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Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART II
To: All 6345 Engineers
From: Jay W. Forrester
Date: October 1, 1948

6.0 MATHEMATICS

(P. Franklin)

Studied evaluation of successive approximation methods of solving simultaneous linear equations.

(C.W. Adams)

I have made some small progress on my thesis on coding a practical problem for WWI. A description of the problem and a sample calculation (a typical intact stability study) has been received from the Bureau of Ships. It is still desirable to have some approved input-output proposal for WWI in order to put a beginning and end on the program planned.

(Edgar Reich)

The study of the numerical solution of partial differential equations of the elliptic type is being continued. Attention is being given to the type of matrices obtained when the continuous problem is approximated by a system of linear algebraic equations with a view towards applicability of iteration processes.

The report on solution of linear algebraic equations by iteration, originally to be classified as M-565, will be issued as E-148.

(P. Rabinowitz)

New formulae for high order differential equations were found in the latest issue of ZAMM and codes for fourth order

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6.0 MATHEMATICS (cont)

(P. Rabinowitz)

equations are being prepared. These formulae give sixth-order accuracy and also save some time, especially in the special type $y^{IV} = f(x, y, y', y'')$ where the saving is more than 25%.

Engineering note E-147 entitled "The Error in the Runge-Kutta Method" was completed and distributed to the members of the Mathematics Group.

(M. Daniloff)

Conference Note C-61 entitled, "The Use of the Differential Inequalities of Chaplygin for Establishing Bounds on the Approximate Solution of Ordinary Differential Equations of Arbitrary Order," has been prepared and distributed to the Mathematics Group.

The contents of the book of L.V. Kantorovich and V.I. Krylov "Methods of Approximate Solution of Partial Differential Equations" (Leningrad, 1936) have been examined and a list of topics covered therein prepared. The work is unique both in its scope and in its shabby appearance. The contents are not entirely original: liberal use is made of results, previously known due to Fourier, Ritz, Bateman, Neumann, Bieberbach, Bochner, Lovitt, Courant, Hilbert, Bergmann, Christoffel, Schwatz, Tricomi, Dini, Runge, Poisson, Webster, Szego, Cauchy and others. Some topics are new and appear to be valuable, such as the acceleration of the convergence of Fourier series (Methods of Krylov and Maliev).

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7.0 INPUT-OUTPUT7.1 Eastman Kodak Recorders

(J.A.O'Brien)

A meeting was held at the Eastman Kodak Company Hawkeye Plant between H.R. Boyd and myself of MIT and members of the Eastman Kodak Co. on September 29th. The meeting included discussions on the progress on the model of the reader recorder unit and on the establishment of signal specifications.

(H.R. Boyd)

J.A. O'Brien and I visited Eastman on September 29. The details of the conference will be written up in M-634.

We inspected the Recordak automatic film-processing prototype and received assurance that the Recordak group would build a special processing machine for our use starting in about a month. The unit will be ready in March and will process film at the rate of 2 per minute. The prototype film drive assembly is nearing completion and is nicely engineered. Reliability tests on the breadboard drive have been very satisfactory to date.

7.4 Magnetic Recording

(G. Cooper)

Several modifications were made in the circuit of the recording amplifier to secure improved operation. The substitution of 7AD7's for 6AG7's eliminated some spurious oscillations which developed. The circuit of the current amplifier portion was redesigned to change the operating point—resulting in considerably more current through the head.

The parts ordered for the pickup amplifier have not all been received yet. Construction of the breadboard is waiting the arrival of these parts.

Some consideration has been given to the design of an amplifier for driving the erasing head.

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

(R. Shaw)

Drawings are being prepared for a new beryllium strip tube for stability studies. This will utilize only mechanical pressure to maintain contact between the beryllium surface and the leads. This will eliminate the possibility of variations in resistance due to chemical action between the beryllium and the silver paint which was formerly used to make contact.

A storage tube having a mica storage surface is being constructed. Glass will also be used as soon as it is available. Various alternate designs for this tube are under consideration.

A study of some recent literature on electrolytic polishing indicates that this process may be of considerable use in the preparation of flat, smooth surfaces on aluminum signal plates. However, it will not eliminate the need for a first-class machine finish.

