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Memorandum M-1147

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Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, Project 6345, January 5, 1951.

To: Jay W. Forrester

From: Project Whirlwind Staff

1.0 SYSTEMS TESTS

1.1 Whirlwind I System Test

(S. H. Dodd)

ES Row reliability continues about the same in spite of deteriorating gun current in the storage tubes. During the next bi-weekly period we expect to replace two storage tubes because of bad spots on the surface and one because of deteriorating gun current. The bad areas on the surface of the two tubes which we expect to replace are not new developments but have been in the tubes since they were installed.

Deflection shifts probably caused by glass charging have continued to cause much difficulty. The replacement tubes mentioned above will probably have all glass surfaces covered with a connecting coating and a comparison will be made between the new tubes and the ones where glass charging is suspected.

Plans are being considered for a closer tie-in between the marginal checking equipment and the rest of Whirlwind I. These plans would allow Whirlwind I to choose new marginal checking lines and apply a different test program to each line if desired. Thus a number of marginal checking programs could be written with each program specifying the marginal checking lines to be used.

A tube failure during the last bi-weekly period was found responsible for many Flexowriter printer troubles. An increased effort has been started toward obtaining high Flexowriter reliability.

Schedules are now being made a week in advance for use for use of Whirlwind by the different groups. A schedule

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1.1 Whirlwind I System Test (Continued)

for the following week is posted on the bulletin board in the control room about Wednesday or Thursday and no changes will be made in this schedule after posting unless unusual circumstances so demand.

(H. F. Mercer)

Component Failures in WWI - The following failures of electrical components have been reported since December 22, 1950:

<u>Component</u>	<u>No. of Failures</u>	<u>Hours of Operation</u>	<u>Reason for Failure</u>
<u>Capacitor</u>			
20 x 20 Mfd. 450 V. (Plug-in)	1	1836	Shorted
<u>Crystals</u>			
D-357	1	4553	Low R_b
	1	4704	
<u>Tube</u>			
7AD7	1	5463	Low I_b

Marginal Checking

(T. Leary)

In order to make better use of the daily marginal checking data, it has been decided to keep records of the excursions set in on each line. A form for recording these settings has been devised and for the past five days the excursions on a number of lines have been set in each day. The excursions are set at approximately 10% below the excursion which will produce an error except in cases where the maximum permissible excursion will not produce an error. Lines which produce errors in the course of routine marginal checking have their excursions reset accordingly. It is felt that this procedure will make dropping lines more obvious and will make evident lines whose excursions are below the general level for other lines of the same voltage.

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1.2 Five-Digit Multiplier

(C.N. Paskauskas)

The multiplier has been operating without an error since 8 December 1950 -- a period of 27 days.

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

1 1N34	Clamp crystal
1 D-358	Clamp crystal
1 6AS6	Gate tube - retired after 3606 hours in service
1 6AS6	Check gate tube - retired after 13,720 hours in service

Two other 6AS6 check gate tubes were removed for retest.

Operation during the last quarter of 1950 was very satisfactory. Three isolated errors were recorded in October. The month of November was error-free except during a major power failure in greater Boston. Operation in December was error-free except for one five minute period not connected with Christmas or New Year's Eve.

2.0 CIRCUITS AND COMPONENTS

2.1 Circuits and Components

(C. W. Watt)

403 I-O Register

The prototype of the DC In-out Register is progressing in the shop. Testing will be done under the direction of J. A. O'Brien.

(J. A. O'Brien)

The test specifications and testing procedure for the new In-Out Register panels is being written up to be ready for testing of the prototype panel.

2.5 Tubes and Components

(H. B. Frost)

During this past period the vacuum tube pulse current tester has been debugged and checked. This unit is now operable, but power supplies must be provided for operating convenience. During the next period instructions for the use of this unit will be written up.

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2.5 Tubes and Components (Continued)

Certain troubles with 12AT7 tubes used in plug-in flip-flop units have recently been discovered. These will be examined as soon as possible.

An attempt will be made in the next period to compile a summary of all vacuum tube failures as to tube types and classes of failures.

