Selenium

to reduce the temperature of the mass to below the critical point at which the reaction begins or continues to take place.

What the cooling effect in such an operation can be, no one could attempt to estimate, nor could an estimate be made as to how many B.t.u.'s need be extracted from the zone to extinguish the fire, but with known conditions the calculation could be made.

The steam which would emanate from a well, upon condensation could be used again and, even if it eventually became concentrated H_2SO_4, its power of absorption of heat would still be about 600 B.t.u. per pound.

Philadelphia, July 10, 1917. **William Jones.**

Danger in Brass Carbide Lamps

Selenium

Some time within the last two years I have noticed several articles in the technical press dealing with the subject of danger in brass carbide lamps, as a result of someone's suggestion that he had once heard that brass should not be used for acetylene lamps. According to my recollection, the Bureau of Mines investigated the subject and reported that it had been unable to demonstrate any good reasons why brass should not be used for this purpose. Hence the following incident, observed and tested by me may be of interest:

A man in the course of cleaning his lamp picked up a soft-iron spad and began to scratch off the deposit that had formed on the bottom of the water compartment, which, by the way, was already as clean as careful scraping with pieces of wood could make it. At the very first scratch made with the blunt end of the spad, a large smoky yellow flame, comparing favorably in size and color with that of the common wax match used in Cuba, burst forth.

Upon further investigation it was found that a dense-black scale, probably not over 0.01 in. thick, which covered the bottom of this water compartment, would yield large, fat sparks resembling those obtained from the iron selenide sparking alloy, whenever scratched with the head of the soft-iron spad, but no sparks could be obtained by scratching with the point.

After clearing away a considerable area of this deposit and repeating the test on the really clean brass, no suggestion of a spark could be obtained. In the absence of means for further investigation we concluded that the deposit was carbon which from recent use of the lamp was sufficiently charged with absorbed acetylene gas to ignite under the conditions described. Other lamps which showed analogous conditions, except, that they had not been used recently, failed to yield sparks when such deposits were attacked.

These lamps were all of brass and had once been galvanized. We were unable to attribute the sparks to the brass, but it may possibly be proved that such deposits do not form upon metals of lower heat conductivity.

John B. Stewart.

National City Bank Building, Havana, Cuba.

Tube-Mill Practice in Rhodesia

In the *Journal* of Mar. 17 there is an article by A. W. Allen, on "Tube Mill Practice in Rhodesia," in which he makes disparaging reference to the work done by Komata liners as compared with El Oro liners. I would have replied to this criticism earlier, but have been awaiting answers to inquiries as to who supplied this particular liner, and find that it must have been obtained outside of any accredited agents and is probably not correctly designed for the work it is doing at the property in question.

The remarkable success of the Komata liner in the United States and other countries shows that it can hold its own against any other type. A few years ago some careful tests were made at one of our leading Western mines to ascertain the relative cost and efficiency of the Komata and El Oro liners. Tube mills 4 ft. 6 in. diameter by 20 ft. long were used and the following data obtained:

The first cost of the two types of liners is about the same, but the Komata shows very much less wear of metal than the El Oro. Power consumption with the Komata liners is slightly above that of El Oro liners, but the actual work done with the Komata is considerably greater than that done with the El Oro, as shown by the following tests:

TESTS OF EL ORO AND KOMATA LINERS IN TUBE MILLS

	El Oro		Komata	
Mesh	Feed	Product	Feed	Product
28	14.6%	0.6%	18.5%	0.1%
35	13.7	2.3	16.8	0.7
65	38.7	11.4	35.3	11.6
80	7.3	5.5	8.0	.8.4
150	18.1	37.5	15.5	35.5
280	5.3	15.1	3.7	18.5
—280	2.3	27.6	2.2	25.2
	100.0%	100.0%	100.0%	100.0%

Silver City, Idaho, June 13, 1917. **F. C. Brown.**

Gold-Bearing Quartz on the Saramacca River, Dutch Guiana

While attention has heretofore been directed mainly to placer mining, gold-bearing quartz veins are known to occur in Dutch Guiana, South America, and several attempts have been made to develop them.

Rich ore has now been opened up by the Janapau Gold Mining Syndicate on the Saramacca River, samples taken over the reefs showing as high as 34 oz. Au per ton. The distance from Paramaribo, the capital of the colony, to the district is short; the government railroad runs up to a point on the Saramacca known as Kwakoegren, from where the landing proper is but a stone's throw. This trip from Kwakoegren can be made by means of steam launches in three hours, making the whole trip up the river from Paramaribo in seven hours.

There is at present, according to the manager's report, 20,000 tons of ore in sight already developed and in shape for milling.

The syndicate, which is purely a local one, has a capital of $20,000 in shares of $20 each; a great deal of the stock has already been taken up, but this amount it is anticipated, will be inadequate for what is actually required to install an up-to-date milling plant and for working expenses.

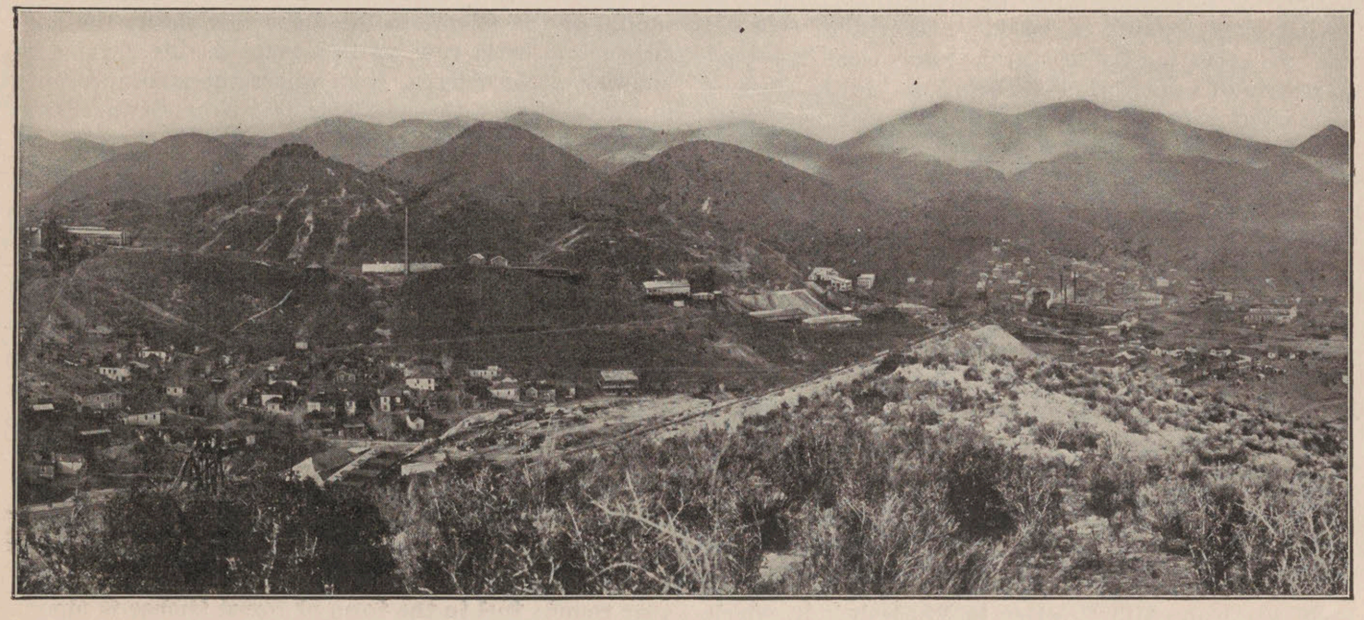
It has been suggested to erect the plant at the water front or landing, to have a light tramway line laid down for transporting the ore and to establish headquarters for the staff at this point. Water is in abundance the year round; fuel in the form of forest timber is almost unlimited. **J. B. Percival.**

Paramaribo, Dutch Guiana, June 12, 1917.

Bisbee, Arizona's First

TOWN OF BISBEE, RECENTLY

This view shows the residential section, the famous Sacramento Hill (and the stacks of the old



LOWER PART OF BISBEE DISTRICT, SHOWING GARDNER MINE, LOWELL MINE, SACRAMENTO HILL (IN BACKGROUND), C. & A. JUNCTION SHAFT (RIGHT CENTER) AND C. & A. HOSPITAL

DS

PHOTOMETRIC EXPERIMENTS WITH SELENIUM.

BY FITZHUGH TOWNSEND.

