passing through and stopping up flues.

In conclusion I will say that we must educate everybody who handles engines to the importance of keeping even temperature in these large boilers, to applying feed water correctly, to properly opening blowers and house blowers, and against cooling the engine down too quickly and washing with cold water. Boiler must be washed out properly and not be allowed to fill up with mud which produces cracked bridges. All flues should be bored out; brick arches should be applied in every engine before leaving the roundhouse, and last, but not least, we must have good flues and good flue work.

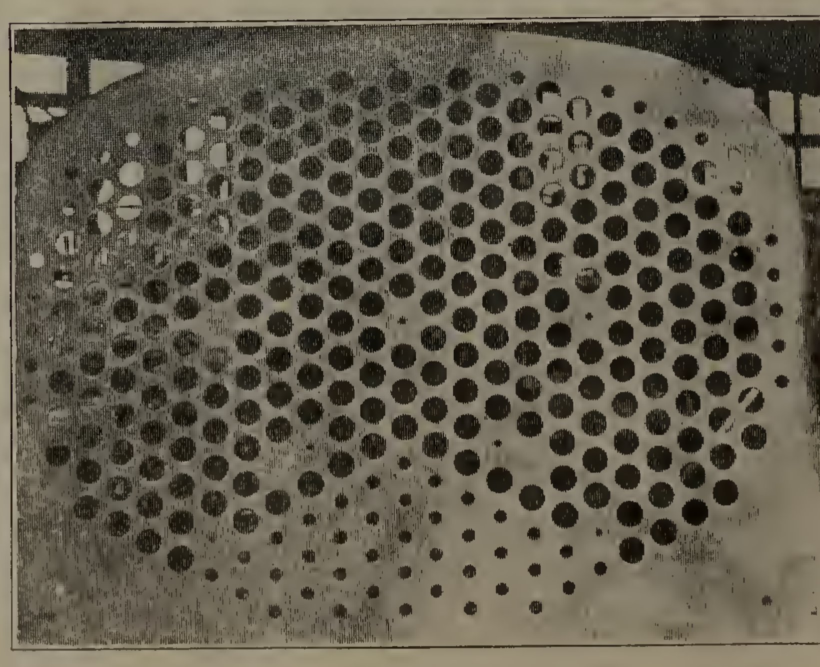


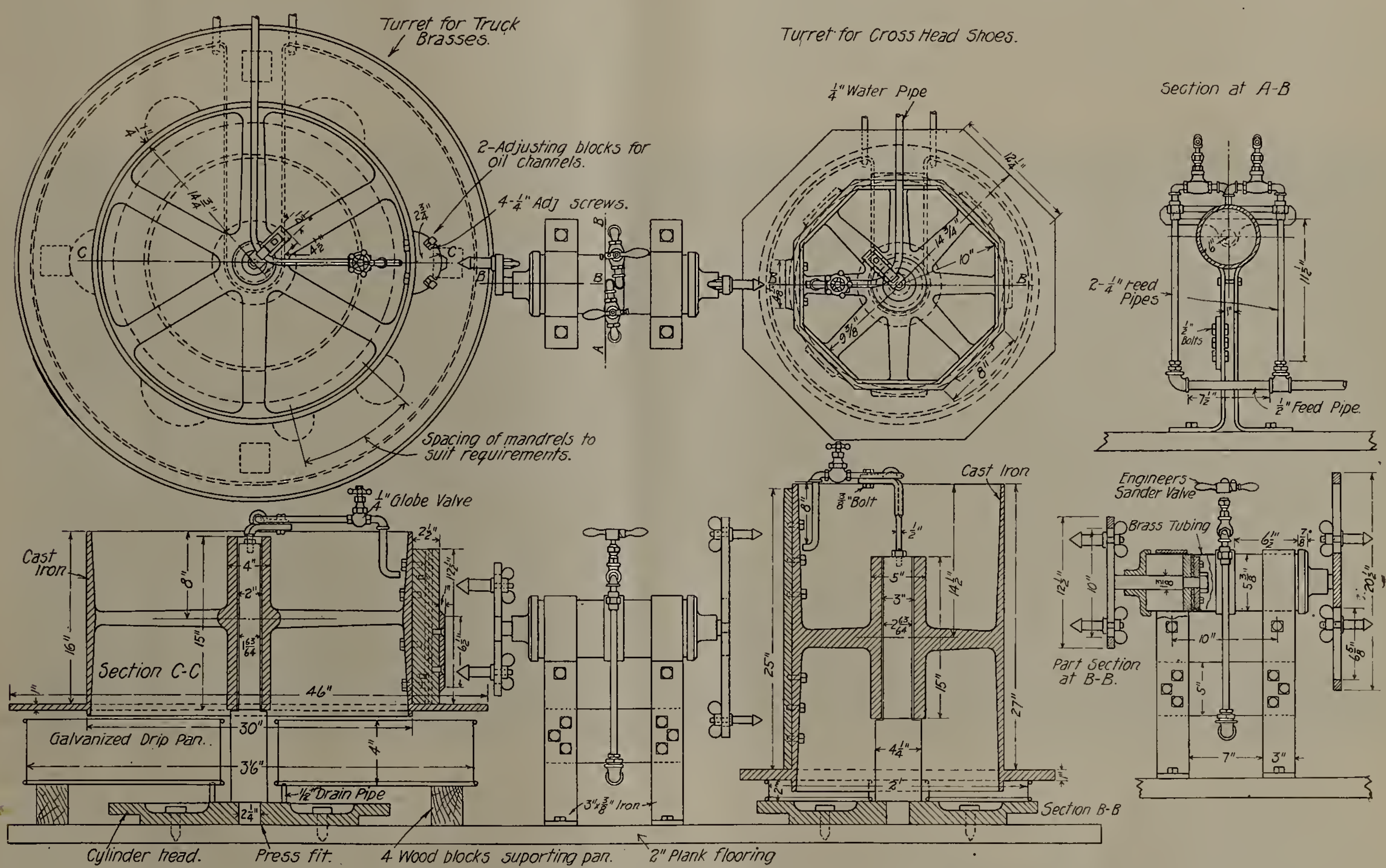
Figure 6.

SHOP KINKS.

CROSSHEAD SHOE AND JOURNAL BEARING BABBITTER.

The babbitting of such brasses as crosshead shoes locomotive trucks bearings is a large item in locomotive shop expense and any time which can be saved in this department represents a considerable economy in the total output.

The device shown in detail in the drawing is in use in the Beech Grove shops of the Cleveland, Cincinnati, Chicago & St. Louis Ry. We are indebted to Mr. M. J. McCarthy, superintendent of shops, for the drawing. The idea of the turrent lathe is carried out in that turrets are used for the babbitting of both crosshead shoes and journal brasses. The machine is double ended and is water cooled as is shown. Its operation is evident after a study of the drawing.



Device for Babbitting Cross Head Shoes and Truck Brasses.

TESTING DEPARTMENT OF A RAILWAY.*

By B. S. Hinckley.

The testing department is the result of natural development in the modern organization of any well managed railway. The existence of such a department in itself demonstrates that money is saved by supporting it and when we consider that the greater part of the economy is indirect and invisible, so far as actual accounting will show—it is the more commendable to the shrewd insight of the management in appropriating thousands of dollars each year for its support.

Only recently has a testing department been considered of any special value to the large corporations who heretofore have considered such a department one of expense only and one not necessary to secure the greatest possible economy of operation. Today we rarely find a live railroad corporation without its Testing Department.

The question arises, quite naturally, why has this new department, this additional expense, been developed as a most essential adjunct and an added revenue earner for its corporation? It is because such a department can handle the difficult problems concerning material and design, problems that require for their solution practical experience and theoretical knowledge combined. Primarily the testing department works hand in hand with the department of purchases.

The basis of all the work of an analytical and testing laboratory is the preparation and execution of the specifications for the material under investigation. In this class of work it is of the utmost importance for the purchaser or consumer to bear in mind, that nothing should be embodied in the specifications for any material that will tend to increase the cost of that material to an amount over and above a price at which a satisfactory grade of the material under consideration can be purchased in the open market and taken from the reserve stocks of the large manufacturers of that material.

In other words, while the specification should be made sufficiently rigid to protect the purchaser from substitution of inferior or adulterated material, they should not go to the other extreme and place such restrictions on the method of manufacture that the manufacturer cannot produce the goods without upsetting the ordinary routine of his daily operations, and adopt, or be forced to adopt, methods entirely foreign to his common practice.

There are many manufacturers and contractors by whom the word "specification" is uttered with a feeling of irony—the word leaves a bad taste in their mouths; they consider specifications unnecessary, discriminating, and very frequently unfair. The engineering profession alone is responsible for this feeling, for the reason that so many specifications have been prepared without proper regard for the interests of the manufacturer or contractor and involve only the interests of the purchaser.

The work of the department is as closely related to com-

*From a paper read before the New York Railroad Club.

mercial life as the traffic department or the purchasing department. The men of the testing department become familiar with the qualities and value of raw material as well as with the manufacture of almost every conceivable product of our mills and factories.

It is the desire of the testing department that it be considered as a bureau of consulting engineers and chemists and not a department whose main object is to find fault and offer destructive criticism.

Our whole object is to build up—to formulate and have executed specifications that are satisfactory to both the manufacturer and the railroad company. Without specifications the only protection at hand for the railroad is careful inspection and accurate records of the service of material bought on a guarantee basis.

We will admit that many classes of material are bought more economically on a guarantee basis than on specification but of what use is the guarantee if it is everybody's business (which means nobody's business), to see that the guarantee is fulfilled.

Among the supplies that may be more economically purchased on a guarantee basis are rubber goods, paints and possibly bearing metals. In the manufacture of these materials there are perhaps secret tricks of the trade which give to a particular brand its own particularly valuable characteristic and a chemist may never be able to reveal just what treatment is given outside of mixing together various quantities of the separate ingredients which he is able to discover.

The layman is not in a position to dictate to a manufacturer as to how he shall make his product; he may advise him what service he will expect from it but he must leave it to the manufacturer to produce the article.

As may be expected of a department just coming to its own—a department considered by short sighted and penurious managements, as an unnecessary expense, the size and importance of the testing departments on the railroads of this country are small compared to what they should be. On a great many roads the man or men in charge of testing materials and equipment are employees of the mechanical department and report either directly or indirectly to the motive power official. This is a great mistake—it is just as absurd as it would be to have the auditor of accounts report to the cashier.

The testing department should be independent of all mechanical or engineering departments for the chief economical results are secured only by giving freedom to the department of tests in its work of checking the quality, handling, and use of the materials purchased.

What the testing department should do is to show up the defective material, not only at the factory and mill, but after the material has reached its destination and been applied to the equipment, road-bed, or structures. From a disinterested point of view the testing department should follow up the material and apparatus applied to the locomotives and cars, or bridges and buildings, should be free to state plainly wherein one device or another was not economical although possibly that device might be in the opinion of the motive power man, or the chief engineer, the best for the purpose. The necessary independent and unbiased investigations and reports are impossible from a subordinate to his superior when the subordinate knows that his reports may be embarrassing to the man to whom he reports. If the testing department is directly or indirectly under the mechanical department head or under the chief engineer, it is quite certain that materials, patent devices or mechanical specialties not appealing to the chiefs of these departments will be found of no value to that company and that reports which in any way reflect on the efficiency or economies of the mechanical department or the engineering department might be safely consigned to the dusty archives and copies not forwarded to the man in charge of purchases.

The need of laboratory and service tests was naturally first felt by the mechanical department and this class of work was handed over to men acquainted with technical investigations. These men were in many cases college graduates who had chosen railroad work for their occupation. Some were special apprentices, others perhaps draughtsmen or bright, young machinists' apprentices. They spent a portion of their time doing this test work and finally the whole time of one man was required to handle the work. This man was usually a chemist for the mechanical test work could be handled by the force of the mechanical engineer or chief draughtsman. On many roads today and many of them large systems—this condition still prevails and anyone taking the time to superficially look over the quality of material received by these railroads will be impressed with the necessity for a quick development of the testing work and the proper organization of a testing department.

Even a single employee would produce good results if he were allowed to report to the proper official but usually, if not always, where the test work is handled by one or a few men, they are subordinate to the mechanical officer and their efficiency practically eliminated thereby. The motive power and engineering departments, are the departments using or having jurisdiction over most of the material and supplies purchased by the railroad company. Why should either of these departments have charge of examining and testing this material? Wherein is there any protection for the supply house which is on the outside, wherein is there any protection for the railroad against favoritism and how can the official in charge of purchases know the true relative merits of the various materials on which he has secured prices? As said before the testing department should be independent of all operating and engineering departments—the man at the head of the department, the engineer of tests, or whatever title he may have, should report to the highest official having any jurisdiction over the purchases. Only in this way and by such organization is the full benefit of a testing department secured.

While as stated, the testing department should be directly responsible to the highest official having jurisdiction over purchases, it should be the right and privilege of the heads of all departments of the road to request investigations, analyses or tests of any proposition, material or device in which they may be interested or may consider worthy of attention. Reports on these matters should be sent to the department head submitting the proposition and copy of the report sent to the official to whom the head of the testing department is directly responsible.

The greatest single item of expense for a railroad outside of payrolls and equipment is the coal bill. One of the greatest economies that can be instituted on a railroad is to give practically full jurisdiction of the fuel supply to the testing department. By careful systematic checking of the coal shipments from the mines to its consumption at the firebox door—by correct sampling, analyses and tests very material economies can be obtained. All of this work can well be handled by the testing department and it is safe to say the visible saving from this one branch of the work will cover the cost of the maintenance of the testing department many times over.

Frequent statements are made that proper inspection and tests of bridge material can not be handled economically by the testing department of a railroad company. These same people will say that it is better to employ the outside bureaus and pay a certain price per ton for the mill and shop inspection. This all depends on the size and importance of the testing department under consideration. It is easily possible to handle this work satisfactorily and economically if the railroad company can keep men busy in the territory where the bridge material is being fabricated. The same men can cover an area of one or two hundred miles radius and handle the inspection of other classes of material purchased within that area. These men should be resident inspectors in the city where the greater part of their work is located and they should be reimbursed for all expenses incurred outside of their home city. In rare cases the outside bureaus should be used—this will occur when the tonnage to be inspected is too small to warrant the expenditure of salary and traveling expenses of the railroad's inspector. In handling the inspection of bridge material in this way the railroad company secures more loyal and interested inspection than can be possible when the outside bureaus are given a blanket contract to handle the entire inspection of the bridge material. Naturally each road must decide on this matter as best suits its conditions and organization.