The backlog of work in the vacuum tube test shop is gradually being reduced. At the present time adequate tested stocks of vacuum tubes are available. However, re-test of all test equipment tubes with replacement of defective tubes is demanding large numbers of new tubes.

(R. E. Hunt)

Am in the process of compiling data and writing an E-Note on a resume of our experiences on relay contacts and arc suppression.

It has been our experience that manufacturers' contact ratings vary widely for like contacts and conditions and in general are not consistent or very reliable. I have evolved a chart whereby the rating of a given size contact may be selected, factors for various contact materials and shapes are given. This chart was evolved from the published ratings of the 6 relays most used on the project. Considerable evaluation of data was necessary.

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3.0 STORAGE TUBES

3.1 Construction

(P. Youtz)

Another storage tube, ST-306-3, designed to minimize the drift of the high-velocity beam resulting from charged glass surfaces was constructed for use in Whirlwind. A similar storage tube, ST-305-2, has been tested and installed in ES row. In these tubes, the glass was completely dagged and the holding gun had a 1-1/2" diameter metal A_3 cylinder. If these tubes operate satisfactorily in ES row, a series of these tubes will be constructed as replacement tubes for any storage tubes that might fail in the computer. We have scheduled the construction of five tubes in this series for the next bi-weekly period.

Another problem is the life of the cathodes. We are continuing the program to test our techniques for reprocessing to a new all-dag specification the storage tubes with paralyzed cathodes and good storage surfaces. These tubes also have the new holding gun. We have built another research tube, RT-198-1, with a deflecting electrode in the G_2 anode to provide a means for interrupting the high-velocity beam without interrupting the cathode current.

We have built another research tube designed to reduce the space charge effect of holding beam electrons. This tube is similar to the recent all-dag storage tubes except an additional 40 mesh collector screen was mounted 7/8 of an inch in front of the standard collector. This extra collector screen is at the A_3 potential.

The experiment to settle a uniform layer of powdered 707 glass on a metal backing plate and sinter it to the backing plate has been very promising. These experiments are one of the attacks on the problem of finding a suitable thin dielectric surface with as low a dielectric constant as possible.

(R. Shaw)

RT-153 has a signal plate consisting of concentric rings of silver instead of a continuous silver film. It will be used to investigate holding beam intensity distribution. In order to test the technique, concentric silver rings were evaporated onto a second-quality mica surface,

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3.1 Construction (continued)

January 4. Since the technique seems satisfactory, the process will be repeated next week using a good surface.

A considerable part of the past two weeks has been spent in acquainting other members of the group with the details of my work in preparation for my transfer to Building 32 on 15 January 1951.

3.2 Test

(A. Stein)

Pretests were conducted on the television demonstrator unit.

ST-305-2; RT-196 were pretested and passed.

Disposal tests, designed to check storage tubes prior to their reprocessing were performed on the following: ST-141, ST-151, and ST-183.

Special tests were made on RT-195, which uses a split G_2 cylinder to produce H.V. beam cut-off without interrupting the cathode current. Transfer characteristics of this tube were obtained.

(G. L. Corderman)

The storage tube Life Test Unit is now in operation with 8 tubes, the eighth being RT-195 which was added on January 5th. RT-195 is under test being cut off with the G_2 deflector plate and a G_1 bias to give normally a 30 μ a. beam current. In the past week of operation the most significant change observed has been the reduction in beam current of ST-175 from 125 to 18 μ amp. This tube was being life tested normally off with a heater voltage of 5.1 volts on the HV gun and the gun appears to have deactivated. RT-150, the research tube having an auxiliary 40 mesh screen mounted in front of the collector and tied to A_3 , has been checked at 32 x 32 density with quite promising results. Marginal cycling is possible and the spot interaction test for WWI tube checkout requires only 25 μ sec. of holding gun time per read for continuous operation. Further tests are planned for both this tube and a second similar tube RT-196.

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3.2 Test (continued)

The first all-dag tube to be put in a mount, ST-305, has been checked out satisfactorily in the STRT. When looking for glass charging effects many errors appeared during the first 20 minutes of operation. However, this effect was traced to a drift in the DVG output amplifier after a rest period in the cleared position O, O. If possible, this drift will be remedied; at least it will be kept in mind during future testing.

