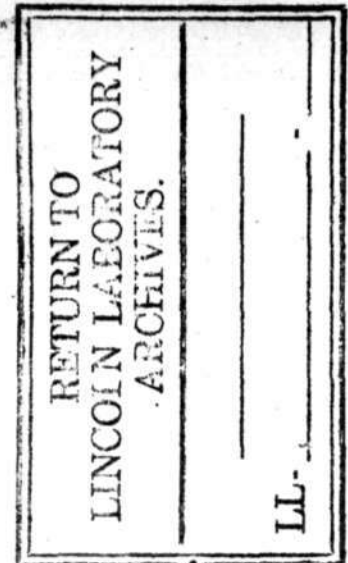


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Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts



SUBJECT: BI-WEEKLY REPORT, PART II, May 14, 1948.

To: 6345 Engineers

From: Jay W. Forrester

6.0 MATHEMATICS

(P. Franklin)

Organized codes for the application of the Runge-Kutta method to a single first order equation.

(N. Daniloff)

At the request of the storage tube group consideration has been given to the problem of finding the radial density of the heating coil distribution ("heating function" density in the terminology of integral equations) which will give a uniform layer of evaporated material. The problem reduces to the numerical solution of an integral equation of the first kind. The general solution is being sought, but presents considerable difficulties since the kernel of the integral equation is constituted by a complete elliptic integral of the second kind. (The work of calculation is being taken up by Mr. Battean).

At the request of the storage tube group the extent of the umbra and penumbra behind the weave and woof of the mesh of the screen has been investigated. It was found that in the absence of an accelerating field and under conditions such that the mean free path exceeds ρ (see M-395 or Strong, Page 178) the width of the umbra should be about .0015 inch. "Gravitational diffraction" effects may however, narrow this width, although it is doubtful that these can account for the observed phenomena in their entirety.

Calculations pertaining to M-395 are being continued.

In view of the urgent nature of the problems of the storage tube group editing of memorandum on the simulation of empirical functions by polynomials is temporarily postponed.

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(E. Blumenthal)

I have completed the insertion of all equations and figures in the copies of three Russian technical articles recently translated by M. Daniloff. They are:

1. "Theory of the Action of an External E.M.F. on a Trigger Circuit (Electronic Relay)."
V.V.Vitkovich, Journal Tech. Physics (1945).
2. "The 'Hard' Regime of Self-Excited Relaxation Oscillations in a Generator (or Multivibrator of the Abraham-Bloch Type)."
V.V.Vitkovich, Journal Tech. Physics (1945).
3. "Continuous Self-Sustained Oscillations in a Multivibrator of the Abraham-Bloch Type."
K.F.Theoderchik, Journal Tech. Physics (1946).

(C. W. Adams)

Study of coding certain special problems has been continued. Some coding of numerical integration and of input and output conversions has been carried out.

(E. Reich)

Prof. Franklin's first two lectures in the seminar series have been written up and hectographed.

Last Friday I attended a symposium on numerical methods of analysis at the Illinois Institute of Technology. A critical memorandum covering the subject matter discussed in the papers will be prepared.

(D. W. Bateson)

The continued study of smoothing functions of non-constant distributions in relation to the oxide coating problem at times show solutions which unfortunately have no physical representatives.

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7.0 INPUT AND OUTPUT

7.3 Binary to Analog Conversion

(E. W. Sard)

The decoder (pulse code to pulse time) was made to operate. Work is now proceeding on the decoder gate generator, with expected date of completion uncertain.

7.4 Magnetic Recording

(E. S. Rich)

The draft of the thesis report on magnetic recording has been completed and has been checked by the supervisor. The report is now being typed in final form.

7.6 Output Printers

(F. A. Foss)

Model 19 teletypewriter equipment has been received and utilized for testing the output printer system. This model 19 unit contains a keyboard transmitter, receiving printer, transmitter distributor, and a tape-cutting head. Only the receiving printer was used for test purposes. However, the other components were used to check the adjustment and functioning of the teletypewriter printer mechanisms.

The thesis report on output printer systems is in its final stage of completion.