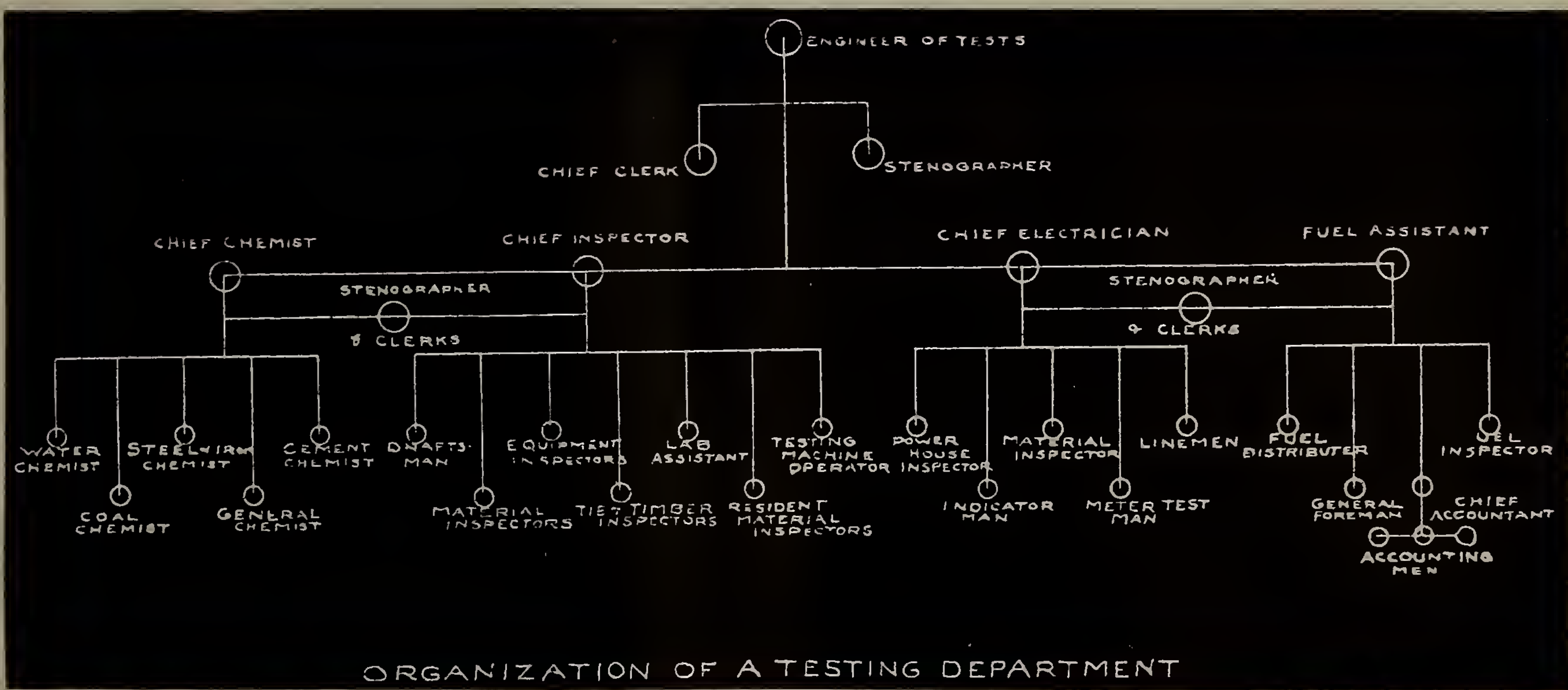
The inspection of new equipment—locomotives, cars, both passenger and freight, at the builder's shops, is another line of work that may very profitably be left to the testing department. This method of handling the work is not common, but where it has been tried, it has proven quite satisfactory. Owing to the fact that this work may at one time be rushed and at another dropped altogether it is of no advantage to have men retained on the payroll of the testing department to handle this work alone. Practical men taken direct from the shops are best fitted for the work as they are acquainted with the standard practice of the company. On this account men should be selected from the shop forces and temporarily turned over to the testing department so far as reports are concerned. It is not necessary to remove them from the payroll of the mechanical department. This arrangement is quite necessary on account of the close connection of the material inspection with the use of the material in the construction of the equipment. Furthermore the highest official in charge of the purchases is kept in close touch with the character of work and materials furnished by the builder.

Where a railroad produces on its line of road a substantial percentage of its tie supply the testing department, which naturally handles the inspection of the ties and timber, can very handily have charge of the collection and distribution of the ties.

The specifications for cross ties should be so drawn that it is made clear to the tie producer—that by the actual inspection of the tie the purchase of the accepted tie is completed by the railroad company. This is quite necessary to protect the railroad company from dissatisfied tie producers who otherwise might say they would not accept the inspection of the railroad company and haul away the ties which the railroad company had accepted and this would mean a loss to the railroad company of its inspectors' time as well as the time of the men used in handling the ties.

So closely is the inspection and purchase of ties related that it becomes naturally the work of the testing department to handle entirely the cross tie supply. The inspectors are advised daily to whom the ties should be consigned and in the office of the engineer of tests are the complete records of purchase, inspection, shipment and disposition of all the cross ties as well as native timber.

The cross tie and timber division of the work is further closely related to the test work in the case of treated ties or timber. Where the railroad company is not equipped with its own treating plant the inspection of the process of treatment and analysis of the creosote oil used is handled naturally by the laboratory force.



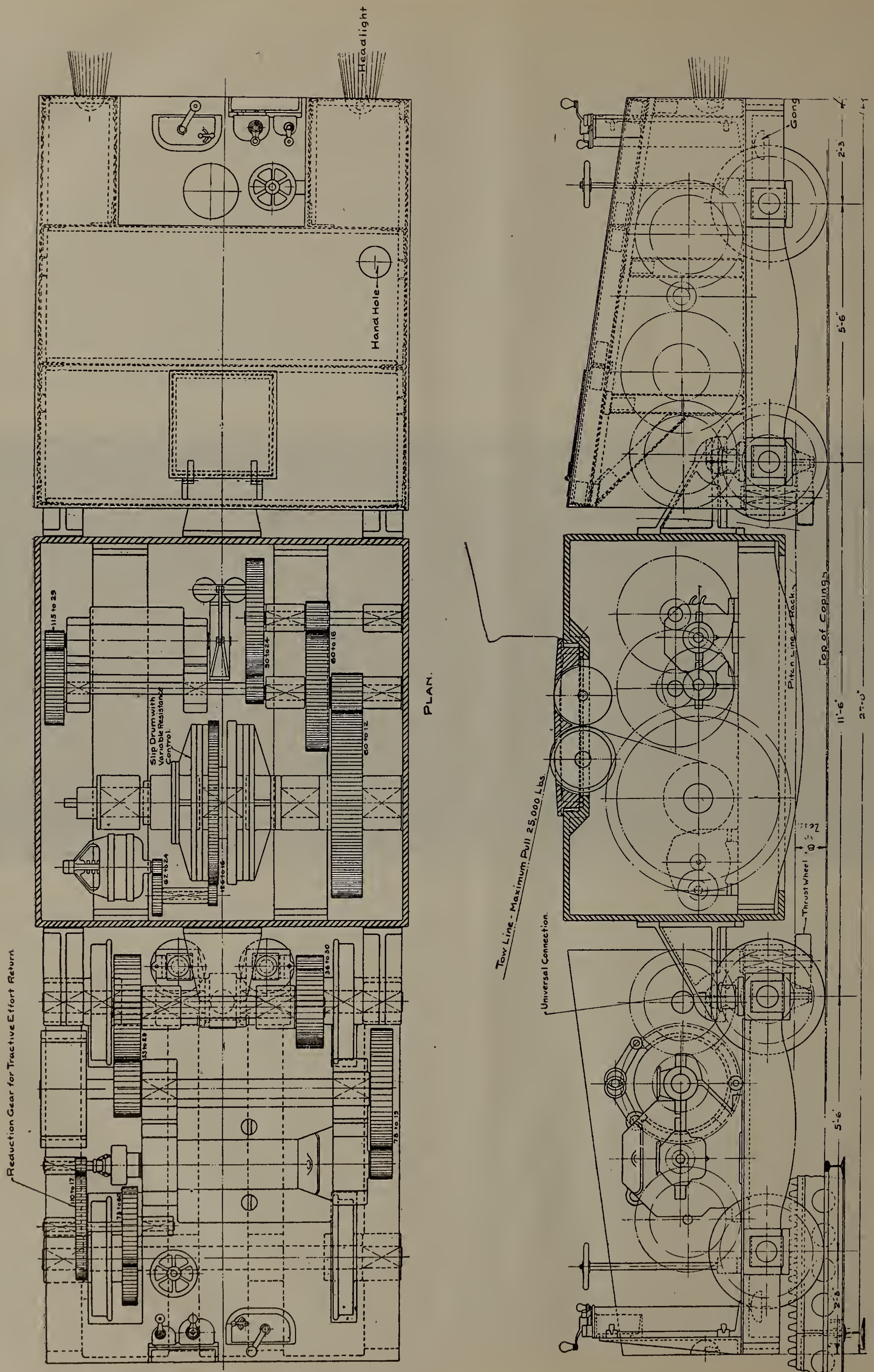
B. S. Hinckley's Idea for a Railway Testing Department Organization.

The time is coming and that day is not far off when the eastern roads will find it advisable to treat a portion, if not all the ties used each year. There is money made in treating ties and timber, and a large portion of this money may be reclaimed by the railroad company that is progressive enough to have installed either under its own management or that of a reliable creosoting company one or more creosoting plants on its own line of road. These plants should be located either in the center of the tie-producing districts on its own line or at some seaport to which ties can be shipped at reasonable rates.

The supervision of such plants in case they are owned by the railroad company or the inspection of the work at these plants in case they are operated by outside companies should be handled by the testing department.

An additional advantage and an advantage resulting in substantial savings to the company maintaining its testing department is the prevention of legal suits against the company.

The very valuable records and reports contained in the files of the laboratory are of permanent value in case of



Suggested Design for an Electric Towing Locomotive, Isthmian Canal Commission.

damage suits, traceable to material or equipment failures. Suits have been withdrawn entirely as a result of unanswerable evidence and proof incorporated in the reports of the laboratory assistants who have been detailed to investigate the claims made by the complainant's attorney.

A representative case of this sort arose when an oyster grower made complaint that waste water from a round-house being contaminated with oil was killing his young oysters in an oyster bed located near the round-house. Under the directions of the chief chemist a small oyster bed was planted in the vicinity of the seat of trouble and enough evidence secured to eliminate all liability on the part of the railroad company to the oyster grower.

In addition to the tests and analyses of material, the inspection of equipment and investigations on special subjects pertaining to all branches of railroad work, the testing department is in a position to handle the manufacture of numerous supplies on which a great saving may be shown. Among such supplies may be named dry fire extinguishers, charges for liquid fire extinguishers, boiler compound, hektographs, electrolyte polishes, inks, paints and disinfectants.

The question of policy places certain limitations on the manufacture of material by the railroad company. In many cases economy might result should the company manufacture an article which is made by factories on the line of road but in such cases it is invariably better policy and better business judgment to patronize the home company rather than compete with it.

ELECTRIC LOCOMOTIVES FOR THE PANAMA CANAL.

The study of the method of moving the vessels into and out of the locks of the Panama Canal has been continued during the past year, and a design has been suggested by Edward Schildhauer for an electric locomotive which it is thought will do the work satisfactorily. The design, as at present adopted, is shown in the accompanying drawings, which give a general view of the machine, for which the detailed drawings are now being made.

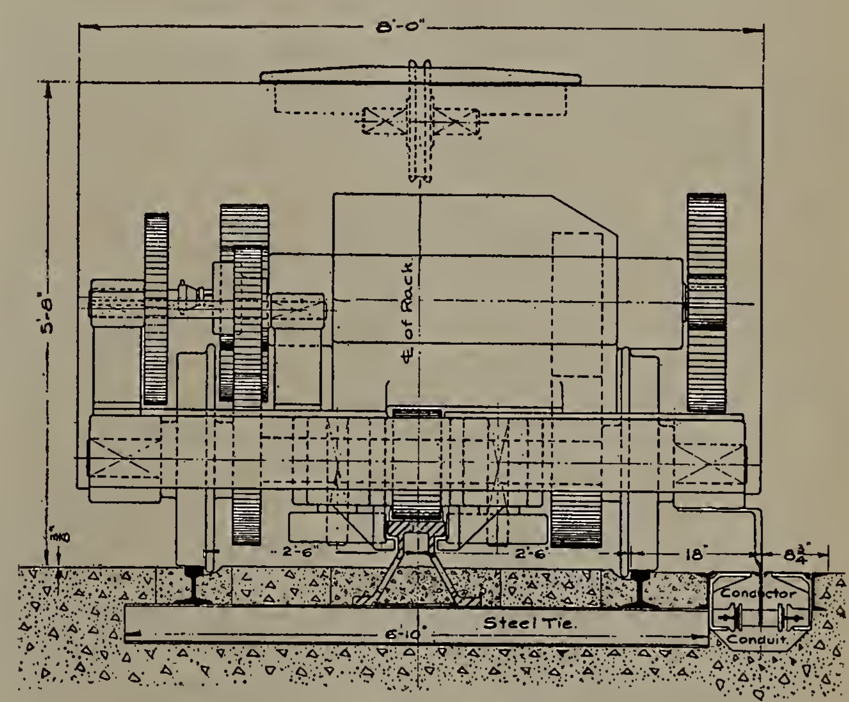
It is the intention to tow vessels through the locks, using a number of these locomotives, varying with the size of the vessel; the typical case requiring four locomotives, two ahead, one on each wall, imparting motion to the vessel, and two astern, one on each wall, to aid in keeping the vessel in a central position and to bring it to rest when entirely within the lock chamber. When passing the vessels up through the locks, while the water levels are being equalized, the forward locomotives will advance up the incline of the lock walls to the level of the next lock chamber and will not be required to exert towing effort while on these inclines. As will be seen from the drawing, the electric locomotive consists of three distinct elements. Two of these, the front and rear elements, are mounted upon rigid four-wheel trucks, each one of which is driven by an independent motor controlled from either end of the machinery. The third element is connected with the tractive elements by universal joints and is equipped with a slip drum towing windlass and hawser. The line can, therefore, be taken in or paid out by the windlass, thus permitting varying the distance between the ship and locomotive, and a pull can be exerted or relieved without actual motion of the locomotive on the track. The ability to do this is eminently desirable, especially in bringing the vessel to rest or in changing the length of the towline, as, for instance, when the locomotive ascends the incline to the next lock, while the levels in the two locks are equalizing and the vessel necessarily stationary. For general purposes, however, in towing, the locomotive derives its tractive effort from one of the end elements, through a pinion engaging a shrouded semisuppressed rack anchored in the coping. The side pull of the towing line is taken up by horizontal thrust wheels, which bear on the side of the track.

Each flight of locks will be provided with two towing tracks, one on the side and one on the middle wall. On each side wall there will be one return track and on the middle wall a third, common to both of the two twin locks. All tracks will run continuously the entire length of the respective flights and will extend some distance on the guide and approach walls at each end. At the termination they will be joined by a switch. The current for the operation of the locomotives will be taken from underground conduits. The maximum pull on the towline is fixed at 25,000 pounds, at which force a friction coupling will relieve further strain. The central racks are provided only on the towing tracks and inclines. On the level portion of the return tracks the locomotive is driven by friction on the side rails.

The capacity and equipment are as follows:

Speeds.

Locomotive, towing	2 miles per hour
Locomotive, returning	5 miles per hour
Slip drum, towing	10 feet per minute
Slip drum, idle	200 feet per minute



End Elevation of Electric Towing Locomotive.

Motors.

Two 75 H. P. at 500 R. P. M. for driving units.
One 7½ H. P. at 750 R. P. M. for slip drum.. 10 feet per min.
One 2 H. P. at 750 R. P. M. for slip drum....200 feet per min.

Starting Torque at 1 ft. Radius.

For 75 H. P. motors	each 1,150 lbs.
For 7½ H. P. motors	each 100 lbs.
For 2 H. P. motors	each 20 lbs.
Maximum pull	25,000 lbs.

SOME KINDS OF BOILER INSPECTION.

The following recited experience of the agent of an insurance company should prove of interest to those who are watching the efforts of politicians to secure a federal locomotive boiler inspection law:

In soliciting fly wheel insurance of Mr. Jones he asked me what kind of inspections we give on fly wheels.

"Do you give buggy inspections, or shovel inspections?" he inquired.

I told him he could have both if he wanted them, and added that there isn't any kind of an inspection that the company wouldn't give the assured, if he desired it. But I added that I was unfamiliar with the special kinds he had mentioned, and asked him to explain.

He said that a few years ago they received visits from an inspector who, when his horse was particularly fractious or his rheumatism was bothering him, gave them a buggy inspection, by driving to the engine room and whistling to attract the attention of the boiler man. Without alighting from his buggy he would then ask a few question, after which he would drive back to the office and whistle again; and when some one from the office went out to him, he gave them his inspection report. At other times, when he had a quiet steed that would stand without hitching, and when his rheumatism was not particularly aggressive, he sometimes went into the boiler room, opened the furnace door, and poked at the bottom of the boiler with a long-handled shovel. If this particular part of the boiler seemed reasonably solid, and his shovel did not perforate it, he said everything was all right.

I asked Mr. Jones who he was insuring with at that time, and he said with my company. I need not tell you that I was shocked to hear one of our patrons give such an account of our service as that. I hardly knew what to say, so I merely told him that I had never heard of one of our inspectors making any such examination as that.

"Neither have I," he responded. "It is true that I was insuring with you at the time, but these particular inspections were made by the state inspector."

At that a great load was lifted from my soul, and I thought that if the state inspector had known that we were insuring the boilers, his own examinations might have been more carefully made.—The Locomotive.

VOLATILE MATTER OF COAL.

