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Memorandum M-342

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Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART II, April 29, 1949

To: 6345 Engineers

From: Jay W. Forrester

6.0 MATHEMATICS

(P. Franklin)

The mathematics group has continued work on linear equations, an eigenvalue problem, and the use of input output facilities for a problem requiring excessive storage.

A study of systems of air traffic control has been started.

(P. Rabinowitz)

E. Reich and I have completed the code for multiplying two 50 by 50 matrices. This code involves integration of the computer with input output. The electrostatic storage required is about 2020 registers, which includes orders and data. This amount which is so close to the maximum was found to be necessary in order to minimize the number of times data would have to be read in from film.

On the assumption that the average time of an operation is 50 microseconds and that the time to transfer an element between film and the computer is 1 millisecond, it was found that the time for this problem is a little more than 2 1/2 minutes.

(E. Reich)

Report R-165, entitled "The Convergence of the Gauss-Seidel Iterative Method" has been issued. It discusses necessary and sufficient conditions for convergence, and gives a new result for the case where the system matrix is real, symmetric, and has no non-positive terms on its main diagonal. E-148 which was issued last September contains a more complete discussion of the background material. Recently, however, I came to the realization that the Seidel scheme can be considered as a special case of the "back-substitution method" in which the system matrix is approximated by a triangular matrix.

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6.0 MATHEMATICS (cont)

(T. W. Hildebrandt)

I have learned something of the plans proposed for the following systems of air traffic control: Navar (Federal Radio and Television), Teleran (RCA), Automatic GCA (Hilfillan), General Railway Signal Company Block System, and Lanac (Haziltine). I expect to write a short resume of the important features of each of these systems to aid those who are or will be engaged with the air traffic control problem.

(M. Daniloff)

Conference Note C-105, "Numerical Determination of Eigen-Values of Arbitrary Order for a Special Class of Differential Equations" was prepared for the use of the Applications Study Group.

The study of this problem led to a consideration of the relative accuracy of various available methods of numerical integration of ordinary differential equations. This query brought to light the fact, that the Runge-Kutta method can, in at least one case ($\dot{y} = y; y(0) = \dot{y}(0)=1.$) give rise to errors which are 60 times larger, - after only 20 steps with $h = 0,2$ - than the errors generated by the more accurate methods (notably, - by the central - difference method). In the case mentioned the ratio of the errors increased, very nearly, as the $7/5$ - th power of the number of steps of integration.

The performance of the Runge-Kutta-Nystrom method was not significantly better.

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

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

Two storage tubes, ST87 and ST88, in the Be mosaic-on-mica series were constructed and processed with "lint-free" precautions and care to reduce the surface leakage of the storage surface. Argon gas was allowed to flow through the tube during all of the glass-working stages. A head of argon gas was used to prevent a film of carbon depositing on the storage surface. However these two tubes still showed evidence of a low surface resistance. Therefore we have again re-evaluated all of our tube-construction procedures to ascertain some explanation for this thin film on the surface. To date we have not found a satisfactory explanation. Two research tubes were made to investigate whether the electron guns were a source of contamination. Tests on these tubes eliminated the guns as the offenders. We will continue our investigations toward the end of eliminating this surface leakage.

(R. Shaw)

Drawings of a secondary-emission-study tube, RT51, will be completed May 2, 1949. A tube for heater investigation, RT52, was constructed without drawings and an assembly sketch made for record purposes.

Drawings have been made of a modified target assembly proposed by W. J. Nolan. The main purpose of the changes is to reduce the r-f impedance of the signal-plate leads. Minor modifications have also been made to current evaporation tubes and storage tubes.

Samples of Nichrome V and TaW alloy have been ordered and received. These materials, both of which retain their strength up to relatively high temperatures, will be used for snubbers and springs in our tubes.

A polariscope for investigation of strains in glassware has been received. Certain changes to improve its flexibility of operation are being considered.

Since our anodizing equipment is no longer in use, it has been transferred to Fort Heath.

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8.11 Tube Construction and Processing (Cont'd)

(J. S. Palermo)

Mechanical Components - In general, the inventory of all mechanical components for evaporation and storage-tube target assemblies is sufficiently ample for tube construction.

A new fixture has been completed to expedite and insure concentricity in the construction of Mod. II storage-tube target assembly.

Two sets of guns for storage tubes will be available at all times to avoid any delay which may be encountered in storage-tube construction. These guns have had a primary inspection.

All ten-pin and six-pin flat-press stems will be inventoried from the IR in the future. These stems have been cleaned in an acid fluoride solution and stored in a desiccator.

The "lint" problem encountered in past tubes seems to be eliminated judging from the last series of storage tubes. Our efforts will continue to insure "lint free" assemblies, and will take any added precautions to produce cleaner assemblies.

(W. E. Pickett)

Glass Components - During this last period components for the large evaporating tubes were constructed. The supply of envelopes for this type tube should be ample for this next period.

Several envelope assemblies for storage tubes were constructed and it is planned to continue on this item until the inventory is large.

