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Memorandum M-1082

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Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PROJECT 6345, August 4, 1950

To: Jay W. Forrester

From: Project Whirlwind Staff

1.0 SYSTEMS TESTS

1.1 Whirlwind I System Test

(R. W. Read)

The first week of the last period was spent checking out the Selective Write system and attempting to determine the best operating conditions. The work was interrupted in order to plan for another mode of operation of the ES system. The conditions at the end of the week appeared to be quite favorable. All tubes were operating correctly for a few simple tests, with tolerable margins. A circuit weakness in the Gun Drivers was located and subsequently changed.

The changes in the ES system center around the elimination of rewriting after each read. A few test equipment additions will be necessary to provide the flexibility necessary to test each digit column under several modes of operation. The principal changes are:

- 1) Elimination of rewrite,
- 2) Elimination of ES read-out check during a read operation,
- 3) Provision for a delay in the step counter to allow for intensification of a scope in locating errors determined by a check order (partly a temporary change for immediate testing purposes),
- 4) Provision for a precisely controllable holding gun time (only for test purposes).

Only part 3 is concerned with changes in central control; the other parts include minor changes in ES control.

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1.1 Whirlwind I System Test

Component Failures in WWI

(H. F. Mercer)

The following failures of electrical components have been reported since July 21, 1950:

<u>Component</u>	<u>No. of Failures</u>	<u>Hours of Operation</u>	<u>Reason for Failures</u>
<u>Crystal</u>			
D-358	1	1034	Low back resistance
<u>Tube</u>			
6SN7	1	2996	Open Cathode

1.2 Five-Digit Multiplier

(E. A. Guditz)

The multiplier has made errors only once since the last report. This occurred on August 2. The previous recorded error occurred on July 12, making an error-free run of 20 days.

During the period of this report the following were replaced as a result of marginal checking:

6 crystals
 1 7AD7
 1 2C51
 1 6AS6
 1 6AG7

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2.0 CIRCUITS AND COMPONENTS

2.1 Circuits by System Number

112 Restorer Pulse Generator

(N. L. Daggett)

Changes have been made in the restorer pulse generator to provide a separate restorer line to clock pulse control which does not receive computer complement pulses.

300 Arithmetic Element

(N. L. Daggett)

In order to make possible shift operations without roundoff or BR clear, modifications are being prepared which will utilize the presently unused AC 15 carry flip-flop as a Shift Roundoff Control. To encode a shift without roundoff operation, a constant, 1600 or 800, will be added to the address section of the shift order; if this constant is present, the Shift Roundoff Control flip-flop will gate out the roundoff and BR clear pulses.

302 Accumulator

(W. L. Poland)

To permit use of the temporary operation Read/Shift Right, the wiffletree in AC 0 has been re-installed, and a clear line for FF01 (partial sum) from 1 to Right has been added.

820 ES Deflection

(R. L. Best)

A sweep generator is being built in the shop to replace the one that came with the television set, that is now being used. The present generator, besides being quite non-linear, has considerable noise on the vertical sweep. It is hoped that the new circuit, based on the phanistron, will eliminate these troubles.

2.1 Circuits by System Number (Continued)831 ST Mount

(W. J. Nolan)

The possibility of using a long low-current pulse for reading signals out of the storage tube has necessitated a program for the reduction of r-f leakage in the storage tube mount boxes. The two WWI prototype mounts tested about a year ago had a leakage of about 25 microvolts which was entirely satisfactory for the output signals contemplated at that time. Changes made in the signal plate coupling circuit since that time have slightly increased the leakage. Unexplained random variations in the production mount-boxes have sometimes resulted in much larger signals, but in some cases almost complete cancellation of one leakage signal by another.

Investigation has so far disclosed at least 3 main leakage paths:

1. from G_2 and A_2 of the HV gun to the signal plate, as a result of a finite admittance in the lead grounding A_2
2. circulating currents in the sides of the mount and the tube shield provide considerable coupling between the grid circuits and the signal plate transformer
3. uncertain contact between the covers and the sides of the box, causing them to act as coupling capacitances rather than shields.