(H. J. Platt)

The greater part of the last bi-weekly period was spent on vacation.

I am now in the midst of running tests on ST-305-2, an all-dag tube, on the STRT with C. L. Corderman.

(A. R. Tanguay)

The T.V. and Restoring Current Tester is nearing completion. It should be ready for Restoring Current tests within a few days.

The first tube to be tested will be ST-305, to determine its restoring current characteristics as influenced by a long metal A_2^1 cylinder and an all-dag (A_3) construction.

(M. F. Mann)

All data pertinent to J. O. Ely's inspection of cathodes from dissected tubes has been collected and catalogued, and given to J. O. Ely for interpretation.

A correlation has been attempted between gun life and rate of decay of beam current for tubes in WW. Pulsed beam current was measured for all tubes at two different times, at an approximately constant interval for all tubes. It was expected that the older the gun the less the percent of decay of beam current during the interval. The data shows, however, that the decay seems to be a fairly random function of gun life at the first measurement.

A list has been compiled of all storage tubes dissected, and of the data and reason for dissection.

The December Research and Storage Tube Summary has been issued.

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4.0 INPUT-OUTPUT EQUIPMENT

4.1 Eastman Kodak

(D. Hageman)

During the past two weeks, information has been recorded on film and then read into Whirlwind successfully. In each case, reading and recording, the criterion for success was satisfactory performance of the in-out check which is a part of the operation of the In-Out Element. One of the films was spot checked visually and found to contain the correct data. In addition, each word was displayed as read. The films involved were of three types: (1) "powers of x;" (2) a checkerboard pattern; (3) a program for computation and display of the "powers of x".

These results were achieved as a result of certain compromises. As mentioned in an earlier report, the spot size on film was increased; a one-inch length of film now contains 50 words instead of 100. The speed of the CRT sweep was decreased to provide more time for decay of screen fluorescence and thus improve the response of the phototube circuits during reading. As a result of the latter change, a complete word may be read in 50 instead of 32 microseconds.

On one occasion, the number of words read off a loop of film was counted repeatedly. Following adjustment of the reference marker light source, a consistent count (together with alarm-free operation) was obtained for about an hour. However, the margin involved in connection with operation of the reference marker circuit and related optics is not regarded as satisfactory. On the other hand, a considerable margin now exists between the smallest "wanted" digit pulse and the largest "unwanted" or noise pulse during reading.

It may be of interest to mention that it was possible to obtain alarm-free operation with IOR and COR deprived of restorers for periods as long as 125 microseconds.

4.2 Display

(R. E. Hunt)

Satisfactory progress is being made on the display unit. Drafting work on the tube-amplifier unit is about 50% complete.

4.3 Typewriter and Tape Punching Equipment

(C. W. Watt)

One night was spent testing the Output Equipment with the computer. The trouble that had proved most annoying so far, hanging-up of the printer, was traced to a defective thyratron in synchronizer II. Replacement of the tube cured this trouble. Other troubles continue to plague the equipment and two evenings during the coming week have been set aside for trouble location.

(J. S. Hanson)

Some additional data has been added to the timing diagram for the "Words Only" mode of operation of the tape output equipment, and a new diagram for the "Word-Complement" mode has been started. This diagram will show relay counter presetting action during issuance of "Blank Preset" signals by the computer, followed by normal printing and tape punching cycles.

4.4 Input-Output Planning

(E. S. Rich)

Attention to other work has prevented completion of the analysis of the methods of controlling the magnetic tape units which was mentioned in the last report. It is expected that this analysis can be finished within the next week.

Work has been started on a system for adapting the E.R.A. photoelectric tape reader as an input unit. The circuit design is to be done by Irish under supervision of J. A. O'Brien.

Testing of the Eastman Kodak reader-recorder units has been suspended so the manpower can be used for other work. A summary will be written of the present status of the units including notes on methods of operating, testing and trouble shooting the equipment which have been found to be helpful in the past.