Since equipment and personnel are now available a policy has been established of making a thorough inspection of all critical tube components. Records are being kept of the results of this inspection.

Two draftsmen have been moved to room 006 and are available for full-time work on storage tubes.

(E. S. Prohaska)

The rewiring of the anodizing bench for the recording of temperature, current and voltage has been completed. A detailed layout of the new anodizing bench will start on 10-4-48.

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8.11 Tube Construction and Processing (cont'd)

A sketch of a jig for brazing the screen to the screen support ring has been made. (The brazing is to be done by R. F. induction heating.) An experimental coil is expected to be ready early next week.

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

The third five-inch storage tube with a beryllium mosaic, ST 37, developed gas suddenly during one of the test runs. To determine the cause of this gas, the tube was opened under a hood filled with argon and sealed on the exhaust system. The tube and exhaust system were filled with argon during this sealing on process to keep oxygen away from the activated cathodes. This storage tube, now designated ST 37-1, was tested on the exhaust system for several days. Then the tube was opened and the storage surface was examined critically under the microscope. Since the aluminum oxide broke down during these tests a new series of storage tubes were designed with a storage surface of a beryllium mosaic on mica or thin sheet of glass. However, a fourth five-inch storage tube with a beryllium mosaic on aluminum oxide, ST 38, was put on the exhaust system and will be tested on the system early next week.

A fifth five-inch storage tube with only an aluminum oxide storage surface was processed and tested on the system. It is now ready for the regular test rack.

We have procured from Huse-Liberty Mica Company mica for a series of large evaporation tubes to produce a beryllium mosaic on a thin sheet of mica. One such evaporation tube has been constructed.

Thin glass disks to be used as storage surfaces have been ordered. These will be put in evaporation tubes as soon as they are received.

E. R. Owen. On September 29 we were visited by Mr. E. R. Owen of Patterson Screen Div. of Dupont. The principal topic of discussion was the optimum calcium

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8.11 Tube Construction and Processing (cont'd)

tungstate phosphor for our application and a review of our procedures with respect to its application to aluminum oxide.

Dr. Geo. Bancroft. We were visited October 1 by Dr. Geo. Bancroft of D.P.I. for a discussion of what equipment D.P.I. might supply for recording ionization gauge pressures as well as the most desirable D.P.I. ion gauge to use with such a system. We felt a recording gauge should go down to 5×10^{-8} to be of use to us whereas most inquiries they have had have been for the recording of pressure in the 10^{-5} to 10^{-6} range. Some further discussion was made with respect to demountable systems for evaporation.

(H. Klemperer)

Evaporation Tube. The beryllium evaporation cup which is heated by a free standing tungsten coil and contains double Ta heat shields proved adequate to obtain good and heavy mosaics. The cup structure can be used for several evaporations and needs only refilling with Be chips after opening of the tube.

8.12 Tube Testing

(J. S. Rochefort)

Glow and spark discharges were observed between signal plate and collector of ST 37-1 while it was being tested on the exhaust system. These observations indicated a breakdown of some kind between signal plate and collector. After the tube was sealed off, leakage resistance measurements were made without electrode voltages applied to the guns. First measurements were made with a high impedance circuit; and resistance values between 2000 to 70,000 megohms were obtained for various voltages. Measurements were next made with a low impedance circuit and arcing developed between the surface and the collector for voltages in the range of 1000 to 2000 volts. A portion of the surface was destroyed by the arcs. The tube was next cut apart to allow the surface to be studied under a microscope.

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8.12 Tube Testing

Resistance measurements were made on ST 30 with a high impedance circuit. Throughout a range of zero to 1000V between signal plate and collector, resistances of the order of 500,000 megohms were obtained. The tube was next cut open to allow observation under a microscope.

(C. L. Corderman and R. L. Sisson)

ST 37, a new five-inch storage tube with a beryllium mosaic surface, was tested for its forward and reverse curve characteristics. It was placed on the demonstrator and it was found possible to store spots. The tube in general seemed to operate rather well although the stability limits are close together. The tube went gassy while in the demonstrator.

It was then returned to the pumps and designated ST 37-1. While on the vacuum system numerous tests were made to investigate the probable cause of gas, namely an arcing between the signal plate and the spacer ring or collector screen. Some good photographs of this arcing were obtained. It was then sealed off and further leakage tests were run.