The desired attenuation is over 150 db or 3×10^7 which is quite difficult to achieve when provision must be made for an object as large as the storage tube in which most of the conducting surfaces can be grounded only through long leads. Considerable progress has been made through the use of an additional baffle across the mount box at the gun end and through additional short ground leads to the HV gun shield and A_2 lead. Shielding the signal plate transformer has also helped. However, there is as yet no certainty that the desired reduction in direct feed-through can be achieved without intentionally introducing a signal to cancel the remaining leakage. Nor is it certain that the present results on a steel prototype mount box will be duplicable on a WWI mount.

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2.5 Vacuum Tube Studies

(H. B. Frost)

Recently several pieces of information from outside the laboratory which have a bearing on the problem of cathode interface formation have come to my attention. In Report #12, Fundamental Research on Raw Materials Used for Electron Emissivity on Indirectly Heated Cathodes, by James Cardell of Raytheon, section 4 reports on variable surface impurities in cathode sleeves as received. These impurities may be quite high when compared to the body values. Moreover, the surface impurities are not uniform, but vary from place to place. This would be a place to expect trouble in tubes which show interface formation on cathode material with low silicon. For example, the B&B production, 7AD7 tubes. It would appear that this trouble could be avoided by proper cleaning procedures prior to coating the cathodes.

In addition, two reports which treat the effects of cathode interface resistance among other things have been received on loan from the Boston O.N.R. Office. The report numbers are PIB 153 and PIB 169, both by G. Conrad Dalman, of the Microwave Research Institute, Polytechnic Institute of Brooklyn. These are the only recent reports available on this subject outside of those by Eisenstein, which the laboratory does not have in complete form. So far, the above reports have not been read carefully.

A recent life test of 5687's shows some interesting effects. Previous life tests had shown considerable poisoning of the "off" side. However, the current test, in which the 5687's under test were cooled by forced air blast, showed no poisoning of the "off" side.

Vacuum tube failure reports for the past three months are currently in preparation.

R-179 "Vacuum Tube Life" is now being distributed.

3.0 STORAGE TUBES

3.1 Construction

(J. O. Ely)

During the first three days of this bi-weekly period, one research tube, RT160, was constructed and processed. As mentioned in the last bi-weekly report, this tube had all known parameters selected in an attempt to achieve higher storage density. It differs from the previous tube in this group, RT159, in the means used to secure uniform collector-to-surface spacing. Small glass spacers were used in RT159, but in constructing RT160, it was found that uniform spacing could be secured without the use of spacers by reducing the outside diameter of the mica washer which separates the screen from the storage surface at its outer edge.

During the latter part of the first week, all equipment was prepared for moving to the new tube shop in the basement, and all of the equipment except the glass lathes was then moved. Vacuum systems 1, 2 and 3 were torn down and all glassware cleaned prior to moving. System 3 was rebuilt and tested in its new location. System 2 was reassembled. This system has not been tested because of a crack in the high-vacuum line which will require the services of a glassblower to repair. System 1 was moved but has not yet been reassembled. After being moved to its new location, system 4 was torn down for cleaning. Some minor modifications will be made before this system is reassembled. The r-f bomber was moved to its new location and tied in to the power line, but was not tested because cooling water was not available.

Most of the tube construction personnel were on vacation during the second week of the period and will not return until August 14th. During this time, however, the work of setting up equipment in the basement is being carried out by the available tube construction group personnel and by machine shop and building maintenance personnel. Most of the piping required has been installed and it is expected that installation will be complete early next week. Both glass lathes have been set up, levelled, and generally checked over.

While a considerable amount of work still remains to be done, we expect to have all equipment set up and tested, except for vacuum systems 1 and 2, by the time the construction group returns.

3.2 Test

(C. L. Corderman, H. B. Frost, H. J. Platt)

Further tests have been run in the STRT using ST159 with a read signal plate gate equal to V_{HG} . The first group of tests

3.2 Test (Continued)

verified that equal signal plate gates could be used on writing negative and reading, that the focus voltage had very little effect when statically reading a 16-25 square positive spot, and that operation at "best" focus with roughly twice the write plus charge previously established (M-1071) was desirable for giving adequate margins on writing positive.

Tests in the restoring current setup and the STRT correlated well in showing that increased restoring current could be obtained by operating with the first and second holding gun anodes at 1000 volts and a bias of 25-60 volts depending upon the particular gun. Graphs SA-38025-G, 27-G, and 29-G show the variation of restoring currents with holding gun bias.