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8.0 STORAGE TUBES8.1 Tube Construction and Testing8.11 Tube Construction and Processing

(Frank Caswell, T. F. Clough and P. Youtz)

Eight tubes were processed during this period and complete components for several more tubes were prepared.

Another storage tube ST31-1 with a $3/4$ " storage surface having a beryllium mosaic with 85% conducting area and a 100 mesh 2 mil screen .005 from surface was constructed and processed. Tests on a similar surface in ST28 indicated it would be desirable to use in this next tube a 100 mesh screen instead of 40 mesh and space the screen .005 inches from the surface instead of .012 inches. Processing difficulties required the construction of two tubes in order to get a satisfactory tube.

Two research tubes RT23 and RT24 were constructed and processed to study the secondary emission characteristics of calcium tungstate surfaces similar to the surfaces in the first three five-inch storage tubes.

Complete components are prepared for the fourth and fifth five-inch storage tubes, ST29 and ST30. However, all attempts to evaporate a beryllium mosaic on a large surface have been unsuccessful. Therefore, we cannot finish these large size storage tubes until we develop further our evaporation techniques. The evaporation tube has been redesigned and a new processing procedure will be used. We have constructed several holders and pieces of equipment to aid our evaporation process. Under consideration is the design of a relay system to automatically control the degassing and evaporation procedures. Preliminary considerations have been given to the design of a control system to shut off the ovens and pumps properly in case the glass work should break.

Test results from the life studies of secondary emission and the investigation of storage property of a beryllium mosaic indicated a need for some new research tubes. These tubes were designed and components were constructed.

The filtered air room (room 020 in the basement) is

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now being used for all tube component construction except the glass work and exhaust.

RCA has been unable to send us any electron guns because their demands for television guns have withdrawn technicians and other facilities from the 'scope department. We were promised a few electron guns in June. Sylvania has promised us ten guns after a month of procrastination. However we are prepared to resuscitate some of the old guns from tubes which did not process properly.

(R. Shaw)

Drawings have been made of the 5-inch evaporation tube mentioned in the previous report. For detailed description see M-418. Memos describing two other tubes will be released as soon as necessary drawings are completed.

A new large evaporation tube will be made in the near future incorporating changes in both the target and the evaporating cup in order to obtain a more sharply-defined mosaic than has been possible in the past.

Parts are being made for a new type of signal plate assembly for storage tubes.

Parts are complete for ET-41: a special evaporation tube to produce a mosaic for stability studies.

8.12 Tube Testing

(S. H. Dodd)

A number of tests for spot stability have been made on ST28 which is a small storage tube with 40 mesh .002 inch, Be mosaic and a 40 mesh .002 inch wire screen. These tests have indicated an unexpected instability of spots on a conducting mosaic surface. It had been expected that a conducting mosaic would result in increased stability because spots of charge would be unable to creep in size slowly but would have to jump by discrete areas. Instability as a function of holding beam current density is being studied to determine possibility of field emission or other phenomena causing spot creepage. Calculations on field emission currents are at present inconclusive because estimates of field strength cannot be made closely enough for computation. Possibilities of a film covering the Be mosaic areas which is conducting to high velocity electrons but not

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8.12 Tube Testing
(S. H. Dodd)

to very low velocity electrons is being studied in the secondary emission test set-up. Further tests using an electrostatic voltmeter are contemplated to indicate point of instability.

(W. J. Nolan)

In the course of writing up thesis conclusions it was noticed that both beryllium mosaic and willemite surfaces showed an unusual and inconsistent variation of secondary escape ratio with change in collector potential. The tests were repeated and the data found to be correct but variation of focus of the beam used in making the tests indicated that this affected the figures used in calculating the capacitance of the surface. Although revision of the capacitance values in accordance with this data provided better agreement with other sources, there are still unexplained discrepancies.

(J. S. Rochefort)

Model 11A was tested on the EST Demonstrator. The best holding beam accelerating potential was found to be -420 v. The third anode was found to have a large effect upon negative signals read out of the tube. As third anode was increased from 0 to -60 v, an increase in magnitude of negative signals read out of the tube was found.

