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Memorandum M-790

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Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART II, February 18, 1949

From: Jay W. Forrester

To: 6345 Engineers

6.0 MATHEMATICS

(P. Franklin)

Organized a ballistic problem and solved a problem on approximation E-194.

The mathematics section is principally engaged in working up codes for various practical applications.

(E. Reich)

The various portions of the code for the ship location problem are being fitted together, and a consistent notation for storage positions is being devised together with P. Rabinowitz.

A paper by G. B. Dantzig dealing with a logistics problem, and entitled, "Programming in a Linear Structure", is being studied. Some of the mathematical detail seems to be in error.

Certain results obtained for the Gauss-Seidel method have been modified to take into account the possibility of non-real characteristic roots.

(T. W. Hildebrandt)

Work is being done on the coding of the Runge-Kutta method in connection with the solution of the ballistic problem.

(P. Rabinowitz)

Coding of the ship location problem is nearing completion. The code will contain between 300 and 400 orders.

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6.0 MATHEMATICS (cont)

(M. Daniloff)

The application of machine calculations to the solution of "optimum proportions" eigen-value problems was studied (partly in cooperation with Mr. G. Welchman). Vibration and stability problems in which the elastic constant is a function of the independent variable were specially considered as being particularly important for the applications.

The problem of target location in the plane from one fixed transmitter and two mobile receivers has been coded up completely. The code uses 32 storage registers and 119 orders. This calculates the radius vector of the target as well as the sine and cosine of its azimuth. The count does not include the subprogram for finding the square root (Cf. C-77).

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7.0 INPUT AND OUTPUT

7.4 Magnetic Recording

(G. Cooper)

The research on magnetic recording has been discontinued. An engineering note has been written describing the work done on this subject.

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8.0 STORAGE TUBES

8.1 Tube Construction and Testing

8.11 Tube Construction and Processing

(M. I. Florencourt)

Construction and processing memos have been issued for the following tubes:

ST67	E-193
ST71	E-196
ST64	E-198
ST51	E-199

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

The fifteenth storage tube, ST71, in the beryllium mosaic-on-mica series was processed and turned over to the test group. This may be the last storage tube using our original type of target assembly.

A new and more compact target assembly is ready for a new series of storage tubes. This assembly was necessary for storage tubes using a glass storage surface instead of mica. We have now prepared Be mosaics on five glass targets. No difficulties were encountered during the evaporation process.

The first storage tube, ST51, in the beryllium mosaic-on-glass series using the new target assembly was processed and turned over to the test group. A second tube in this series will be processed next week.

The first storage tube, ST64, in the beryllium mosaic-on-mica series using the new target assembly was processed and turned over to the test group. A second tube in this series will be processed next week.

In the first type of target assembly it was difficult to put the screen closer than .015 inches to the storage surface. When we made our first tubes with the new target assembly we reduced the spacing between screen and storage surface to .010 inches. The second tube in the series will have a spacing comparable to the spacing in the old assembly for purposes of comparison.

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A program has been started to tape all of the storage tubes with Scotch electrical tape to protect personnel from implosions.

(R. Shaw)

The most practical method for shatterproofing storage tubes appears to be wrapping with electrical Scotch tape. This method was tested on a six-inch diameter envelope and considered satisfactory. The protection is therefore being applied to all existing tubes. A plexiglass shield is being made to protect the operator while applying the tape.

A study is being made of methods of measuring the thickness of the beryllium mosaic.

The storage tube drafting group has been making modifications that have been found necessary in the storage tube using a glass storage surface. Work has also been done on a tube processing oven, mountings for storage tubes in WWI, illustrations for memoranda, and nomograms for the solution of frequently used formulas.

(J. S. Palermo)

Mechanical components. - The supply of glass plates for the Be-on-glass type of storage tube has been exhausted with the construction of ET124 and ET125. The procurement of additional surfaces has been postponed until we get the results from our present series of Be-on-glass storage tubes. The type of glass, and the surface finish desired, will be determined within the next fortnight.

The status of all other components remains satisfactory. Additional mica of a less perfect grade will be procured shortly to eliminate the use of good mica for shims and spacers.

