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Memorandum M-616

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Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, MassachusettsSUBJECT: BI-WEEKLY REPORT, PART II, September 17, 1948

To: 6345 Engineers

From: Jay W. Forrester

6.0 MATHEMATICS

(E. Reich)

The study of methods for the numerical solution of partial differential equations is being continued. A scheme for obtaining a solution to Laplace's equation in two dimensions is receiving attention at present.

A summary of the work of the Mathematics Group has been prepared for the August Summary Report.

(J. W. Carr)

An investigation of round-off error using a consistent round-off "up" and consistent round-off "down" (rounding off all positive numbers up, and all negative numbers down, for instance) was made in an attempt to have the machine determine its own round-off maximum error. This is not yet determined to be possible, but will be further investigated.

Planning of a program for full matrix manipulation under sub-programming is also under way.

(M. Daniloff)

A seminar lecture was given to the mathematics section on the subject: "The use of differential inequalities for establishing bounds on the approximate solution of ordinary differential equations of arbitrary order."

Engineering Note M-142 entitled "The Mechanism of Secondary Emission from the Inner Regions of Ionic Crystals" was completed and distributed to the members of the Storage Tube Group.

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6.0 MATHEMATICS (cont.)

(M. Daniloff)

Since the electrical capacity of a mesh is appreciably smaller than that of a plate, a study of the deflection of an individual wire of the grid of the electrostatic storage tube has been started. In contradistinction to calculations previously made (Cf. Memo. M-216) the bending stiffness of the wires is being taken into consideration (a most significant factor), as well as the fact that for the direction in which the deflection actually takes place, the individual wires are in effect "fixed" at the supports. The significant factor of the stretch of the wire is also considered.

(A. Orden)

The write-up of my report on coding for simultaneous equations was completed.

(P. Rabinowitz)

A seminar on numerical solution of differential equations was presented to the mathematics group.

A code was prepared for systems of the special differential equation type $y'' = f(x,y)$ which saves 50% in time with but small increase in code length in comparison with the standard Runge-Kutta Method.

(A. J. Perlis)

A report on numerical methods of solving linear integral equations has been completed. The purpose has been to survey existing methods as well as to postulate others which may prove valuable.

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7.0 INPUT AND OUTPUT

7.1 Eastman Kodak Recorders

(H. R. Boyd)

Eastman expects to have a second breadboard mechanical assembly in operation this week. This assembly incorporates all of the latest mechanical design changes, and, if it performs satisfactorily, will serve as the production prototype for the film drive.

The final layout and design of the electronic assemblies is partially completed. It is expected that the entire design will be frozen on October 1 and delivery on two units made in March, 1949. J. A. O'Brien and I expect to visit Eastman during the next two weeks. We should like to be informed of any changes or questions on the Eastman units.

7.4 Magnetic Recording

(E. S. Rich)

Laminations for constructing magnetic heads are being heat treated and should be available within a week. A jig for cutting the gaps and stacking the laminations is being made up.

(Gerald Cooper)

The final models of the gated multivibrator and the recording amplifier have been constructed and their operation has been checked. The reading amplifier has been designed tentatively. It will be constructed as soon as those components which have been ordered are received.

7.6' Output Printers

(F. A. Foss)

Memorandum E-141, which proposes several modifications in the design of the teletype demonstrator input and output devices, has been completed. The principal cause of printing errors it is felt will be eliminated by raising the level of operating current through the transmitter distributor segments and relay contacts. Control operations would also be simplified.

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

(E. S. Prohaska)

A proposal for new equipment for the anodizing system has been submitted to P. Youtz. It includes a new stand, automatic temperature, and automatic current control, as well as automatic recording of temperature, current, and voltage.

Visits were made to Kinney Mfg. Co. and National Research Corp. in company with T. Clough to discuss equipment available for the design of high-speed, high vacuum systems, and the feasibility of using a demountable system. National Research claimed that they had reached 2×10^{-7} mm Hg with a demountable glass bell jar system (untrapped). This indicates that a demountable system for evaporation is feasible.

