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Memorandum M-1088

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Project Whirlwind  
Servomechanisms Laboratory  
Massachusetts Institute of Technology  
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, Project 6345, August 18, 1950

To: Jay W. Forrester

From: Project Whirlwind Staff

1.0 SYSTEMS TESTS

1.1 Whirlwind I System Test

(H. Fahnestock)

In order to expedite testing of the electrostatic storage system and to provide more time for routine maintenance on the computer, the operating schedule will be changed effective Monday, August 21. The hours from 7 a.m. to 9 a.m. will be devoted to marginal checking and maintenance. From 9 a.m. to 9 p.m., the computer will be used exclusively in connection with storage tests. The time between 9 p.m. and midnight will be shared by input-output tests and computer maintenance.

The first week of the last period was devoted mainly to correcting minor errors in wiring which were made during the recent shutdown and to installing the modifications to the electrostatic storage system described on the first page of the August 4 Bi-Weekly (M-1082).

Following these changes, tests have been made in one digit column on ST-159 to compare its performance with the new mode of operation in the computer with that obtained in the storage tube reliability tester. After a rather complete set of tentative specifications have been met in this digit column, the tests will be extended to include all 16 columns. In the course of this, the tentative specifications will be frozen and a bank of 16 tubes which meet these specifications will be installed.

Considerable time during this week was spent in getting full agreement among a number of engineers as to exactly how the line up procedures should be carried out. Having accomplished this, the line up of the remaining tubes will go more rapidly. A number of equipment troubles developed. Some difficulty was encountered in the calibrations of meters, and more adequate meters are being procured. In the new mode of operation, the timing of certain gates appears to be more critical than before, and some modifications will probably be required

## 1.1 Whirlwind I System Test (continued)

in the timing in the drivers. Since ST-159 was tested in the storage tube reliability tester, a drop of 50% in the high velocity beam current has been observed. This reduces the margins in the operating conditions, and it has been found necessary to increase the R-F reading current (at the expense of the number of consecutive positive readouts) in order to increase the margin upon R-F pulser amplitude. Heater burn-out in several of the tubes in the HV cathode supply resulted in application of the unregulated -4200 V. supply to the cathode of all 16 storage tubes. It was probably applied for less than a minute and possibly only a few seconds. This may or may not be connected with the drop of beam current in ST-159.

(N. Daggett)

The present WWI Test Control is being considerably revised with the primary aim of making it simpler and easier to use yet at the same time more flexible. By making it more flexible, it is hoped that the need for haphazard temporary cabling arrangements will be minimized. Operation will be simplified by controlling most commonly needed functions from a central video switching panel. In order to make operation more understandable, a complete block schematic is being prepared showing all video interconnections.

When these revisions are completed, a memo will be prepared describing the functions that are available and listing the switch positions necessary for each mode of operation.

(E. S. Rich)

Test on Input Tape Reader - Three short tests of the operation of the Input Tape Reader with the computer have been made during the last two weeks. This piece of terminal equipment is designed to read information from a punched paper tape into FF storage register #3. It has two modes of operation; in the "normal" mode a single word is read in on receipt of an order from the computer (order qr); in the "free-running" mode the reader cycles at its maximum speed and inserts information into the FF register asynchronously with the computer program.

Some changes in the relay control circuits were indicated by the first tests but after these changes were made the equipment seemed to perform satisfactorily under control of the computer.

At present minor wiring changes and clean-up of "haywire" connections remain to be done. About one day's work would be necessary for this. If time permits, further testing with the computer will be performed before the reader is turned over to the system.

1.1 Whirlwind I System Test (continued)

(H. F. Mercer)

Component Failures in WWI - The following failures of electrical components have been reported since August 4, 1950.

| <u>Component</u> | <u>No. of Failures</u> | <u>Hours of Operation</u> | <u>Reason for Failure</u> |
|------------------|------------------------|---------------------------|---------------------------|
| <u>Crystal</u>   |                        |                           |                           |
| D-358            | 1                      | 1918                      | Drift                     |
|                  | 1                      | 2079                      | Drift                     |
| <u>Tubes</u>     |                        |                           |                           |
| 2C51             | 1                      | 700                       | Burn out                  |
| 7AD7             | 2                      | 3900                      | Change in characteristics |
| 7AK7             | 1                      | 1983                      | Mechanical                |

1.2 Five Digit Multiplier

(H. Fahnestock)

The only error counts recorded during the period were one on August 4 and three on August 6.