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4.4 Input-Output Planning (continued)

(J. A. O'Brien)

A program of investigating block diagrams and circuits to be used with the photoelectric tape reader has started. The block diagram of the required equipment appears to be simple and straightforward. The problem remaining appears to be one of deciding upon the simplest circuit that will perform the required functions with the desired reliability.

(T. Roess)

Magnetic Tape

Final work is being done to complete the breadboard reading and recording circuits for the magnetic tape units to be delivered soon by Raytheon.

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5.0 INSTALLATION AND POWER

5.2 Power Supplies and Control

(J. J. Gano)

D-C Plate Supply Alternator: Removal of the 120-208 regulated feedback to the Regulator Power Supply and substituting unregulated voltage rendered the system extremely stable when tested on Saturday with a computer load. However, on occasions during the week when the Regulated Laboratory Power system was operating under more severe conditions of loading, the two systems showed a tendency to oscillate slightly. The same modification of disconnecting the regulated feedback to the Regulator Power Supply will be tried on the Laboratory Power system.

Marginal Checking Power Supply: The first draft of the report is nearing completion.

5.3 Video Cabling

(T. Leary)

The video jack panels mentioned in the last bi-weekly for connections between the Synchronizers and Test Control have been built and installed, as have six of the twenty long cables needed for this purpose. The other fourteen cables as well as about ten other miscellaneous cables remain to be built.

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6.0 BLOCK DIAGRAMS

(J. M. Salzer)

A block diagram (SD-37296) of the whole in-out system now contemplated and being designed or constructed, has been prepared. This diagram shows all interconnections between the in-out element of the computer and the following in-out units: magnetic tape readers and recorders; photoelectric tape reader; paper tape reader, punch, and printer; and scopes.

The three new in-out orders, si, rd, and rc, have been redesigned to fit the operation of the in-out system as proposed in the above block diagram.

(R. P. Mayer)

The "Transfer Check Delay" switch inserts a short "Stop Clock" delay for every transfer check, and can not be used when Eastman units or display scopes are being used without upsetting the required "Stop Clock" interlock system. This is because "rc (or rd) sense" and "Transfer Check" both occur on time pulse 6.

Drawing SA-36434 shows a proposed ES Cycle Alarm system which can cause an alarm if ESC produces an end carry at any time except the proper time, plus or minus 1 μ s.

Two new proposals (B-1 and C-0) for a method of ES Bank Selection have been sketched for S. H. Dodd.

A design is nearly completed for the "ES Digit-Loss Check" which rings an alarm if digit 5 of an order does not agree with the number of "ones" (modulo 2) in digits 0 through 4.

Drawings SA-36455-1 and SB-36467 show a system for selecting any of several (perhaps ten) PC resets by a manual rotary switch or by marginal checking lines. Each marginal checking line can thus select a specific program for an effective check.

A second proposal is being investigated in which the program selects the marginal checking lines to be varied.

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7.0 CHECKING METHODS

7.1 Test Problems

(G. Cooper)

A new ES Test Program, ESTPR XVI, has been written for use in studying errors believed to be due to deflection shifts. Considerable time has been spent running this program on the computer with interesting, but inconclusive results.

Efforts are being directed towards obtaining a set of test problems to be placed in ES and used in conjunction with marginal checking. Each voltage variation line will select the particular problem which is appropriate for that line. As a starting point, Test Program Iie is being revised so that it may be placed in ES.

8.0 MATHEMATICS

(C. W. Adams)

Special subroutines for handling floating-point numbers are being worked out in detail and will be tested in the computer when finished. Such subroutines are of such a length (100 to 250 registers) as to be more or less impractical for use in performing problems of practical importance with 256 registers of storage. However, they show great promise for use when more storage is available.

The tentative procedure for handling the preparation and filing of punched paper tapes has been in use for the past two weeks and appears to be reasonably effective. It is described in detail in M-1130.

(J. M. Frankovich)

A program for the industrial problem mentioned in the last bi-weekly report has been written and a tape prepared for trial in the computer. The program gives an approximate solution for a set of four differential and integral equations that relate the productions and capacities of two hypothetical industries over a period of time. Provision is made for varying all of the parameters in the equations

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8.0 MATHEMATICS (continued)

so that various solutions can be examined. Information obtained from this kind of program will be useful in finding equations that fit a more realistic problem.