"The Volatile Matter of Coal" is the title of the first bulletin to be issued by the new Federal bureau of mines. The authors, Horace C. Porter and F. K. Ovitz, conducted their investigations at the Pittsburg station while it was under the technologic branch of the Geological Survey, the work being a continuation of the fuel investigations begun several years ago at the Louisiana Purchase Exposition, St. Louis, Mo. The results obtained at that plant showed that the work of determining the fuel values of the coals and lignites in the United States with a view to increasing efficiency in their utilization would be incomplete if it did not include systematic physical and chemical researches into the processes of combustion. Hence in their later investigations the authors carried on such researches, concentrating attention on those lines of inquiry which promised results of greatest economic importance. This bulletin is therefore a report on an investigation of the volatile matter in several typical coals—its composition and amount at different temperatures of volatilization.

Quoted directly the authors say: "The investigation has already shown that the volatile content of different coals differs greatly in character. The volatile matter of the younger coals found in the West includes a large proportion of carbon dioxide, carbon monoxide, and water, and a correspondingly small proportion of hydrocarbons and tarry vapors. The older bituminous coals of the Appalachian region yield volatile matter containing large amounts of tarry vapors and hydrocarbons, difficult to burn completely without considerable excess of air and a high temperature. Coal of the western type, moreover, gives up its volatile matter more easily at moderate and low temperatures than that of the other type. The volatile matter produced at medium and low temperatures is rich in higher hydrocarbons of the methane type, such as ethane and propane, which contain a larger portion of carbon than is present in methane.

"These facts help to explain the difficulty of burning Pittsburg coal, for example, without smoke, the low efficiency usually obtained in burning high-volatile western coals, the advantage of a pre-heated auxiliary air supply introduced over a fuel bed, and the advantage of a furnace and boiler setting adapted to the type of fuel used. They bear directly also on the question of steaming 'capacity' of coal for locomotives, the designing and operation of gas producers for high-volatile fuels, and the operation of coke ovens and gas retorts.

"The results show further that certain bituminous coals of the interior and Rocky Mountain provinces give promise of good yields of by-products of coking, notably ammonia and high candle power gas, comparing favorably in these respects with the high grade coking coals and the eastern province.

"They show also that inert, noncombustible material is present in the volatile products of different kinds of coal to an extent ranging from 1 to 15 per cent of the coal."

The bulletin will be of interest to fuel engineers, designers and builders of gas producers, gas and coke manufacturers, superintendents of power plants, railway master mechanics and those engaged in the suppression of smoke. The bulletin may be obtained by applying to the Director of the Bureau of Mines, Washington, D. C.

MECHANICAL DIVISION, ISTHMIAN CANAL COMMISSION.

The report of A. L. Robinson, superintendent of the mechanical division of the Isthmian Canal Commission, for the fiscal year 1909-1910 is in part as follows:

During the first three months of this fiscal year the mechanical division operated under the same organization as that maintained during the previous fiscal year. It was then recognized that by concentrating all manufacturing work and all repairs to rolling equipment other than steam shovels in one shop a greater economy in the operations of this division could be thus obtained. On September 17, 1909, Circular No. 183-M was issued, which circular turned over the Empire shop to the central division, said shop to be used for the repair of steam shovels only and for the finishing of steam shovel parts.

All other repairs to rolling equipment and manufacturing work previously performed at Empire shop was transferred to Gorgona shop, including the maintenance and repairs of all steel cars.

Following the issuance of this circular, a general reorganization of the supervisory force of the mechanical division occurred. After the resignation of the superintendent of motive power and machinery the position of head of the mechanical division was filled by the electrical engineer and master mechanic of Gorgona shop, with the title of superintendent of the mechanical division. The former master mechanic of Empire shop was made superintendent of outside engine houses and air compressor plants, the position of chief boiler inspector was abolished, and the boiler inspection department and the testing department were placed directly under the supervision of the mechanical engineer. Later in the year other changes were made in the supervisory force of this division, which consisted in the abolishment of the position of superintendent of outside engine houses and air compressor plants, the foremen of engine houses reporting direct to the superintendent of the mechanical division, and the air compressor plants were placed under the jurisdiction of the superintendent of electric light plants. The position of master car builder was also abolished and the car inspection service was placed in the hands of a chief car inspector, reporting directly to the general foreman of the car and foundry department, Gorgona shop. In addition, general reorganization of clerical and drafting forces, as well as all supervisory forces, was effected, which resulted in very material decreases in the overhead expense of the mechanical division.

During the fiscal year 1908-9 the average overhead expense of the mechanical division was 37.29 per cent of the total expenditures, this overhead expense consisting of supervisory and shop expense only, and not including any moneys expended for new equipment, additions, or improvements, as such moneys were charged to an existing plant account. During the nine months' operation of the mechanical division under the reorganization, from October to June, inclusive, of the present fiscal year, the average overhead expense has been 29 per cent of the total expenditures. This overhead expense includes all supervisory expense, shop expense, and in addition, all moneys expended for improvements and new equipment, except for air compressor, electric light plant, and foundry equipment, the plant account having been abolished July 1, 1909. This saving in overhead expense amounts to approximately $105,000 per annum.

The organization of the mechanical division consisted on June 30, 1910, of the following: Superintendent, A. L. Robinson; mechanical engineer, J. H. Flynn, Jr.; superintendent of electric light and air compressor plants, Hartley Rowe; chief clerk, William Taylor; chief draftsman, C. E. Whipple; testing engineer, Q. A. Hall.

Gorgona Shop.

During the year few additions have been made to Gorgona shop, and such additions have been limited to only those necessary to care for the increased work thrown upon these shops by the reorganization of October 1, 1909.

In the machine shop a 79-inch wheel lathe, motor driven, transferred from the Empire shop, has been installed. A number of templates, gauges, boring bars, double end cutters, forming tools, special taps, special milling cutters, jigs, and fixtures have been manufactured; all to reduce the cost of manufactured material. That portion of the machine shop formerly used for casting storage has been devoted to an extension of the air brake room, and additional benches, test racks, and other facilities for the overhauling of engineer's brake valves, pumps, triple valves, lubricators, etc., have been installed; also a machine for the grinding of triple valves.

An extension of 1,440 additional square feet was made to the blacksmith shop. Three new oil furnaces, one Bradley hammer, one light shears for cutting bolts, two 330-pound cranes, one upsetting block, one 25-horsepower motor, and two jib cranes were installed. In addition, numerous dies and formers have been made to cheapen the manufacture of standard repair parts for cars, locomotives, etc.

A "calorix" brazing furnace was installed in the pipe and tin shop for brazing large work.

The amount of structural iron and steel manufacturing work sent to these shops during the past year made the floor space of the boiler shop entirely inadequate. Changes were therefore authorized, which allowed the construction of a new steel storage yard back of the boiler shop, allowing the present storage yard, containing 9,000 square feet of floor space, to be used as part of the boiler shop proper. Construction of this storage yard necessitated the moving of approximately 4,000 cubic yards of dirt and the laying of approximately 1,780 linear feet of track. In addition, a template and pattern storage room 11 by 36 feet for storage of steel templates and patterns was erected. One angle-bar heating furnace for flange fire, 36 by 72 inches; one flange-fire forge, 54 by 84 inches; one punch, 12-inch throat; one punch, 18-inch throat; one Lennox bending clamp; one 1-ton jib crane; three penumatic hoists; and two electric motors were installed. A large number of templates, forms, patterns, etc., for the manufacture of standard repair parts were also manufactured in this shop.

All repair work to flat cars and other rolling equipment formerly performed in the two car shops was concentrated on October 1, 1909, into the new car shop, the old car shop being used from that date for the repairs of steel dump cars, which repairs were formerly made at Empire shop. This change required the installing of blacksmith forges, a tool and stock room 22 by 60 feet, the overhauling and putting into service of a 10-ton French crane for handling side doors and other heavy parts of steel cars, and other minor accessories. During the past year the car repair yards at Las Cascadas and Gamboa have been abolished, and the work formerly performed at these two points has been concentrated at Gorgona shop, with the desired resultant economy. Also the work performed at Pedro Miguel car yard has been cut down to only the making of the lightest running repairs, all cars requiring even medium repairs being sent to Gorgona shop. With the abolishment of the position of master car builder, a reorganization of the car-inspection service was made, which resulted in cutting the field repair forces by some 45 "silver" men and at the same time put into effect a system whereby every car handling dirt is given a thorough inspection at least once each day.

There has been transferred from Empire shop and installed in the car machine shop one bolt cutter and two drill presses.

The foundry work at Gorgona has increased during this fiscal year until now the output of our foundry is approximately 65 per cent greater than in June, 1909. This increased output, together with the large number of patterns being manufactured and stored, required additional space for both the foundry and the pattern storage. A new pattern-storage building was therefore erected, 42 by 100 feet, two stories, with a total floor space of 8,200 square feet, together with all the necessary shelving. Some 16,000 patterns are now stored in this building, the value of which are estimated at between $150,000 and $200,000. The old pattern-storage building was converted into a brass foundry, and there has been installed in same two No. 150 and one No. 60 Steel-Harvey crucible melting furnaces, which use oil as fuel. The brass foundry now has a capacity of 3,000 to 4,000 pounds of brass per eight-hour day, an increase of approximately 50 per cent over the old pit furnaces formerly occupying space in the iron foundry. One 1-ton jib crane, for handling large castings; one 5-horsepower motor; one emery wheel; and one tumbler and brass separator for cleaning brass castings are in process of installation in the new brass foundry. By the removal of the brass foundry to the new building and the addition of a lean-to 20 by 160 feet between power plant and the old foundry the floor space of the iron foundry was increased by about 4,160 square feet. Two 3-ton jib cranes have been installed and one 10-ton jib crane is under erection in the iron foundry.

Engine Houses.

This division maintains outside engine houses at the following points for the purpose of hostling and making running repairs to equipment:

Pedro Miguel engine house; general foreman in charge, Mr. J. J. Bartley.

Las Cascadas and Gamboa engine houses; general foreman in charge, Mr. E. B. Connor.

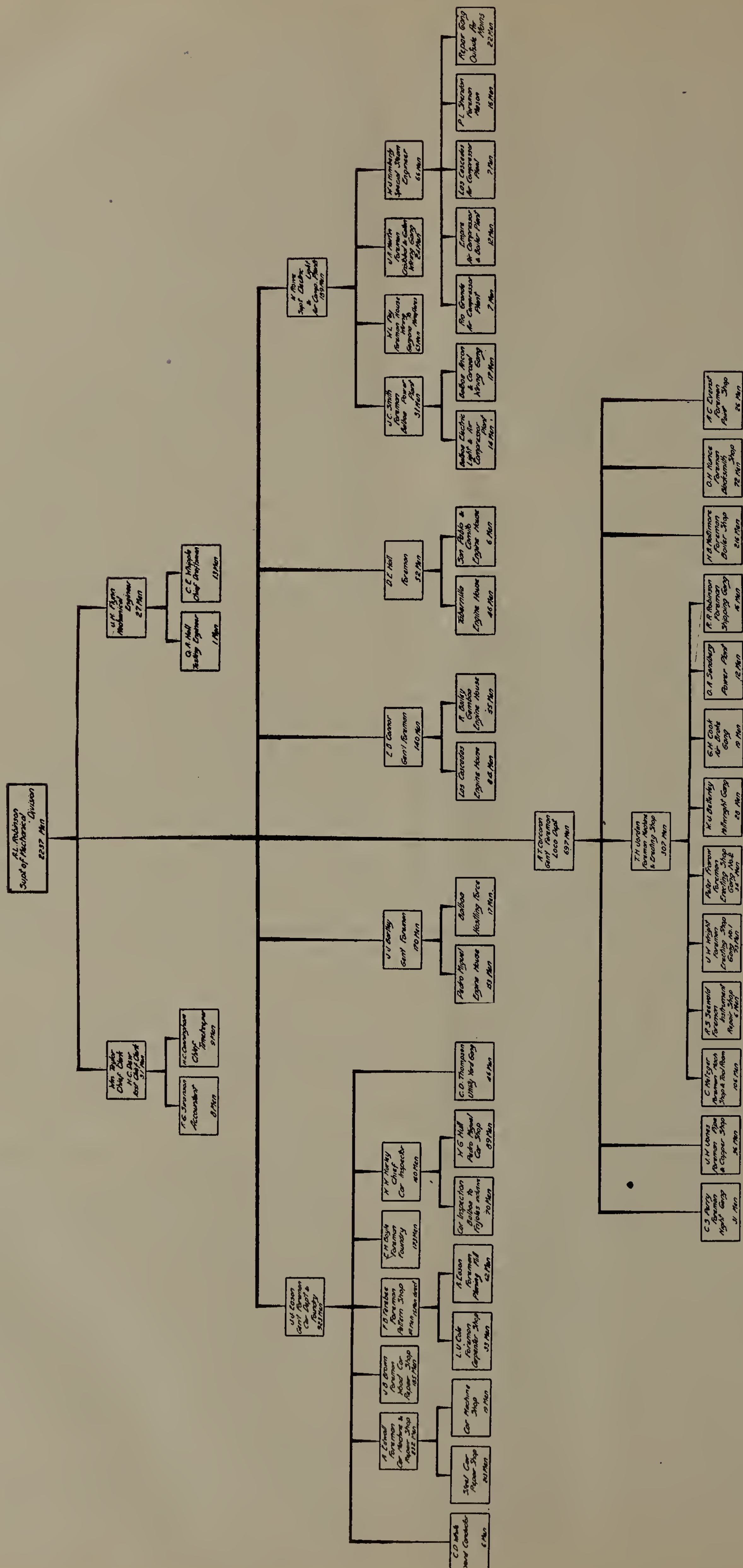
Tabernilla engine house; foreman in charge, Mr. D. E. Hall.

At these points during the past year there were handled 63,278 hostlings to locomotives, 6,417 hostlings to other equipment, a total of 69,695 hostlings, at a labor cost of $74,281.56, material, $12,843.67, a total of $87,125.23. The average labor cost for the year for all hostling points was $1.065 per unit hostled.

Mechanical Engineer's Department.

With the reorganization, the office of the mechanical engineer was removed from the Culebra general offices to Gorgona shop, this move producing much more efficient results in that the mechanical engineer's force was brought into closer contact with actual shop operation.

All requests for articles to be manufactured at Gorgona shop, whether accompanied by drawings or not, are referred to the mechanical engineer, where they are checked for proportion and design for the most economical method of manufacture. This department ascertains whether the necessary material for



Organization of the Mechanical Division of the Isthmian Canal Commission, Aug. 1, 1910.

manufacture is in stock, and if shortages occur arrange for the substitution of other stock material to facilitate the prompt completion of the manufactured article. Detail shop drawings are made for the individual shops before shop order is issued. Detail of all repair parts for all new equipment are prepared and shop orders issued for the manufacture of such repair parts as it is considered advisable to prepare on the Isthmus, while requisitions are issued for such repair parts as it is considered advisable to order in the States. Standard specifications for all classes of material are prepared for the purchasing department and, in addition, all requisitions for stock material pertaining to any mechanical appliances are forwarded by the quartermaster's department to this division for check. Records of all equipment in service and condemned, together with condition of same, are maintained, and other general work such as pertains to the mechanical engineer's department of a manufacturing plant is performed.

The boiler-inspection service, as a branch of the mechanical engineer's department, consists of four boiler inspectors, who make regular inspections and reports of all boilers in service on the Isthmus for both the commission and the Panama Railroad Co. All inspections are made in conformance with the rules and regulations for boiler inspection as approved by the chief engineer, records of same being kept and the heads of divisions and departments duly notified of the conditions of boilers in the several departments.

The testing department as a branch of the mechanical engineer's department has made during the past year 637 tests. These tests are of a wide variety and nature, but consist mainly in the testing of various classes of material, such as belting, cables, coal, grease, hose, lubricating oils, etc. Also efficiency tests upon various plants, which tests have unquestionably resulted in materially assisting in obtaining fuel economies. Tests were also made upon the boiler plants of the Miraflores and Gatun power plants to determine the efficiencies of boilers in those plants and to ascertain whether they came within the specified contract efficiencies. Also the testing of fuel oils for percentage of water and sediment, upon which fuel oil a rebate is paid to the commission for all water and sediment in same in excess of 2 per cent.

Electric-Light and Air-Compressor Subdivision.