The peculiar properties of selenium have only been generally known for about thirty years. In 1873 Willoughby Smith made use of selenium as an ohmic resistance in connection with experiments in telegraphy, and he accidentally discovered that the resistance of this peculiar metal was lessened by exposure to light. A valuable investigation of this property of selenium was carried out by Siemens in 1875, and his experiments threw a great deal of light on the various forms which selenium assumes under different conditions. He also employed a sensitive resistance for the purpose of measuring candle-power. Most of the succeeding work since these experiments has been in the direction of practical applications rather than scientific investigation, and resistances sensitive to light have been repeatedly used in methods of transmitting sound and in light telegraphy. It will be found that there is very little literature on the subject which gives really accurate information with regard to the preparation and the properties of selenium.

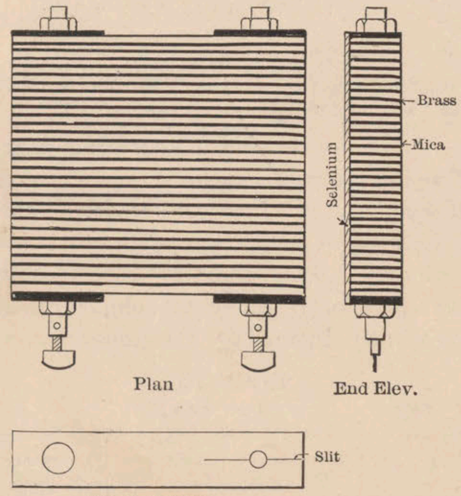


FIG. 1.—FRAME FOR SELENIUM RESISTANCE.

This element, which was discovered in 1817 by Berzelius, can be obtained in various forms. After being melted and cooled quickly the selenium assumes a translucent vitreous formation, and upon being held up to the light it will be seen to have a rich dark red color. While in this condition it is a dielectric, and can be electrified by friction, like glass. If the molten selenium is, however, cooled slowly it will assume a gray crystalline formation, and it is then opaque to light and conducts electricity. This latter property, according to the electromagnetic theory of light, could not be present if the material were to remain translucent, and it is well known that all conducting metals are opaque to light. While in this condition the specific resistance of the element is extremely high, and in general too high to be put to any practical use. It is, however, sensitive to light. By heating for a number of hours either the vitreous form or the crystalline form just described the conductivity of the metal becomes greatly increased, and, if the temperature is reduced very slowly to atmospheric temperature, a high degree of sensitiveness to light is attained. It is in this conducting crystalline form that selenium is employed for signaling purposes. The vitreous form of the element melts at 210 degrees centigrade, but the crystalline forms have a considerably higher melting point.

Selenium, even when in metallic crystalline form, has an extremely high specific resistance, and it is necessary, therefore, to construct a rheostat made of it in such a way as to offer a great many paths for the current between one terminal and the other. One of the most usual methods is to cut two parallel threads in a refractory tube made of glass or lava, or some such material. A pair of parallel wires are then put on the tube so that they run spirally side by side along the threads. These two wires form the opposite electrodes. The tube is then made to spin in a lathe, and at the same time heated somewhat above 210 degrees centigrade. The vitreous selenium is then run along the tube, to which it clings in a thin sheet. This method of construction necessitates the use of a parabolic mirror, because otherwise the light rays would only fall on one-half of the sensitive material. In order to obviate this, resistances can be constructed so as to be plane instead of circular. Such a construction is illustrated in Fig. 1, which shows a series of metallic plates grouped together and separated from each other by mica. Alternate plates are connected together and to one of the binding posts.

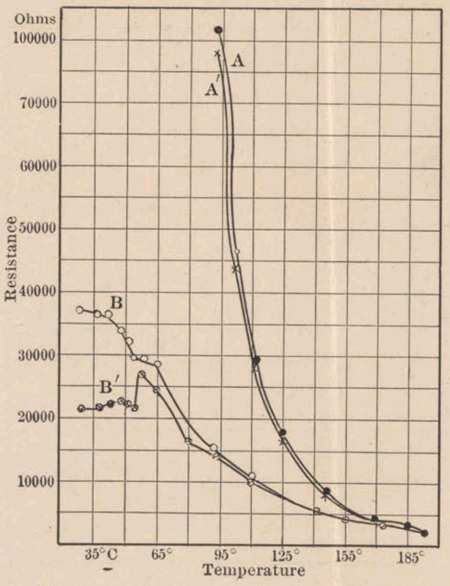


FIG. 3.—BAKING CURVE SHOWING EFFECT OF LIGHT AT VARIOUS TEMPERATURES DURING TREATMENT.

A —Curve in Dark—Heating.
A' " Light "
B " Dark—Cooling.
B' " Light "

Another way of accomplishing the same result is to wind two parallel wires close together along a broad piece of refractory material, such as slate.

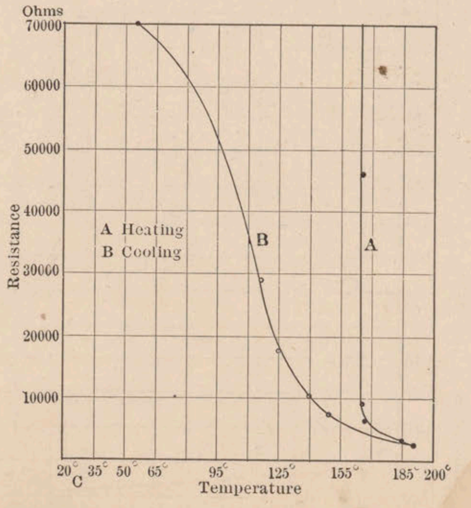


FIG. 2.—BAKING CURVE INITIAL RESISTANCE 746,000 OHMS, FINAL RESISTANCE 261,000 OHMS.

In order to cut down the ohmic resistance it is necessary to bring the adjacent wires or steps as near together as possible. This distance should be in any case considerably less than a millimetre. The selenium must be put on so as to form an extremely thin coating, because the light appears to act only on the surface of the metal, it being opaque; therefore, if any appreciable thickness is allowed, a great deal of current will be conducted from one electrode to the other through a part of the material which is not affected by the light, and it is desirable to cause the current to flow along the surface where the resistance is altered by the effect of the light rays.

It is obvious, since the two electrodes are composed of a series of wires or plates extremely close together, that the effect of any moisture deposited on the surface will be very noticeable, and that the surface must be kept dry, if the resistance is not to be affected by atmospheric conditions. In the latest developments by Professor Ruhmer, of Berlin, the selenium resistance is enclosed in an exhausted glass bulb, this having been found to give the best results.

Either brass, copper or silver may be used in the construction of a selenium resistance. One of the difficulties in the construction is to make the molten substance stick fast to the electrodes. The selenium appears to combine to some extent with the surface of the metal on which it is deposited when in a molten state, forming an extremely thin layer of selenide; this, however, is brittle when cold and extremely liable to chip off. If the copper or brass is slightly tinned, the adhesion of selenium is facilitated.

After the selenium has been successfully laid over the electrodes in the form of a thin sheet, the resistance thus formed should be baked in an oven at a temperature of approximately 190 degrees centigrade for a period of three hours, after which it should be slowly cooled; this process occupying possibly another three hours.

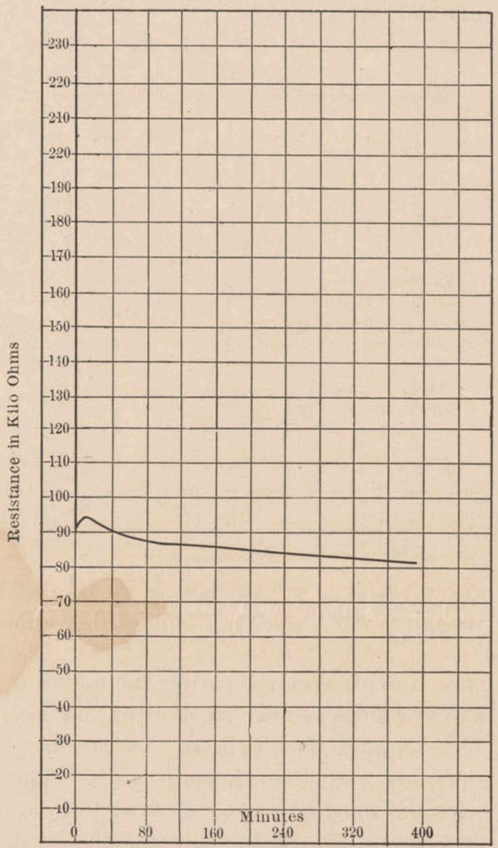


FIG. 4.—CURVE SHOWING EFFECT OF PROLONGED EXPOSURE TO LIGHT. RESISTANCE USED OF TYPE SHOWN IN FIG. 1, COATED WITH PURE SELENIUM.