A new supply of support rings for the new target design has been received. This lot of rings has been produced by a spinning operation, using flat stock. The resultant ring eliminates the necessity of a welded joint and produces a uniform and well-finished ring.

(W. E. Pickett)

Glass components - During the last period we constructed evaporating envelopes from a 7" CRT nonex glass blank. It is

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planned to change to these envelopes as soon as possible. The flat press stems on hand are enough to carry us through the next month. No decision has been made as yet about the local vender's flat press stems. The local vender has sent us an additional 25 stems, which on a visual check, seem to be suitable for the construction of evaporating tubes.

Some difficulty was encountered with the ten pin stems made on the new stem die. There are enough ten pin stems on hand now made from the old die, so that no slacking of the program should result.

There are on hand envelopes for two complete storage tubes. This is a low inventory, but as most of the planned glass activity for the coming period will be centered on increasing this item no delays should result from lack of envelopes.

On hand in the glass shop are two completed evaporating tubes for processing. One of these tubes is the new 7" CRT type using the new surface mounting and having a pyrex glass disc for the target.

(E. S. Prohaska)

Work on the design of a new cylindrical oven has been temporarily discontinued to permit the design of a storage tube mounting assembly.

The polarizer of the polariscope has been assembled and tested. Difficulties with the glass for the analyzer have delayed the testing of the analyzer and the complete polariscope.

A three-phase 110 volt outlet will have to be provided in the vicinity of the glass working lathe to energize the lamps of the polarizer.

(H. Rowe)

Spot Welder - The new thyatron control for the IKW AC spot-welder was tested and adjustments made to insure proper operation. The control panel is now installed and applied for the heavier welds in construction of storage tubes.

8.12 Tube Testing

(H. Klemperer)

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Construction work - During this period construction work was

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8.12 Tube Testing (Cont'd)

in the foreground of S.T. Test Lab. activities. Since we now have a rather steady supply of well operable storage tubes coming it is necessary that emphasis be shifted from component research to Quality test and Life test. In addition, experiences with the storage tube reliability tester show that it requires a three period automatic write read schedule to which our High Rep. Rate Unit has to be adapted.

Construction and design work as outlined is well under way, with first priority being given to the requirements of the reliability tester, and second priority being held by the S.T. Life test setup.

Quality and Life Testing - With the present limited equipment, life testing was continued. ST48, with about 900 hours of life, developed a signal to noise ratio of 2:1 on the worst spot on the surface, which coincides with the center of the holding beam.

Quality tests of ST67, ST71 and ST64 indicated the need for closer investigation of the mechanical forces acting between the collector and storage surfaces under various conditions of charge distribution. The program was outlined and work started in cooperation with the tube construction group.

Studies of surface leakage on the Beryllium on Glass mosaic lead to the suggestion of temporarily abandoning mosaics extending right to the edge of the dielectric plate. Such plates are being held by the tube construction group for later investigation, when properties of glass as a dielectric are better known.

Component Research - Work on high velocity gun models with the electrolytic tank as well as beam velocity and distribution measurements with the analyzer tube were temporarily postponed.

(A. H. Ballard)

During the past two weeks, four new tubes were received from the construction group and were given initial tests in the television setup.

ST67 is the 14th tube in the Be-on-mica series. As in some of the previous tubes in this series, several small spots on the surface appear to stay at collector potential at all

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8.12 Tube Testing (Cont'd)

times. On the hypothesis that some foreign particle had become lodged between collector and mosaic, the collector was forced into vigorous oscillation at its natural frequency to free any such particle. A subsequent view of the surface showed the dark spot at the center to have disappeared but the ones at the edge remained, probably because the amplitude of vibration was smaller there.

There are several areas of high surface leakage in ST67, principally at the edges. A spot written there becomes large and irregular.

ST71 is the 15th Be-on-mica tube. There is a tadpole shaped area near the center where the mica has buckled and may be in contact with the collector. Although spacing is closely checked during construction, it must be remembered that attractive electrostatic forces exist between these electrodes during tube operation. It may be necessary to reinsert the spacer bead which was used previously. With the exception of the area named, storage seems excellent in ST71.