This division continued the operation of all electric lights on the Isthmus, amounting to approximately 31,000 lights, as well as the furnishing of 1,338,997 kilowatt-hour metered current for the operation of motors, arc lights, etc. During this year they installed a 5½-mile, 6,600-volt, 3-phase pole line between Gatun and Cristobal; installed a complete fire-alarm system in Gatun; took over from the Panama Railroad Co. all of their lighting system in Cristobal and Colon, and reconstructed all pole lines and accessories taken from the Panama Railroad Co. All lights in Cristobal and Colon had been formerly operated by two small belt sets installed in the cold-storage plant of the Panama Railroad Co. During the past year these two generators were replaced by two 200-kilowatt-hour frequency changer sets, operated from current brought from Gatun power plant over the above-mentioned 6,600-volt pole line. An entire remodeling of the electrical engine room of the cold-storage plant was made, and all necessary switchboards and other apparatus for the operation of frequency changers were installed. In addition, one 35-horsepower motor for wireless station, Colon; one 35-horsepower motor for Colon sewerage sump; and one 35-horsepower motor for sawmill, Mount Hope, were installed. During this year the price of lights as operated for all divisions has been reduced to 50 cents per month per lamp, and to 4 cents per kilowatt-hour for current on meter basis. The revenue derived from this operation pays for the maintenance of all pole lines, lamp renewals, building wiring repairs, and in addition covers the expense of all new installations, such as the above-mentioned frequency changers, switchboards, etc.

The air-compressor subdivision has generated during the past year 7,227,203,513 cubic feet of free air, as against 4,935,110,000 cubic feet for the preceding fiscal year, an increase of 46 per cent.

One additional 2,500 cubic feet capacity compressor has been installed in the Empire plant, and one 2,500 cubic feet capacity compressor has been installed in the Rio Grande plant.

All compressor plants have been equipped with hot-water meters, fuel-oil heaters, and other accessories for keeping close accounting of the output per barrel of fuel oil, of water evaporated from and at 212 degrees per barrel of oil, and the general economies of plant operation.

Eighteen thousand eight hundred and ten feet of main pipe line have been removed and rebuilt on account of slides occurring through "Culebra cut." Also 3,600 feet of 8-inch main installed between Balboa plant and Ancon rock-crushing plant.

Prior to July 1, 1909, all additions and improvements to air-compressor plants were charged to a plant account. Since that date all additions, improvements and reconstructions are charged in operating expense. Yet the cost of air generation per 1,000 cubic feet in June, 1910, was 0.0339 cent, as against 0.037 cent in June, 1909.

In general, the repair shops and equipment on the Isthmus are adequate to meet all requirements during the construction period. Nothing as yet has been done toward permanent shop facilities needed after completion of the canal, but in respect to this feature the commission at its one hundred and fifty-sixth meeting declared itself in favor of a policy which will, if adhered to, result in confining such permanent shop facilities to two points, one near each end of the canal, equipped to meet all the requirements of the United States in connection with the maintenance, operation and protection of the canal, as well as the needs of the Panama Railroad, and those arising from the commercial use of the canal.

During the year special attention was paid to reducing the cost of maintenance and operation of equipment in the shops, including the standardization of salaries and wages, and of material and supplies necessary in construction repair work. In line with this policy two traveling engineers were appointed, who have been instructing and supervising engineers, firemen and hostlers in all divisions, including the Panama Railroad, in the use of fuel and oil in connection therewith. A saving has resulted of fully 50 per cent in the amount of lubricants used, and of approximately 10 per cent in coal consumption per train-mile.

To provide for the increased amount of work performed at the Gorgona shops, additions to buildings and equipment have been made when necessary. Among the former may be noted a new two-story building 42 feet by 100 feet erected for the storage of patterns aggregating 16,000, the estimated value of which is from $150,000 to $200,000. The old pattern-storage building was converted into a brass foundry, and three crucible melting furnaces installed therein. This arrangement enabled an enlargement of the iron foundry by the addition of 4,160 square feet of space. During the year 4,820,762 pounds of iron castings were made, at a cost of $0.02937 per pound, and 393,995 pounds of brass castings, at a cost of $0.1723 per pound, both exclusive of surcharge, but inclusive of the cost of patterns and material.

The appropriations made by Congress for the Isthmian Canal and available to the close of the fiscal year 1909, amounted to $210,146,468.58, or 56 per cent of the total estimated cost of the canal, which is fixed at $375,201,000. On June 25, 1910, $37,855,000 were appropriated for the fiscal year 1910-11 leaving $127,199,531.42 of the estimated total cost of the canal to be appropriated. The total classified expenditures for canal work to June 30, 1910, amounted to $191,258,113.93, of which $31,188,426.37 were the net expenditures during the fiscal year covered by this report. Of the total classified expenditures to June 30, 1910, $25,699,450.81 were for plant and equipment for construction work, of which $4,388,511.55 were expended during the fiscal year.

PROTECTION OF METAL EQUIPMENT.*

Many people take the stand that protective coatings are not as good, and do not last as long as coatings of fifty years ago. And it is unquestionably a fact that much of the stuff foisted upon a confiding public does not merit the name of protective coatings. Competition, avarice, greed of gain, or get-rich-quick ideas are responsible for this. But in passing it may he said that these industries do not stand alone, and that "all that glitters is not gold" is true, to a large extent, in almost every line of trade.

While the entire mechanical department was evolving an acceptable and satisfactory vehicle, the master painter, educated and trained like his predecessors for generations past to painting and varnishing over wood, was quietly preparing himself for the new conditions. True, he had previous experience and opportunity for observation in treating locomotives and tanks, which at least demonstrated the practicability of protective metal coating, but the conditions were different. The finish on a locomotive and tender was of necessity harder, because of the impact of hot cinders, constant wiping and more frequent shopping. But more and better things were expected in the case of a car; it must give longer service, a more elastic varnish must be used, and its general appearance must be better, the public do not board and ride on a locomotive, and naturally it was the wish and desire of all parties concerned to have the metal cars look and wear as well as the wooden car. Before metal cars were ever thought of, locomotives and tenders had to be of metal; they had to be painted and varnished, and whether fine appearance was short or long, the engineer, the round-house foreman, and all who had to do with it, had to adapt themselves to the conditions of this gigantic monster. And, while the United States Navy, scientists, chemical and technical paint makers were pursuing elaborate, exhaustive and time consuming tests by submerging painted surfaces in salt and fresh water, acids in dilute form, sulphuric and carbonic gases, oxygen and nitrogen airs—separated and combined,—the time for action had come, the cars were here, they were in the shop, they stood there as a great interrogation point, as much as to say with all the insolence of a Bill Tweed, "What are you going to do about it?" Bill Tweed in his day found out, and so did these formidable ugly things of iron find out that they were to be converted into presentable and beautiful shape, retaining all their strength, but rendered as mild and gentle in appearance as a lady's riding horse.

The metal car is here to stay and has been here long enough to demonstrate that it can be protected and made to appear attractive. Every one of us, layman or not, have been interested. Many have paid a great deal of attention to the development of the metal car as it appears today. And when this topic was assigned to the writer for the October meeting, he realized how large a subject it is, altogether too great for any one man to properly handle, and so being blest with a large acquaintance among the master painters of the leading railway systems he put himself in communication with a number whose experience in painting, both in the building and repairing of metal cars, made them the best fitted to speak intelligently, and so it was decided to make this a composite paper, embodying the views of the men who have had to jump in and meet—not a theory, but a condition—that demanded their best thought. So in order that this paper may be helpful, not only to those who hear it, but to all who may read it outside of the New York Railroad Club, the writer formulated eight questions that if answered might impart most of the information required on the subject of "Protection of Metal Equipment." We will now proceed to take up these questions in their order, and in condensed form give an outline of the answers received, and, perhaps, some comments as we pass along:—

Question No. 1.

The difference and difficulties encountered as between wood and metal?

To this question there is quite an unanimity of opinion. All call attention to the fact that wood is porous, and metal only partially so. From the standpoint of difficulty some favor wood, because it comes to the paint shop from the hands of the wood worker ready to receive the priming coat, and no preparatory work has to be done.

One advocates a treatment of the plates before assembling, so that there may be no opportunity for rust, which forms so quickly while the car is being built. Nearly all recognize the necessity for sand blasting all parts before anything is applied; some advocate pickling to remove all scale and flash. Another, going right to the root of the matter, calls attention to the importance of looking out for parts unseen, thus:—"all lap joints where metal is placed against metal or metal against wood should be thoroughly painted with a red lead lute before being riveted together. The material, to be used as heavy as possible, to be applied with a brush. All hidden parts of metal such as steel sills, trusses, bracings, roof trusses, floor beams, etc., in fact, all metal parts of car not to be surfaced and varnished, should be given not less than two or three coats of the best protective paint obtainable, and suitable time allowed between coats for drying. The life of the car will largely depend upon this protection. Inasmuch as so much depends upon the proper protection of all metal parts of the car and especially the hidden ones, at least one of the inspectors at the car building plant should be a man thoroughly familiar with paint in every detail and mode of application."

Another one remarks:—"(All difference). Different mixture for priming coat, account of difference in absorption; less number of paint and varnish coats required on account of the improvement in the manufacture of steel sheets in being nearer to a perfect surface; less paint and varnish coats required, consequently increasing average life of painting."

Another one answers as follows:—"The difference between painting wood and metal is, the metal should be thoroughly sand blasted to remove all scale and rust, and then primed with a material adapted for metal work. This treatment to be followed in the same manner as for wood cars. In rubbing the surfacer down to a smooth and level surface use emery cloth and oil, instead of pumice and water. Rubbing in this manner will prevent water from getting into joints or behind rivet heads, which would cause corrosion."

From all of which it is evident that the life and appearance of the car will depend upon the care taken in thoroughly sand blasting to secure a uniformly smooth surface; and no time must be lost between the sand blasting and application of the initial or priming coat, as the natural moisture in the air rapidly condenses on the new bright surface and will soon form rust.

Question No. 2.

What do you consider the best treatment from foundation to last varnish coat?

(A) The primer coat should be applied, and when dry, all imperfections should be puttied up and time allowed for drying and hardening. Next operation, sandpaper and dust lightly, and to all flat surfaces apply one coat of glazing or knifing putty. This should fill the surface to such an extent that three coats of rough stuff should form body to rub to a smooth, level surface. When perfectly dry this surface should be carefully sandpapered with No. 00 emery cloth, well dusted off, and the surface given two or more coats of

*From a paper by Wm. Marshall before the New York Railroad Club.

body color. When dry, ornament and allow 24 hours to dry. Then apply first coat of varnish, medium drying. When dry, apply second coat with more left on to give a perfect flow. This coat should have three days to harden, when it should be lightly rubbed with pumice pads, rinsed and dried off thoroughly. After which, apply the third coat of a slower drying car body finishing varnish, and leave to harden."

(B) "1st day:—one coat primer; should have little oil and should be well brushed out.

2nd day:—One coat No. 2 Surfacer.

3rd day:—One coat No. 3 Surfacer.

4th day:—One coat No. 3 Surfacer.

5th day:—One coat No. 3 Surfacer.

6th day:—Car to be rubbed smooth with a rubbing brick and water or emery paper block, one-half raw linseed oil and one-half benzine.

7th day:—After it is thoroughly dry, give two coats of flat color; one coat morning and one coat in afternoon.

8th day:—Car to be striped and lettered.

9th day:—Car to be first coated with a good finishing varnish.

10th day:—First varnish coat drying, 48 hours.

11th day:—First varnish coat drying, 48 hours.

12th day:—Second coat good finishing varnish.

13th day:—Second coat drying, 48 hours.

14th day:—Second coat drying, 48 hours.

15th day:—Third varnish coat applied.

16th day:—Third coat drying, 48 hours.

17th day:—Third coat drying, 48 hours.

18th day:—Car ready to turn out."

(C) "After the usual surfacing materials have been applied, use an elastic coat of color, one coat of enamel, and at least two coats of finishing varnish."

(D) "........After above process (preparation of metal).

Allow priming coat to dry, 24 hours..............1st day.

Then putty all depressions, and knife in surface one or two coats, as conditions may require (if two coats of latter) .... 2d and 3d days.

Then apply one or two coats of rough stuff (according to condition of surface).

When dry, rub with block pumice stone and water. Sandpaper with No. 0 sandpaper, and apply .... 4th and 5th days.

One coat varnish ....6th day.

One coat varnish ....7th day.

One coat varnish ....8th day.

Say three days for drying third coat ....9th, 10th and 11th days."

(E) "The difficulties encountered is in securing large metal plates free from buckles and other defects. When varnish is applied to plates containing the slightest buckle, they are magnified to such an extent as to resemble mountains. These buckles do not interfere with the durability of the painting, only detracts from the beauty of finish."

(F) "We consider any of the well known paint surfacers with primer manipulated to suit the steel, with the minimum number of surfacer and enamel body color coats, and to include not more than two coats of Body Varnish for finishing."

A number of others agree in saying that there should be no material difference in treating a metal from wood, except, that priming coat should have less oil, on account of the smaller porosity of metal.

Remarking on answer to question No. 2. The writer would say that (A's) process would take about seventeen days, (B's) eighteen days, and (D's) eleven or twelve days. It will be noticed that (D) does not recommend puttying and glazing coat, but in place thereof uses three coats of No. 3 Surfacer. The objective point in the use of all Surfacers (called rough stuff) is to obtain an absolutely level and smooth surface before the color coats are applied, contributing not only to the appearance of the car, but aiding largely in holding up evenly the color and varnish coats. If such a surface was not secured it would be wavy, dimply and nibby, causing the paint and varnish to be broken off during the terminal mopping or regular cleaning. Were it not for rivets and laps, a metal car could be finished up so that at a glance it could not be distinguished from an unbroken surface of wood. For illustration of this, think of the many times we have had to tap with knuckles to find out whether any smooth surface was wood or metal.

As to the relative merits of the "glazing or knifing putty coats" applied over the primer, in place of rough stuff, no reasons are given, but it is evidently used to reduce the number of rough stuff coats.

Question No. 3.

"In the few years metal cars have been in service, what has been your observation in regard to the appearance and durability in comparison with wood?

(A) "We have on our line over two hundred steel passenger cars, which have been in service over four years. As far as the general surface is concerned, I see no material difference between them and our wooden passenger cars. One has the appearance of being equally as durable as the other. Upon a critical examination, however, we find that wherever there is the slightest opening of the joints, moisture creeps in causing corrosion. How long a time would elapse before this corrosion will eat into the frame work, so as to cause weakening of the whole structure, time alone can determine."

(B) "Metal is better, both in appearance and durability."

(C) "Metal car will, undoubtedly, be more durable than wooden cars. The metal freight car has proved its superiority over the old wooden cars, and, no doubt, the metal passenger car will do the same. As to the appearance, we are not accustomed to the appearance of the inside of metal cars, but as time rolls on we will get used to them and they will look all right. Besides being plainer, they are much more sanitary."

(D) "I think the argument is all in favor of the metal car as regards appearance. The stability and safe aspect provided by the use of metal cannot help but win in the estimation, not only in the eyes of the practical man, but in the eyes of the uneducated as well. As to the durability regarding the painting, there is probably little difference between the wood and metal surface, with the odds slightly in favor of the metal."

(E) "The appearance of the exterior of the cars is equal to wood; also the durability. The steel cars retain the luster of the varnish for a more extended period than is the case with wood exteriors."

(F) "In the few years metal cars have been in service, our observation has been that they are superior to wood, both in appearance and durability."

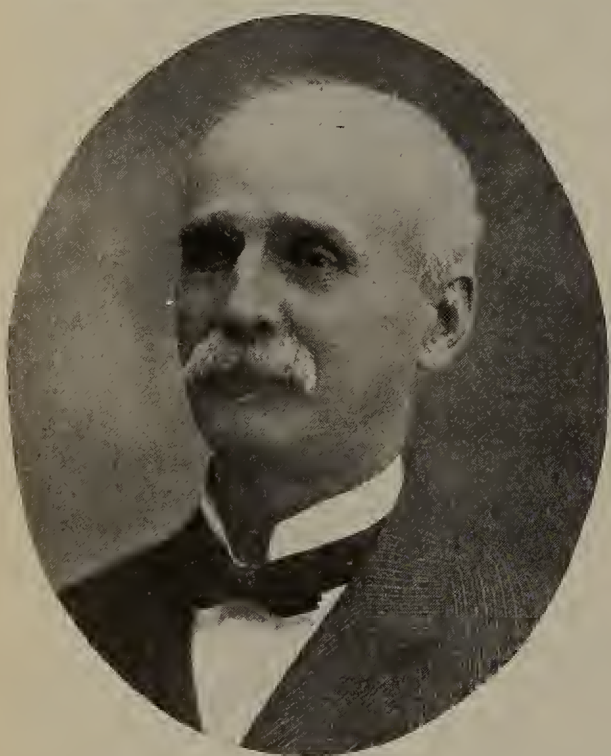
(G) "This all depends upon what care has been taken in the preparation of and painting the steel sheets. We have seen wooden cars fail in three years, more from careless work than from poor material; on the other hand we have had steel passenger equipment under observation for five years and consider them in good condition. To our mind, there is no question but that painting on a wooden car will have a longer average life than a steel car. The latter has the disintegration that starts from the time the car or steel sheets leave the sand blast house and continues until it becomes necessary to remove and repaint that particular sheet, which usually materializes at the age of five and one-half years to six years. There is no primer of any of the surfacing systems on the market today that will prevent this deterioration."