(J. D. Porter)

The program for calculating the solutions of the magnetic tape problem was modified as discussed in M-1139 and run on Whirlwind on December 27th and again on January 2nd. The program now types out all of the values of magnetic field that are calculated.

The program itself worked as expected but the results showed an unexpected trend. In studying the results an error was found in the initial data which could be the cause of our difficulty. A new corrected tape has been prepared and another run will be made as soon as possible.

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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>
E-393	Marginal Checking System, WWI	49	12-6-50	R. E. Hunt
E-395	Cathode Interface Impedance and Its Effects in Aged Vacuum Tubes (Paper delivered at Conference on Electron Tubes for Computers at Atlantic City)	5	1-2-51	H. B. Frost
E-396	Crystal Diode Life Experience in WWI Computer Circuits (Atlantic City Paper)	3	1-2-51	H. B. Frost
M-1102	The Influence of Gases and Vapors on the Emission of Oxide-Coated Cathodes, by G. G. Herrmann and O. Krieg	19	11-20-50	{M. F. Mann, tr. (H. B. Frost, tr.)
M-1130	Preparation and Filing of Punched Paper Tapes for WWI	8	11-20-50	C. W. Adams
M-1138	Master's Thesis Proposal: Use of Electronic Digital Computers for Information Searching	8	12-19-50	P. Bagley
M-1139	Bi-Weekly Report, Project 6345, December 22, 1950	20	12-22-50	
M-1140	Progress Report: A Study of the Holding Beam in the M. I. T. Storage Tube	2	{9-1-50 to (12-27-50	J. O. Ely
M-1141	Inspection of Electron Guns	2	12-29-50	R. Shaw
M-1143	Electronic Computer Division Personnel	3	1-1-51	
M-1144	December 1950 Storage and Research Tube Summary	5	1-4-51	M. F. Mann
M-1146	Inspection of Glass Envelopes	3	1-5-51	R. Shaw

Library Files

	Proceedings of the IRE: January, 1951	I. R. E.
	RCA Review: December, 1949; December, 1950	R. C. A.
.004	European Scientific Notes: December 1, 1950	ONR/London
47	Technical Information Pilot: December 11, 1950	{ONR/Library of (Congress General Radio Co.
113	General Radio Experimenter: December, 1950	General Radio Co.
150	Fundamental Research on Raw Materials Used for Electron Emissivity on Indirectly Heated Cathodes. Second Engineering Report: 1 October, 1950 to 1 January, 1951	{J. Cardell (Raytheon Mfg. Co.

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9.1 Publications (Continued)Library Files (Continued)

<u>No.</u>	<u>Title</u>	<u>Author</u>
180	Document Office Bulletin: December 29, 1950	R. L. E./M. I. T.
181	Pegasus: November, 1950	Fairchild Corp.
280	Digital Computer Newsletter: December, 1950	ONR/Washington
372	Numerical Analysis: Course 6.532, chapters 1 and 2. Boundary Value Problem: Variational Methods; Iterative Methods. (Course Notes)	J. Salzer
698	Physics Abstracts: November, 1950	I. E. E.
1067	The Transmission of Information -- II. Technical Report No. 149. February 6, 1950	(R. M. Fano R. L. E./M. I. T.)
1068	Periodic Sampling of Stationary Time Series. Tech- nical Report No. 156. May 16, 1950	(J. P. Costas R. L. E./M. I. T.)
1069	Theorie des Servo-Mecanismes Non Lineaires. Reprint from <u>la Radio Francaise</u> , No. 5, May, 1950	J. R. Dutilh
1070	Analysis and Design of R-C Phase-Shift Oscillator Networks. NRL Report 3676. June 13, 1950	(K. A. Morgan Naval Research Lab.)
1071	The Theory of Digital Handling of Non-Numerical Information and Its Implications to Machine Economics. Technical Bulletin No. 48, 1950	(C. N. Mooers Zator Co.)
1072	Introduction to Digital-Computer Coding and Logic: Notes for Course 6.535	W. G. Welchman
1073	Final Report on Computron. National Defense Research Committee, Div. 7 - Fire Control. NDRC Symbol 1413, RCAL Order No. 13005, March, 1943	(J. Rajchman R. L. Snyder, Jr. P. Rudnick RCA Labs)
1074	Tables of Trigonometric Functions to Five Significant Figures, and for Every Tenth of a Mil. AMP Report No. 24.1 September, 1943	(Applied Math. Panel, NDRC)
1088	Military Specification: Connectors "N" for Radio Frequency Cables. MIL-C-71A. 15 November, 1950 (Supercedes JAN-C-71, 31 January, 1945)	(Army Signal Corps Navy Bureau of Ships)
1089	Quarterly Progress Reports: Accelerated Life Pro- gram. Nos. 1 through 5: October, 1949 to October, 1950	Sylvania Electric Co.