Subsequent testing has been concerned with the ST lineup procedure as outlined by J. W. Forrester. This procedure is the outcome of extensive testing during the past month in the STRT and follows through the adjustment and measurement of all significant aspects of a tube operating with selective write and equal signal plate gates on read and write minus. As of this date only two tubes, ST159 and ST103-2, have been checked and passed on all points of the lineup procedure, while additional tubes from ES Row are being examined. In two of the four tubes from WW which have been partially checked, a notable decrease in the positive restoring current at 100 volts VHG has been observed. A check upon the restoring current showed the first crossover voltage of these two tubes to be 15-20 volts higher than the normal value of volts above the negative stability point found for the other tubes. While this apparent loss of secondary emission is felt to be associated with tube life, similar results were not obtained in several other tubes which had been operated an equal number of hours in the computer, so that some basic difference between storage tubes is indicated, possibly in mosaic composition and depth or the type and amount of residual gases in the tube.

(M. I. Florencourt)

No standard tests were run because no new storage tubes were made.

Five storage tubes were transfer-tested, and ST138, ST173, ST175 and ST177 were accepted. ST176 was conditionally accepted, contingent upon the seriousness of several tiny surface imperfections. (ST138 was transfer-tested this second time to check it after its use at Bell Telephone Laboratories; its characteristics were unchanged.)

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3.2 Test (Continued)

Holding-gun restoring-current curves were run on ST138 and ST171 as a function of bias and accelerating voltage. The bias for the holding beam to just cover the surface was also measured as a function of accelerating voltage, using the TV demonstrator.

The July 1950 Storage and Research Tube Summary has been prepared and will be issued immediately.

(A. R. Tanguay)

An Engineering Note entitled "The Distribution of Capacitance on the Beryllium Mosaic Surface" has been completed and will be issued shortly.

Several tubes have been tested on the restoring current test setup in conjunction with tests being run on the reliability tester. As compared with new tubes, the tubes tested show a marked drop in the ratio of maximum positive to maximum negative restoring currents, as well as an increase in the first crossover voltage of the secondary emission curves.

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4.0 INPUT-OUTPUT EQUIPMENT

4.1 Eastman Kodak

(J. A. O'Brien, D. Hageman)

The difficulty encountered during the most recent tie-in with WWI was found to reside in an unstable (free-running) Gate and Delay unit associated with "block-forming" test equipment. Satisfactory operation of the EK unit as a recorder, with manual starting and stopping, was subsequently achieved.

Modification of a second EK unit is complete and various electronic and optical adjustments have been made. It is intended that this unit be used as a reader; further evaluation of this function will require the use of WWI.

4.2 Display

(R. H. Gould)

It was found that when a given spot was displayed once every 15 seconds on the 304-B oscilloscope the single 10 microsecond intensifying gate produced a visible flash but no visible persistence. To reach the desired result of 15 seconds persistence increases were made in the amplitude of the intensifying gate and the accelerating voltage of the cathode ray tube. The latter had negligible effect. Increase in the control grid drive of the CRT caused an increase in beam current and defocussing of the spot. This gave more excitation but to a greater area of the tube screen and resulted in no longer persistence.

The best solution with the equipment available is to increase the time of intensification to 100 microseconds and make the necessary modifications in the deflection decoders.

(R. L. Best)

A deflection amplifier is being built in the shop to drive a twelve inch television tube. The required gain of about 1000 is being obtained from two separate three-stage amplifiers in series, with each one stabilized with feedback. This display is primarily for project 6673, but will also be used for general purpose display.

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4.3 Typewriter and Tape-Punching Equipment

(R. E. Hunt)

Tape Output Unit - Drafting is about 50% complete on this unit; approximately another week will be needed to finish. All components needed have been ordered.

Construction should commence almost immediately and the unit should be completed about 8/30/50.

Flexowriter Units - Some work is being done to improve the reliability of these units. It has been found that several contacts arced excessively in the readers. Satisfactory arc suppression has been worked out for this case and installed in one reader. Further investigation will be made to ascertain whether all components operate correctly under all conditions.

Holding yokes are being designed to clamp all power connectors positively. There is a marked tendency for these to shake loose during operation.