(To be continued.)

New Books

STANDARD SPECIFICATIONS. By John C. Ostrup; 99 pages, cloth, 6x9; published by the McGraw-Hill Book Co., 239 W. 39th St., New York. Price $1.00 net.

This work is designed for the reference of engineers, architects, contractors and students. As its title denotes, it is made up of ten chapters, each containing a set of specifications on a certain subject. The specifications cover all the more important materials used in construction work without repetition, and conform to the requisites of best practice as found by modern experimentation and investigation. The author states that any design made, or structures built in strict accordance with these specifications will insure first-class details, excellent materials and creditable workmanship, as well as safety, durability and economy. The subjects are as follows: Steel Framework of Buildings; Highway Bridges; Railroad Bridges; Plate Girders; Materials and Workmanship; Inspection, Painting and Erection; Structural Timber; Cement; Portland Cement Concrete; Reinforced Concrete.



E. B. Gilbert.

C. J. Stewart.

A. Dinan.

Personals

Leo Meehan has been appointed master mechanic of the Ashland Coal and Iron Co., with office at Ashland, Ky.

E. B. Gilbert has resigned the office of superintendent of motive power of the Bessemer & Lake Erie and has been appointed special agent of the motive power department with office at Pittsburg, Pa.

G. M. Gray has been appointed superintendent of motive power of the Bessemer & Lake Erie, succeeding E. B. Gilbert.

H. C. May has been appointed superintendent of motive power of the Chicago, Indianapolis & Louisville (Monon), succeeding John Gill, who recently resigned. Mr. May's office is at Lafayette, Ind.

E. Nolan succeeds J. W. McCarthy as road foreman of engines of the Chicago, Peoria & St. Louis.

W. H. Dooley has been appointed superintendent of motive power of the Cincinnati, New Orleans & Texas Pacific (Queen and Crescent), with office at Ludlow, Ky. He succeeds J. P. McCuen.

M. A. Kinney has been promoted to succeed G. J. DeVilbiss (deceased) as superintendent of motive power of the Hocking Valley, with office at Columbus, Ohio.

J. E. Davis succeeds M. A. Kinney as master mechanic of the Hocking Valley with office at Columbus, O.

H. B. Brown succeeds W. McIntosh as master mechanic of the Illinois Central at Memphis, Tenn.

Henry C. Manchester, assistant superintendent of motive power of the Maine Central, has been promoted to the office of superintendent of transportation of that road. His office is located at Portland, Me.

A. R. Manderson, master mechanic of the Maine Central, has been promoted to succeed H. P. Manchester as assistant superintendent of motive power with office at Portland, Me.

H. A. Southworth succeeds A. R. Manderson as master mechanic of the Maine Central at Portland, Me.

Geo. H. Bussing has been appointed superintendent of motive power of the New Orleans Great Northern, with office at Bogalusa, La.

C. M. Hoffman has been appointed superintendent of motive power of the St. Louis, Brownsville & Mexico, with office at Kingsville, Tex. He succeeds John Nicholson.

C. J. Stewart, master mechanic of the Central New England, at Hartford, Conn., has been appointed master mechanic of the New York, New Haven & Hartford, with office at Waterbury.

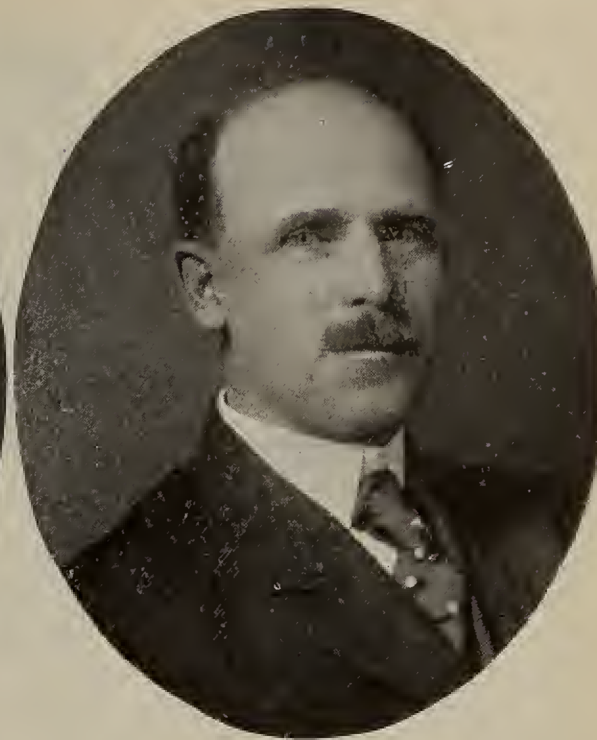
A. Dinan, division master mechanic of the Atchison, Topeka & Santa Fe at Ft. Madison, Iowa, has been appointed mechanical superintendent of the southern district of the western lines, with office at Amarillo, Tex. He will have jurisdiction over the Pan Handle division and territory from Clovis, Tex., to Belen, but not including shops or roundhouse at Belen. The Albuquerque shops and roundhouse have been transferred from the coast lines to the northern district of the western lines, and will be under the jurisdiction of M. J. Drury, mechanical superintendent of the northern district at La Junta, Colo., the northern district including the Western, Arkansas River, Colorado, New Mexico and Rio Grande divisions. W. H. Hamilton, division master mechanic at Argentine, Kan., has been transferred to Chanute, Kan., succeeding A. Mitchell, retired. E. E. Machovec, division master mechanic at Newton, Kan., succeeds Mr. Hamilton, and James McDonough, general foreman at Emporia, Kan., succeeds Mr. Machovec.

Willard Kells, master mechanic of the Lehigh Valley at Buffalo, N. Y., has resigned. Mr. Kells will go to the Atlantic Coast Line as assistant general superintendent of motive power with headquarters at Wilmington, N. C. Mr. Kells has been in the service of the Lehigh Valley for the last ten years.

George Hunter, former master mechanic at Palestine, Tex., for the International & Great Northern, and for the past few years master mechanic for the Kansas City Southern at Pitts-

Willard Kells.

John Gill.



J. T. McGrath.

burg, Kan., has been made master mechanic of the Missouri Pacific at Jefferson City, Mo.

J. F. McDonough has been appointed master mechanic of the Middle division of the Atchison, Topeka & Santa Fe, with headquarters at Newton, Kan., vice E. E. Machovec, transferred.

C. R. Dobson has been appointed a general foreman in the car department of the Rock Island Lines, with office at Cedar Rapids, Iowa, succeeding C. Setzekorn, resigned.

G. H. Watkins has been appointed an assistant master mechanic of the Pennsylvania Railroad, New Jersey division, at Meadows, N. J., succeeding Edwin Schenck, Jr., promoted.

John Gill, who resigned the office of superintendent of motive power of the Chicago, Indianapolis & Louisville in October, 1910, began railway work when but 13 years of age as machinist apprentice on what is now the Chicago, Burlington & Quincy at St. Joseph, Mo. He later became a machinist and gang foreman at this point. He then entered the operating department as a foreman and was promoted eight months later to engineman. In 1887 he went west of the Missouri on the Chicago, Rock Island and Pacific as engineman. In this service he was injured by train wreckers and after recovery was promoted to roundhouse foreman. He was later successively promoted through the positions of machine shop foreman, general foreman, traveling engineer, air brake instructor, and master mechanic. He left the service of the Rock Island in 1901 to become superintendent of motive power of the Chicago, Indianapolis & Louisville (Monon), which position he has successfully filled until his resignation. Mr. Gill has a rare railway mechanical experience, and yet is still in the prime of vigorous manhood.

J. T. McGrath who heretofore has very successfully filled the position of master mechanic in charge of the Battle Creek shops of the Grand Trunk, has been appointed superintendent of rolling stock on the Chicago & Alton to succeed Peter Maher resigned. His office is in Bloomington, Ill., at the shops. If Mr. McGrath can do as much in the interests of efficiency at the Bloomington shops as he has done at Battle Creek, his record will be a desirable one indeed. Moreover if certain others of his hobbies are put into effect such of the residents of the city of Bloomington as are admirers of the city beautiful will have reason to sing the praises of the new regime. The field is there, J. T.

Among The Manufacturers

NEW DRIVE FOR FLATWIST DRILLS.

The questions connected with using and driving twist drills forged or twisted from flat bars of high speed steel are probably receiving more attention from mechanics at the present time than any others connected with the use of tools. Although attempts to solve the problem of drive have been numerous—complicated chucks have been designed to hold and drive the rough end of the flat bar of steel; the shank ends of the bars have been spirally twisted and machined to form taper shanks fitting regular taper sockets; more or less cumbersome taper shanks have been soldered or riveted to the shank ends of the flat twist drills—none of these methods has seemed to settle the matter beyond the possibiliy of further question.

The Cleveland Twist Drill Co., of Cleveland, Ohio, has recently applied for patents on a new device for driving flat taper shanks that are tapered both on the flat sides and round edges. These shanks are regularly furnished on this company's "Paragon" flat twist drills and are driven by sleeves or sockets internally equipped with flat taper holes accurately fitting the shanks and externally tapered to fit standard taper sockets or spindles. In the case of large diameter flat twist drills having No. 6 shanks this drive has found to have certain disadvantages as it made necessary the use of cumbersome extension reducing sockets to adapt the large shanks to the drill press spindles which seldom have a taper hole larger than No. 6. To overcome this difficulty as well as to provide additional driving strength is the two-fold object of the new device.

To this end both the No. 5 and No. 6 "Paragon" shanks have been redesigned the same length as regular taper shanks, the taper on the round edges being regular Morse taper as formerly. When, therefore, this modified shank is inserted directly in the spindle the upper end of the shank is received and driven by the flat slot in the spindle just as is the tang of an ordinary taper shank drill. This alone would constitute a strong and practical drive, but for the lack of support the shank would have on its two flat sides at the lower end of the spindle. To provide against the resultant possibilities of vibration and wear between the

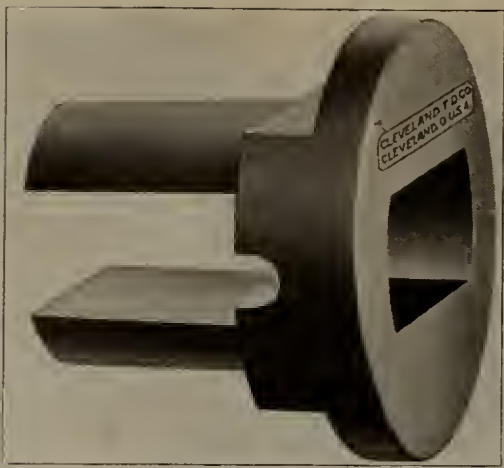


Fig. 1—New Drive for Flat Twist Drills.

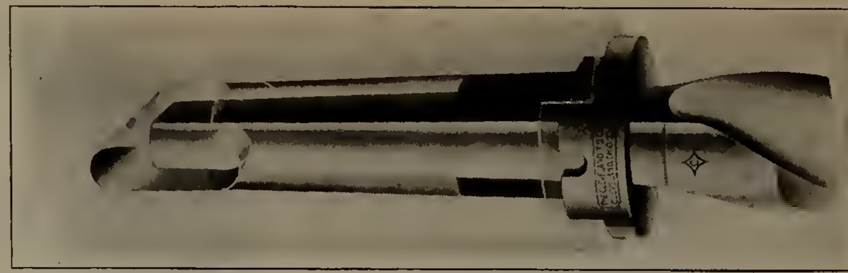


Fig. 2—New Drive for Flat Twist Drills.

shank and spindle, and to furnish a powerful additional drive at the lower end of the shank where its cross sectional area is greatest, a new and original type of socket, called the "Paragon" collet, has been evolved.

As shown in Fig. 1 the collet consists of two lugs (L, L) projecting upward from a flattened disc through which is cut a rectangular hole to receive the "Paragon" shank. The lugs have rounded outside surfaces ground to standard taper and flat inner surfaces tapered to fit the flat taper shank. The groove (G) is provided to receive the point of a drift key in case the collet should stick in the spindle. When the collet is on the shank the combination is practically an interchangeable taper shank with unusually long tang.

Fig. 2 shows the shank, collet, and spindle in combination. The additional drive is provided by means of an extension (E) projecting (upward—in the case of vertical drilling) from the circular base of the collet. This projection mortises into a slot cut across the end of the spindle conforming to the standard slots now being put in the spindles of heavy duty drill presses by several well-known manufacturers. That this tongue-and-groove drive at the large end of the shank is very much stronger than any drive on the tang could possibly be is made evident by a single glance at the figure. The collets without this extension will fit any spindle or socket and will be furnished to those whose spindles are not fitted with slots, when this requirement is plainly specified, but they will, of course, not have the additional driving strength otherwise afforded. With the extension, they make what would seem to be an almost ideally perfect drive for the large sizes of flat twist drills.

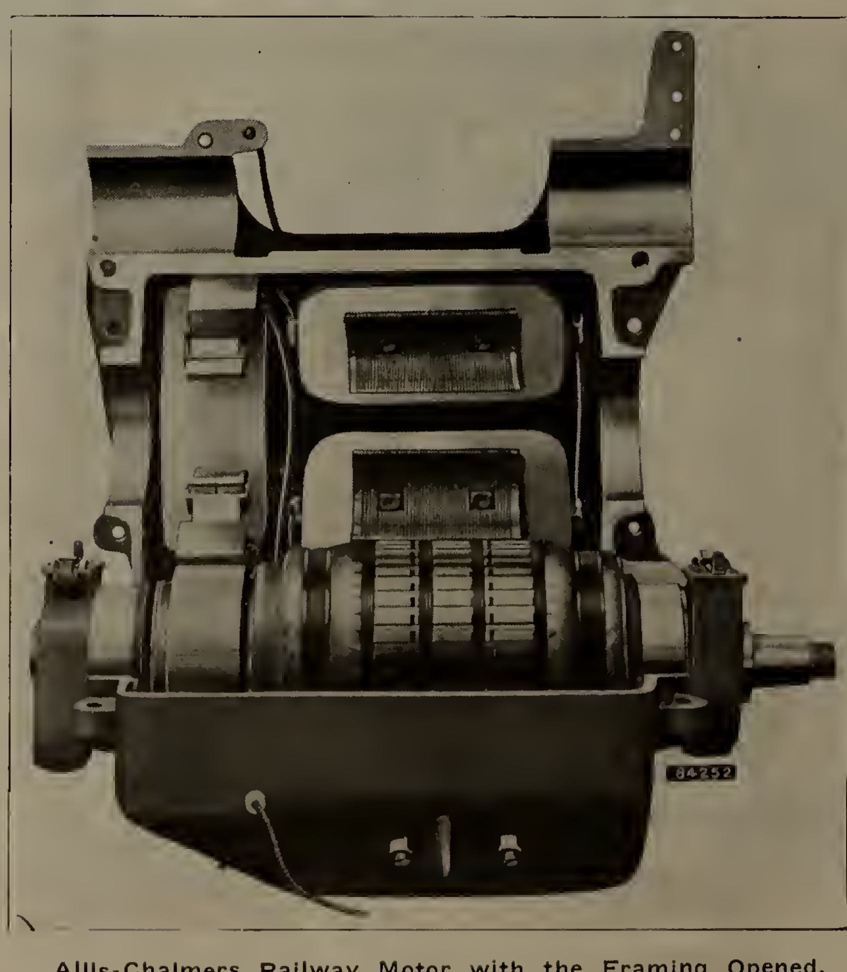
NEW RAILWAY MOTOR.