Books

High Speed Computing Devices

(Staff, Engineering
Research Associates)Ferranti High-Speed Digital Computer, Moston,
Manchester, England

B. V. Bowden

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9.2 Standards, Purchasing and Stock

(H. B. Morley)

Standards:

The following standards have been recently issued:

JAN-R-93 - Resistors, Accurate, Fixed, Wire-Wound

JAN-C-76 - Cable (Hook-Up Wire), Electric, Insulated, Radio and Instrument

ASESA List No. 100 - Armed Services Index of Electro Standards

Armed Services Preferred List of Electron Tubes

Armed Services Electro Standards Agency - Supplement #37-Index

Procurement and Stock:

It should be noted that the cost of all types of materials is increasing rapidly; especially, office supplies and drafting supplies. In view of this situation, it is very necessary that every effort be made in the conservation of these materials. This also applies to all types of electronic and other components.

It is again called to the attention of all laboratory personnel having any tools or numbered equipment which is not required or in actual use, that these should be returned to the stockroom.

Engineers in submitting requirements for scheduled construction have in the past tended to underestimate quantities to be ordered. It is desirable to slightly overestimate these requirements and to make adequate provision for spares. Also the tendency has been to assume that standard parts would be available in any quantity needed, and to order only special or non-standard items. It should be remembered that most standard parts are stocked in quantities for normal requirements, and that large construction schedules will necessitate ordering additional supplies of standard parts, as well as the special items.

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9.3 Construction

(R. A. Osborne)

Production Report

The following items have been completed and inspected since December 22, 1950:

- 1 Magnetic Tape Read-Record Circuit Breadboard
- 6 98' Temporary Video Cables
- 3 Jack Panels
- 1 Short and Leakage Tester
- 1 Deflection Amplifier for 16" Scope

The following items are under construction:

- 1 In/Out Switch Register Driver Panel
- 1 In/Out Switch Bus Driver Panel
- 1 In/Out Register Prototype

9.4 Drafting

(A. M. Falcione)

1. New Drawings:

- A. Accumulator Digit 15: Information regarding this unit has been received. Complete drawings will be made for it as soon as possible.
- B. Power Supply WWI: A new drawing entitled, "Power Supply and Control Cabling Diagram, WWI" is now being made. This drawing will indicate locations and wiring for all power supplies related to Computer operation. (R-35365)

- 2. Thesis drawings for R. Read's thesis have been completed.
- 3. Drafting Load is heavy.
- 4. Storage Tube Test Equipment:

In order to properly record and identify all units of test equipment used in the Storage Tube

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9.4 Drafting (continued)

department, M. Mann, C. Corderman and the writer will act as a committee to assemble the information in proper form for record and file.

10.0 GENERAL

(J. C. Proctor)

New Non-Staff

Charles T. Grindal is a new electronic technician in the construction shop. He has had experience in electronic construction with the Submarine Signal and Raytheon Manufacturing Companies and has operated an electrical repair shop of his own.

Mrs. Helen O. Warren will replace Sally Rounds as a receptionist and switchboard operator. She attended George Washington University and has typing and clerical experience. Her husband is a graduate student at Harvard University.