Fig. 2 shows the result of baking a resistance formed of vitreous selenium. The treatment was imperfect. It will be seen from the curve A that the material went over into the crystalline form at a temperature of about 170 degrees. In this experiment, readings for which are given in table i, the selenium was maintained at about 180 degrees for an hour and a quarter, and on cooling it was found to be sensitive to light.

Fig. 3 illustrates the result of a second baking on the same resistance. In this case a lamp was placed in the oven and the variation of resistance with light was observed at successive temperatures. The results show that at the start the resistance was 100,000 ohms and that there was only a slight sensitiveness to light. As the temperature increased the sensitiveness—indicated by the difference between the dotted curve and the full line curve—diminished rapidly, disappearing entirely at about 170 degrees. As shown in table ii, the temperature was maintained at about 180 degrees for a considerable time, and slowly reduced to that of the surrounding air. The curve sheet shows that the material began to be sensitive to light on cooling at about 130 degrees, and at sixty degrees there was a marked increase in the reduction of the ohmic resistance produced by turning on the light, and this remained as a permanent property of the resistance. It will also be noticed that the selenium on being cooled slowly did not return to the original high resistance, but that this was reduced to about 37,000 ohms in the dark and 21,000 in the light.

TABLE I.

READINGS.

Time.	Temperature. Degrees.	Resistance in Ohms.
10.50 A. M.	20	......
11.00 “	70	7,460,000
11.15 “	165	70,600
11.28 “	165	46,000
11.30 “	165	21,000
11.32 “	165	12,300
11.35 “	165	9,540
11.37 “	165	8,870
11.42 “	166	7,880
11.46 “	171	6,700
11.50 “	174	5,600
11.52 “	174.5	5,330
11.56 “	175	4,840
12.00 M.	175	4,730
12.10 P. M.	178	4,270
12.15 “	179	4,150
12.20 “	179	4,030
12.35 “	185	3,280
12.40 “	190	2,770
12.50 “	185	3,080
1.00 “	181	3,590
1.15 “	176.5	4,100
1.30 “	169	4,850
1.45 “	156	6,820
1.50 “	149	7,880
1.55 “	140	10,300
2.05 “	135.5	13,220
2.12 “	124	18,530
2.20 “	116	27,000
2.23 “	115	29,200
3.00 “	31	2,610,000

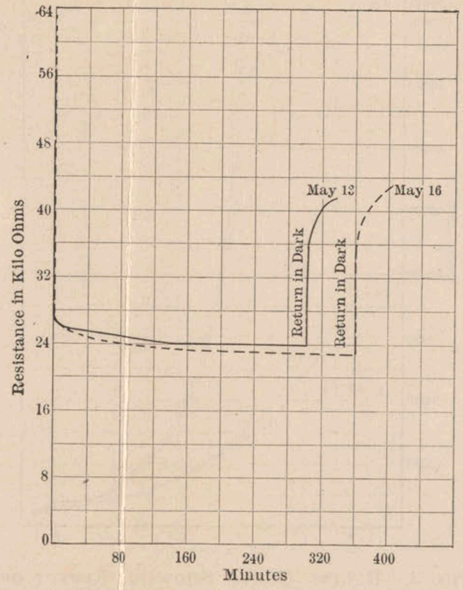


FIG. 5.—EXPOSURE CURVE SHOWING RESULTS OBTAINED WITH A RUHMER RESISTANCE OF THE FLAT TYPE.

Other similar experiments showed that on cooling slowly the marked increase in the difference between the curve for darkness and the curve for light occurs always at about sixty degrees centigrade.

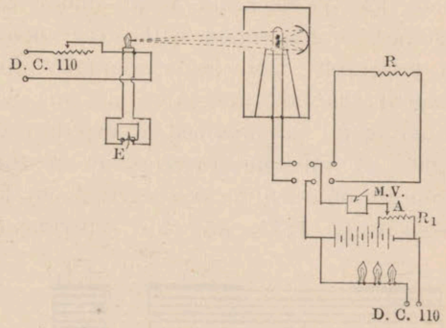


FIG. 6.—RUHMER CELL IN EXHAUSTED BULB IN CONNECTION WITH A PARABOLIC MIRROR.

It will be noted, therefore, that the prolonged baking and slow cooling have the effect of reducing the ohmic resistance, and increasing the sensitiveness.

TABLE II.

READINGS.

Time.	Temperature. Degrees C.	Resistance in Darkness.	Resistance in Light.
12.04 P. M.	......	928,000	230,000
12.16 “	81.5	164,000	140,800
12.20 “	93.5	101,700	94,700
12.28 “	103	44,600	44,500
12.36 “	107	36,000	34,600
12.42 “	111.5	29,100	28,500
12.50 “	118	21,300	21,000
12.58 “	125	17,300	17,200
1.04 “	135.5	13,080	12,830
1.08 “	137.5	11,770	11,600
1.13 “	147	8,280	8,080
1.14 “	155	6,890	6,830
1.15 “	160	6,080	......
1.17 “	169	4,810	......
1.19 “	170	4,340	......
1.23 “	172	3,990	......
1.41 “	175	4,010	......
1.47 “	182.5	3,010	......
1.49 “	183.5	3,140	......
1.53 “	185	3,070	......
1.55 “	189.5	2,860	......
1.56 “	192	2,660	......
5.32 “	189	2,700	......
5.50 “	173	3,890	......
5.56 “	159	4,570	......
5.58 “	155.5	4,780	......
6.01 “	152.5	4,300	......
6.04 “	147	5,420	......
6.06 “	141.5	5,930	......
6.15 “	138	6,890	......
6.18 “	128	7,880	......
6.22 “	126	8,290	......
6.29 “	111	10,760	10,480
6.33 “	102	12,830	12,200
6.37 “	92	15,430	14,220
6.39 “	81.5	18,530	16,250
6.42 “	70	24,600	21,300
6.44 “	64	28,500	24,700
6.45 “	58.5	29,650	27,500
6.47 “	54.5	29,700	21,350
6.50 “	48	33,200	22,150
6.54 “	42	36,000	22,200
6.57 “	36	36,600	21,250
7.05 “	31	37,500	21,400

Experiments were carried on to determine the effect of slight impurities in the selenium used, and it was found that one or two per cent of copper selenide or nickel selenide could be present without affecting to a marked extent the sensitiveness of the resulting resistance.

The idea of using a sensitive resistance for the purpose of measuring light is a very attractive one in that it involves reducing photometry to a mechanical process. The reading of a current indicating instrument being substituted for the opinion of the observer would make the results more definite. The main difficulty lies in the fact that selenium is more sensitive to some wave lengths than to others; therefore, at present, it seems difficult to use selenium as a light standard. It can, however, be used for purposes of comparison between similar lights. Its properties in this respect can be judged from the results to be described.

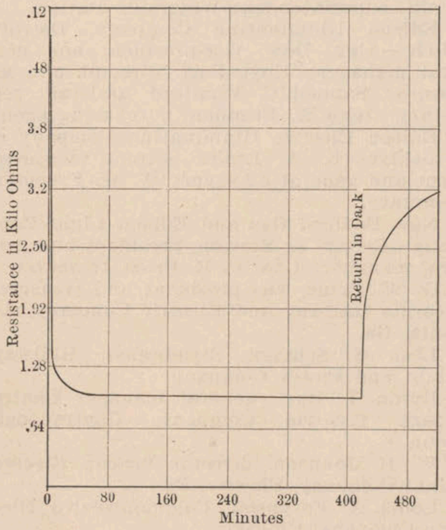


Fig. 7.—Exposure Curve of a Cylindrical Type Ruhmer Resistance Enclosed in an Exhausted Bulb.

Fig. 4 gives the variation in the resistance during exposure to light in a plate made of pure selenium; an incandescent lamp was used, giving seven candle-power, its voltage being maintained constant. The distance between the surface of the selenium and the axis of the lamp was forty centimetres. The curve illustrates the characteristic behavior of selenium during exposure to light. A kind of fatigue appears to exist in the sensitive material, and, as the time elapses, the ohmic resistance drops at a nearly uniform, though slow, rate for a very long time. This is apparently not due to a change in temperature, because the temperature of the resistance undoubtedly reaches a constant value well inside of 400 minutes on account of the small mass and large radiating surface. The curve shows the characteristic sudden decrease in resistance when the light is turned on at zero time.