ST 39, with a 5" aluminum oxide surface, was next tested while on the vacuum system. Numerous tests were run to study the pressure and holding gun current variations as a function of the cathode to collector voltage. So far satisfactory storage has not been obtained.

8.14 Television Setup

(R. Sisson)

The television set was used to observe the triggering of storage surface in the following tubes: ST 18, ST 15B, ST 37, ST 39. The setup is in the process of being mounted in a rack. A preamplifier is being built to increase the overall sensitivity of the video part of the system.

For the last week the TV setup has been used to aid in testing ST 37-1 and ST 39 on the pumps.

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8.2 Storage Tube Research

8.21 Surface Material Characteristics

(J. H. McCusker)

The resistances of the beryllium surfaces in RT 38A, a beryllium strip tube, were approximately 10^9 ohms. High voltage (1000-1500V) was applied across the surface. The resistance then dropped to about 10,000 ohms. However, the mutual resistances between strips and between strips and dees were also about 10,000 ohms.

(N. S. Zimbel)

Tests on RT 39 which has a beryllium oxide surfaced target were suspended. Tests which were run indicate a low secondary emission ratio ($\delta \approx 1.1$ to 1.3). This is attributed to the fact that most of the primary beam was deflected off the surface over the range of negative values of $I_s - I_p$. Because of this fact, correlation of the triggering data with the $I_s - I_p$ curve is not feasible. A peculiar curve was obtained from the $I_s - I_p$ vs. V_{ok} data at negative values of $I_s - I_p$. This curve was roughly the shape of a full sine wave. This is probably due to the silver contacts which are in the path of the incident beam.

Further tests were conducted on RT 36 in order to clarify more completely the data previously obtained. The original rough draft of the memorandum on this tube has been rewritten as a result of information from these tests.

8.23 Output System Circuits

(C. H. R. Campling)

The signal-plate driver has been assembled with the exception of the load resistors for the output tubes. These resistors are on order but have not arrived. Substitutes will be used in the meantime for tests on the unit.

Further experiments have been conducted with back-to-back connected crystal-diodes. IN21B crystals obtained from Sylvania were used. The results are not

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8.23 Output System Circuits (Cont'd)

especially promising. Complete information on these crystals has not been available. However, it appears that the back resistance is considerably lower than that of IN34's.

Various modifications of the clamp circuit have been tried in the hope that the input impedance to ST signals could be increased. These changes have resulted in decreased reliability or distortion of the output waveform or both, and no satisfactory method has been found.

Consideration will also be given in the coming weeks to the components for the proposed R. F. read-out system.

8.24 Holding Gun Studies

(H. Klemperer)

Improved assembly methods increased considerably the beam intensity of the holding gun, which now varies between 5 and 8 ma at 1000 volts first anode voltage.

8.3 Unclassified

(W. J. Nolan)

Calculations have been started on the effect of non-uniform velocity of the holding beam on stability of stored signals. Of approximately 20 different velocity distributions assumed so far, only one indicated the probability of significant effect on the stability. This was the case in which half the electrons in the holding beam were slowed by about 20 volts, a possible but not very probable circumstance. Since only the most simple effects have been investigated, it is not yet safe to say that the phenomenon may be neglected in future work.

8.4 Deflection Circuits

(J. O. Ely)

All displays have operated satisfactorily during the past week with the exception of a one-day shut-down

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8.4 Deflection Circuits (cont'd)

for repair of a burned-out resistor in the control and for a general cleaning and maintenance.

Work has been started on a study of ways in which the present demonstrator may be combined with standard test equipment, storage tubes, and associated storage-tube circuits, to produce a satisfactory demonstration of storage-tube operation.

Preparation of a report on the design of the deflection-voltage generator used in the demonstrator has been resumed, as has work on a bachelor's thesis "Analysis and Measurement of Certain Performance Characteristics of a 1024-Position Deflection-Voltage Generator".

(L. J. Nardone)

During the week of September 20, 1948, the deflection-voltage generator was attended by E.G. Nickerson. The unit was kept operating continuously each day. Any defects which occurred were corrected.