ST64 is the first tube using a beryllium on glass storage surface. The usable range of holding gun voltage is 185V-250V compared to 75V-250V for the mica tubes. The lower limit depends upon surface characteristics, while the upper limit seems to depend somewhat on collector-to-mosaic spacing.

Surface leakage is very high near the edges in ST64, probably because the Be mosaic was extended to the extreme edge of the surface and is therefore in contact with the collector. Writing positive in this area causes a whole outside ring to switch positively.

ST51 is the 16th beryllium-on-mica tube, and is equipped with the new target assembly, as is ST64. ST51 also has several spots which remain at collector potential. The spots become larger and more numerous with increasing holding gun voltage indicating probable contact due to electrostatic attraction. At $V_{HG} = 100V$, this effect is not visible and storage is quite reliable and uniform.

(C. L. Corderman)

Work has been done on a Life Test Unit for storage tubes. The unit will accommodate eight storage tubes, include TV viewing, and provide for setting up an aging

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8.12 Tube Testing (Cont'd)

condition of one half of the surface positive with a TV scan applied. Pending delivery of meters and tube shields the unit may be operating within two weeks.

(N. S. Zimbel)

High Repetition Rate Write-Read Unit - Storage tube life tests with this equipment were suspended in order to make the high speed unit available for testing storage conditions as indicated by the TV setup. ST57, which has been on life test, had operated for a total of 695 hours. A particular spot was subjected to the high energy electron beam for about 176 hours of the above time.

Considerable progress has been made toward procurement of the equipment necessary for the final form of this unit. The original block diagram has been modified to give the following cycles:

1. W+, W-, R
2. W-, W+, R
3. Manual operation

Delivery of a d-c register panel and a gate panel to be used with the register panel have been promised by the beginning of the week of February 20th. All other components are on hand.

(J. S. Rochefort)

208TV Unit - The prototype video amplifier has been completed and tested. A band width of approximately 3.5 mc has been obtained. Rise and fall times are less than 0.1 μ sec and a gain of 85 db may be obtained with a 3 mv input signal. The amplifier was designed to drive a 70 μ mf capacity with a 50 volt pulse.

The surfaces of ST48 and ST53 were observed with the experimental 208 TV unit. A $2\frac{1}{2}$ inch picture was obtained with horizontal and vertical sweep frequencies of 60 cps and 13.3 kc. Contrast and detail of the images were comparable to those obtained with the Belmont TV unit.

A vertical sweep generator and adapters for horizontal and vertical sweeps are under construction. This panel, together with the prototype video amplifier, will be used with the new life-test rack.

Horizontal and vertical sweep generators and adapters

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8.12 Tube Testing (Cont'd)

have been constructed in breadboard form. The frequency of the horizontal generator is variable between 11 and 20 kc. Both of these units will be constructed on a panel and used with a 208 TV unit in conjunction with the Storage-Tube Reliability Tester. A second video amplifier is being constructed for use with this unit.

(W. J. Nolan)

Power Supplies - A modification of the circuit used in the holding gun power supply has been developed. The new circuit permits the low voltage section to operate down to approximately 30 volts (the exact figure may vary with the tubes used) and to deliver full load up to a maximum voltage of 300. Higher voltages can be supplied at reduced load. Although ripple and regulation are not as low as formerly, they are below 0.1 volt and 1% respectively. In addition, a bias supply furnishing 150 volts at 15 ma has been incorporated in the circuit.

8.13 Storage Tube Reliability Tester

(R. Sisson and J. O. Ely)

The r-f readout system has been installed in the reliability tester, and has been adjusted and tested using ST68. The results of the r-f system are very encouraging. Unwanted transients are reduced to tolerable amplitudes and the exact shape of the signal plate switching pulse is not critical, which was not so with video readout.

ST68 was removed to allow it to be coated with silver paint. It is felt that this will reduce r-f pickup problems.

In the meantime ST60 has been used. The amplitude and timing of the output signals were satisfactory with this tube only when reading at one point. A 16 x 16 array did not read out well at all points.