Model 14A gave good operation with a holding beam acceleration of -135 v; and signal plate potential of -50v. These tests indicate a first cross over potential of about 50 v.

8.13 Storage Tube Demonstration
(J. S. Rochefort)

The Demonstrator was modified to provide signal plate potentials which are variable from +25 v to -240 v.

8.2 Storage Tube Research

8.21 Surface Material Characteristics
(H. L. Heydt and J. H. McCusker)

Life tests on storage surfaces have been temporarily suspended so that time can be spent investigating in detail certain peculiar characteristics observed in obtaining secondary emission measurements on the surfaces. The apparent secondary emission from the surfaces seems to be a function of beam focus and beam position. The question of whether beryllium is a conductor to primary electrons of various velocities is being investigated. The storage

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8.21 Surface Material Characteristics (Cont'd)
(H. L. Heydt and J. H. McCusker)

surface potential distribution resulting from a stabilizing beam is also being studied.

To aid in such studies a set-up which measures secondary emission by measurement of current has been employed in addition to the regular set-up which measures secondary emission by the measurement of charge.

A new research tube is to be constructed which will differ from the conventional research tubes for secondary emission measurements in that it will contain deflection plates. It will thus be possible to make measurements at various points on the storage surface.

8.23 Out-System Circuits
(C. H. R. Campling)

Sufficient experimental work on the proposed output circuits has been completed to make possible a comparison of their merits. A typed draft of the thesis report has been finished. Revisions and corrections are being made now and the final draft is being typed as these alterations are worked out.

8.25 Electrolytic Tank
(S. H. Dodd)

The tank has been set up with electrodes to simulate the penetration of electric fields through the 40 mesh and 100 mesh screens which are used in the storage tubes. Further tests are planned to simulate mosaic surfaces and also the secondary emission research tubes.

8.3 Unclassified
(M. Florencourt)

A pictorial survey of the storage tube program is being prepared for demonstration purposes.

Drawings of storage tubes 11 through 15 have been checked and returned to the drafting room.

The task of cross-referencing notebooks of storage tube group personnel will be started shortly.

8.4 Deflection Circuits
(John O. Ely)

The experimental 32-position deflection-voltage generator has operated approximately 100 hours since the last report (4/20/48).

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8.4 Deflection Circuits (Cont'd)
(John O. Ely)

A complete set of 7AK7's out of the new batch was installed at approximately 50 hours, along with an elapsed-time meter to record filament hours. Filaments are not left on (except for very short periods) without plate voltage on the unit. The unit was placed on extended operation test Thursday, May 13, using the counting scheme described below to insure that all tubes except read-out gates operate at a duty factor of 50%.

During the past two weeks mixing circuits were constructed to allow operation of the decoder as a scale-of-32 counter. This is done by using the read-out gate of each section as a high-speed carry gate to feed the cathode of the flip-flop and control-grid of the read-out gate in the next-larger increment switch. It was found that a screen-grid voltage of ± 120 and a plate voltage of ± 250 were required to secure sufficient output from the gate tubes.

A series of photographs of the output waveforms has been started. These photographs will be taken at frequent intervals to furnish a record of any changes which occur in output amplitude during the extended-operation test period.

The gated voltmeter mentioned in the last bi-weekly report has been constructed in bread-board form and partially tested. It appears that amplitude measurements of any 0.1 μ sec. section of a complex voltage waveform can be made to within $\pm 1/2$ volt or better over a range of from ± 40 to ± 200 volts. No careful voltage measurements of the output of the deflection-voltage generator have been made yet, but this series of measurements should be started next week.

Construction of the second deflection-voltage-generator (horizontal coordinate) will be completed this week except for installation of resistors in the output amplifier stage and 1N38 crystals in the a-c coupling circuits of the buffer amplifiers. These components have been ordered but have not been received to date. Tests on this second unit must be deferred until 7AK7 tubes are received for the 18 positions which require this type.

The control planned for demonstration and test purposes will require three dual gate-and-delay units, two push-button pulse generators, two pulse mixers, and two 5-digit coders in addition to the display 'scope and switching equipment. Twelve different 'scope presentations will be supplied by this equipment.