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5.0 INSTALLATION AND POWER

5.2 Power Supplies and Control

(J. J. Gano)

D-C Power Supplies - The resistances and capacitors in the cushioning circuits of the thyratrons on the +250 supply were changed so as to reduce the rate of application of inverse voltage from 8 volts per microsecond to about 1.5 volts per microsecond. This latter value still exceeds the manufacturer's rating of .75 volts, but is about one-third of the rate on the +150 supply which has offered no tube troubles. A further reduction can be accomplished at the expense of more power consumption by the cushioning circuits. The present circuit represents a compromise. Six new tubes were installed to facilitate determining the effects of the change.

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6.0 BLOCK DIAGRAMS

(R. P. Mayer)

Block diagrams showing new computer connections are being held up by last-minute changes which are rather extensive. Such changes include (1) inclusion of shift left and shift right without roundoff (sl, sr 800), (2) operation of MS with no re-write, (3) scope intensification without changing to pushbutton on the ck order transfer check.

An attempt is being made to keep computer-room personnel posted on last-minute changes in the computer. This is being done by means of a book in the computer room which contains block diagrams labeled "Up-to-the-minute". In order to avoid delays due to red tape, these drawings are not graded and are not being distributed. Only two copies of each drawing will exist: one in the computer room book, and one in a book in the block diagram office. Due to the manner in which these drawings are prepared, they should be treated as sketches and might contain errors or unessential information. They should, however, fill the gap between a computer change and the eventual appearance of an up-to-date graded block diagram. These up-to-the-minute drawings should also show any temporary changes which will never appear on graded drawings, and may show helpful information which is not required on graded drawings.

Any errors or changes in the up-to-the-minute block diagrams should be marked IN RMD on the drawings. An attempt will be made to provide a corrected drawing as soon as possible. Any suggestions for other drawings will be welcomed.

In order to avoid confusion in the assignment of CPO (Control Pulse Output) Units, all such assignments must be cleared through, and recorded on, a drawing in the block diagram office labeled "Master List" of Control Matrix output connections.

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7.0 CHECKING METHODS

7.1 Test Problems

(G. C. Cooper)

The note on ES test programs has again been delayed because of revisions of the ES system. This necessitated writing some additional programs. Modifications of existing programs were also made to provide greater flexibility. It is hoped that the situation has been stabilized sufficiently so that N-359, ES Test Programs, will appear before the next bi-weekly.

7.4 Marginal Checking

(J. M. Salzer)

A test panel was constructed to facilitate marginal checking of individual WWI panels. It will be part of the test setup being put together in Room 226. The marginal-checking test panel will eventually use the amplidyne in the multiplier room for the variation of voltages.

The purpose of the test panel constructed may be two-fold: first, to test WWI panels (spare ones and others); second, to study the effects of changes in electronic components on the operating margins.

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8.0 MATHEMATICS AND PROGRAMMING

(C. W. Adams)

The input program (to be stored in test storage) by which the computer is directed to read from paper tape to electrostatic storage has been written. Techniques and conventions have been worked out by which programs can be inserted and re-inserted with a minimum of manual adjustments. The conventions adopted will apply to most practical (not test) programs to be used in the next few months, and these conventions will be described in a memo soon.

Manual intervention has been thoroughly worked out in collaboration D. Israel and a program for manual intervention has been written. It will occupy registers 244 through 287. This program provides the means for monitoring and altering a program after the computer is in operation.

The details of the equipment to be used for interim input, output and manual control are being described in a note to be written by J. Arnow. A block diagram of the entire interim system is also being prepared.

(F. C. Helwig and J. D. Porter)

Two tentative codes have been prepared for the numerical solution of the partial differential equation given in the last bi-weekly report. An analysis is being made to determine the effects of round off errors.

A preliminary calculation will be carried out with a desk calculator to check the programs preparatory to their use on the computer itself.

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9.0 FACILITIES AND CENTRAL SERVICES

9.1 Publications

(J. N. Ulman, Jr.)

The following material has been received in the library,
Room 217, and is available to 6345 personnel.