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## 2.0 CIRCUITS AND COMPONENTS

### 2.1 Circuits by System Number

#### 832 ES Output

(W. J. Nolan)

When the first production r-f amplifiers were tested it was noticed that there was some undesirable coupling of the phase reference signal into the input transformer of the amplifier. After amplification, this amounted to about 1 volt and was considered to be negligible. However, recent changes in the operating conditions of the storage tube have resulted in operating the amplifiers at a gain of 10 or 20 times the value for which they had been designed. Under these conditions, the leakage signal may approach the saturation level of the amplifier, resulting in loss of gain, and the d-c level of the output may be such as to interfere with the operation of the gate tubes.

As a result, two modifications have been proposed. The first consists of a crystal detector on the plate of the output tube to make available a measurement of the magnitude of the voltage at this point without regard to its phase, as would be the case if measured by the phase detectors. This modification merely provides a measure of a condition (and an uncertain one requiring considerable study to interpret at that) but does nothing to alleviate it. Another effect of the detector is to slow the rise time of the output signal.

The second modification, shielding of the input transformer, is a more difficult operation but one that must eventually be performed if operation at signal levels below 100 microvolts is contemplated. Although it introduces problems of its own, it does largely eliminate coupling of the phase reference signal into the input transformer. With the amplifier operating at nearly maximum gain the feed-through did not appear to amount to more than 2 or 3 volts at the output. Since the noise level is several times this figure the measurement is somewhat doubtful.

### 2.5 Vacuum Tubes

(H. B. Frost)

At the present time vacuum tube test data is being analyzed to determine the centering of characteristics on test.

2.5 Vacuum Tubes (continued)

Deviations are also being determined. These data will be used in establishing new limit specifications.

Two interesting reports on cathode sleeve alloys written by the Superior Tube Co. have been received. Superior has submitted tubes to this project in the past for interface measurements. A large amount of information, including interface measurements, is presented for all current cathode sleeve alloys. Both reports are highly technical in nature. (Superior makes cathode tubing, not vacuum tubes).

2.7 A Coincident-Current Magnetic Memory Unit

(W. N. Papien)

A draft of the entire thesis, including illustrations, should be ready for approval on Monday, 21 August 1950.

Communications have been received from Allegheny Ludlum and General Ceramics and Steatite indicating that 1/4-mil-tape metallic materials and improved rectangular-loop ferrites, respectively, may be available in the near future. Reduction of response times and improvement in signal ratios should result.

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### 3.0 STORAGE TUBES

#### 3.1 Construction

(P. Youtz)

The storage tube construction group was on vacation the first week of this bi-weekly period. The second week was devoted to completing the work associated with moving into our new quarters in the basement. Both exhaust systems #1 and #2 were tested and used to process an evaporation tube.

We have begun an intensive and accelerated program to train more personnel to handle the glass work of the storage tube group. Toward that end we are taking motion pictures of all our glass work techniques.

(R. Shaw)

Some evaporation tube drawings are being changed in order that the grouping of parts into sub-assemblies may conform to that given in the assembly instructions, which are now in preparation.

A limitation on the performance of "stubby" storage tubes has been the fact that the deflection plates intercept part of the high-velocity beam when it is aimed at the outer edge of the target. Calculations have therefore been made which indicate that the space between deflection plates of 5U guns should be increased to .108 inch in order to obtain  $10^6$  deflection without interception of the beam. A potential of .064 times the accelerating voltage will be required to produce this deflection. A locating fixture is being designed to provide this spacing while the plates are being cemented into place; however, no construction will be started until the computation has been checked independently.

#### 3.2 Test

(M. I. Florencourt)

Disposal tests were run on three old 100-series storage tubes: ST 108, ST 109, and ST 110. Since these tubes are to be dissected all the information and test results available on them had to be obtained. The tests run to obtain these final data are called disposal tests, and include a re-run of all the tests connected with surface stability, gun currents, and deflection voltages.