The construction used in this case was that shown in Fig. 1; it was employed mainly because it enabled the same frame to be used for a series of tests. A wire-wound resistance gives better results because the adhesion of the material is stronger, and the flow of current is more along the surface on account of the fact that the material sinks down between the wires.

Fig. 5 shows results obtained with a selenium plate made by Ruhmer; it shows the same slight decrease in ohmic resistance during exposure to light, and also indicates the gradual way in which the resistance recovers on turning off the light. Complete recovery requires twenty hours.

It was found that under the proper conditions the same curve between time and candle-power can be obtained from day to day at the same temperature, and this matter was investigated quite thoroughly.

A cylindrical Ruhmer cell contained in an exhausted bulb was used in connection with a parabolic mirror. The source of light was maintained at a distance of 150 centimetres from the selenium.

The connections were as shown in Fig. 6, in which a double throw switch is used to compare the reading of the millivoltmetre when connected to the selenium resistance with its value at the same voltage when connected to the adjustable ohmic resistance R.

Fig. 7 shows a curve giving the behavior of a cell of this type during exposure to light. It will be seen that the change between the resistance in the dark and in the light is very great, and that there is a slight variation in the value of the resistance during the exposure. It was found that the time during which the selenium had remained in the dark, the intensity of the light to which it had been previously exposed and other conditions affected the curve thus obtained, and it was necessary to determine some method by which the same reading of resistance could be reproduced by the same candle-power from day to day.

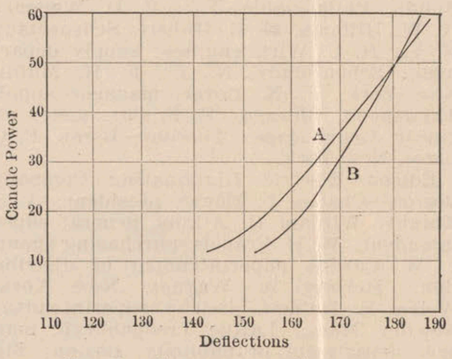


Fig. 8.—Calibration Curves.

After trying several methods, the following was found to give very good results: having allowed the resistance to stand in the dark for about twenty hours, the battery current is then sent through the selenium resistance after the voltage has first been adjusted to the desired value, by noting the deflection obtained, using the resistance R in Fig. 6. This voltage was then maintained constant, and the double throw switch was allowed to remain thrown, so as to connect the battery permanently to the selenium resistance. This is kept in the dark with the current flowing through it for ten minutes. At the end of this time it is exposed to the first lamp, and at the end of five minutes the reading of the millivoltmeter is taken; the light is cut off at the end of five minutes' exposure, and the deflection is allowed to drop to some value above the minimum deflection which would be obtained by keeping the resistance permanently in the dark. In this case the deflection dropped to 100, the minimum deflection corresponding to permanent darkness being in the neighborhood of eighty-four.

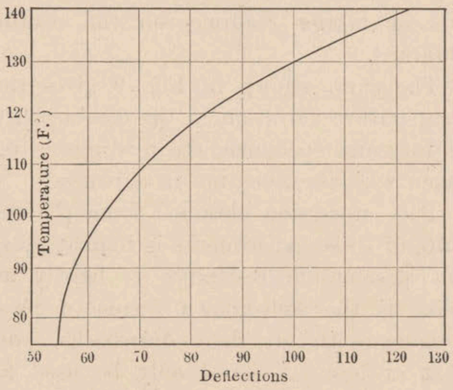


Fig. 9.—Curve Showing Temperature Variation in Conductivity.

Upon reaching this value the selenium was exposed to the next light in the series for five minutes, and then darkened. The deflection having been again allowed to drop to the same value as before, it was exposed to the next succeeding lamp for five minutes. In this method, each successive lamp must be of a higher candle-power than the preceding, and the results obtained furnished a calibration curve, which is indicated by the letter A in Fig. 8, and it is possible to reproduce this curve from day to day.

The method described, however, is altogether too slow for convenient use, and it would be impossible to be sure that after testing one lamp the next one would be higher in candle-power.

The second method will overcome this difficulty, and is as follows: The resistance is exposed to a high candle-power lamp for about forty-five seconds, and the deflection is then allowed to drop in the dark to a value somewhat above that used in the case given before. This value was taken at 110. When the deflection reaches this value, the resistance is exposed to the first light of the series for five minutes; it is then darkened and the deflection allowed to drop again to 110; this process is repeated for a succession of different lamps.

By this method the curve B was obtained with a number of lamps, and it may be taken as a calibration curve for the selenium resistance in question. The curves A and B illustrate in an interesting way the effect of the different methods of taking readings on the results obtained.

The curve shown in Fig. 9 gives the temperature variation in the conductivity of the same specimen, the readings being taken with the selenium in darkness.

The impression obtained from the results of these experiments is that at present a selenium resistance is hardly as good as the well-known forms of photometer with all their drawbacks, and that at best it should only be used to compare lights substantially similar in color. For measuring the illumination of a room, however, it is extremely convenient and quite accurate enough. It is, no doubt, possible to increase the value of the selenium resistance as a means of measuring light by further investigation and development. The difference between the results obtained with a crude construction, as shown in Fig. 4, and an improved type of resistance which gave the values of Fig. 7, indicate what can be done in this way, and there is at least reason to hope that when as much time has been spent upon the development of a selenium photometer as on that of prevailing types, very different results may be obtained.

The experiments described were carried on in the laboratory of the Electrical Engineering Department of Columbia University, and the writer desires to acknowledge the assistance of Messrs. J. E. O'Shea, M. Palmer, C. Baumgarten, C. F. Strong and G. W. Hochsprung, students in the Department, who have assisted in carrying on the experiments from year to year.

◆

Lake Erie & Western Will Experiment with Electricity.

On the Peoria division, where the competition of the electric surface lines is very keen, the Lake Erie & Western Railroad, belonging to the Vanderbilt group, will install electric motors in an attempt to recover some of its lost traffic. Should this experiment prove successful, it is probable that the Lake Erie & Western will have an electric passenger service for the entire distance between La Fayette and Indianapolis.

THE ASSOCIATION OF EDISON ILLUMINATING COMPANIES.

TWENTY-FIFTH CONVENTION HELD AT NEW CASTLE, N. H.

The Association of Edison Illuminating Companies held its twenty-fifth convention at Hotel Wentworth, New Castle, N. H., August 30, 31, and September 1, 1904.

The meetings were presided over by President J. B. McCall, of Philadelphia. Interest in the proceedings was well sustained, and there was a very complete attendance of the delegates at each session. All the papers on the programme were read and elicited full discussion. President Edgar, of the Boston company, extended an invitation to all the delegates to join in the reception to the foreign electrical engineers in Boston on September 2 and 3.

The attendance was the largest in the history of the association, the following companies being represented by the gentlemen named:

General Electric Company—C. A. Coffin, president; Eugene Griffin, vice-president; Elihu Thomson, Lynn, Mass.; J. R. Lovejoy, manager lighting department, Schenectady, N. Y.; B. E. Sunny, Western manager, Chicago; E. D. Mullen, manager, Philadelphia; Fred M. Kimball, manager small motor department, Boston, Mass.; Charles P. Steinmetz, William LeRoy Emmett, Caryl D. Haskins, Schenectady, N. Y.; Wallace S. Clark, engineer wire and cable department, Schenectady, N. Y.; Walter D. A. Ryan, illuminating engineer, Lynn, Mass.; George F. Morrison, manager lamp works, Harrison, N. J.; A. D. Page, Francis W. Willcox, Harrison, N. J.; Sidney B. Paine, Boston, Mass.; George H. Stickney, assistant illuminating engineer, Lynn, Mass.; Charles A. Mosman, A. L. Rohrer, W. S. Andrews, Schenectady, N. Y.; Clyde A. Houghton, Lynn, Mass.; Martin J. Insull, Pittsfield, Mass.; Harry J. Buddy, Philadelphia, Pa.; P. D. Wagoner, H. W. Hillman, E. E. Gilbert, Schenectady, N. Y.; H. C. Wirt, engineer supply department, Schenectady, N. Y.; E. H. Mullin, New York; F. N. Boyer, manager supply department, Chicago; F. P. Cox, meter engineer, Lynn, Mass.; Theodore Beran, F. C. Bates, New York.