Design work on the ovens is still in the rough layout stage.

A calibration curve has been run on a Kovar-Tungsten thermocouple made from a different spool of wire. It checks the first curve quite well.

(R. Shaw)

An evaporation tube having a crucible enclosed in ceramic was considered unsatisfactory because of the difficulty in de-gassing the large volume of ceramic.

A modification employing metal radiation shields was more successful. Two tubes incorporating this feature have been built, and a third is under construction.

A study is being made of the possibility of electrolytically polishing aluminum signal plates before anodizing.

(H. Klemperer)

An evaporation cup for beryllium evaporation was

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8.11 Tube Construction and Processing (Cont'd)

designed and built which centers around a free standing tungsten heater with concentric double tantalum heat shields. The cup was operated at 4 volts 21 amperes.

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

A third five-inch storage tube with a beryllium mosaic, ST 37, has been constructed and processed. The tube is now ready to be tested. The coating of the beryllium mosaic in this tube is thicker than any of our previous mosaics. Also we used a thin aluminum sheet reflector to protect the mosaic during the glass-working stage. As a result the temperature of the mosaic did not exceed 125° C during this operation. Otherwise the tube was processed similarly to other tubes. The holding gun current was twice as great as the current of our best previous holding gun.

Two evaporation tubes designed to give thicker coatings of beryllium mosaics have been constructed and processed. We studied and recorded the thickness of each coating with microscope slides placed along the evaporation target. We will continue to design new evaporation tubes to produce thicker, more uniform, and reproducible beryllium mosaics.

We have scheduled two five-inch storage tubes. One has a calcium tungstate surface and the second has only the aluminum oxide surface. The test group requested these tubes for comparative test purposes.

8.12 Tube Testing

(C. L. Corderman)

Further tests on ST 29 revealed that when approximately 400 positive spots on a negative background were on the surface, the tube went into oscillation. This was evidenced by an audible oscillation, as if the collector was vibrating, and simultaneously a sine wave of 1.5 volts RMS appeared between signal plate and ground. The frequency of this sine wave was about (cont'd on next page)

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8.12 Tube Testing (Cont'd)

170 cycles for a collector to cathode voltage of 500 volts, the frequency being inversely proportional to collector voltage between 400 and 600 volts. Near these limits of collector voltage, the oscillation gradually died out. A satisfactory explanation of this phenomenon has not as yet been given.

A memorandum covering the tests on ST 29 to date is being prepared.

(J. S. Rochefort)

Memorandum M-611, "The Dispersion of the Holding Gun Beam within the Collector-to-Target-Surface Field", has been issued.

A memorandum covering tests performed on ST 32 between July 12 and August 20 is still in the preparation stage. It is expected that preparation of this memo will consume more time than previous ones because an attempt is being made to correlate all data with existing theories.

ST 30, a 5" Be mosaic tube, has been tested. Tests performed on this tube have revealed a holding gun cathode current of 0.6 ma with 1000V on A₁. The holding beam only covered a segment of the storage surface. At an accelerating voltage of 700V on the collector, and the signal plate at ground potential, arcing was noted between the spacer ring and the signal plate. Gas pressure measurements on the tube have revealed an approximate pressure of 8×10^{-6} mm of mercury.

(S. H. Dodd)

Automatic read-write equipment has been set up and some of the equipment is operating. A bad 5687 in one of the G & D units gave undependable operation until replaced. It is expected that this equipment will be operating satisfactorily next week. The push-button panel being designed by Kenosian would help this setup materially.

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8.13 Storage Tube Demonstration

(R. Sisson)

ST 18 and ST 15B were tried in the demonstrator and results identical to previous ones on these tubes were obtained.

ST 29 was placed in the demonstrator. Storage operation was found possible, but not very reliable. As many as 150 positive spots were written on a negative surface and observed with the TV setup.