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### 3.2 Test (continued)

(A. R. Tanguay)

Several storage tubes have been tested for their holding gun restoring current curves. A comparison is being sought between the HG currents of the 40 mesh standard tube and that of the 40 mesh stubby tube.

Some difficulty had been experienced in obtaining data because the calibration of the Model 5 synchroscope varied with line fluctuations, etc. Recalibration after every few readings takes too much time; therefore, some quick and easy method for calibration must be devised.

A first step has been taken via the insertion of a switch which eliminates disconnecting and reconnecting coaxial cables. The number of tests to be run will determine the feasibility of incorporating further refinements.

(C. L. Corderman)

Attempts were made to "rejuvenate" the surface of ST152-1. When checked in the STRT after several months of operation in WWI, the tube would no longer hold positive areas at a  $V_{HG}$  of 100 volts. Accordingly, several overnight runs were made in the TV Demonstrator, using the new standard conditions proposed in M-1077-2. Slight increases in the secondary emission ratio were in evidence on areas left positive and bombarded by the holding gun only; more pronounced increases were obtained over positive areas struck by the scanning high-velocity beam as well. The higher SER appeared to be temporary, however, since with a positive array all spots would not hold more than five minutes with  $V_{HG} = 100$  volts. A more significant event observed during the overnight tests was the appearance of a dark blotch in the center of the surface after only 20 hours of operation under the new standard conditions. Such an area has been observed in other tubes after several hundred hours of operation, but the formation has invariably taken place at a much slower rate. The black spot is thought to be caused by ion bombardment, possibly  $Ba^+$  released by the holding gun cathode. Subsequent tests on new tubes, rejected for other reasons, gave a definite indication that the black area of reduced SER was accentuated by operating with  $V_{A1}^1$ , the holding gun 1st anode voltage, at 1000 volts. Checks in the restoring current setup showed that most of the increase in positive restoring current of the new standard conditions was obtained by raising only the holding gun second anode to 1000 volts, leaving the first anode at its former value of 500 volts. Thus, while life tests are still in progress, these voltages have been decided upon as being standard.

### 3.2 Test (continued)

Test and line-up of ST159 is now proceeding in digit #1 of ES Row in accordance with M-1077-2. This tube was previously checked out satisfactorily in the STRT. An unexplained drop of 50% in the high-velocity beam current has been observed which tends to give very slight margins from the desired operating conditions. It has been found necessary to increase the rf reading current (at the expense of the number of consecutive positive read-outs) in order to increase the margin upon rf pulser output amplitude.

It appeared that the tube would have to be rejected because of insufficient W-charge; however, an equipment limitation was later uncovered. A critical examination of the gate timing revealed that there was an 0.8  $\mu$ sec. overlap between the high-velocity gun video gate and the W-signal plate gate.

(H. B. Frost, H. J. Platt)

In the course of running tests using the new standard conditions of M-1077-2 on ST152, it was found that this tube exhibited characteristics of a low secondary emission ratio. The surface was given an overnight holding gun and high velocity gun bombardment in an effort to increase the secondary emission ratio. The bombing did not appreciably help the tube. It was found that a stored array would not hold at  $V_{HG} = 100V$ . At  $V_{HG} = 150V$  it was impossible to find a suitable RSPG. In addition an area in the center of the surface after bombing showed different secondary emission characteristics from the remainder of the surface.

A check was made on the correlation between rate of spot size increase and writing time on RT125-2, RT150, and RT154. It appears that the logarithm of the rate of increase of spot size is correlated with the collector to signal plate spacing.

### 3.3 Unclassified

(H. B. Frost)

The Laboratory for Insulation Research has checked two dielectric samples of mica cut normal to the cleavage plane. These tests made in open atmosphere show a high (15-20) dielectric constant at 1 kc, which drops to 7.5 at 1 mc. Checks will be made in vacuum to determine whether the high value at 1 kc is due to moisture in the sample.