Edison Electric Illuminating Company, Boston—Charles L. Edgar, president; A. S Knight; William H. Atkins, general superintendent; W. H. Francis, purchasing agent; J. W. Cowles, superintendent of distribution; Herbert A. Wagner, New York; Welles E. Holmes, district superintendent, Newton, Mass.; LaRue Vredenburgh, manager department of publicity, Boston; Sidney Hosmer, superintendent of installation, Boston; Charles H. Parker, assistant superintendent generating department, Boston; Arthur G. Pierce, Boston; Leonard L. Elden, electrical engineer, Boston; Gerhard M. W. Goettling, storage battery engineer; R. S. Hale, Charles H. Merrick, contract agent; John S. Vogler, claims and adjustments; W. P. Hancock, superintendent general department; Charles J. Hatch, special agent; Crawford R. Brown, superintendent of standardizing and testing; F. Ellwood Smith, suburban district manager.

Chicago Edison Company—Samuel Insull, president; Walter M. Anthony, comptroller; Peter Junkersfield, George N. Eastman, Ernest Lunn, superintendent of storage batteries; Robert C. P. Holmes, John W. Ferguson, assistant to contract agent; Edwin J. Fowler, W. G. Carlton, assistant to chief operating engineer.

Edison Electric Light Company, Philadelphia—Joseph B. McCall, president; Joseph D. Israel, secretary and manager; William C. L. Elgin, electrical engineer; William F. Harrity, Charles J. Russell, district manager; John W. Meyer, P. H. Bartlett, superintendent of installation; Howard K Mohr, manager advertising bureau.

New York Edison Company—Thomas E. Murray, second vice-president; H. M. Edwards, Robert A. Carter, A. H. Ackermann, engineer meter and test department; Arthur Williams, general inspector; Walter F. Wells, superintendent Waterside station.

Edison Illuminating Company, Detroit, Mich.—Alex. Dow, vice-president and general manager; Hoyt Post, director and attorney; Samuel C. Mumford, assistant secretary; John W. Brennan, purchasing agent.

Edison Electric Illuminating Company o Brooklyn—E. A. Leslie, second vice-pres dent and general manager; W. W. Freemai secretary.

New Bedford Gas and Edison Light Company—George K. Stetson, president and general manager; Charles R. Price, treasurer.

G. W. Brine, vice-president and treasurer Georgia Railway and Electric Company, Atlanta, Ga.

Leon H. Scherck, Birmingham Railway, Light and Power Company.

Byron T. Burt, general manager Chattanooga Electric Company, Chattanooga Tenn.

W. H. Johnson, director Beacon Electric Light Company, Chester, Pa.

Louis A. Ferguson, Commonwealth Electric Company, Chicago.

Mathias E. Turner, Cleveland Electric Illuminating Company.

J. H. Lovejoy, president Des Moines Edison Company, Schenectady, N. Y.

Thomas G. O'Dea, Erie County Electric Company, Erie, Pa.

Harry Bottomley, superintendent Fall River Electric Light Company, Fall River, Mass.

Charles C. Perry, secretary and treasurer Indianapolis Light and Power Company, Indianapolis, Ind.

James B. Foote, Jackson Light and Power Company, Jackson, Mich.

J. W. Reeves, general manager Citizens' Light, Heat and Power Company, Johnstown, Pa.

A. M. Worthington, general manager Louisville Lighting Company, Louisville, Ky.

R. S. Wallace, superintendent Peoria Gas and Electric Company, Peoria, Ill.

W. S. Barstow, consulting engineer, Portland General Electric Company, Portland, Ore., New York.

M. A. Beal, Rockford Edison Company, Rockford, Ill.

W. F. White, Union Electric Light and Power Company, St. Louis (Missouri Edison Electric Company), New York.

William Chandler, Edison Sault Electric Company, Sault Ste. Marie, Mich.

Dwight P. Robinson, engineer Seattle Electric Company, Boston.

G. H. Edes, J. R. Lovejoy, vice-president Edison Electric Light Company, Schenectady, N. Y.

F. G. Sykes, electrical engineer Schenectady Railway Company, Schenectady, N. Y.

D. L. Huntington, second vice-president and general manager Washington Water Power Company, Spokane, Wash.

E. J. Bechtel, superintendent of lighting, Toledo Railways and Light Company, Toledo, O.

H. W. Fuller, general manager Potomac Electric Power Company, Washington, D. C.

Ernest H. Davis, Edison Electric Illuminating Company, Williamsport, Pa.

Wilson S. Howell, Electrical Testing Laboratories, New York.

March 10, 8.

A-4536.

Mr. H. A. Prosser, Met. Director,
U. S. S. R. & M. Co.,
100 Broadway, New York City.

Dear Sir:-

<u>SELENIUM:</u>

I enclose herewith diagram showing the course of selenium through the plant during 1907. Our financial books show a profit for the year of $5,875.23 on the selenium operations, as follows:-

2171 $\underline{12}$	lbs.	c.p. shipped
947 $\underline{8}$	"	Commercial shipped -
3119 $\underline{4}$	lbs.	total

Cost	$7189.00	=	$2.30 per lb.
Sales	13064.23	=	$4.19
Profit	5875.23	=	1.89

Both the metallurgical and financial sides show opportunity for considerable development. The present process is an entire departure from previous trials and has overcome difficulties of low grade product. The process per se is due to Mr. Liddell and the practical development of it to Mr. Green.

One of the chief items of cost is hydrochloric acid, and as this acts only as a catalytic and restraining agent, we hope to recover it and use it over and over. We are carrying out various experiments, but as the field is new, progress is necessarily slow.

The diagram shows factors of recovery, and where possible, factors of dilution. It is based on 100 lbs. of selenium in the form of slimes sent from the Tank House to the Silver Building, and the figures for pounds in different parts of the diagram indicate the part of the original 100 lbs. to be found at that stage of the process. The percentage figure, where given, shows the richness of the product in selenium.

It must be remembered that these are the average conditions for the year and that our practice improved during the year, so that our actual present conditions are better. The lead chamber was only in service half the year, for example. Also we sent one-eighth of the total selenium back to the Anode furnaces because the lead slimes work had made this flue dust unmanageable.

The diagram brings out the following:-

1. There is an enormous loss up the Silver Bldg. stack.
2. There is a probable preventable loss in the Silver Building wash waters.
3. There is but a moderate quantity circulating, so that we are not drawing upon old United Verde selenium as our source.
4. The ideal place to recover selenium would be direct from the slimes.

Regarding the stack loss, we have already taken steps in the right direction. The lead chamber helps catch what passes the scrubber, and as this mud runs but 8.95% Se., the probability is that the loss is chiefly in solution in water carried over from the scrubber. We are now working on the reclaiming of these dilute liquors. Another outlet from the Silver Building - the iron tanks - is not shown on the diagram, but our present data shows this loss to be negligible. Also we can safely neglect the selenium in the dore.

A laboratory experiment, volatilizing some selenium and bubbling the gas through various liquids, showed a very small recovery, and this is probably analagous to the stack losses.

As to the second point, we are trying various schemes to recover both the acid and the selenium in wash waters - one way being precipitating the selenium on iron, though this does not recover the acid. We have considerable difficulty in getting concordant analytical results in some of this work.

The third point needs no comment, and passing to the fourth, the difficulty is that the reagents that act upon selenium also tend to dissolve gold and silver - in fact selenic acid is generally given as a solvent for gold, and tackling any proposition for leaching the slimes looks dangerous. I have not, however, put this altogether out of mind.

For 1908 we xxxx will have much more complete data, as we are running anode slags, incoming pig, etc. The anode slag figures on the diagram are those for January 1908 on

No. 1 furnace. For lack of better data I have assumed Smelter ores make up anode furnace losses.

If we can get our profit up to $3.00 and our production to 1000 lbs. a month we would make $36,000. a year, which is well worth working for.