In adding to its line of railway motors Allis-Chalmers Co. has recently placed on the market its Type 302. This motor embodies not only the ideas gained by years of manufacture, but also has the advantages of being developed in the light of actual experience. Superintendents and master mechanics of a large number of important roads throughout the country have been consulted in regard to the features of this motor. Simplicity of design and construction has been an important factor in its development and much care has been used to remove, as far as possible, the usual sources of trouble.

This motor is of the same general type as the other motors in this class which Allis-Chalmers Co. builds. The field frame is of cast steel and is split horizontally through the armature and axle bearings. It has a large bore at each end to receive the armature bearing housings. An opening in the top half over the commutator and hand holes at each end of the bottom half are provided for inspection of the motor. The top half carries the axle bearings and lugs for the cross bar suspension. The pole pieces are made of soft steel punchings clamped between malleable iron plates and securely riveted. The field coils are of the mummified type. Special insulation is used on these coils and, for final finishing, the whole coil is treated with an insulating varnish by the vacuum process. This method of construction gives a coil having excellent heat conducting properties. The armature bearings are in solid housings and are made large for strength and improvement of wearing qualities. The pinion end journal is 3 1-2 inches in diameter by 9 1-2 inches long and the commutator end 3 inches in diameter by 7 1-8 inches long. The bearing bushings are cast metal, lined with high-grade babbitt, and fit accurately the bore of the housing to which they are securely keyed. The method of oiling keeps the shaft constantly lubricated and at the same time surplus oil is prevented from working into the armature windings and commutator.

Gears are furnished either in solid or split types as desired. These are 5-inch face and have 3 pitch involute cut teeth. The pinions are high-grade hammered steel and are bored taper to fit the taper on the armature shaft to which

Allis-Chalmers Railway Motor.

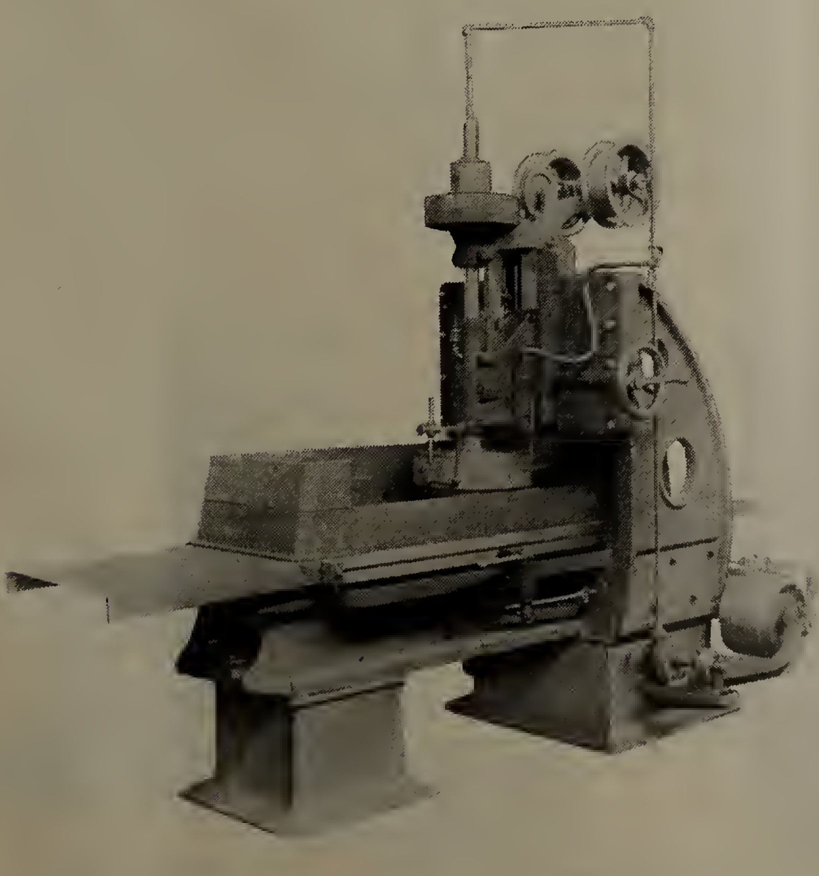


Allis-Chalmers Railway Motor with the Framing Opened.

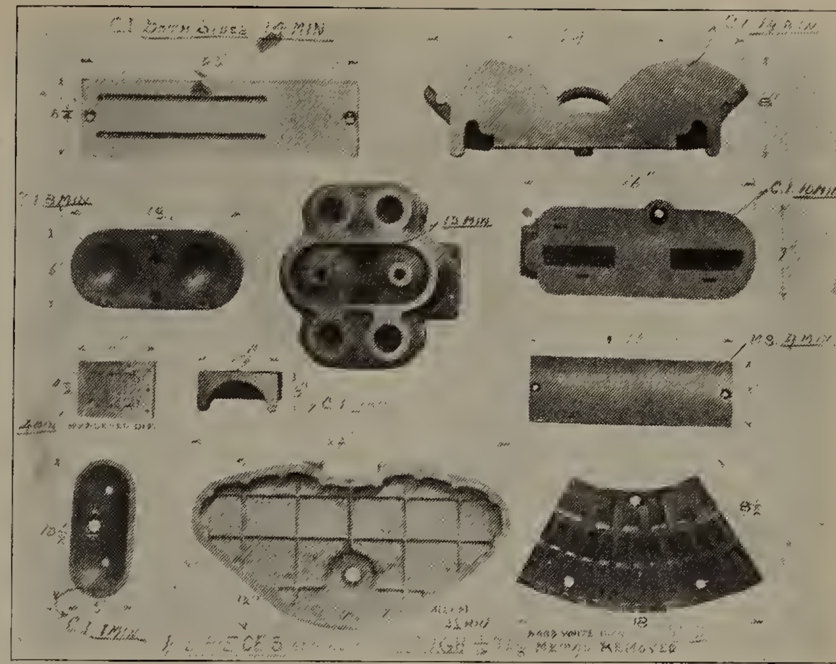
they are securely keyed. Gear cases are supplied either in sheet steel or malleable iron. The company recommends sheet steel cases on account of their greater strength and less weight. Satisfactory methods of construction and suspension have been worked out whereby the usual troubles experienced with this style of case have been entirely elminatd.

The armature core is built up of soft steel laminations which are carefully annealed and varnished after punching. These are secured between end heads which have rims to support the coil ends and protect the coils. Satisfactory ventilation is provided by leaving spaces between the laminations at intervals. The company's usual method is followed of mounting the core and commutator on a cast spider into which the shaft is pressed. This method makes possible the replacing of the shaft without disturbing the windings. The coils are wire wound and very carefully insulated. They are secured in place by numerous bands sunk well below the surface of the core. The commutator bars are of hard drawn copper mounted on a cast steel sleeve. The mica between the bars is of extra soft quality to insure even wearing. The diameter of the commutator is 11 1-2 inches, face 4 1-4 inches and the wearing depth about 7-8 inch. Two brush holders are located in the top half field frame. A braided copper shunt is used to make good electrical contact between brush and holder. A spring clip is used at the brush end to facilitate exchange of brushes.

This motor has a nominal rating of 55 h. p. at 500 volts based on a rise of temperature, by thermometer, not to exceed 75 deg. C. above the surrounding air when run for one hour on shop test at rated load and voltage. It has a continuous capacity of 50 amp. at 300 volts and 45 amp. at 400 volts with a temperature rise as given. A two-motor equipment will operate cars weighing 25,000 pounds without electrical load or equipment on city and suburban service at a schedule speed of approximately eleven miles per hour and a maximum speed of about thirty miles per hour. A four-motor equipment on interurban service will operate cars weighing about 35,000 pounds without electrical equipment or load at a schedule speed of about twenty-four miles per hour and a maximum speed of about forty miles per hour. These schedules and speeds are based on straight and level track and 500 volts line pressure.



Springfield-Brandes Planer Type Grinder, Springfield Mfg. Co.



Pieces Ground by the Springfield-Brandes Grinder in One to Fourteen Minutes. Removing 1/32 to ¼ inches of metal.

NEW VERTICAL GRINDING PLANER.

A redesigned planer type of grinder manufactured by the Springfield Mfg. Co., Bridgeport, Conn., is shown in one of the accompanying illustrations. The machine as now built is a very heavy and substantial tool. It has a normal capacity to grind 12 ins. wide, 12 ins. high and 4 ft. long, but can be built for longer work if required.

The wheel head and spindle are of particularly heavy design, the spindle being of large diameter and mounted in exceptionally long bearings, also provided with a ball thrust on the under side, and is equipped with a ball bearing spring take-up on the upper part of the bearing to prevent back lash when the wheel is running off the work. The driving pulley is mounted upon an independent bearing relieving the spindle of all strain of the belt. The wheel is 16 ins. in diameter, mounted in a chuck which permits of easily changing the wheels and is also well protected by guards to insure against accidents in case of damage to the wheel. The guard around the table is made in sections on the front side, so as to permit of being easily removed, the photograph showing the machine with the upper section left off.

The table drive of this machine is of the general planer construction except that in this case the power is transmitted through a worm and worm gear on the rear of the machine, direct to a large and substantial screw which runs in a long nut to insure long life and giving an absolutely smooth action to the table.

The machine as shown is arranged with a hand feed for feeding the wheel to the work and equipped with a micrometer dial back of the hand wheel to facilitate the setting, and getting sizes; and while this machine as shown is arranged for hand feed only, it will also be made with a power feed when desired.

The machine is equipped with a pump to supply lubricant to the wheel, which can be applied either through the spindle, or from the outside, and when applied through the spindle the water is forced against a deflector on the under side of the spindle, so as to force the water to the periphery of the wheel, which is a very essential feature in grinding narrow or interrupted surfaces.

One of the illustrations shows some of the work turned out by this grinder, with dimensions. It is stated that the pieces were all ground from the rough with a removal of stock of from $\frac{1}{32}$ to ⅛ in.

AN INTERESTING TOOL HOLDER.

The illustrations show a tool holder manufactured by the G. R. Lang Co., Meadville, Pa. The most prominent feature is the triangular-shaped steel for the cutters. This is conceded to be the proper idea, as the triangular shape not only lends itself to a more rigid seat in the holder, but is more economical in the use of high speed steel. The holders have an unusually large cutter. For example, the vertical boring mill holder has a shank 1 1-4 inches deep, that is, it will fit a vertical mill which ordinarily uses 1 1-4-inch square high speed steel. The cutter in this holder is 1-inch triangular steel. There is no top grinding necessary. It is in fact a one-grind tool, the grinding all being done around the front end of the cutter where the least grinding is necessary in order to resharpen the cutter. In actual tests made with this tool against a solid forged tool on such work as turning fly wheels, this tool has taken heavier cuts and heavier feeds than were possible with the solid tool as ordinarily used. This is attributed to the fact that the cutters have a better cutting angle than is usual on the solid tool and also to the fact that there is no forging necessary. The cutter being cut from the bar and hardened, seems to retain the cutting quality of the steel. There is no slip to these cutters in the holders as they are provided with a positive stop which can be advanced behind the cutter as the latter is worn off through grinding.

The general lathe and shaper tool is intended for the same class of work as usually done with tool holders of this style. The cutter is inserted in the center of the holder and can be used either right or left or the point ground to any shape the same as a square cutter. The advantage of the triangular steel in this case is the fact that there is no side spring between the holder and cutter, and the "V" shaped seat which is a steel bushing pressed into the holder can be renewed if it should become worn. This is a valuable feature as the tendency of the constant pressure on end of the cutter point is to wear the seat down on the front end which causes the cutters to break off. There is no remedy for this on holders which have the seat broached directly into the solid tool.

The triangular steel used in both styles of these holders can be bought either in cutter or bar lengths per pound and there is no extra charge for the shapes. The holders are made entirely of tool steel and properly hardened.

NEW VERTICAL MILLING MACHINE.

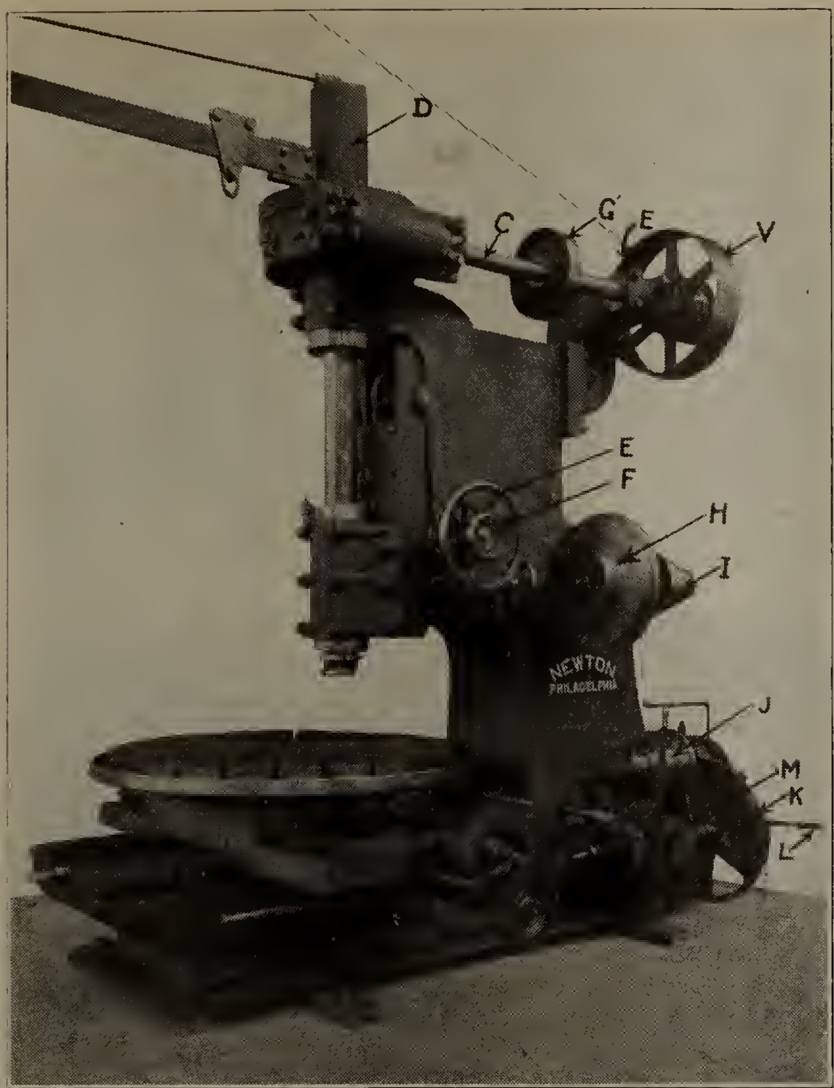
The illustration shows a new design of vertical milling machine made by the Newton Machine Tool Works, Philadelphia, embodying features that are a radical departure from existing bevel or spur gear driven machines. The machine is of very rigid construction throughout, the frame being one solid casting and all gears are cut from steel. The spindle is 6⅜ in. in the main bearing, which is bronze bushed and capped. The length of this bearing is 21½ in. The driving worm wheel is of very large diameter, and has a bronze ring with teeth of steep lead. The sleeve is cast solid and revolves in a bushed capped bearing, which is bolted to the top of the frame to permit of adjustment should it ever be required to maintain alignment if wear has to be compensated for. The spindle is caused to rotate with the sleeve by means of a double keyway.

The drive is taken from a General Electric 220 volt 30 H.P. motor having a speed of from 400 to 1,200 R.P.M. through a 7 in. belt to the pulley "A," which revolves on the finished end of the bearing "B" in order to give a large substantial wearing surface. The rotation of the shaft is obtained by keying a large washer onto the shaft which has a broad face key extension fitting into a corresponding slot in the end of the pulley hub. The driving worm is of hardened steel fitted with roller thrust bearings and is fitted on to the shaft "C." Both of these bearings are bushed and capped. The driving worm and worm wheel are entirely encased, permitting of their continual lubrication. The construction at "D" is notable as it gives a simple design for the attachment of the swinging crane and also protects the top of the spindle and the driving mechanism from dirt. The spindle saddle is counterweighted, has square lock gibbed bearings on the upright and adjustments are made by means of taper shoe. At "E" is shown the method of obtaining the vertical fast hand movement and also the hand slow adjustment by engaging or disengaging the clutched hand wheel "E" by the small combined nut and hand wheel "F." Motion for the feed is taken from the pulley "C" to the two step cone "H" to which is attached a four step cone of smaller diameter, which is bolted to one of equal proportions at "J." Motion is further transmitted through the large gear "K," which rotates freely on the horizontal driving shaft and feed can only be obtained by the engagement of lever "L" and when in its opposite position fast traverse is available. The feed and fast power motions are further carried through the double train of bevel gears giving reverse to both motions for the circular, in and out and cross movements. All gears on this machine are of steel or bronze and all movements are clutched. The circular table is 60 in. in diameter over the "T" slots, entirely surrounded by an oil pan, is of very heavy construction and has an exceptionally large central bearing in the table saddle. The cross saddle has square lock gibbed bearings on the base. Adjustments are made by means of taper shoes.