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3.4 Unclassified

(C. L. Corderman)

Checkout of the Decoder Control Unit has been completed and this unit, together with the Decoder and the Output Amplifier were installed in the TV Demonstrator set-up.

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4.0 INPUT-OUTPUT EQUIPMENT

4.1 Eastman Kodak

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

For the past two weeks the work on the E. K. units has been done on the evening shift so as to obtain the use of the computer.

All of the work on this run so far has been with the first unit. Several recording runs were made in order to determine the best control settings, and then film was recorded for use in the reading tests.

The signal to noise ratio is not as good as is desired during reading operations, but we were able to read for short periods without error (4000 words). The next problem is to determine the source of the errors.

Trouble shooting on the units should be made less difficult, because we have synchronized the E. K. unit sweeps with the computer restorers, so that we now can observe WWI pulses and E. K. unit pulses on the same test scope.

4.3 Typewriter and Tape-Punching Equipment

(J. S. Hanson)

Output Typewriter and Punch - A bracket designed this past week for the purpose of mounting a Clare relay inside the tape punch has been sketched for fabrication by the shops. A positive acting catch is being worked out for installation on the tape punch translator relay bank to prevent punch vibration from jarring loose the translator relays.

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5.3 Video Cabling

(T. Leary)

The past week has been spent in catching up with the paper work, neglected in the rush to get the cables built, associated with the change to "selective write".

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6.0 BLOCK DIAGRAMS

(J. M. Salzer)

R-180 (draft), "Functional Description of Whirlwind I", has been issued in hektographed form. Each copy consists of two volumes: the text (A-size) and the drawings (B-size). This report supersedes R-127 as far as internal use is concerned, but it is only as up-to-date as was possible in view of dynamic evolution of the computer.

The purpose of this issue is twofold: first, it is to fill the gap between R-127 and the present state of the computer for the use of project personnel; second, it is preparatory to a final (if such is conceivable) report. The word "draft" indicates that the report is not as polished as a final report would be.

Only a limited number of copies (15 complete copies and 5 additional volumes of text) are available; consequently, some coordination and care must be used in their distribution. It is suggested that those interested in having a copy see me. Similarly, any suggestions and criticisms, however trivial, will be appreciated.

(R. F. Mayer)

The techniques for using electrostatic storage slave to test storage, Double ES register operation, and an Initial Fill from TS have all been superseded by the present ES testing techniques. Consequently the memoranda on these previous techniques have been cancelled.

A test-equipment setup for testing ES has been set up. An important feature (shown on the "Up-to-the-minute" drawing for ES) is the "change-to-pushbutton" and "Restart" that occurs after every ES Read. Unless this circuit is disabled, no program using ES can be made to run in any fashion except automatic. (i.e. cycling will not work under certain conditions. Single pushbuttons will work only up to the first use of ES, at which point a restart will occur.) The dotted PF and GT on the ES drawing would avoid this difficulty, but is not considered necessary.

## 7.0 CHECKING METHODS

### 7.1 Test Problems

(R. H. Gould)

A test sequence occupying 14 registers of test storage has been written. It appears to be able to detect all detectable failures in the Time Pulse Distributor and Clock Pulse Control and at least half of the possible failures in the Program Counter. Further analysis may show ways of detecting more of the Program Counter faults but the Clock Pulse Control has many possible failures that are impossible to detect automatically. The Time Pulse Distributor is checked completely by the test sequence with the exception of two of the many possible faults.

### 7.5 Miscellaneous

(J. M. Salzer)

Minor modifications are being made in the computer to provide a built-in check of the setting up of the program counter during an sp instruction. Such a check is very desirable because the malfunctioning of the PC input would result in erroneous operation with confusing symptoms, since sub-programming to a wrong place could do most anything. It is not even sure that an alarm would result. E.g. it is possible that by subprogramming to the wrong subroutine the computer would use the log of  $x$  rather than the square root of  $x$ .

In general, an effort is being made to check every component used in any transfer by a transfer check. It is tolerable not to check every transfer, as long as the same equipment is checked during some other transfer. E.g. the transfer from AR to Storage is not checked during a ta order but the components taking part in this transfer are checked by other orders.