The effects of the holding gun cathode potential on the surface charges were observed on the TV setup in ST 29, ST 30 (5" tubes), and ST 23 (a Mica Surface). Of these only ST 29 appeared to give "normal" results.

Attempts are now being made to devise test procedures using the demonstrator which will give more information about storage tubes.

8.2 Storage Tube Research

8.21 Surface Material Characteristics

(N. S. Zimbel)

Stability and auxiliary tests are being run on RT 39. A 15 Eimac was attached to this tube in order to obtain the constant for an RT tube which will enable the pressure to be read by direct use of the electrodes. The following formula holds for pressure measurement in such a tube with $A_2 = 1500V$:

$$\text{Pressure in mm Hg} = \frac{\text{ion current (in } \mu\text{a)}}{400 \text{ emission current (in } \mu\text{a)}}$$

The order of magnitude of the constant is correct; however, its value is not exact. It was noticed that the electron beam was visible down to a second anode voltage of 500 volts, which was the lowest value obtainable. The pressure was 1×10^{-5} mm Hg.

It was found that the resistance between various electrodes was relatively low; that of the third anode to beryllium surface being the lowest, varying from $10^9 \Omega$ to $7.6 \times 10^7 \Omega$ over a range of voltage 0 to 500 volts.

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It was also noticed that the silver contacts to the beryllium were in the path of the incident beam. At this writing, difficulty is being encountered in positioning the beam onto the surface for collector to cathode voltages below 150 volts.

(J. H. McCusker)

Further tests were made on RT 38, a beryllium strip tube, to investigate some of the peculiarities in the original data. No conclusive results were obtained.

8.23 Output System Circuits

(C. H. R. Campling)

Layout for the signal-plate driver was completed. Drafting room has completed schematic and layout drawings for this unit, and it is now in the electronics shop for construction.

Further attention has been given to the problem of raising the impedance presented to a signal from the storage tube by the clamp circuit.

8.24 Holding Gun Studies

(H. Klemperer)

Holding gun life test was discontinued and tube dissected. The center portion of the cathode was found to be stripped of emitting coating which was believed to be an effect of ion bombardment.

Difficulties were encountered with subsequently built holding guns due to poor lineup and leakage between elements. The mechanical design was revised and new guns were assembled which partially consist of parts of our own make.

A number of welding electrodes were designed to facilitate the application of our Short Impulse Welder to tube construction.

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8.4 Deflection Circuits

(L. J. Nardone)

All displays on the deflection-voltage generator have operated the past two weeks except "single-pulse operate" which continues to be erratic. Any mechanical or minor defects which occurred were corrected.

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10.0 TRAINING10.1 Seminar Series

(J. M. Salzer, R. P. Mayer)

The regular Block Diagram seminars were held on Sept. 8 and Sept. 15. On Sept. 8, J. M. Salzer discussed the Details of Step Counter Operation, while on Sept. 15, R. P. Mayer explained the Arithmetic Check. The gist of this latter lecture has been written up and hectoed. It will be distributed in the form of a Conference Note, with additional copies available both previous to and during the next seminar. Since the topic of the next Block Diagram seminar (Special Add) is closely related to Arithmetic Check, it is suggested that those attending should familiarize themselves with Arithmetic Check.

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11.0 FACILITIES AND CENTRAL SERVICE