Lang Lathe Tool Holder.

Left Hand Boring Mill Holder.

Lang Boring Mill Tool Holder.



Newton Vertical Milling Machine.

This machine is particularly intended for locomotive work, permitting of the heaviest possible cuts and the intention has been to design a machine to give as efficient results as can possibly be obtained from the planer type machines, on which we are already removing one cubic inch of metal per H.P.

The maximum distance from the end of the spindle to the table is 22 in., the length of the in and out feed is 33 in., the length of the cross feed is 33 in., and the distance from the center of spindle to upright is 34½ in. The machine occupies a floor space of about 12 ft. 2 in. by 8 ft. 5 in., with an additional extension of 5 ft. in the rear for motor when arranged for motor drive. The extreme height with the spindle in its highest position is 12 ft. 6 in.

IMPROVEMENT IN HYDROSTATIC LUBRICATORS.

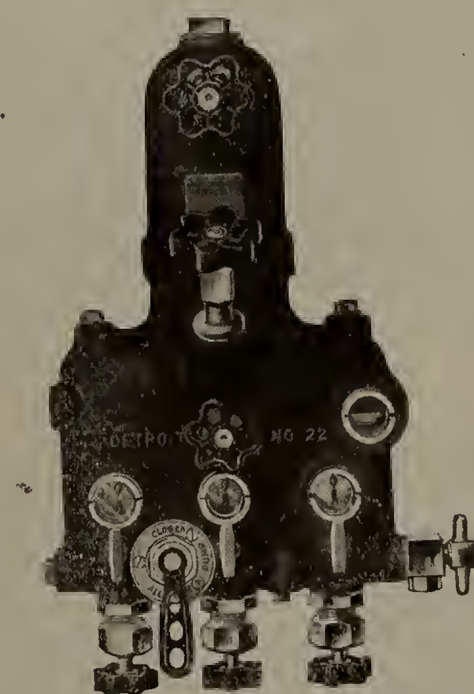
The introduction of the Detroit No. 22 Bullseye Lubricator with its oil control valve, as exhibited at the convention in June, 1910, marks another very important improvement in the hydrostatic lubricator; as important, in fact, as the bringing out of the first practical Bullseye lubricator by the Detroit Lubricator Co. at the convention in 1903.

Owing to its reliability and the form in which the lubricant is delivered, the hydrostatic lubricator has always been acknowledged the ideal method of obtaining perfect lubrication for simple, compound or superheated locomotives, although its use in the old tubular glass form was attended with more or less danger to the operator. Consequently, the bullseye feature, insuring absolute safety, was received with great favor by all railroads whose management desired to protect its employees and equipment against harm by the use of a safe, reliable and economical device.

In designing the first bullseye lubricator, known as the Detroit No. 21, the paramount idea was safety, with simplicity and economy as secondary considerations, and in the six years which this device has been upon the market, its safety has been demonstrated beyond all question, under all conditions of service, the world over.

In designing the Detroit No. 22, the safety features of the No. 21 having been retained, particular attention has been given to greater economy and convenience of operation, with the result that in this device we have set a new standard of excellence which is not even approached by any other lubricating device in the market.

The ability of the modern locomotive to do the work for which it was designed, its economy in fuel and cost of up-keep, as well as its hauling power is dependent to a very large extent upon the proper lubrication of its valves and cylinders. What, ten years ago, would have been considered satisfactory lubrication of the locomotives then in use, for the large and more powerful engine of today, is entirely inadequate. Ten years ago, if the valves and cylinders of the locomotive working above 65 per cent or 70 per cent of its efficiency were not properly lubricated, the consequent loss in hauling power, fuel, speed and up-keep means little (in dollars and cents) as compared with the same condition applied to the locomotive of today. The difference in earning power and operation between the modern



Detroit No. 22 Bullseye Lubricator.

locomotive properly lubricated and one that does not have constant and proper lubrication when working at above 70 per cent, represents a figure too large to be longer ignored. A modern locomotive should be lubricated according to modern ideas as embodied in a modern and up-to-date device. Modern lubrication means complete and perfect lubrication under every condition, and perfect lubrication cannot be obtained from a device which, at the time a locomotive is performing its heaviest duty, fails to deliver the lubricant. Neither can it come from a mechanically driven device where the quantity of lubricant per mile remains the same irrespective of the duty requirements.

To satisfactorily perform the work required of it, a modern lubricator should have certain essential features, most important of which is the ability to deliver the lubricant under all conditions and up to the full efficiency of the locomotive. It should automatically, through the decreased speed of the locomotive in heavy duty on grade, increase the amount of oil per mile and, on level track at higher speed, return to the rate of feed required for that class of service. The means for accomplishing this should be of such a character as will place within the hands of the operator the power to instantly stop, start or throttle the rate of feed without disturbing the adjustment of his regulating valves, or the ability to withhold the lubricant from the valves and cylinders and allow the air pump feed to continue working.

The duty of the modern air pump is so severe that it requires almost constant lubrication from the time it leaves a terminal to its return to the roundhouse. It is therefore most important that the air pump feed be left working while the locomotive is temporarily at rest at a station or on a siding. A modern lubricator should be so constructed that, having once adjusted the regulating valves for perfect lubrication in a class of service, these valves need not be disturbed or touched again until the class of service is changed. The importance of this as regards perfect lubrication, economy and convenience can hardly be overestimated.

The introduction of an oil valve in the oil passage between the reservoir and the sight feed regulating valves in the Detroit No. 22 bullseye lubricator, places in the hands of the operator an instantaneous means of starting, stopping or throttling the rate of feed, does away with the necessity of shutting off the feed regulating valves at a terminal or in refilling on the road and consequently the necessity of opening and readjusting these valves after refilling or at the commencement of a service movement. Under the old method of closing, opening and adjusting the regulating valves, the frequency with which this occurred not only shortened the life of the device, but the length of time consumed in this operation made it impractical to require the operator to shut off his cylinder feeds during temporary stops, with the result that much oil was wasted and the oil-mileage decreased. This oil valve has a lever handle and index plate, and is so designed that from the "Closed" position, a half turn will open all feeds, or a quarter turn the feed to air pump only, and vice-versa.

In adjusting the feed regulating valves of a lubricator, the practice differs, the usual custom being to trace the feeds and gradually throttle, which means a waste of oil on account of the cold condition of the steam chest and cylinders and the washing action of the heavily saturated steam during the initial movement. Another practice, attended also by decreased oil mileage and even more harmful results, is that of starving the valves and cylinders through insufficient lubrication due either to error in judgment on the part of the operator as to the number of drops per minute at which he should set the feeds, or through not starting the lubricator in sufficient time before leaving the terminal. This practice will result in distortion of the valve motion through dry valves, waste of fuel, loss of time and speed and the necessity of racing the feeds in order to get the valves back into proper working condition.

The use of the oil valve, the regulating valves having been once adjusted, makes the starting of the lubricator an instantaneous operation and insures the correct amount of lubrication. The operator knows that as soon as the lubricator has reached its proper temperature, the oil will feed at the rate required.

The adjustment of the lubricator feeds in night service or where the device is inconveniently located is always a matter of more or less difficulty. As the oil valve does away with the opening and closing of the regulating valves and the necessity for observing the sight feed features when starting and stopping the device, it becomes a great convenience to the operator, as under all conditions, night or day, he can by the sense of touch alone, place the lever handle of this valve in only one of its three positions.

Interior of Wood Working Department, Milwaukee Car Mfg. Co.

COMPLETE CAR MANUFACTURING PLANT.

The accompanying illustrations of the plant of the Milwaukee Car Mfg. Co., Milwaukee, Wis., give an idea as to the size and equipment of the works. This company has, in the past, specialized in the manufacture of refrigerator

General View of Plant, Milwaukee Car Mfg. Co.

cars, but its plant is now equipped for the manufacture of all classes of freight equipment. Repair work for several railroads has also been handled in large orders.

The power plant is equipped with Babcock & Wilcox boilers and Allis-Chalmers engines and generators. The current generated is sufficient to allow for motor drive on all machinery and also to light the offices, factory and yards. At the present time there is being constructed a heater fan building for the installation of two high-speed fans to be operated by independent engines. This building is of brick and fireproof. The equipment is of sufficient capacity to heat the entire plant.

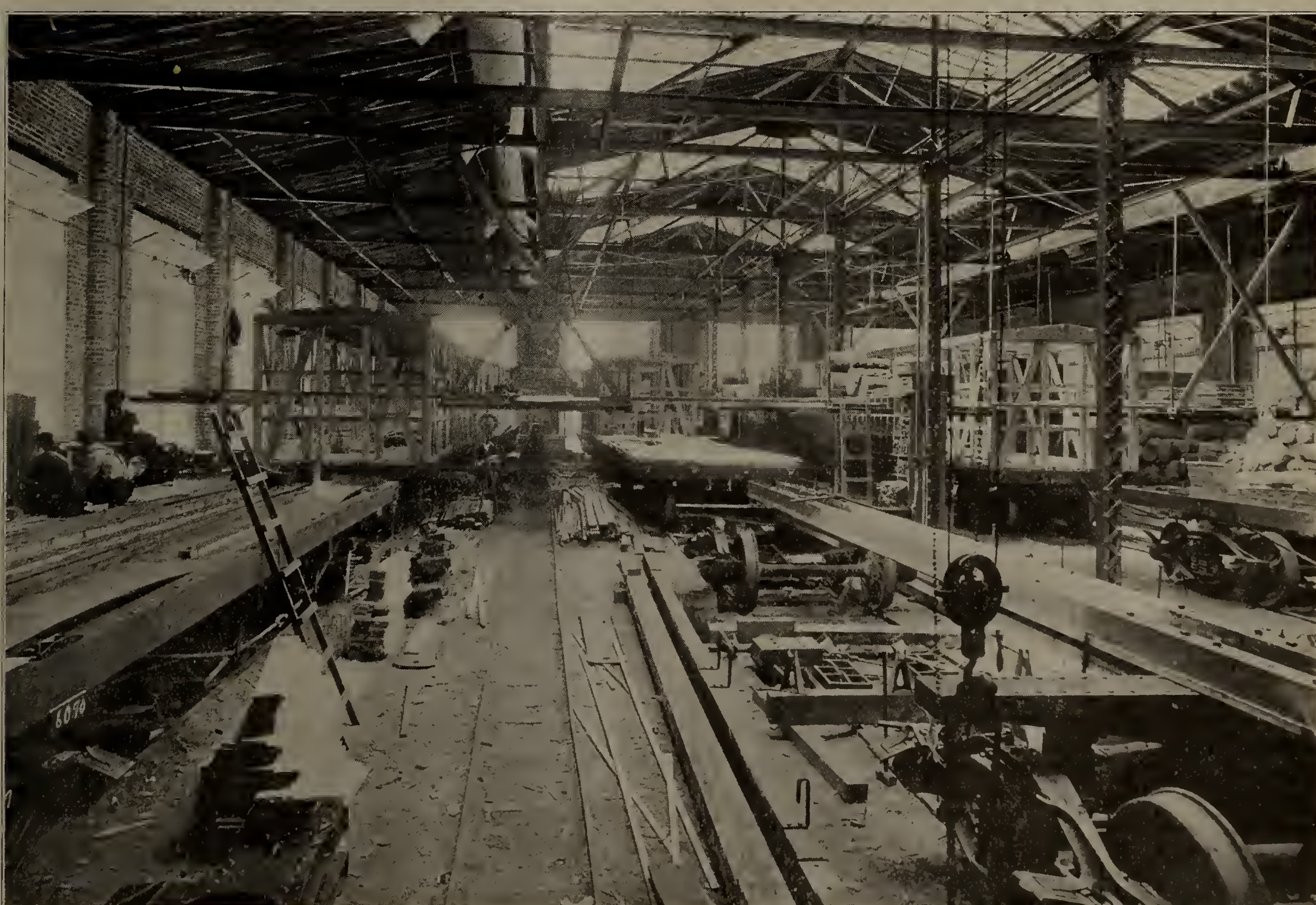
The general view shows the erecting shop in the foreground, with four tracks traversing its length. This trackage allows for the progress of work on forty cars at once. This shop is 82 feet wide by 390½ feet long.

The wood shop, the interior of which is shown in one of the illustrations, is 82 feet wide by 134 feet long, and is fully equipped with woodworking machine tools.

The blacksmith shop is 50 feet wide by 61 feet long and is equipped with the necessary hammers, forges, bulldozers, etc., to do all the iron and steel work incidental to the manufacture and repair of freight cars.

The office and stores are in a two-story brick building 34 feet wide by 97 feet long. The first floor is occupied as a storeroom and the second as a general office.

The plant has a daily capacity of five refrigerator or ten box cars. We are indebted to H. W. Marsh, general manager, for the above information.



Interior of Erecting Shop, Milwaukee Car Mfg. Co.

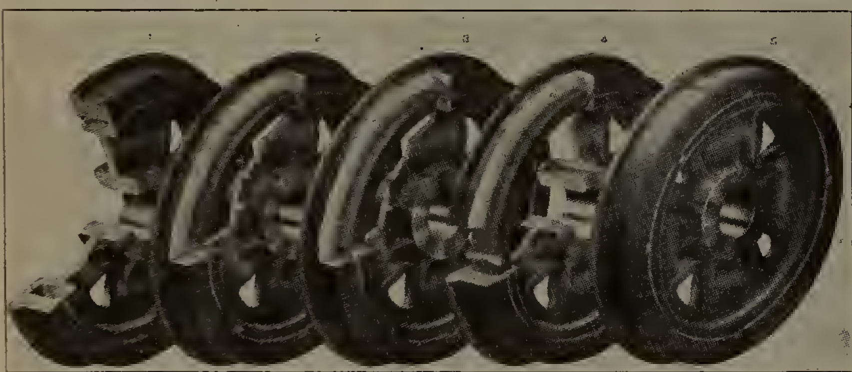
THE McCONWAY WHEEL.

A pamphlet recently published by the McConway & Torley Co., Pittsburg, deserves more than ordinary mention. The illustration herewith is taken therefrom and the description of the McConway wheel, which is steel-tired of the built-up type, consisting of a cast steel center, cast iron hub, and rolled steel tire, is as follows:

1. Tire, center and hub assembled; next operation casting locking wedges into space shown between tire and rim of center. To perform this operation, wheel is laid flat and molten iron is poured through annular opening on the side.

2. Locking wedges shown in the first position, the temporary spacing wedges not yet removed.

3. Temporary spacing wedges removed and locking wedges driven home, points of wedges about—but not quite—in contact, and the final spaces left between large ends of wedges.



The McConway Wheel.

4. Sprags in place and final closers cast, showing projecting ends of sprags which engage in the inner flange of the tire to prevent revolving of tire on center.

5. Completed wheel.

Commercially considered, the first cost of the initial wheel of this design is the value of:

A. The tire. B. The cast steel center. C. The cast iron hub. D. The cast iron locking wedges.

Renewals of the initial wheel means the purchase of a new tire only. The salvage in the scrap value of the old tire is more than enough to remelt the locking wedges and attach the new tire to the old center, which is itself indestructible. More broadly stated, it may be said that the salvage from the old tire will pay the cost of removal of the wheel and its return to the axle, which reduces the computation of the cost of wheel renewals to the price of a new tire.

New Literature

A recent booklet of the Dodge Mfg. Co., Mishawaka, Ind., tells of a test which was conducted on one of its wood rim pulleys in which the pulley attained the speed of 29,000 feet or five and a half miles per minutes with no bad results. Which is "going some."

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The Thermit process of rail welding is well described and illustrated in a booklet recently issued by the Goldschmidt Thermit Co. of New York.