6345 Reports

<u>No.</u>	<u>Title</u>	<u>No. of Pages</u>	<u>Date</u>	<u>Author</u>
R-179	Vacuum Tube Life Experience	32	6-29-50	H. B. Frost
M-1070	Correlation Between Signal Plate to Collector Capacitance and Mica Thickness and Collector-to-Mica Spacing	2	7-24-50	(M. Florencourt (H. Platt
M-1071	Bi-Weekly Report, Project 6345, July 21, 1950	22	7-21-50	
M-1072	Measurements of Deflection Plate Spacing and Deflection Factors of 5U Guns	4	7-26-50	(R. Shaw (H. Platt
M-1073	Terminal Equipment and Manual Control Devices Using Flip-Flop Storage - Present Status and Future Plans (<u>Internal Distribution Only</u>)	8	7-26-50	C. W. Adams
M-1074	Electronic Computer Division Personnel	3	8-1-50	
M-1076	Progress Report: Check Problems for Automatic Failure Detection in an Electronic Digital Computer	2	{ 7-10-50 to { 8-1-50	R. H. Gould

Library Files

.004	European Scientific Notes: 1 July, 1950	ONR/London
47	Technical Information Pilot: 22 March, 3 July, 6 July, 12 July, 19 July, 24 July, 1950	(ONR/Library (of Congress
113	General Radio Experimenter: July, 1950	Gen'l Radio Co.
180	Bulletin of the Document Office: July 28, 1950	RIE, MIT
232	Physics Today: May, July, 1950	Amer. Inst. Phys.
271	Investigations for Design of Digital Calculating Machinery: Progress Report Number 10. May 10 - August 10, 1950	(Computation Lab. (Harvard Univ.
622	The Aerovox Research Worker: July, 1950	Aerovox Corp.
698	Physics Abstracts: January, May, 1950	IEE
770	The EDSAC: (a) Electronic Calculating Machine Development in Cambridge; (b) An Ultrasonic Memory Unit for the EDSAC; (c) The EDSAC: An Electronic Calculating Machine; (d) Programme Design for a High Speed Automatic Calculating Machine. Journal Reprints	(M. V. Wilkes (W. Renwick

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9.1 Publications (Continued)Library Files (Continued)

<u>No.</u>	<u>Title</u>	<u>Author</u>
799	System Studies for the Pulse-Code-to-Analog Servo-mechanism. Engineering Memorandum No. 17	(Servo. Lab. { J. O. McDonough
800	The Role of High-Speed Computers in Psychological and Educational Research: Editorial Revision of paper presented at Psychometric Society at Denver 7 September, 1949. Printed in Bulletin of the Educational Research Foundation: May, 1950	{ A. C. Hoffman, ed. { J. W. Forrester
801	Ferromagnetic Materials for Applications Requiring Rectangular Hysteresis Loops and Short Response Times: E. E. Seminar, Course 6.501-2. Jan., 1950	W. N. Papian
802	Investigation of a Yaw Damper for Aircraft. Instrumentation Lab. Report No. 6445-T-29. M. S. Thesis, 1950	{ E. F. Gallagher { R. L. Jungklas { W. D. Spiegel
803	Effect of Variations in the System Constants and External Loads on a Servo-Elevator System Dynamic Response. Instrumentation Lab. Report 6445-T-32 M. S. Thesis, 1950	R. E. Wilson
804	Use of Angular Accelerometer to Improve Aircraft Stability. Instrumentation Lab. Report 6445-T-28. M. S. Thesis, 1950	E. F. Smith
805	Patent Agreement: Calculating Device. Patent No. 2,404,697, filed 21 March, 1942. July 23, 1946	{ J. R. Desch { R. E. Mumma
806	Patent Agreement: Computing System. Patent No. 2,404,250, filed January 22, 1944. July 16, 1946	J. A. Rajchman
807	Patent Agreement: Electronic Computer. Patent No. 2,415,190, filed April 30, 1942. February 4, 1947	J. A. Rajchman

Books

Germanium Diodes	General Electric Co.
Number Series Method of Solving Linear and Non-Linear Differential Equations. D. Sc. Thesis, 1950	A. Madwed
Analysis and Synthesis of Linear Servomechanisms. Thesis Copy	A. C. Hall
Report of a Conference on High Speed Automatic Calculating Machines, 22-25 June, 1949, Cambridge, Eng.	Univ. Math. Lab.
Advances in Electronics, Vol. II	L. Marton, ed.
MIT Bulletin - Catalogue Issue 1950-51	MIT

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9.2 Standards, Purchasing and Stock

(H. B. Morley)

Standards - No new standards issued this period.