11.1 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 Draws.</u>	<u>Date</u>	<u>Author</u>
R-142	Talk Delivered by Jay W. Forrester at the Modern Calculating Machinery and Numerical Methods Symposium at the University of California, Los Angeles, July 29, 30, and 31, 1948.	7	8	8-31-48	J.W. Forrester
M-597	Television "Readout" of Storage Surfaces Part I: System Setup	3	5	8-30-48	R.L. Sisson
M-602	Standard Power Connectors, WWI	2	-	9-3-48	H.S. Lee
M-603	Trip to David W. Taylor Model Basin, August 31, 1948	3	-	9-3-48	E. Reich
M-604	Bi-Weekly Report, Part I, 9-3-48	17	-	9-3-48	
M-605	Bi-Weekly Report, Part II, 9-3-48	17	-	9-3-48	
M-608	Progress Report: Trouble Location in a Large-Scale Electronic Digital Computer	1	-	8-30-48	G.C. Sumner
M-609	Proposed Five-Digit Multiplier Marginal-Checking Installation	3	2	9-9-48	E.S. Rich
M-611	The Dispersion of the Holding Gun Beam Within the Collector to Target Surface Field	2	3	8-30-48	J.S. Rochefort
M-612	Accumulator Circuit Schematic	1	-	9-10-48	H. Fahnestock
M-613	Digit Interlock and Fixed Voltage Switching Panels, Revision of Schedule	1	-	9-13-48	C.W. Watt
M-614	Authorization of Pass-Out Slips on Saturday Mornings	1	-	9-15-48	J.C. Proctor

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<u>No.</u>	<u>Title</u>	<u>No. of Pages</u>	<u>No. of Drawgs.</u>	<u>Date</u>	<u>Author</u>
<u>Translation</u>					
E-142	Contribution to the Understanding of the Mechanism of Secondary Emission from the Inner Regions of Ionic Crystals - by M. Knoll, O. Hachenberg, and J. Randmer, Zeit. F. Physik, 122, 137-162, (1944)	23	9	8-31-48	M. Daniloff
<u>FB Reports</u>					
60788	Formation of Focussed Space-Charge-Limited Electrons and Ion Beams	14	12	2-10-46	D. Bunemann E. U. Condon A. Latter
60789	Formation of Focussed Space-Charge-Limited Electrons and Ion Beams, Part II, Design of Electrodes	22	27	1-6-47	D. Bunemann E.U. Condon A. Latter
<u>Library Files</u>					
51	Tracerlog, September 1948				Tracerlab
52	Progress Report for WWI Electronic Digital Computer for Period August 14 - August 27, 1948				Sylvania
52	Progress Report for WWI Electronic Digital Computer for Period August 28 - September 11, 1948				Sylvania
73	Pre- and Post-Analyses by Reeves Analysis and Computer Group: 1) August 23, 1948; Post-Analysis of Job no. 15-1 2) August 31, Sept. 2, 1948; Pre- and Post-Analysis of Job no. 9-3 3) September 8, 10; Pre- and Post-Analylsis of Job no. 9-2				Reeves Instrument Corporation
151	The Mechanics of Secondary Emission inside Ionic Crystals (In German-Z.S.F. Physik, 122, 137-162, 1944)				(Von M. Knoll (O.Hachenberg (J. Randmer
152	Servomechanisms Laboratory 6345, Specifications and Standards Components Book; Volumes 1, 2, and 3				
153	The David W. Taylor Model Basin - U. S. Navy Rep. 576				M. Gertler

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<u>No.</u>	<u>Title</u>	<u>No. of Pages</u>	<u>No. of Drwgs.</u>	<u>Date</u>	<u>Author</u>
<u>Library Files (Cont'd)</u>					
154	USAF Technical Report 5659 - Non-Dimensional Equations of Motion				U.S. Air Force
155	A Storage System for use with Binary Digital Computing Machines				T. Kilburn (Radio Technical Commission for Aeronautics Nicholson and McMannus Physics Dept. Cornell Aero. Laboratory
156	Report of SC41				
157	Automatic Air Traffic Control Equipment				
158	Preliminary Survey of Computer Applications to Air Traffic Control				
159	Mathematical Theory of Airport Air Traffic Control				
559	National Bureau of Standards Technical News Bulletin September 1948				(National Bureau of Standards

11.2 Standards Committee

(S. R. Abbott)

The following specs. have been approved and distributed:

- S7.400-5 WWI Test Specs. 7AD7 Tubes
- S7.400-2 WWI Test Specs. 7AK7 Tubes (Revision)
- S7.410-1 WWI Test Specs. 301/103 A Register/Program Register

The following specs. have been revised:

- 6.074A, 6.074B, 6.074C, 6.074D, 6.074E, 6.074K
- 6.051A, 6.052B, 6.161A, 6.115B

The following specs. have been approved for distribution:

- S7.501 Systems Standards (Revision)
- S7.502 Layout Standards "
- S7.503 Wiring Standards "
- S7.504 Markings "
- S7.505 Diagrams "
- S7.506 Component Standards "
- S7.420-1 Test Specs., Filament Transformer, WWI

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11.2 Standards Committee (cont)

- 7.209 Radio Electron Tubes
- 7.211A Co-Axial Cable
- 7.184A Solderless lugs.

Administrative Memo. A-71 "Standards" has been approved for distribution.

11.3 Purchasing - Stock

(H. B. Morley)

The new metal dials have been received from Waltham Horological Company, and appear to be satisfactory. The use of a stainless steel dial skirt should eliminate trouble with dials becoming warped and bent by the locking devices. An alternate supplier has offered a better price on this item, and the next stock order will be placed with them.

The Procurement Section plans to prepare a supplement to the Standards Book listing sources of supply and approximate prices for all standard items.

Charts have been prepared showing the current status of orders for pulse transformer and Hipersil cores, together with a week by week comparison of estimated requirements and actual receipts. Personnel interested in pulse transformer requirements may examine these charts in the Procurement Office.

It has been found in many instances that considerable savings can be achieved by anticipating requirements by several weeks, even though the material may be more readily available from another supplier. In other words, we are sometimes forced to pay a premium price for material, for the sake of a few weeks earlier delivery.

11.4 Electronic Construction

(F. H. Caswell)

A high voltage power supply for use in precipitation of Calcium Fungstate on Aluminum Oxide has been constructed and tested.

Several 2S Aluminum discs have been ground to a flat surface and polished.

11.4 Electronic Construction (cont)

A protective device for the vacuum systems has been developed and is in the breadboard stage.

Three holding gun power supplies were checked and current regulators calibrated.

Other smaller items consist of jigs and machined parts for storage tube construction and the glass blowing department.

Technician load, as usual, continues to be heavy.

(Al Taylor)

Now under construction are the following: 75 Filament control Panels, 75 D.C. Filter Panels, 150 Cable Terminators, 15 Gate Panels, 20 Pulse mixers, and various prototype and "breadboard" units.

(R. Murch)

The following jobs and units are in the Electronic Laboratory for Construction:

1. 2 Holding Gun Power Supplies
These units are about 60% Complete.
2. Step Counter WWI
This unit is about 65% complete.
3. 10 D.C. Bench Outlet Boxes
4. ACO Auxiliary Panel WWI
This unit is about 10% complete.
5. 10 93 ohm attenuator boxes.
6. Signal Plate Driver
7. Rack Current Surge Suppressor
8. Eight Temporary DC Power Cables for WWI
9. Modifications to Multiply and Shift Control WWI
10. Test 500 WWI Filament transformers.
It will take one man at least a month and a half to test these transformers.

11.4 Electronic Construction (cont)

11. Video Probes and Video Amplifiers
Dan Mach has been assigned to this for the next three months.

The work load in the Electronic Laboratory is as follows:

- 2 WWI Proto-type technicians have a work load of 4 weeks.
- 2 technicians are being employed full time on maintenance of Test Equipment .
- 1 man is being employed for several weeks on salvage.
- 1 technician has work for at least 1 1/2 months on job #10
- 1 technician has work for 3 months on video
- 3 technicians have a work load of 5 weeks on jobs # 1,3,5, 6,7, and 8.