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(E. S. Prohaska)

The Boeing rudder pedals and pilot's seat (now in Building 32) have been purchased from Boeing, and a B-29 control column ordered from Spencer Aircraft Industries in Seattle, Washington. Some progress is being made in the analysis of the tachometer drive stresses. We are at present attempting to determine the maximum loads sustained by the drive when the column is driven into "stops" of different stiffnesses at full speed and under maximum differential pressure on the "force-loading" piston.

9.13 Control Force Loading.

(C. G. Eaton)

The demonstrator has been operating for the past two weeks. The mechanical backlash, friction, etc. that existed has been cleaned up as well as possible using the present components.

At present the servo amplifier is not performing well, and it appears that the trouble lies in the parallel T network.

Any major improvements in the demonstrator call for redesign of electrical and mechanical components.

9.2 Sampling Servo Stability Study.

(W. Linvill)

The problem of stability analysis and design of a servo fed on intermittent data can be handled by the familiar methods of studying continuous systems provided that the switch and its associated circuit is treated as a linear system plus a noise source. The method for obtaining the transfer function and the noise function has been worked out in detail and applied to one simple example. The advantage of this scheme of analysis over that used by Hurewicz is that it is simple enough to be used in design and allows all the techniques of continuous servo design to be used directly. Further the output is given continuously in time rather than at discrete instants. This design method will be derived and described in a report now being prepared.

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10.0 TRAINING

10.1 Seminar Series

(R. P. Mayer)

The present mathematical seminars by Professor Franklin are being written-up and issued by E. Reich.

Earlier seminar write-ups are again delayed by more urgent matters.

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(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>No. of Draws.</u>	<u>Date</u>	<u>Author</u>
E-115	Testing and Modification of Bus Driver Circuit BA-1	4	3	5-5-48	R. H. Gould
E-117	Filament Power Panel	1	1	5-6-48	R. H. Murch
E-119	Standard Pin Connections, Power Connector WWI	1	-	5-11-48	H. S. Lee
M-384	Discussion of Proposed Flip- Flop Register	3	1	4-28-48	H. Kenosian
M-385	Variable-Frequency Clock- Pulse Generator, Model 2	1	1	4-26-48	H. Kenosian
M-386	6345 Personnel, Barta Bldg.	1	-	5-2-48	Mrs. E. Weil
M-387	WWI Video Cabling	1	-	4-29-48	H. Fahnestock
M-388	Time Pulse Distributor, Counter Panel; Design Changes	1	-	4-30-48	H. Fahnestock
M-389	Bi-Weekly Report, Part I, April 30, 1948	18	-	4-30-48	
M-390	Bi-Weekly Report, Part II, April 30, 1948	19	-	4-30-48	
M-391	Painting of Panels for WWI	3	-	4-30-48	C. W. Watt
M-392	Signal Plate Assembly for ST-26 (Second 5" Storage Tube)	1	-	4-30-48	R. Shaw
M-393	Signal Plate Assembly for ST-27(Third 5" Storage Tube)	1	-	4-30-48	R. Shaw
M-394	Conference with Eastman at MIT, April 21 & 22, 1948	5	-	5-3-48	(H. R. Boyd D. R. Brown)
M-396	Preliminary Accumulator Test Specifications	5	-	5-5-48	N. H. Taylor
M-398	Cathode-Follower Probe	1	1	5-5-48	D. R. Brown
M-399	Master Clock Drawings	1	-	5-5-48	H. Fahnestock
M-400	Program Counter-Modification of Layout	1	-	5-5-48	H. Fahnestock
M-401	Check Register Checking	2	1	5-5-48	R. P. Mayer