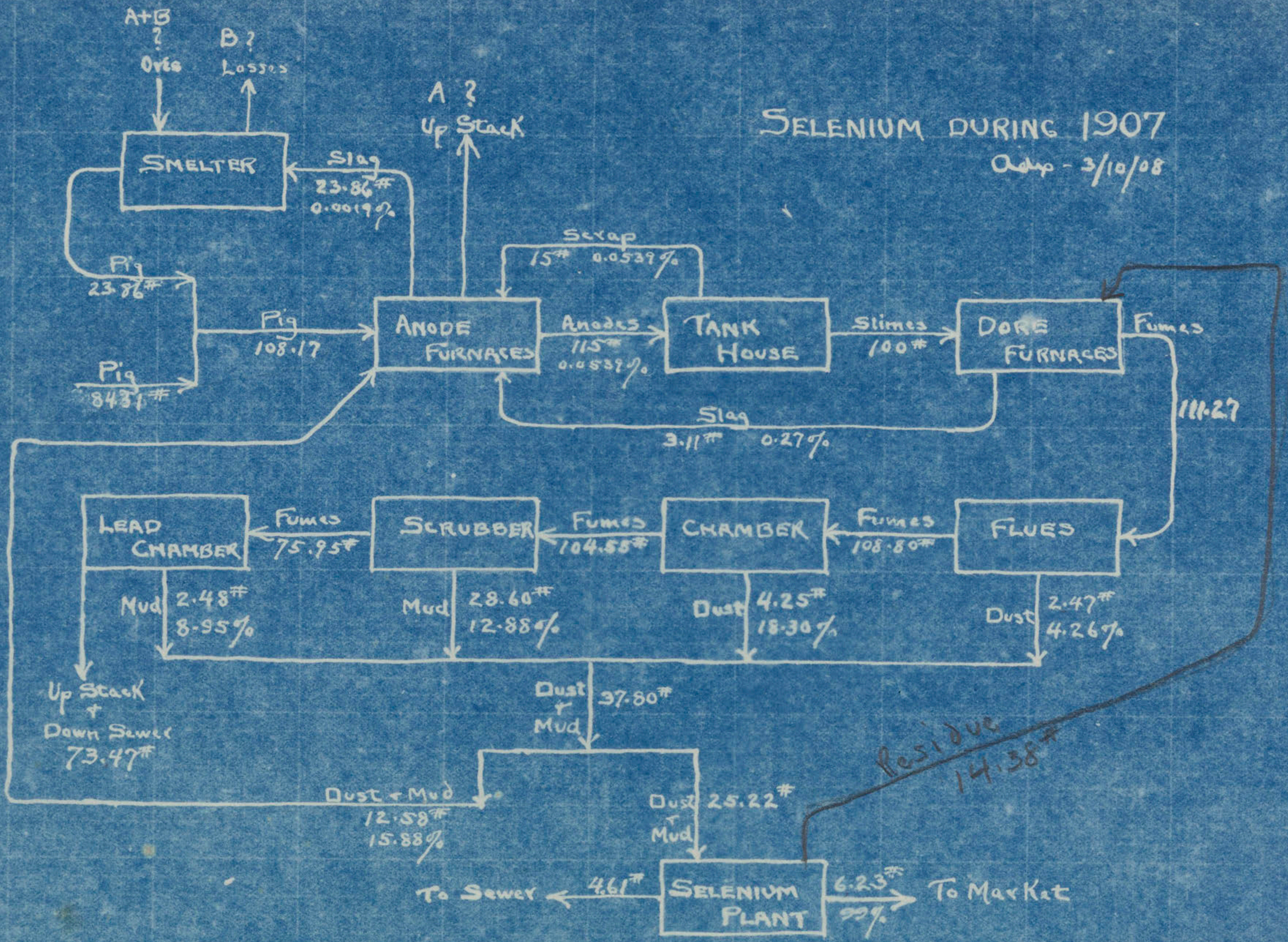
Yours truly,

ADX/EJB.

Copy to Mr. L. Vogelstein.

SELENIUM DURING 1907

3/10/08



1907 Calculation

CALCULATION ON THE COURSE OF SELENIUM THROUGH THE SILVER BUILDING AND SELENIUM PLANT.

The anodes for March, 1907 carried 154.9 oz. Ag, 9.04 oz. Au, and .073% Se. These metals, except the mechanical losses in the cathodes, quantitively enter the slimes.

Hence in the slimes we have the following proportion:

Au : Ag : Se :: 1 : 17.1 : 2.3.

In April the output of Au and Ag in the form of dore was 28331.39 oz. and 515,390.17 oz. respectively, which numbers are in the proportion 1:18.2, thus approximately checking the anodes. Calculating the weight of Selenium at 2.3 times the weight of the gold we have 4460 lbs. per month. The slag corresponding to the above dore weighed 27851 lbs. and carried 0.04% Se. or 11.14 lbs. or .25% of all the Selenium. This leaves 4449 lbs. per month to be accounted for by flue-dust, scrubber liquor and losses.

The following table shows the distribution of Selenium in the flue-dust from Nov. 3, 1906 to Jan. 31, 1907, a period of 2.9 months.

Locality	lbs. dry Flue Dust	% Se.	Lbs. Se.	lbs. Se. per Mo.
Holes 11-19	5998	5.77	321	111
Overhead flue fan neck	14575	23.81	3470	1197
Flue Dust Big Chamber	6508	28.95	1884	649
Scrubber Mud 10.7% H O 20	9664	14.37	1389	479
			7064	2436

Sheet No. 2.

Frome the Selenium Plant records it can be shown that the output from the scrubber solution was about 175 lbs. per month for the past year; Consequently we can make up the following table:

MONTHLY DISTRIBUTION.

Selenium to Scrubber Solution	175	=	3.9%
" " " Mud	479		10.8
" " Big Chamber	649		14.5
" " Overhead Flue	1197		26.9
" " Holes 11-19	111		2.4
" " Silver Building Slag	11		.3
	2622		
Losses	1838		41.2
	4460		100.0

It may be noted that of the above distributions that the percentages for Scrubber Solution, Scrubber Mud, and losses increased during the hot months of the year, and that the Big Chamber, Overhead Flue and Holes 11-19 decreased. The loss shown above of 41.2% is probably a minimum rather than an average.

There is no attempt made to treat the dust from holes 11-19, owing to low Selenium and high Te, so that we have for the Selenium entering the Silver Building:

Silver Building to Se. Plant	2400	=	56.1
" " " Anode Furnace	11		.3
" " Circulation	111		2.4
Lost	1838		41.2
	4460		100.0

And taking that sent to the Selenium Plant as a Basis:

Sent to Selenium Plant	2400	lb	100.0 %
We have Selenium recovered	223		9.3
" lost at Se. Plant)	) 2177		90.7
" returned to Silver Building)	)		
	2400		100.0

Sheet No. 3.

Or on the 4460 lb. basis, (The entire refinery):

Selenium recovered		5. %
" lost at Se. Plant	)	51.1
" returned to Ag. Building	)	
		56.1 %

This loss at Selenium Plant probably does not exceed over 5% of the amount recovered, and includes losses by solutions spilled, losses by traces of Se unprecipitated, losses by volatilization in distilling and in the melting, and losses in crushing.

Calculation on the course of Selenium through the Silver Building and Selenium Plant.

The anodes for March, '07 carried 154.9 oz Ag, 9.04 oz Au, and .073% Se. These metals, except for mechanical losses in the cathodes, quantitatively enter the slimes.

Hence in the slimes we have the following proportion:

Au : Ag : Se :: 1 : 17.1 : 2.3.

In April the output of Au and Ag in the form of Dore was 28331.39 oz and 515,390.17 oz respectively, which numbers are in the proportion 1:18.2, thus approximately checking the anodes. Calculating the weight of Selenium at 2.3 times the weight of the gold we have 4460 lbs per month. The slag corresponding to the above dore weighed 27851 lbs and carried 0.04% Se or 11.14 lbs, or .25% of all the selenium. This leaves 4449 lbs per month to be accounted for by flue-dust, scrubber liquor and losses.

The following table shows the distribution of Selenium in the flue-dust from Nov. 3,1906 to Jan. 31,1907; a period of 2.9 months.

Locality	lbs Dry Flue-dust	% Se	lbs Se	Lbs.Se per Mo.
Holes 11-19	5568	5.77	321	111
Overhead flue fan neck	14575	23.81	3470	1197
Flue-dust Big Chamber	6508	28.95	1884	649
Scrubber Mud	9664	14.37	1389	479
10.7% H_2O			7064	2436

Sheet No. 2.

From the Selenium Plant records it can be shown that the output from the scrubber solution was about 175 lbs per month for the past year; Consequently we can make up the following table:

MONTHLY DISTRIBUTION.

Selenium to Scrubber Solution	175	=	3.9 %
" " " Mud	479		10.8
" " Big Chamber	649		14.5
" " Overhead Flue	1197		26.9
" " Holes 11-19	111		2.4
" " Silver Building Slag	11		.3
	2622		
Losses	1838		41.2
	4460		100.0

It may be noted that of the above distributions that the percentages for Scrubber Solution, Scrubber Mud, and losses increased during the hot months of the year, and that the Big Chamber, Overhead Flue and Holes 11-19 decrease. The loss shown above of 41.2% is probably a minimum rather than an average.