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8.0 MATHEMATICS AND PROGRAMMING

(J. Arnow)

A note concerning the interim input, output and manual control equipment is being prepared, and programs for various modes of output for the interim equipment were written.

(C. W. Adams)

A block diagram of the interim control and terminal equipment has been prepared in tentative form (SD-37291) and is being distributed to all interested persons for comment.

Manual intervention is being described in a note to be issued soon.

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

The two tentative codes prepared for the numerical solution of the partial differential equation described in a previous bi-weekly report (M-1071) were resolved into a single code combining the better features of each. The preliminary calculations served as a guide in selecting a convenient correction program and in setting a scale factor.

Work is progressing on predicting the accuracy of the results that will be obtained.

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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<br/>Pages</u> | <u>Date</u> | <u>Author</u> |
|------------|----------------------------------------------------------------------------------------------------------------------|-------------------------|-------------|---------------|
| R-180      | Functional Description of the Whirlwind I Computer. Vol. I, Text. Vol. II, Figures. (For Internal Distribution Only) | 299                     | 8-18-50     | J. M. Salzer  |
| E-356      | Equipment and Techniques for Inserting Information Into WWI                                                          | 9                       | 7-12-50     | C. W. Adams   |
| E-360      | Vacuum Tube Life Experience (Abstract and Appendix of R-179)                                                         | 2                       | 8-8-50      | H. B. Frost   |
| E-361      | Additions to the Whirlwind I Order Code (October 1949 to August 1950)                                                | 3                       | 8-10-50     | C. W. Adams   |
| M-1079     | Vacuum Tube Failures During the Month of May, 1950                                                                   | 3                       | 8-7-50      | H. B. Frost   |
| M-1080     | Vacuum Tube Failures During the Month of June, 1950                                                                  | 4                       | 8-7-50      | H. B. Frost   |
| M-1081     | Vacuum Tube Failures During the Month of July, 1950                                                                  | 3                       | 8-8-50      | H. B. Frost   |
| M-1082     | Bi-Weekly Report, Project 6345, August 4, 1950                                                                       | 20                      | 8-4-50      |               |
| M-1083     | Interim Display Equipment and Temporary Operation of: F - Scope Display                                              | 1                       | 8-7-50      | C. W. Adams   |
| M-1084     | Temporary Operation of: Punch/Shift Right                                                                            | 1                       | 8-10-50     | C. W. Adams   |
| M-1086     | Master's Thesis Proposal: A Study of the Holding Beam in the M. I. T. Electrostatic Storage Tube                     | 13                      | 8-15-50     | J. O. Ely     |
| A-99-1     | Fire Drills                                                                                                          | 2                       | 8-14-50     | J. C. Proctor |

Library Files

|      |                                                                                                                          |                   |
|------|--------------------------------------------------------------------------------------------------------------------------|-------------------|
| .004 | European Scientific Notes: 15 July, 1950                                                                                 | ONR/London        |
| 698  | Physics Abstracts: June, July, 1950                                                                                      | I. E. E.          |
| 810  | Error-Channel Capacity for a Pulse-Code-to-Analog Servo-mechanism. Engineering Memo No. 16, Project 6694, July 11, 1950. | J. O. McDonough   |
| 811  | Instructions for Reader Recorder Film Processor                                                                          | Eastman Kodak Co. |

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9.1 Publications (Continued)Library Files (Continued)