The system has been modified to produce a write +, read, write -, read cycle, which may aid in discovering the causes of unsatisfactory operation over the surface.

A TV test setup is being constructed to use with the reliability tester which will be of great value in studying the problems now delaying this part of storage tube testing.

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8.13 Storage Tube Reliability Tester (Cont'd)

(J. A. DiGiorgio, Jr.)

The gun end of the storage tube mount was revised for r-f read-out.

Three separate Blocking-Oscillator stages were built in bread-board fashion to be used as the clock to replace the A/R 256-B scope for extended operations.

The control and deflection display cable was pre-fabricated, also two special d-c power cables.

At present a video amplifier (designed by J.S. Rochefort) for a TV unit is under construction.

8.2 Storage Tube Research8.23 Output System Circuits

(C. H. R. Campling)

The completed r-f pulser has been turned over to J. O. Ely and is being used at present in the reliability tester.

A second pulse is now being constructed for use in the ST lab. The operation of this new circuit will not be greatly different from the original. There will be some changes in the circuit and layout, however, and an entirely different phase shift circuit will be used. All the tank circuit coils for this unit have been wound and the assembly has been started.

8.3 Unclassified

(M. I. Florencourt)

Visitors to the Storage Tube Group during the past fortnight have been Messrs. C.F.A. Wagstaffe, A.W. Lines, and E.B. Callick of the British Joint Services Mission; J.M. Richardson and M.C. Long of ONR, Washington, D.C.; R.J. Bergemann and R.W. Hart of ONR, Boston; and Prof. Nottingham of MIT.

8.4 Deflection Circuits

(L. J. Nardone)

A time schedule has been set up including the design

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8.4 Deflection Circuits (Cont'd)

for the final testing of the WWI Deflection Circuits. According to this schedule, the final testing should be completed in the first half of October.

Layouts of the increment panels and the indicator panel are completed except for minor details which are dependent upon the design of the output amplifier. Design and preliminary testing of a bread boarded output amplifier should start in the near future. All schematics, excepting that of the output amplifier, are being drawn up at present.

Design and layout problems that have been, or are being, considered are as follows:

1. Methods of marginal checking
2. Power plug connections
3. Overhead lines for the transmission of restorer pulses, clear pulses, etc., throughout the panel
4. Feeding of storage tubes from the output amplifier through various types of lines, including:
 - a) Unterminated RG 62/u cable
 - b) Terminated RG 62/u cable
 - c) Special transmission line

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11.0 FACILITIES AND CENTRAL SERVICE11.1 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>No. of Drwgs.</u>	<u>Date</u>	<u>Author</u>
R-143	Specifications for Standard Test Equipment	28	-	1-18-49	R.R. Rathbone
R-153	Electrostatic Storage Tubes for Digital Computers and Other Information Processing Systems	16	16	1-24-49	J.W. Forrester
E-185	Beryllium Strip Tubes, Test Results on RT 37, RT38, and RT41	10	22	12-16-48	J. McCusker
E-187	Influence of Ions on Holding Beam in Storage Tubes	4	1	1-28-49	H. Klemperer
E-189	A Method of Determining Tube Types for Digital Computers	4	1	2-2-49	H. Kenosian
E-191	Research Tube RT50: Construction and Processing	2	-	1-31-49	M. Florencourt
E-192	Testing of Storage Tube ST69	2	-	2- 9-49	H.E. Rowe
E-193	Storage Tube ST67: Construction and Processing	3	-	2-9-49	M. Florencourt
E-194	Vertical Parabola through n- Points	2	-	2-14-49	P. Franklin
M-768-1	Navy Logistics: - Note for Members of the ONR Committee Studying the Application of Computers	7	-	2-4-49	W. Welchman
M-774-1	Tube Conferences - January 31, 1949	2	-	2-7-49	E.S. Rich
M-775	Bi-Weekly Report, Part I, 2-4-49	14	-	2-4-49	
M-776	Bi-Weekly Report, Part II, 2-4-49	16	-	2-4-49	
M-777	Control Switch Output Drawing Changes	1	-	2-4-49	H. Fahnestock
M-778	WWI Production Engineering Assignments	2	-	2-8-49	C.W. Watt
M-779	Testing of Storage Tubes ST40 and ST48	7	-	2-1-49	C. Corderman
M-780	Study of Checking and Trouble Location Methods	2	-	2-10-49	J.W. Forrester
M-781	Progress Report: A Dual-Triode Capacitively-Coupled Flip-Flop	2	-	2-10-49	M.H. Hayes
M-783	Envelope Daggging	2	-	2-10-49	J.S. Palermo