There is no attempt made to treat the dust from holes 11-19, owing to low Se and high Te, so that we have for the Selenium entering the Silver Building:

Silver Building to Se Plant	2400	=	56.1
" " " Anode Furnace	11		.3
" " Circulation	111		2.4
Lost	1838		41.2
	4460		100.0

And taking that sent to the Selenium Plant as a Basis:

Sent to Selenium Plant	2400	lb	100.0 %
We have Selenium recovered	223		9.3
" lost at Se Plant) " returned to Silver bldg.)	) 2177		90.7
	2400		100.0

Or on the 4460 lb basis.(The entire refinery):

Selenium recovered	5.%
" lost at Se Plant)	51.1
" returned to Ag Bldg.)	
	56.1 %

This loss at Selenium plant probably does not exceed over 5 % of the amount recovered, and includes losses by solutions spilled, losses by traces of Se unprecipitated, losses by volatilization in distilling and in the melting, and losses in crushing.

DWL.

Mr Knorr's Methods

May 29, 1906.

Mr. Addicks:-

Following is out method of procedure in the analysis of selenium.

SELENIUM: For Se weigh one gram of finely powdered sample into a 100 cc.beaker, dissolved on water bath in 8c. c. of concentrated HNO_3 keeping covered until solution is complete. Uncover, using smallest possible amount of wash water to rinse cover glass, and evaporate to complete dryness. Selenious acid is quite volatile even at comparatively low temperature, evaporation should, therefore, not be carried on above the bed of the water bath.

The dry selenious acid is dissolved in a few c. c. of concentrated HCl, and the solution filtered through asbestos, using only concentrated HCl for washing, bulk of filtrate should be about 75 C. C. If desired this filtration may be made over a gooch-crucible, the subsequent increase in dry weight of which will represent the acid insoluble portion of the selenium (mainly silica).

In dissolving selenious acid in HCl as above, no heat should be applied, as selenious chloride is also quite volatile.

The hydrochloric acid filtrate is precipitated in a very slow current of SO_2 gas, 1 bubble of gas per second, and it is advisable to cool in running water. Stir from time to time and when precipitation is nearly complete finish in a brisk current of gas precipitated in this way the selenium will be flocculent and easy to filter and wash.

The gas should be passed for sometime after complete precipitation which is recognized by the supernatant solution becoming clear and smelling of SO_2 when stirred, If the Se is precipitated too fast the solution becomes warm from the heat of reaction, and the selenium will be a semifused mass which is very difficult to wash.

The precipitated selenium is filtered over a tared gooch crucible, rinsing out beaker with Conc. HCl, give precipitate one washing with HCl. Then remove all traces of acid by washing with plenty of water. Dry to constant weight at 100 degrees C.

For fixed residue (including Te, SiO_2 and heavy metals), take 1 gram, dissolved in nitric acid in a weighed platinum dish: when dissolved add a few (3)drops concentrated H_2SO_4 and expel SeO_2 and H_2SO_4 on hot plate. Ignite residue gently and weigh. Remember that if there is arsenic or antimony present the platinum is liable to be damaged. For iron dissolve 10 grams in a 400 c.c. Jena beaker (Tall shape) using necessary amount of HNO_3. Evaporate to dryness and expel~~l~~ selenious acid on hot plate. By heating the bottom only and shielding the rest of the beaker, the selenious acid will sublime and collect on the sides, whence it can be removed by proper manipulation, having the non-volatile residue on the bottom.

Take up the residue with HCl, precipitate small amount of Se together with Te and heavy metals by H_2S filter expel H_2S, dioxidize with HNO_3 or $KClO_3$ and precipitate iron with ammonia. Filter and weigh Fe_2O_3.

THE PREPARATION OF SELENITE OF SODA:

($Na_2Se O_3$) The powdered selenium is dissolved in concentrated Nitric Acid, the Nitric Acid oxidizes the Selenium very readily, forming $H_2Se O_3$, and after evaporating and taken up with water in which it dissolves readily, Iron Oxide and Silicic Acid remain as an insoluble residue. The solution may be filtered through a cheese cloth filter. The filtered solution of $H_2Se O_3$ is now neutralized by means of a solution of Carbonate of Soda, and evaporated to dryness on a water bath, the temperature of which is about 85° C. The salt does not stand evaporation on free fire, as it seems to decompose at a temperature a little above 100° C. (We have found that the mixture of Nitric and Muriatic have an oxadizing effect on selenium, and when the selenium is dissolved in this mixture and then neutralized, Selenate of Soda is formed, and large quantities of the Iron and Silicic acid seem to enter into this Selenate as impurities). The Selenite when finished and dissolved in water, in which it should dissolve readily, should give off no free chlorine, on the addition of strong Hydrochloric acid. We would like to draw your attention to the fact that the Selenite of Soda has a very corrosive action on the skins, and it would be well to have your workmen employ rubber glowes while handling this preparation.

EIMER & AMEND

P.S.-
To get the Selenite to a light color, it is advisable to filter the solution through animal charcoal (for discolorizing and glarifying.)

The above formula is not permitted to be used for any body else except Eimer & Amend.

Mr. Addicks for yr files JCB

~~Mr. Bryan:~~ June 25, 1906.

SELENIUM PROCESS.

The first stage of the recovery of selenium is the distillation of the flue dust containing selenium, which is at present carried on in Dixon's #9 Graphite Retorts. These retorts will take a charge of about 135# of flue dust, with which we are at present mixing 15# of commercial sulphuric acid. The object of this acid is to combine with the ~~other~~ bases present in the flue dust and set free the selenious acid. In part the sulphuric acid also acts as an oxidizing agent, part of the selenium in the flue dust being present in metallic condition. The experiment has been tried of running the flue dust, using 15# of nitric acid in connection with 135# of flue dust but this seems to give high silver values in the output. Whether the action is mechanical or chemical we have not been able to ascertain. In this stage of the process there are considerable losses by volatilization, both the metal and the selenious acid passing through the water into which these retorts are connected and going off as fumes. It takes about 12 hrs. to distill a charge in one of these retorts and even then the elemination of selenium from flue dust is far from complete (an experiment is at present under way to determine the relative amount of selenium recovered to that remaining in the retort but so far there are no definite figures). The liquid which gathers in the receivers under the downtakes from these retorts is then filtered, giving a clear solution containing selenium as selenious acid and leaving behind a slimes, which, in the case of the iron retort at first used, was marketable as commercial selenium, but at present thia must be treated with nitric acid and thrown back into the retorts as it carries only 63% of selenium and about 530 ozs. of silver to the ton with 6% silica. The clear solution is diluted so that it will contain about 6 to 8% of selenious acid and then about 15 to 25% by volume of commercial muriatic acid is put in (this acid is about 30-Bé. The solution thus prepared is treated with

SO_2 gas so that the gas just does not bubble up through the liquid to the surface. The passage of this gas is continued until the liquid above the selenium, precipitated by it, turns black when looked down on in the tub but is clear like water when looked upon by trnsmitted light (the black appearance by reflected light is due to the precipitation of minute quanities of Te after the Se has gone down, ~~and~~ the analysis of our c.p. Se shows .045% Te). It usually takes about 6 to 8 days to get the selenium precipitated in a tub of solution. Although no gas can bee seen to escape from the liquid so that apparanetly the only losses of SO_2 gas are due to the throwing away of the mother liquors ~~separated~~ saturated with SO_2, nevertheless this part of the process seems to be very inefficient, only about 60% of what one would expect, so that an effort will be made, when the output is up a little higher and both the quantity and the ~~present~~ quality of the product seemed to be assured, to again run the sulphur burner as a cheaper way of producing this gas. When the selenium is entirely down the product is filtered free from the mother liquor and then washed until the free acid in the wash waters is less than 1/10 of 1%, and in many cases is sufficiently free from acid to be drunk like ordinary water. The method used for washing is to fill up the tub with water, stirr well and then syphon off the wash water, using one of Mr. Knorr's filter blocks to prevent any loss of the selenium. The thorough washing of this precipitate is a vital matter as otherwise the losses of the melting become too great and the melting is too prolonged. It is equally important to completely precipitate the selenium from the solutions containing it for if this is not done it is impossible to wash it thoroughly and difficult to dry the precipitate. It is quite as important not to precipitate the selenium in too concentrated a solution, for, if this is done, a purple modification is thrown down which is difficult to wash, impossible to dry except at very high temperatures.