| <u>No.</u> | <u>Title</u>                                                                                                                                     | <u>Author</u>                                     |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| 812        | Kodak Digital Reader-Recorder Model A: Instructions for Adjustment of Optics                                                                     | Eastman Kodak Co.                                 |
| 813        | M. I. T. Electrostatic Storage Tube: Paper given at AIEE Northeastern District Meeting, Providence, April 26-28, 1950                            | (S. H. Dodd<br>(H. Klemperer<br>(P. Youtz         |
| 814        | The Digital Computation Program at M. I. T.: Paper for the Symposium on Large-Scale Calculating Machinery, Harvard U., September 13-16, 1949     | J. W. Forrester                                   |
| 815        | High-Speed Electronic Computing Devices. Draft of paper for the American Chemical Society National Meeting, Atlantic City, September 19-23, 1949 | J. W. Forrester                                   |
| 816        | Symposium on Role of Electronic High Speed Computers in Psychological Research. Psychometric Society, Denver, September 7, 1949                  | J. W. Forrester                                   |
| 817        | Berger and Walker Miscellaneous Circuit Notes                                                                                                    | Radiation Lab.                                    |
| 818        | The California Digital Computer: U. of California, June 20, 1950                                                                                 | P. L. Morton                                      |
| 819        | History and Development of Methods Used in Automatic-Sequence-Controlled Computing Machines. E. E. Seminar, M. I. T., January 20, 1947           | D. R. Brown                                       |
| 820        | An Investigation of the Power Spectral Density of Atmospheric Turbulence. Instrumentation Laboratory 6445-T-31. D. Sc. Thesis, M. I. T., 1950    | G. C. Clementson                                  |
| 821        | The Relation of the Base Metal to the Performance of Thermionic Cathodes. Superior Tube Company Electronics Lab. Report No. 22, April 6, 1950    | (T. H. Briggs<br>(C. D. Richard, Jr.<br>(T. Small |
| 822        | Indicating Instruments at the Servomechanism Frequencies. Preprint from <u>AIEE Transactions</u> , Vol. 69, 1950                                 | (W. S. Pritchett<br>(R. M. Saunders               |
| 823        | The Design of Broad-Band Transformers for Linear Electronic Circuits. Preprint from <u>AIEE Transactions</u> , Vol. 69, 1950                     | H. W. Lord                                        |

Books

Extrapolation, Interpolation, and Smoothing of Stationery Time Series

N. Wiener



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9.1 Publications (continued)

(R. Pathbone)

Report R-180, Functional Description of the Whirlwind I Computer, has been completed as a two-volume draft; fifteen copies are now available in the library. (See section 6.0)

Summary Report 23 arrived from the printers August 13 and has been distributed.

Summary Report 5, Project 6673, has been returned from Jackson and Moreland for checking.

9.2 Standards, Purchasing and Stock

(H. W. Hodgdon)

Standards - No new or revised standards issued this period.

Procurement and Stock - Pursuant to the report on the crystal situation in the last bi-weekly report, decision was made to change outstanding orders for D-358 crystals to type 1N38A, and the necessary change orders have been issued.

An order was placed with Electrons, Inc. for 10 Type ELCL6J Control Rectifiers, providing a full set of spares for the WWI power supply.

In an effort to provide a more reliable instrument of the multimeter type than those commonly used in the lab, three Weston Type 785 Industrial Circuit Testers have been ordered.

Special tools for servicing the Flexowriter equipment have been ordered from Commercial Controls.

Due to vacation schedules, the stockroom has been operating under a handicap this period, and little progress has been made toward cleaning up storage areas. More time will be devoted to this as soon as the vacation period is passed.

9.3 Construction

(R. A. Osborne)

Production Report - The following items have been completed and inspected since August 4, 1950:

- 5 Breadboards - 12" TV Deflection Amplifier
- Deflection Pre-Amplifier
- TV Sweep Generator

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9.3 Construction (continued)

2 chokes  
1 24 wire cable

9.4 Drafting

(A. M. Falcione)

Tube Characteristic Drawings - Engineering Note E-186 on this subject has been revised and re-issued as a (-1). Copies are available in the Library for those who desire them. It now includes all tube characteristic drawings to date.

Thesis Drawings - Thesis drawings for Papian, Frost, and Collier are completed and should be ready for the September 1st deadline date.

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10.00 GENERAL

(J. C. Proctor)

New Non-Staff

Miss Ruth Cullinane of Dorchester is replacing Helen O'Connor, secretary in the storage tube group. She has had secretarial experience at Little, Brown and Company and Boston University.

Mrs. Joan Strober has joined the Laboratory as a receptionist and switchboard operator. She received a Bachelor of Arts degree from Brooklyn College and has had experience in selling, receptionist work, and modeling. Her husband is a student at the Harvard Medical School; their home is in Brooklyn, New York.

Staff Termination

William L. Poland has transferred to Building 32.