11.5 Drafting

(A. Falcione)

1. Mechanical Drafting Standards A meeting was held on 11 Sept. '48 at Bldg. 32 including Mr. Aitken, Mr. Lofgren and the writer for the purpose of review and approval of the first section of the Mechanical Drafting Standards. Revisions and additions were made and will be incorporated in the book. The second section (Drafting Standards) was discussed. Mr. Lofgren is now working on this section. The first section will be published in the near future.

2. Mr. John Essigman was employed as a Mechanical Detailer (Temporary) as of 13 Sept. '48, and will work for Chan Watt on Installation.

3. The drafting requirements of the Storage Tube group have steadily increased in the past few weeks, and it is expected that a heavy load on drafting will be required for some time to come. In order to meet the requirements, the following plan will be put in effect as of Monday, 20 Sept. '48:

- a. The following draftsmen will be assigned to the Storage Tube program full time:

George Graff - design draftsman
Natalie Foss - sr. mechanical detailer
Joe Wilson - mechanical detailer

11.5 Drafting (cont)

- b. Harold Lovett (design draftsman) will work for Storage Tube part time. All work in this connection will be channeled through T. Leary or myself.
- c. George Graff and Natalie Foss will be moved to the basement on Saturday, 18 Sept. '48, so that they will be located in the same office with Dick Shaw, Ed Prohaska, and Joe Wilson.
- d. Messrs. Shaw and Prohaska will act as checkers on all drawings made for the Storage Tube program.
- e. Administration of the drafting group will remain with the T. Leary and myself.

11.6 Unclassified

(Al Taylor)

It has become necessary to send more machine shop work to outside shops. So that we can retain the advantages of close coordination between development and manufacture, experimental work is being done in our own shop. Non-experimental work is sent out.

Fifty per cent of the machine shop time is still taken up by storage tube work. The balance of the time is being employed in the manufacture of special parts and fixtures. Backlog - 26 man hours.

The sheetmetal shop has a backlog of 16 man hours.

12.0 GENERALNEW NON-STAFF PERSONNEL

JOHN W. ESSIGMAN is a temporary Mechanical Detailer working in the drafting group. He graduated from Woburn High School and Feener Technical, and spent three years in the United States Army.

ALDEN F. GREENLAW is a temporary Jr. Technician. He is working with the Storage Tube Group, under the supervision of Pat Youtz. He attended M.I.T. and served as a Radio Operator in the Army Air Forces.

MRS. JOAN M. KRONICK is a secretary working for Mr. Forrester, Mr. Fahnestock and Mr. Boyd. She graduated from Connecticut College for Women and last worked for Conde-Nast Publications in Greenwich, Connecticut.

LAWRENCE W. NELSON is a student technician working for the Storage Tube Group. He is attending Northeastern University, where he is studying electrical engineering.

JOSEPH S. PALERMO is a Sr. Mechanical Technician working for the Storage Tube Group. He graduated from Boston College and attended Tufts Medical School. He has a wide range of experience in the technical field, and worked for the A. F. Curtiss Valve Company of Medford.

TERMINATIONS

Mrs. Loyce Johnson
Mrs. Alice Wilson
Raffaele Belluardo
Stanton East
Richard McCoy
Marvin Zimmerman

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12.0 GENERALNew Staff Personnel

ARTHUR H. BALLARD is a Research Assistant in the Storage Tube Group. He graduated from the University of Maryland, and was a test engineer with General Electric. During the war he served as a radio propagation engineer with the Signal Corps.

HAROLD B. FROST is a Research Assistant in the Electronics Group. He is a graduate of the University of Nebraska, and while in the Navy worked on maintenance and repair of radio, radar and sonar.

KENNETH E. MC VICAR is a Research Assistant in the Electronics Group. After graduation from Antioch College, he worked on radar research and development with the U.S. Naval Research Laboratories. Since 1945 he has had his own radio laboratory specializing in electronic research, radio repair and custom designing.

TERMINATIONS

Frederick Foss
Alan Perlis
James Pickel