When the selenium has been properly precipitated and washed it drys very nicely on a steam bath. The precipitate, which should be of a beautiful vermilion color, gradually shrinks together into a hard, compact, purplish-black mass, giving out a volume of occluded water from 3 to 4 times the volume of the selenium residue. These dry cakes carry about 97/1/3% of Se, the impurities being almost entirely oxygen and H_2SO_4. The cakes are then melted down in large kettles which contain about 10 to 15# of this material (Mr. Knorr advocates the use of larger kettles and a greater amount of selenium but on the three times that I have used more of the material I ran into very serious trouble owing to the very poor heat conducting qualities of the metal. The results are better when the material is brought to fusion in several kettles and then the contents poured together in one, but I have found the best results with our present melting furnace under the conditions I have named). The melting furnace is built of red brick, 48 x 60" outside dimensions, fired with a National Supply Co.'s burner, the flame impinging on a magnesite baffle. The top is made of two cast iron plates 24 x 60" and these plates, and the brick work on which they rest, held in place by 60# rails and 4-1" tie rods (even on as small a furnace as this these tie rods are necessary). There is a 12 ft. stack, also of red brick, in connection with this furnace. The vessels in which the selenium is melted are best made of enameled-ware, for cast iron dissolves in the selenium as does also copper, and porcelain is usually quickly broken by the constant crystallization of the selenium slags which form over the metal. There are considerable losses in the melting of selenium as whatever moisture or sulphuric acid is present in the selenium carries off some of the metal with it, while it is necessary to volatilize whatever selenious acid is present in order to obtain the refined metal. The action of the sulphuric acid is largely chemical. With water the vapor will likewise cause large metal losses, as shown by the fact that when a little piece of chemically pure selenium, which had been dipped in distilled water, was thrown into a kettle of molten selenium a dense red cloud immediately arose. When the metal has come to fusion and no more gas bubbles appear the metal is poured into an enameled ware tea-pot, allowed to settle again and then poured off into moulds, 2 1/2" x 2 1/2" x 5 1/2". The ingots thus obtained weigh approximately 5#. There is some little slag, that is 8 to 20%, left behind into which the impurities segregate, as shown by previous analyses. These slags will give up a great deal of their selenium on repeated meltings, the process being a simple liquation, but the constantly increasing iron and silica in the slags renders it impossible to obtain all of the selenium in this manner. At present the disposal of these slags, from which the selenium has been liquated as far as possible, is an unsolved problem, owing to the disadvantages attending the use of nitric acid in the retorts. An experimental iron report will again be placed in a few days and these residues can probably be ~~dissolved~~ distilled, giving a commercial grade of selenium.

Another solution suggests itself as to mixing them with sufficient amount of chemically pure to bring the average tenor up to 97% of selenium. When one considers the metal losses of retreatment through the process and the expense of the process, it would probably more than pay in the end to reduce a certain amount of c.p. to commercial, in case the iron retort does not prove as successful in distilling metallic selenium as it is hoped it will be. Earlier experiments with the iron retort showed that the product obtained in this manner would carry about 97% Se, 1% Fe, of which about .25% could be removed with a magnet and about .5% more could be taken out by crushing and treatment with hydrochloric acid.

The ingots obtained from the casting of molten selenium are then pulverized and shipped in the powdered state. The metal loss on account of the brittleness of the material amounts to about 2 1/2% of the total amount crushed, The cost of crushing, packing, etc. amounts to about 12 1/2 cts. per lb. of selenium produced, and 9 6/10 c. metal loss.

In case the new iron retort turns out selenium at a rate proportionate to that of the small iron retort it would probably pay to get a Sturtevant Sample Grinder with Chrome or Manganese steel plates, both in order to deliver the tonnage necessary and also to eliminate the heavy metal losses here spoken of.

D.M.L.

November 27, 1907.

Mr. Addicks:-

SELENIUM PROCEDURE:

Leaching and oxydizing 70 lbs. flue dust. Washed twice with hot water. Water filtered off flue dust after each washing. Three gallons of muriatic acid added to the wet flue dust, and 12 lbs. of sodium chlorate stirred into same, left standing until the next AM., filled then with water, stirred up thoroughly, allowed to settle and filtered to storage barrels. Three gallons of muriatic acid is added to next two washing, then two washes of boiling hot water. Before filtering it is ~~treated~~ tested for selenium. This is done to stop useless leaching. Scrubber mud is treated in the same manner as the above, except that the preliminary washing is left out,as the sulphuric acid is present in a very small quantity, and 15 lbs. of chlorate is added instead of 12.

PRECIPITATION:

Sulphur Burner generating SO_2 gas carried to settler to catch sublimed sulphur, then to woodaand stoneware storage vessels. Solution in storage vessels, two parts of solution from leaching process and one part of muriatic acid. SO_2 gas entering this solution precipitates out metallic selenium. This is thoroughly washed free from all ~~selenium~~ selenic acid. The metallic selenium is screened through an 80 mesh screen. This screened selenium is put in porcelain bowls and dried to a solid cake. This cake is bucked down and put through a 40 mesh screen, assayed and bottled. If after drying, the cake has a crystaline appearance, it is melted down, then bucked and put through a 40 mesh screen.

September 6, 1935

Selenium

MR. DREW:

Refer to Mr.Addicks letter A-293 of September 4.

Selenium does not appear in any appreciable quantity in the various Cottrell dusts at Oroya.

The copper refining tests at Oroya gave copper slimes carrying from 0.52% to 0.68% selenium and from 0.63 to 1.32% tellurium. The selenium and tellurium content of the blister copper therefore must have been of the order of 0.013% Se and 0.027% Te. When producing 2800 tons of blister per month the total selenium in the blister would be about 700 pounds with about 1400 pounds of tellurium.

A small amount of copper-tellurium dross was produced in the old process of bismuth production. This dross assayed 10-15% tellurium and probably carried a small amount of selenium but at best could not have accounted for more than a few pounds per year.

Some of the selenium in Oroya blister is recovered at US Metals Refining Co., Carteret, N.J. If the Oroya copper in refined in Peru the slime can be treated for selenium recovery but such treatment will require soda ash and sulphuric acid.

W. C. SMITH

G

A-298 September 4, 1935

Mr. C. V. Drew, Vice-Pres.,
Cerro de Pasco Copper Corp.,
44 Wall Street, New York City.

Dear Mr. Drew: <u>SELENIUM</u>

As you know I am advocating a thorough examination of all byproduct possibilities. Selenium appears now to have established itself in the market. I suggest a tabulation of its presence and distribution in our metallurgical products.

Very truly yours,

A-86. 51 Maiden Lane.

New York, N. Y., March 10, 1924.

Mr. C. V. Drew,

Cerro de Pasco Copper Corp.,

15 Broad St., New York, N. Y.

Dear Mr. Drew:

Your letter of February 27th.

The refinery sold 5,000 or 6,000 lbs. of selenium last year. It appears to cost about 65¢ a pound to produce and brings about $1.50 a pound in the market. I have not yet investigated the possibilities in this direction but you can safely say (1) that but a small fraction of the possible production has been marketed, (2) that you furnish but a small part of the input, the principal sources being United Verde, which sometimes runs as high as 0.2% in selenium, and International Nickel, and (3) that your bullion carries more tellurium than selenium which is objectionable.

Yours very truly,

L. A.
B.

CONTENTS NOTED
MAR 14 [illegible]
LAWRENCE ADDICKS

DICTATED BUT
NOT REVISED

Cerro de Pasco Copper Corporation

Office of C.V. Drew,
Room 4-5th. floor.
Telephone Hanover 1684-5-6

15 Broad Street,
New York,

Cable Address:
"Cerrocop, Newyork,"
"Cerrocop, Lima."

February 27, 1924

Dictated by D/G

Dear Mr.Addicks:

According to such data as I can find there is in our blister about 12,000 lbs. of selenium. per annum, Do you knoe how much of this the refinery recovers and how much they get for it? I notice one month's sales amounted to about $2,000.

Yours very truly,

C.V. Drew

To

Mr.L.Addicks,
51 Maiden Lane,
New York City.

CONTENTS NOTED
FEB 28 1924
LAWRENCE ADDICKS

"TULIP HILL"
BEL AIR
MARYLAND

~~3/8/20~~

Dear Mr Drew:

Your letter of Feb 27 –

The refining sold 5000 or 6000 lbs. of selenium last year. It appears to cost about 65¢ a pound to produce and bring about $\$1\underline{50}$ a pound in the ~~p~~ market. I have not yet investigated the possibilities in this direction but you can safely say (1) ~~that~~ but a small fraction of the possible production has been marketed (2) that you ~~par~~ furnish but a small part of the input, the principal sources being United Verde, which sometimes runs as high as 0.2% in selenium, and International Nickel, and (3) that your bullion carries more tellurium than selenium which is objectionable.