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<u>No.</u>		<u>No. of Pages</u>	<u>No. of Drwgs.</u>	<u>Date</u>	<u>Author</u>
M-402	Panel-Selection Circuit Proposal, No. 2	2	2	5-6-48	E. S. Rich
M-403	Five-Digit Multiplier Cables	2	-	5-6-48	H. Fahnestock
M-404	Relays for Voltage Variation Panels	1	-	5-7-48	C. W. Watt
M-405	Progress Report: Coupling Circuits for a Storage-Tube Output System	2	-	5-10-48	C. Campling
M-406	Cross Index of New England Transformer Co. Numbers to MIT. S7.193 Specification Numbers, and Factory Test Specifications	2	-	5-11-48	H. B. Morley
M-408	Check Register; Layout Changes	1	-	5-12-48	H. Fahnestock
M-409	Time Pulse Distributor, Out- put Panel Video Layout Approval	1	-	5-12-48	H. Fahnestock
M-410	Meeting of the Electronic Group, April 23 & May 7	1	-	5-12-48	S. Dodd
M-411	Control Pulse Delays	2	-	5-12-48	J. A. O'Brien
M-412	Multiplier Failure (Report 1)	1	-	5-13-48	N. Daggett
A-59	Material Control Group	7	-	5-11-48	H. R. Boyd
A-60	Distribution Records	1	-	5-6-48	J. W. Forrester

Library Files

47	Technical Information Pilot, No. U400-458				Library of Congress
70	An Electronic Differential Analyzer				A. B. Macnee
71	Instruction Book for Model LR-3 Combined Heterodyne Frequency Meter and Crystal- Controlled Calibrator Equipment				General Radio Co.
72	Management Engineering in Industrial Research Laboratories				H. A. Martin (Wallace Clark & Co., N. Y.)
73	Pre and Post Analyses generated from June 1947 to date				Reeves Simulation Laboratory
555	Technical Data for Army-Navy Preferred List of Electron Tubes				Navy Department Bureau of Ships

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(G. W. Watt)

The representative of Industrial Products Company delivered two samples of the power connector. With minor modifications it will be satisfactory, and a specification has been written covering it. This will not be issued until final drawings of the connector are received. Meanwhile, preliminary drawings and samples are available in my office.

The following specification sheets were issued by the WWI standards group:

P7.214A	Delay Lines
P7.181A	Terminal strips, Barrier
P7.143B	D-c relays, latching type
P7.061D	Fuses, Indicator Alarm
P7.507	Finishes, WWI

(S. Abbott)

A revised General Index and a Detailed Index have been distributed. In addition, a breakdown of the Detailed Index is available to be used in modifying the existing coding system. Cooperation of holders of Standard Books would be appreciated in making this change.

The following sheets have been approved and distributed:

Delay Lines	P6.214A
Fuses Indicator	P6.061D
Terminals, Turret	P6.183A
Coaxial Cable	P6.211A
Connectors, Coaxial BNC	P6.042A
WWI Test Specifications	S-7.400-1
6AG7 Tubes	S-7.400-2

The following sheets have been submitted for approval:

Delay Lines	P7.214A
Fuses Indicator	P7.061D
D-c Relay Mech. Interlock	S7.143-1
Terminal Strip, Barrier Type	P7.181A
Finish-Panel & Cabinet	S7.507

11.3 Purchasing - Stock

(H. B. Morley)

A registration form is being used to accumulate information for a cross-index file of manufacturers' representatives.

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Completion of the standards information on paper capacitors is being made to coordinate JAN specs with manufacturers part numbers, in order to facilitate uniformity in future procurement.

Following completion of the investigation of silk screen printing process for panels, arrangements have been made with a local concern to perform this work as required.

As pointed out in previous reports, delivery schedules are becoming even more extended, and it is increasingly important that requests for procurement and expediting be received as far in advance as possible.

A representative from a small local transformer manufacturer advised that they are equipped to manufacture to very difficult or special requirements, and would be glad to give detailed information on any inquiries.

(R. M. Fairbrother)

The stock room is at present packing and consolidating material in rooms 014 and 024 preparatory to vacating both of these rooms. Items for which there is a regular demand will be kept in the Barta Building, the remainder will be placed in dead storage. The articles in dead storage will be withdrawn by stock room personnel for the people needing them, but a short advance notification will be necessary.

In an attempt to minimize the number of out-of-stock articles, an inventory of standard items will be taken bi-weekly and those at or near minimum quantities will be reported to Mr. Morley for purchasing.