The vacuum-firing and hydrogen-arcing bottle were constructed for the portable vacuum system. Parts for the rest of this system have been received, and the system should be completed in this coming period.

The polariscope has been received in the glass room and is being put into operation as the need arises. A report will be written later on its construction and operation after it has been in operation long enough to collect data.

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8.11 Tube Construction and Processing

(M. I. Florencourt)

Engineering notes E-226, E-227 and E-228 have been issued on the Construction, Processing and Initial Testing of ST80, ST82 and ST83. Engineering note E-230 is in process on the construction and processing of RT50-1.

Correlation studies are continuing to investigate the cause of the high leakage of recent storage surfaces.

8.12 Tube Testing

(H. Klemperer)

During this period, time was made available to improve the instrumentation of the test laboratory. The storage-tube life-test rack was enlarged to accommodate eight storage tubes. The television-read-out unit was equipped with an r-f read-out system, where during the reading period the reading beam is r-f modulated and the signal is detected by means of an I-f amplifier phase-detector type of a read-out system.

A number of storage tubes with increased storage-surface leakage came in conveniently for further studies of leakage effects. It appears very probable that a number of secondary effects, like after-storage, plate switching and the occurrence of more than two stable levels of charge under the influence of the holding beam, can be tied to surface leakage. Electrometer measurements of the surface and body leakage were made on a number of storage plates and the resistance measured is of such a size that it cannot be neglected in explaining the above mentioned effects.

(C. L. Corderman and A. H. Ballard)

Two more tubes in the Be on mica series, ST83 and ST87, were given initial standard tests. First indications were that both of these tubes had low surface-leakage resistance. This was evidenced by (1) low upper stability voltages with both positive and negative areas present, (2) the inability to write small, sharply defined spots, and (3) the failure of a pattern of spots to remain longer than approximately 1/2 second with both guns biased off.

Some improvement with time in the above characteristics was noted with ST83, while for ST87, the improvement over a 6 hour period of operation was sufficient to make it a satisfactory tube.

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8.12 Tube Testing (Cont'd)

(J. S. Rochefort and N. S. Zimbel)

Automatic Write-Read Unit - Initial testing of ST73 showed this tube to possess stable storage characteristics for positive spots on a negative background for values of V_{HG} between 120 and 230 volts. The upper limit of stability was introduced by power supplies and equipment rather than by the tube itself. The lower limit of stability varied from day to day and at times was as low as 90 volts. This lower limit of V_{HG} was characterized by inability to write positive spots on the negative background.

Investigation showed that the lower limit of stability could be reduced to 90 volts if the holding gun were left on during the W+ operation. This observation suggested the possibility that spot spreading and surface leakage were responsible for the higher limit obtained when the holding gun was cut off during the W+ operation. The HV grid pulse for W+ was therefore delayed in time by 10 μ s to make its trailing edge coincide with the trailing edge of the HG gate. This assured that the HG would be turned on immediately after the positive spot was written. Under this condition the lower limit of V_{HG} was found to remain consistently at 90 volts.

The lower stability value of $V_{HG} = 90V$ obtained under the conditions cited above is of the same order of magnitude as those associated with so-called "good tubes." Therefore these tests indicate that surface leakage may be responsible for the relatively high lower limit obtained on some tubes.

An investigation of holding-gun restoration time is in progress. It has been found that 800 to 1000 μ s is the average time required for the HG of ST73 to charge a spot from just above first crossover to a collector voltage of $V_{HG} = 195V$. The restoration time necessary for the HG to charge spots from just below first crossover to cathode potential has not as yet been successfully determined. Erratic surface leakage hindered initial attempts to establish test procedure. However, now that this phenomenon is more fully understood, it is hoped that efforts to measure the restoration time will be more successful.

Life tests on ST63 are continuing; as yet no drastic change in the high-velocity or holding-gun current to the target has been noted.

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8.12 Tube Testing (Cont'd)

(J. H. McCusker)

Plans for a 208 TV unit for the high-speed write-read equipment have been temporarily postponed since it is planned to use r-f readout with this equipment.

The pressure has been measured in most of the storage tubes with small storage surfaces. The pressure, high-velocity and holding-gun beam currents, and capacitance between signal plate and ground have been measured on most of the storage tubes with large storage surfaces.

(W. J. Nolan)

The T.V. Demonstration Unit has been converted for use with r-f output. This change permits more satisfactory output signals, particularly when used with very small sweep amplitudes to permit magnified viewing of the storage surface. The problem of 60-cycle and miscellaneous video pickup in the output circuit is eliminated by the r-f system but it is replaced by a small susceptibility to interference from other r-f apparatus. The use of relays to switch from writing to reading circuits has also been eliminated. Although not necessarily inherent in a video system, they are much more easily replaced when using r-f.

The sweep adapter used with this display system provides for removal of the r-f modulated reading beam, suppression of the T.V. sweep, and deflection of the storage-tube writing beam to any preselected position in a period of about 20 microseconds.