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Record number 67 of the Baldwin Locomotive Works gives details and illustrations of some fourteen locomotives recently built by this company for passenger service.

* * * *

The latest catalogue of the Ajax Mfg. Co., Cleveland, Ohio, is bound in cloth board covers and is an excellent example of what a catalogue should be. It fully illustrates the various lines of hot metal working machines made by the Ajax people and in addition gives many useful tables.

The Steel City Electric Co. of Pittsburg has issued a bulletin which takes up in detail the Fullman adjustable watertight floor outlets for electric lights, fans and telephones.

* * * *

A pamphlet on compressed air for industrial purposes has been issued by the Allis-Chalmers Co., of Milwaukee.

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A new booklet has just been issued by the Joseph Dixon Crucible Company of Jersey City, N. J., entitled "Graphite Products for the Railroads." This, as its name implies, covers the Dixon line of products that are widely used in railroad service.

* * * *

The Dearborn Drug & Chemical Works of Chicago has issued a very attractive booklet on the treatment of boiler feed waters.

Industrial Notes

The Falls Hollow Staybolt Co. announces the appointment of Mr. Thomas F. Meek, 415 Moffat building, Detroit, Mich., as its representative for southern Michigan. Mr. Meek was secretary and manager of sales for the Detroit Steel Casting Co. for 20 years. He has a wide circle of friends and his genial disposition and excellent reputation should make him exceedingly popular and successful in his new line of work.

The Edgar Allen American Manganese Steel Company, Chicago, announces the appointment of Walter Brinton as consulting engineer, with headquarters at New Castle, Del. Mr. Brinton was formerly superintendent of the manganese steel department of the Taylor Iron & Steel Company, High Bridge, N. J., a position which he had held since 1895. The Edgar Allen American Manganese Steel Company is now manufacturing manganese steel at Chicago Heights, Ill., and New Castle, Del.

The W. F. Goltra Tie Company, Cleveland, Ohio, has recently been organized to manufacture and sell railway cross ties. The officers are as follows: President and general manager, W. F. Goltra; vice-president, L. C. Mambourg; secretary and treasurer, P. F. Gallagher. Mr. Goltra has been connected with the New York Central lines for 27 years, having held the position of general tie agent during the last three years, from which position he has recently resigned. The company's offices are located in rooms 804 and 806 Rockefeller building, Cleveland.

The Brady Brass Co., Jersey City, N. J., will erect a factory on the north side of 14th street, between Grove and Henderson streets, as soon as necessary plans aer completed.

The Midvale Steel Co., of Midvale and Nicetown, the latter a suburb of Philadelphia, Pa., has awarded the contract for the construction of a wheel plant at Nicetown. to W. W. Lindsay & Co., Harrison building, Philadelphia. The plant will be one story in height, of steel and corrugated iron, 82x170 ft. Work is to be started at once, and completed this winter. The contracts for the mechanical equipment, which will be required, have not been placed by the company's engineers. The cost of the plant will be about $17,000.

The Railway Business Association, at its annual meeting held at the Waldorf-Astoria, New York, November 22, reelected the following officers: President, George A. Post; vice-presidents, H. H. Westinghouse, O. H. Cutler, W. H. Marshall, E. S. S. Keith, A. H. Mulliken, O. P. Letchworth, A. M. Kittredge; treasurer, Charles A. Moore.

The Canadian Car & Foundry Co. has declared an initial dividend of two per cent on the $3,500,000 common stock for the year ending Sept. 30, payable Dec. 15 to holders of record Nov. 20. Regular quarterly dividends have been paid on the 7 per cent preferred stock since January last.

Burton W. Mudge & Company of Chicago, manufacturers of the Garland Car Ventilation devices, has appointed J. L. Phillips, Manager, Electric Railway Department.

The Falls Hollow Staybolt Co., announces the appointment of Frank R. Goehler, as its Chicago railway representative, with office at 1143 Marquette building, Chicago. Mr. Goehler was formerly connected for some four years with the purchasing department of the A. T. & S. F. Ry., at Chicago, resigning to accept a position as factory business manager with the Buda Co., at the works of Harvey, Ill. He is a young man of wide business acquaintance, among whom he enjoys a most excellent reputation, which, with his genial disposition should make him exceedingly popular and successful in his new line of work.

Walter Brinton, Superintendent of the Manganese Steel Department of the Taylor Iron & Steel Company's Plant at High Bridge, N. J., since 1895, has resigned, and has accepted a position as consulting engineer for the Edgar Allen American Manganese Steel Company, who are manufacturing Manganese Steel at Chicago Heights, Ill., and at New Castle, Del. Mr. Brinton's headquarters will be at the New Castle plant.

William G. Pearce, for some years vice-president and general manager of the Griffin Wheel Co., of Chicago, having acquired an interest in the American Brake Shoe & Foundry Co., on January first next, will become associated with the latter concern as vice-president, with headquarters in New York. Mr. Pearce is well known in the railroad and supply world, having served for a number of years as auditor of disbursements, general purchasing manager of the Northern Pacific Ry., until his resignation from the latter position in 1902, when he became vice-president of the Griffin Wheel Co. Mr. Pearce will retain his considerable financial interest in the Griffin Wheel Co. and continue as a member of its board of directors.

John I. Beggs, president of the Milwaukee Electric Railway & Light Company and interested in several other public service corporations, has been elected president and general manager of the St. Louis Car Company, of St. Louis, Mo., for the purpose of reorganizing the concern and placing it on a paying basis. The plan of reorganization provides that Mr. Beggs, David May, Moses Schoenberg and associates are to put $850,000 into the corporation for which they are to receive seven per cent. cumulative preferred stock at par. The creditors are to take seven per cent cumulative preferred stock in payment of their claims.

Forsyth Bros. Co., manufacturers of railroad supplies, at 213 Institute place, Chicago, have acquired in Harvey, Ill., a suburb of Chicago, a tract of 23 acres of land located at the crossing of the Grand Trunk and Illinois Central railways, on which site the company will begin at once the erection of a large manufacturing plant to cost several hundred thousand dollars. The plant will be built in sections, the first being a two-story machine shop, 100 by 141 ft., to cost $25,000.

W. J. Fauth, formerly treasurer of the W. K. Kenly Company, Chicago, has severed his connection with that company and has opened an office at 310 Monadnock building, Chicago. Mr. Fauth will represent manufacturers of track and signal supplies.

The Pawling & Harnischfeger Company, Milwaukee, Wis., announces the opening of a branch office in the Washington building, Portland, Ore. The office is in charge of R. K. Morse, who has been a member of the engineering staff in the Milwaukee office.

Mr. John N. Faithorn has been appointed by Judge Kohlsaat, of the United States Circuit Court, as receiver for the Brighton Car Co. The complainant was Almerin W. Baer, a stockholder in the company, who in his bill charged that the appointment of a receiver was all that could save assets of the corporation from further depreciation because of the action of Edward S. Simmers, the president, who, it is charged, aligned with Garrison Grawoig and George Volk in an attempt to "freeze" out other stockholders and directors. The basis of the action is a loan made by the Brighton Car Co. of $25,000 to the Minneapolis Car Co. a concern organized in 1909 by Simmers and others.

The Cooper-Hewitt Electric Co. has moved its general offices from 220 West 29th street, New York, to 8th and Grand streets, Hoboken, N. J. The company also announces that the equipment of its new works is completed.

The Brann & Stuard Company of Philadelphia, Pa., has been awarded the contract for the roofiing and skylight work for the new shed for the Pennsylvania's Union Station in New York city. The contract for the steel work for the structure was awarded to the McClintic-Marshall Construction Co.

The stockholders of the Pullman Co. held their annual meeting on Wednesday, November 9, and re-elected the old board of directors. The directors at a meeting which followed re-elected all the old officers.

The Nickelized Castings Co. of Pittsburg report the use of their Nickelized chilled car wheels on four railroads. They have now been in use for 18 months, making a mileage of 45,000 and still running under 100,000-lb. coal cars on heavy grades on trains equipped with steel wheels, and show the same endurance and all that is essential on freight train service at less than one-half the cost per 1,000 mileage.

Dr. F. H. Hirschland has been elected vice-president of the Goldschmidt Thermit Co., 90 West street, New York city.

The Garlock Packing Co. has purchased the factory in Hamliton, Ontario, formerly occupied by the Ontario Tack Co.

Recently the contract was let by the Chicago Rock Island & Pacific Ry. for a new freight station in Kansas City to take care of the constantly increasing freight traffic, inbound and outbound, which had to be handled. H. T. Hawk, architect for the Rock Island Lines, drafted the plans for the new station. Following other experiences in reinforced concrete building construction he specified "Ferro-Lithic" plates manufactured by the Berger Mfg. Co. of Canton, O. This Ferro-Lithic plate consists of dovetailed cross-ribbed steel sheets which act both as form and reinforcement. The concrete is applied on the upper side, while a good plastering surface remains on the lower side. A saving in time is secured by this construction since no wooden forms are needed. It also saves the waste lumber inseparable from wooden forms. This construction is to be used for the ceiling of the second floor of the new station, which will be used by the office force. The building is now under course of construction, the contractors being B. Swft & Company of Chicago.

Announcement is made that Mr. J. S. Coffin, vice-president of the American Brake Shoe & Foundry Co., will on December 31 retire from active service with the company in order to devote himself more closely to the affairs of the Franklin Railway Supply Co., of which he is president; the American Arch Co., of which Mr. Coffin is chairman, as well as the Locomotive Superheater Co. and other allied interests. Mr. Coffin will retain, however, his financial interest in the American Brake Shoe & Foundry Co., and also his membership on the board of directors.

Railway Mechanical Patents Issued During November.

Grain door for freight cars, 973,486—Herbert W. Drew, Chicago, Ill.
Car window, 973,502—Edward H. Harriman, Arden, N. Y., and William R. McKeen, Jr., Omaha, Neb.
Car ventilator, 973,513—Alfred Anthony Kempski, Wilmington, Del.
Car door, 973,701—Adolph J. Ricker, South Milwaukee, Wis.
Extension car step, 973,714—Blake Smith and George Shivadecker, Verona, O.
Dump car, 973,753—Argyle Campbell, Chicago, Ill.
Locomotive ash pan, 973,765—Theodore H. Curtis, Louisville, Ky.
Car, 973,788—Frank S. Ingoldsby, St. Louis, Mo.
Dumping door operating mechanism, 973,874—John O. Neikirk, Morgan Park, Ill.
Passenger car, 973,884—Charles Rudolf Seiser, St. Louis, Mo.
Car roof, 973,888—Howard Stillman, Berkeley, Cal.
Car brake, 973,933—Richard M. Fox, Bluefield, W. Va.
Automatic stopping mechanism for trains, 973,954—William Mingo, Jr., Weimar, Tex.
Automatic brake adjuster, 974,004 and 974,005—John Shaver Washburn, Albany, N. Y.
Automatic dumping car, 974,009—Burt Lincoln Worthen, Tucson, Ariz.
Stock car, 974,068—Jeremiah Conklin Jones, Woodson, Tex.
Train pipe coupling, 974,088—James E. Marble, Albany, N. Y.
Dump car, 974,097—Frederick Seaberg, Chicago, Ill.
Car coupling, 974,153—Eli H. Janney, Fairfax county, Va.
Brake shoe, 974,243—John H. Davis, Brooklyn, N. Y.
Coupling, 974,254—John Froggatt, Camberwell, and Charles Stacey, Malvern, Victoria, Australia.
Brake beam, 974,270—John B. Hoagland, St. Louis, Mo.
Brake beam, 974,283—John A. Lamont, St. Louis, Mo.
Metallic car construction, 974,341—Anton Becker, Chicago, Ill.
Car wheel, 974,363—William H. Daugherty, Jasonville, Ind.
Railway weed cutter, 974,452—Robert Whitty, Horicon, Wis., and Edward Laas, Chicago, Ill.
Locomotive, 974,459—Bert Charles Ball, Portland, Ore.
Friction draft rigging, 974,466—Cyrus L. Bundy, Kingsland, N. J.
Friction draft rigging for railway cars, 974,467—Cyrus L. Bundy, Kingsland, N. J.
Dump car, 974,470 and 974,471—Argyle Campbell, Chicago, Ill.
Locomotive, 974,486—George J. Hatz, Omaha, Neb.
Knuckle pin retainer, 974,509—Charles F. Murray, Chicago, Ill.
Car wheel, 974,549—George H. Bryant and August Ziesing, Chicago, Ill.
Draft sill, 974,569—John James Irvin, Bellwood, Pa.
Reinforced brake shoe, 974,589—Joseph Alexander Panton, Waterloo, near Liverpool, England.
Railway dump car, 974,642—Argyle Campbell, Chicago, Ill.
Reinforced concrete car structure, 974,659—George M. Graham, Chicago, Ill.
Car seat structure, 974,664—Fred H. Henry, Philadelphia, Pa.
Coupling operating attachment for cars, 974,793—Frank Horn, Columbus, Ohio.
Brake beam, 974,797—Charles Francis Huntoon, Chicago, Ill.
Car wheel, 974,798—William L. Jacoby and Frank B. Bell, Chicago Heights, Ill.
Car bolster side bearing, 974,832—Carl L. Schwartz, St. Louis, Mo.
Combination car step and gate, 975,017—Benedetto Capra, Los Angeles, Cal.
Side frame, 975,093—Arthur H. Weston, Baltimore county, Md.
Car door locking device, 975,113—Charles W. Bitner, Oaxaca, Mex.
Locomotive, 975,183—Samuel M. Vauclain, Philadelphia, Pa.
Car door, 975,209—Conrad M. Christensen, Leeds, N. D.
Apparatus for ventilating tunnels, 975,248—Thomas H. Johnson, Pittsburg, Pa.
Car truck, 975,303—Samuel M. Vauclain, Philadelphia, Pa.
Car door fastener, 975,347—Joseph Gauthier, Gorham, N. H.
Process of manufacturing car wheel blanks, 975,383—Herbert R. Keithley, Kansas City, Mo.
Freight car, 975,398—James McCutcheon Coleman, St. Lambert, Quebec, Canada.
Electric locomotive, 975,404—George M. Eaton, Wilkinsburg, Pa.
Journal box, 975,449—John E. Osmer, Chicago, Ill.
Truck connection, 975,475—Evie Stevens, Park, Wash.
Means for protecting freight cars and the like from entry, 975,508—James A. Campbell, Paterson, N. J.
Car door, 975,749—Henry A. Christy, Kenilworth, Ill.
Dumping door for railway cars, 975,804—Edgar W. Summers, Pittsburg, Pa.
Dump car and vehicle, 975,861—Patrick J. Harrigan, McKeesport, Pa.
Car brake, 975,893—Charles V. Rote, Lancaster, Pa.
Brake for railway cars, 975,908—Louis de Vito, Cleveland, Ohio.
Chain hole cap for car couplings, 975,926—Arthur J. Beazley, Cleveland, Ohio.
Buffing mechanism for passenger cars, 975,945—Richard D. Gallagher, Jr., New York, N. Y.
Articulated locomotive, 976,014—Samuel M. Vauclain, Philadelphia, Pa.

STRUCTURES.

The Pennsylvania R. R., according to report, is contemplating the erection of a new steel car shop at Altoona, Pa., thus doubling its present capacity for that class of work.

The Louisville & Nashville Railroad will enlarge it division shops at Etowah, Tenn., at a cost of $19,000. The same road is planning to build new yards at Covington, Ky., in which there will be 27 tracks and other improvements.

The Cincinnati, New Orleans & Texas Pacific, it is reported, will locate repair shops at Somerset, Ky.

The Atchison, Topeka & Santa Fe has appropriated nearly $1,000,000 for stations and other improvements in Kansas. Of this amount nearly $500,000 is for new buildings and headquarters, and the shops to be built in Topeka and the remainder is for new depots, track changes and shop buildings at various other points.

The Memphis & North Arkansas will erect machine shops and a passenger station at Leslie, Ark. Work on the shops will be started at once.

The Atchison, Topeka & Santa Fe will erect a $30,000 passenger and freight depot at Enid, Okla. The plans have already been prepared.

The St. Louis & San Francisco has begun work on an eight-stall roundhouse at Tulsa, Okla.

The Chesapeake & Ohio has about completed its roundhouse and machine and forge shops at Melbourne, Ky. The work has been carried out by the Westinghouse, Church, Kerr Co., of New York. A coaling station will be built at this place at a later date.