11.4 Electronic Construction.

(A. Taylor)

The mechanical shop now has orders for 25 gate and delay units, 20 rack power strips, 20 rack power control units, 10 clock pulse generators and tube tester No. 2. Six gate and delay units are now being constructed on a special order. The backlog now contains about fourteen weeks of work.

(F. H. Caswell)

The electrolytic tank is now in operation - plotting equipotential lines to enable study of field characteristics. Scaled electrodes have been constructed to simulate 40 mesh Beryllium mosaic in S.T. 28. Runs have been made investigating penetration of fields through 40 and 100 mesh. Elec-

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11.4 Electronic Construction (Continued)

trodes are being constructed to simulate a griddle surface and allow investigation of the penetration of fields into griddle pockets. Full time of one technician applied to this work. Full time of one technician utilized in servicing and changes in equipment as required by storage tube group engineers. Full time of two technicians used in construction of tubes and jigs. Full time of one technician for mechanical construction. Backlog of work enough to keep technicians well occupied.

(R. K. Murch)

The following jobs and units are in the Electronic Laboratory for construction.

1. Four d-c bench outlet boxes. These are completed except for relays to control +500 volts.
2. Rack power control unit Model 2 Prototype. This unit is completed except for filament transformers.
3. Horizontal coordinate of deflection voltage generator. This unit will be completed by the first of next week.
4. Tests on filament transformers for WWI. Tests should be completed by the first of next week.
5. Divide control prototype WWI. Terminal board for this unit is under construction. Aluminum panel is 1-1/2 weeks behind schedule due to lack of drawing.
6. Flip-flop breadboard.
7. Sixty d-c patch cords.
8. Special add memory prototype WWI. This unit will not start May 15 as indicated on time schedule C-31659. Layouts have not been completed.

The work load for the Electronic Laboratory is as follows:

Two WWI prototype technicians have work scheduled for fourteen weeks. The other eight men have a work load of about one week.

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(A. M. Falcione)

Layout drawings which are used for drilling templates on panels. Attention is invited to the fact that on the recent video layout for the Divide Control circuit drawing R-31718, the actual dimension on the blue line print was off 1/16 of an inch from the tracing, which is due to weather and/or paper conditions. It is, therefore, necessary that all mounting holes for panels be measured, and the blueprint should not be used for a drilling template for these matching points.

Sepias from Sylvania. It has been noticed that sepias and change notices from Sylvania recently received are not very legible. Mr. Wainwright was informed of the situation and he agreed that this condition should be rectified. All sepias received from Sylvania which are not legible are being returned for legible replacement. An agreement was made with Mr. Wainwright to instruct their ozalid operator on the proper procedure for making sepias and some time during the coming week their operator will spend several days here for this purpose.

It is expected that soon all drafting room personnel will be consolidated in Room 156. It is planned to move Messrs. Graff, Lovett, and Greaves from the second floor at that time. New drafting tables, which have been ordered, should be received during the coming week, and the drafting room will be consolidated as soon as they arrive.

11.6 Unclassified.

(A. Taylor)

One-third of available machine shop time is taken up with storage tube parts manufacture. The prototype of the circuit probe is being made. The backlog contains about 28 manhours of work.

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12.0 GENERAL

(Jay W. Forrester)

NEW STAFF PERSONNEL

Dr. Hans Klemperer has recently joined the Project Whirlwind staff and is working in the Storage Tube Group. He received his Master of Science and Doctor of Science Degrees from Berlin and Aachen Institute of Technology in 1928 and 1930. Dr. Klemperer was a section head and project engineer at Raytheon where he has been employed for the past nine years, before that being at R.C.A., Westinghouse and Harvard.

(H. R. Boyd)

NEW NON-STAFF PERSONNEL

Mr. Richard Corsine is an electronic technician working under Walter Rogers. He attended Boston University and served for two years in the U.S. Navy.

Miss Alice Monroe is an engineering secretary who will be working for the storage tube group. She graduated from the University of New Hampshire and served in the WAVES for three years.

Mrs. Kathryn Nicol is a librarian working for Mr. Ulman. She graduated from Texas State College for Women. Her husband is studying at MIT under the auspices of the Navy.

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