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10.0 TRAINING

10.1 Seminar Series

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

The regular Block Diagram seminars were held on September 27 and September 29. On September 22, R.P. Mayer discussed the Special Add Operation, while on September 29, J.M. Salzer talked on Transfer Operations and Transfer 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 Drawgs.</u>	<u>Date</u>	<u>Author</u>
SR-10	Summary Report No. 10	22		7-48	
E-144	Basic Circuits, Revisions	3	5	9-16-48	E.S. Rich
E-145	Elimination of Common Ground Leads	3	-	9-23-48	J.A. O'Brien
E-146	Control Pulse Simulation	3	1	9-23-48	M. Hayes
E-147	The Error in the Runge-Kutta Method	4	-	9-27-48	P. Rabinowitz
M-602-1	Standard Power Connectors, WWI	2	-	9-20-48	H.S. Lee
M-615	Bi-Weekly Report, Part I	13	-	9-17-48	
M-616	Bi-Weekly Report, Part II	19	-	9-17-48	
M-618	Test Equipment for Production Testing of WWI Panels	2	2	9-21-48	H. Kenosian
M-619	Installation of Equipment and Wiring in Computer Room	1	-	9-20-48	C.W. Watt
M-620	Cable Terminating Resistors	1	-	9-21-48	H. Kenosian
M-621	Check and Comparison Register Layout Approval	1	-	9-20-48	J.A. O'Brien
M-622	Register Driver, Type II, Layout	1	-	9-21-48	H. Fahnestock
M-623	Present Status of Test Equipment	5	-	9-22-48	H. Kenosian
M-624	Video Busses for WWI	1	-	9-27-48	C.W. Watt
A-71	Standards Book	4	-	9-14-48	Stand. Committee
C-59	Analysis of Arithmetic Check	2	-	9-17-48	R.P. Mayer
C-60	Meetings of the Mathematics Group	3	-	9-7-48	P. Rabinowitz
C-61	Meetings of the Mathematics Group	4	-	9-14-48	M. Daniloff

Library Files

.004 European Scientific Notes, 1 August 1948 and
15 August 1948
47 Technical Information Pilot No. V1016-1080,
V1081-1138, V1139-1198, and V1199-1259

(NR London
Library of Congress
Washington, D. C.)

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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>
73	Pre- and Post-Analysis by Reeves Analysis and Computer Group, September 24, Jobs No. 13-1.2, 22-1, 22-2, 22-3				(Reeves Instrument Corporation)
134	Eastman Kodak Progress Report No. 2 on Photographic Digital Reader-Recorder, September 13, 1948				(R.D. O'Neal A.W. Taylor)
160	Electrostatic Deflection Systems for Plan Position Indicators, Naval Research Lab. Report R-3161				E.V. Phillips
161	Theory and Techniques for Design of Electronic Digital Computers, Moore School of Electrical Engineering Lectures; Volume III, Lectures 22-33				Univ. of Pa.
162	Theory and Techniques for Design of Electronic Digital Computers, Moore School of Electrical Engineering Lectures; Volume IV, Lectures 34-48				Univ. of Pa.

11.2 Standards Committee

(S. R. Abbott)

The following specifications have been approved and distributed:

S7.413-1	Bus Driver Panel	WVI Test Specifications
S7.508	Silk Screen Engraving and Printing of Aluminum and Phenolic Panels	WVI Test Specifications
S7.421-1	Fixed Voltage Switching Panel	WVI Test Specifications
S7.507-2	Finishes - Machine Gray	WVI Test Specifications
S7.507-3	Finishes - Neutral Gray and Silver Gray	WVI Test Specifications
S7.410-2	303/403 B Register/In-Out Register	WVI Test Specifications
6.071E	Mounting Hardware, NUTS	

The following specifications have been revised:

6.043-1	6.043-3	6.161A	6.071D
6.043-2	6.043-4	6.046C	

A general index (to-date), of test specifications issued, has been prepared for distribution.

11.3 Purchasing - Stock

(H. B. Morley)

The vendor now doing our silk screening is equipped to make the photo screens by a type set-up process, which does not require the use of a panel legend drawing on bristol board. All that is required

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is a sketch outlining overall dimensions, sizes of letters or symbols, and spacing.