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6345 Reports (Continued)

<u>No.</u>	<u>Title</u>	<u>No. of Pages</u>	<u>No. of Drvs.</u>	<u>Date</u>	<u>Author</u>
M-784	Test Controls	1	-	2-14-49	R.R. Everett
M-785	Progress Report: The Solution of Power Network Performance on Large-Scale Digital Computers	3	-	2-14-49	P.A. Fox
M-786	Physical Electronics Seminar - February 9, 1949	2	-	2-15-49	E.S. Rich
C-81	Solution of Problems Stated in C-78	5	-	2-14-49	W. Welchman
C-86-1	Applications Study Group Working Notes, January 4 to January 11	4	-	1-6-49	W. Welchman
C-94	Example of Coding Procedure	11	-	2-14-49	W. Welchman
C-95	Applications Study Group Working Notes, February 8-15	2	-	2-11-49	W. Welchman

Library Files

.004	European Scientific Notes, 1 January 1949; 1948 Index				London ONR
51	Tracerlog, February, 1949				Tracerlab, Inc.
52	Progress Report for WWI Electronic Digital Computer for Period January 15, 1949 - January 28, 1949				Sylvania
52	Progress Report for WWI Electronic Digital Computer for Period January 29 - February 11, 1949				Sylvania
180	Index to Document Office Bulletins, Volume II				{ Research Lab of { Electronics, MIT
180	Document Office Bulletins; February 1, 1949; February 15, 1949				{ Research Lab of { Electronics, MIT
183	Proportional Displacement Remote Control Study and Development Final Report, Period July 1, 1948 to July 31, 1948				{ Air Associates { Incorporated Cornell Aero Lab
217	The Flight Signal Decoder, November 1948				{ Oklahoma A and M { College
231	Operation and Evaluation of Beacon Triangulation System and Ionosphere Beacon System; Dr. H. E. Harrington				{ Oklahoma A and M { College
232	<u>Physics Today</u> , February 1949				
233	AN/APN-58, Control, Guidance, Radar Homing, Activity Report September - October 1948				{ Consolidated { Vultee
234	DOVAP - Instrumentation and an Analysis of Operational Results; November 16, 1948; A. L. G. deBey, E. D. Hoffleit				{ Ballistic { Research Lab
235	Interim Report on Investigation of Possible Methods for Measuring Air Speed Through the Transonic and Supersonic Range				{ Franklin Inst. { Labs for Research { and Development
236	Improvements in the Characteristics of A-C Lead Networks for Servomechanisms; D. McDonald				{ Aeronautical { Research Center
237	Project Rand: U. S. Air Force - A Statistical Theory of Target Detection by Pulsed Radar: Mathematical Appendix, July 1, 1948				Rand Corp.
238	A Survey of the Theory of the Boundedness, Stability, and Asymptotic Behavior of Solutions of Linear and Non-Linear Differential and Difference Equations; January 1949				{ R. Bellman, Math { Dept. of Princeton { for ONR

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Reports and Publications (Continued)

<u>No.</u>	<u>Title</u>	<u>Author</u>
	Radio Amateur's Handbook, 1948 Edition	(American Radio { Relay League

Book

11.2 Standards Committee

(H. B. Morley)

At the last standards meeting, production schedules and their bearing on procurement of standard and WWI components was discussed. Also several new items were selected for inclusion in standards, which will appear in revisions now being prepared.