Procurement and Stock - A recent conversation with Mr. Hugh Wainwright of Sylvania concerning crystal diodes has disclosed the following:

They will not be able to make any definite promise of delivery of D358 crystals. However, he assured us that the new production of IN38A crystals would equal the D358 specifications. Accordingly a quantity of 100 IN38A crystals were procured and tested. Initial tests of these crystals show that they surpass the usual run of D358 type and that there was not a single reject. Performance tests are yet to be made.

These crystals are of the hermetically sealed glass type and are designated by the suffix "A". It is not known at this time if these crystals are obtainable in the ceramic tube types.

The following crystals are said to equal the "D" type specifications:

IN34A = D357
IN38A = D358
IN58A = D359

We have been requested to change our D358 orders (total quantity of 550 on order) to IN38A if tests show them to be acceptable. Estimated delivery time is from one to two months, price \$1.35 each as against \$1.40 for the D358 type.

Although this substitution may work out satisfactorily it is still urged that tests be conducted to ascertain the acceptability of another manufacturer's crystals so that an alternate may be substituted in case of a long delivery time from Sylvania.

Special BNC Tee connectors ordered from I.P.C. were improperly designed and have been returned for rework. The company is making every effort to correct the design and return the connectors to us early next week. The company is heavily pressed for production on government orders, but has assured us they will make every effort to fill our requirements. Any future plans for cabling requiring connectors in quantity should be made known to this office so orders can be placed well in advance of needed delivery.

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First official notice of impending stainless steel shortages and possible priorities has been received from one of the major suppliers.

Certain surplus materials and equipment have been transferred to Project 6420 to provide more storage space at Fort Heath. ONR office has requested lists of other surplus material available for transfer.

Storage space for stock and WWI spares has become critical, particularly since we were required to vacate Room 012 and lost part of the space in Room 045 for air conditioning installation.

9.3 Construction

(R. A. Osborne)

Production Report - The following items have been completed and inspected since July 21, 1950:

- 1 Input Tape Reader
- 1 Input Connection Panel
- 1 Start Over Control Panel
- 1 D.C. Reset Insertion Panel
- 2 External Power Cables (Synchronizer)
- 12 Shorting Plugs
- 66 Video Cables
- Modification of 2 Flexwriter Tape Readers
- Modification of 1 Indicator Light Panel (No. 19)

(L. Prentice)

Machine Shop - All of the available time in the shop has been devoted to making parts for storage tubes.

The base plate for system No. 4 was modified. The two glass lathes were leveled and the chucks aligned. Some replacement parts are required to bring these lathes to top performance.

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9.3 Construction (Continued)

A new motor mount has been made and installed on lathe No. 1 the clutch has been inspected and repaired.

Sheet Metal Shop - The wireway to extend WWI cables to the first floor has been completed and awaits installation.

Chassis and panels have been delivered for three 2⁶ low-speed counters.

The remaining time in this shop was devoted to making small parts for evaporation boilers.

9.4 Drafting

(A. M. Falcione)

Tube Characteristic Drawings - Engineering Note M-188 is being revised and will be reissued as (-1). The revised note will include all additions made to this group since the original memo was written February 1, 1949.

Input-Output Tape Units - Drawings of a preliminary nature have been made for these units. Final drawings will be delayed until such time as actual tests have been run.

WWI Rack Terminal Schedules - "B" reductions have been made for the terminal schedule drawings for the C-Row and F-Row. We are now getting reductions for A-Row. Reductions for P and E Row will be delayed because of changes now being made. The reductions of Terminal schedule drawings will be bound in a B-size folder and issued to WWI Service File, C. Watt and R. Dickie.

Work Load - The work load on the drafting and print room is heavy.

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10.00 GENERAL

(J. C. Proctor)

New Staff

Mr. Jack A. Arnow of Milwaukee, Wisconsin is a new research assistant who will work with the mathematics group. He received his S.B. in mathematics from MIT in June and will continue graduate work this fall.

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10.00 GENERAL

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