Considerable difficulty has been experienced recently due to delays in transmitting paper work between the Barta Building and Building 32. A new system has been placed in operation to expedite transmittal of paper work between this office and the Purchasing Department in an effort to remedy the situation.

All personnel are reminded that this office maintains up-to-date files of tube manuals, specifications, and other information in addition to the file of manufacturers' catalogs and operating manuals.

(R. Fairbrother)

The amount of material received in the past two weeks was much less than in the corresponding periods of July and August. It is expected that purchases in the future to maintain stock levels will be much less than in the past three months since good supplies of most items have been accumulated.

The storage problem continues to be critical, leading to the moving of more material to Ft. Heath to increase the available space in the Barta Building. One vehicle at Building 32 is unsafe to drive which makes obtaining transportation difficult at the moment.

11.4 Electronic Construction

(Al Taylor)

Now under construction are the following: step counter, holding-gun power supply, clock pulse generators, pulse standardizer, filter panels, and marginal checking system for the multiplier.

Inspection of filament transformers is underway and will be completed October 20.

(F. H. Caswell)

Selenium rectifiers were assembled for use in one pre-amplifier and two vacuum system protective circuit control boxes.

A panel breadboard limiting amplifier was assembled for C. H. Campling.

Electrodes were scaled and assembled for a configuration simulating part of a holding gun structure, this unit to be used in the electrolytic tank.

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The voltage divider circuit at the anodizing bench used in conjunction with a Brown Recorder has been rebuilt and the system calibrated.

All storage tube laboratory equipment has been removed from room 230 except one M. G. set.

Technician work load, as usual, remains heavy.

A trip was made with T. F. Clough to Huse-Liberty Mica Company where facilities were seen and instructions given in handling, cutting, slicing, punching, and machining of mica for vacuum tubes.

11.6 Unclassified

(Al Taylor)

One lathe is now kept on storage tube work at all times. The amount of work going through the shop is limited by the amount of machinery available. The backlog now contains about fifty man-hours work and it is all work that should be done here or at Building 32. At present Building 32 shop is overloaded and can not take anything.

The sheetmetal shop has a backlog of sixteen man-hours.

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Theodore W. Hildebrandt will be working half-time as a research assistant in the mathematics group under Professor Franklin. He received an M. A. in mathematics at the University of Michigan where his undergraduate work was done in physics. He continued graduate study at the Institute for Advanced Study and was employed as a design engineer on the electronic computer project there.

William N. Papien, a research assistant, will be assigned to the electronics group. He has completed his undergraduate work here at MIT in electrical engineering. During the war he was a radio intelligence officer in the Army. Before that time he was station engineer and transmitting technician at RCA Communications.

Richard W. Read, a research assistant, will work on test equipment in the electronics group. He took his undergraduate work at Seattle College. He served two years with the Navy as an electronics technician's mate.

Harrison E. Rowe is a research assistant in the storage tube group. He was graduated from MIT in electrical engineering in September 1948. During the war he served as an electronics technician's mate in the Navy.

TERMINATIONS

John W. Carr
Alexander Orden

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12.0 General

New Non-Staff Personnel:

Bernard D. Ross is a temporary Junior Technician working in Al Taylor's group. He is a student at M.I.T. and also studied at Lowell Institute. He served in the U. S. Navy for over two years.

Betty May Schmidt is secretary to Mr. Morley, in the Procurement Section. She graduated from Trenton High School, New Jersey, and has had several years of secretarial experience. Her husband is attending Graduate School at M.I.T.

Edward P. Szulewsky is a temporary Junior Technician. He graduated from Rindge Technical High School and also from Massachusetts Radio School and Saunders Radio and Electronic School. He has had several years of technical experience, both as a civilian and in the U. S. Army.

Lassie Ulman is secretary to Mr. Everett, succeeding Barbara Oppenheim. She graduated from Smith College, where she majored in History and German. She also attended Hickox Secretarial School, after which she had several years of secretarial experience.

TERMINATIONS

Robert Doyle
 Kasper Kasparian
 Saul Malkiel
 George Moore
 Barbara Oppenheim
 Charles Park

Indoctrination Program

(J. C. Proctor)

The first group of new staff members has completed the two weeks' indoctrination program. It is generally felt that the course has been a success, and it will be continued in the future.

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