Revised standards issued:

Detail Index - Breakdown

11.3 Purchasing and Stock

(H. B. Morley)

Quotations received from a new transformer manufacturer indicate unusually low prices for special transformers. An investigation of the company and their product is being made to determine quality and reliability prior to placing any orders.

This office is now originating an increased quantity of Work Orders for special WWI components which were formerly supplied by Sylvania. The principal difficulty experienced to date has been to determine what raw material Sylvania has available for fabrication of these components. They have agreed to supply all material on hand, but it has not been received to date.

New Products and Items of General Interest: Industrial Products Company has available many types of coaxial connectors not shown in their catalogue. Special requirements should be brought to the attention of this office, since it may be possible to locate a stock item to fill the need. Industrial is also going to supply us descriptive literature on high-voltage BNC and multi-pin connectors with ratings of 3000-5000 volts.

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11.3 Purchasing and Stock (Continued)

Cro-name, Inc. can supply all types of name-plates, dials, markers, etc., with special etched markings and legends. They will give special attention to small orders.

Welwyn Electronics has a line of sub-miniature variable capacitors which appear to be exceptionally well made for their size.

(R. Fairbrother)

Sylvania has furnished about 98% of the materials necessary to complete construction of the following units:

- Register Driver Type II
- Operation Matrix Drivers
- Control Switch
- Storage Switch
- Check Register/Comparison Register
- Program Counter
- Clock Pulse Control
- Voltage Variation Panels (10)
- Toggle Switch Storage Output

Relays for 63 additional voltage variation panels plus miscellaneous small items will arrive later. As parts lists are checked, material which was omitted from Sylvania's shipments is referred to them for supply. If they cannot supply it, then we must arrange either for its purchase or manufacture. To date there have been no shortages that have caused delays.

11.4 Electronic Construction

(A. R. Curtiss)

Work was done on one Protect-O-Vac unit.

Changes were made in a switching unit, and one holding gun power supply was modified.

A TV sweep adapter was constructed and the TV mounting rack was worked on.

The electrolytic tank with associated equipment was moved to the basement, Room 006.

Work is now being done on the storage tube life test assembly.

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11.4 Electronic Construction (Continued)

(A. Taylor)

Except for cases in which part shortages exist, all construction is now on schedule.

Now under construction for WWI are: voltage variation panels, operation matrix driver, and register driver type II units.

11.5 Drafting

(A. M. Falcione)

Oxalid machine - Considerable delay in our print room operations is caused by low line voltage which causes Oxalid machine shutdown. Bob Weiser is now working on this problem.

Work load - The work load has increased and will be quite heavy for the next few months on WWI assembly drawings and related parts. Schedules have been made and all efforts will be made to meet the requirements.

11.6 Unclassified

(L. Prentice)

Sheet Metal and Machine Shop. Sheet metal work is now in progress on panels for WWI. Test equipment panels and chassis work has been completed as scheduled to date.

All of the back-ordered engraving work is complete.

The work load in the machine shop has been somewhat less. We have taken advantage of this fact to overhaul the equipment. The 10-inch lathe has been overhauled and work is currently in progress on the 13-inch lathe.

The lining up of 100 H.P. motor generator set is completed and overhaul of motor exciter is nearly complete.

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12.0 GENERAL

New Staff Personnel:

Donald H. A. Hageman has joined the Project as a Research Assistant and will be working in the test group. Mr. Hageman attended Northwestern University and received a Bachelor of Science in Electrical Engineering in March 1948.

New Thesis Students:

James E. Pierson
John F. Waymouth

Naval Officer Assigned to Laboratory to Study Digital Computers:

Lt. Thomas J. Christman

New Non-Staff Personnel:

Wallace R. Johnson is a student-technician working under the supervision of Al Taylor. He attended M.I.T. and was graduated from Quincy High School, and served for two years in the U.S. Army. He will re-enter M.I.T. next fall.

Robert H. Youden is also working in Al Taylor's group as a student technician. He was graduated from Hicksville High School, Hicksville, New York, after which he studied electrical engineering at M.I.T. He served as a Radio Technician 3/c in the U.S. Navy. He will also re-enter M.I.T. in the fall.

Terminations

Lawrence Martin

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