8.13 Storage Tube Reliability Tester

(J. O. Ely and R. L. Sisson)

This test setup has been used for investigations of charging rates due to the high-velocity guns. Initial curves were rather erratic. This was caused by low sensitivity in the output system requiring high currents and therefore short pulses. By adjusting rise times on signal plate switching pulses and adding a special r-f ground strap the sensitivity was substantially increased and satisfactory curves obtained. For pulsed beam currents of 50 μ a, the charging rates were found to average about 35 volts per microsecond for W+ and 12 volts per microsecond for W- on ST67.

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8.13 Storage Tube Reliability Tester

(J. A. DiGiorgio)

A storage-tube output panel has been completed incorporating the latest changes for a larger storage-tube shield (promised delivery next week) and the relocation of the signal-plate amplifier.

8.2 Storage Tube Research

8.21 Surface Material Characteristics

(H. Rowe)

Design of a research tube to measure the secondary emission of beryllium has been completed.

8.23 Output System Circuits

(H. Kenosian)

A phase-shift amplifier to provide phase-reference voltage for the phase detector is undergoing final tests. Phase shift is accomplished with a tapped, lumped, delay line.

The gate generator for the r-f pulser is complete. The gate is provided by a modified standard flip-flop which operates as a single-shot multivibrator.

(C. H. R. Campling)

The phase shifter and its amplifier continue to give difficulty. The first stage of the amplifier tends to oscillate, and, while this tendency has been counteracted, the gain in the second stage is too low. Consequently the output voltage is too low. Furthermore, the amplitude of the phase-reference voltage varies with phase-shift. The ratio of maximum to minimum amplitude is about 2:1. Further efforts will be made to correct the situation.

A breadboard oscillator with two output channels, each a push-pull buffer, has been assembled. Some initial tests have been made on the unit.

(M. Hayes)

The design of a variable-width gate generator has been completed. This should supply the needs for many of the

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8.23 Output System Circuits (Cont'd)

gate generators in electrostatic storage control. After initial difficulties were solved, operation on the Write-Minus Gate Generator was satisfactory. An Engineering Note is being written on this circuit.

(G. G. Hoberg)

The breadboard of the WWI signal-plate gate amplifier has been tested and found satisfactory. Several changes were made because of the need for adding a crystal gate at the output of the write minus gate generator. Work on a WWI layout will begin immediately.

8.3 Unclassified

(H. Rowe)

Resistance measurements have been made on many of the existing storage tubes with both a Volt-ohmyst and the electrometer. Resistance measurements will also be made on a new high-velocity-gun stem.

8.4 Deflection Circuits

(J. M. Hunt)

Tests conducted on the transmission line and L-C filter section test unit indicate that the performance of the proposed deflection-voltage amplifier and transmission-line system will be entirely satisfactory. Response to a unit step input having an 0.05-microsecond rise time was such that all observable voltage ripples had disappeared at the far end of the transmission line in considerably less than 2 microseconds.

It is believed that no further information concerning transient response can be obtained until the final WWI transmission-line assembly is completed and the actual deflection amplifier is constructed, as uncertainties such as resistor inductances and temperature coefficients, ground-lead inductances, and transmission-line characteristics limit the quantitative accuracy of tests conducted on the present equipment.

Plans for the final model of the deflection amplifier are now being developed.

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8.4 Deflection Circuits (Cont'd)

(L. J. Nardone)

All drawings pertaining to the Deflection-Voltage-Generator Transmission Line are being brought up to standards for checking and grading.

An elbow for making right-angle bends in the transmission line has been designed in order that the line may be carried over the center aisle of the computer room.

The necessary parts for the construction of eight prototype sections of transmission line are being made in the shops. These eight sections will also be used in tests being made on the output amplifier of the deflection-voltage generator.

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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>Classified</u>	<u>No. of Pages</u>	<u>Date</u>	<u>Author</u>
R-165	The Convergence of the Gauss-Seidel Iterative Method (S.M. Thesis)		11	4-15-49	E. Reich
E-225	Study of Input Output Checking		14	4-11-49	J.M. Salzer
E-226	Storage Tube ST80: Construction, Processing and Initial Testing		1	4-15-49	M. Florencourt
E-227	Storage Tube ST82: Construction, Processing and Initial Testing		2	4-15-49	M. Florencourt
E-228	Storage Tube ST83: Construction, Processing and Initial Testing		2	4-20-49	M. Florencourt
E-229	Arithmetic Modification of Operations		8	4-25-49	G. Cooper
M-827	Summary of B-Register/In-Out Register Test Results		1	4-4-49	G.C. Sumner
M-832	Bi-Weekly Report, Part I, 4-15-49	Restr.	17	4-15-49	
M-833	Bi-Weekly Report, Part II, 4-15-49	Restr.	16	4-15-49	
M-834	Change in Video Cabling to Comparison Register		1	4-20-49	C.W. Watt
M-835	Variable Voltage Circuits, Marginal Checking, WVI		8	4-22-49	H.S. Lee
M-837	Input-Output Meeting With Representatives of Engineering Research Associates		3	4-22-49	R.A. Nelson
M-838	Progress Report: Use of Digital Computers for Non-Linear Servomechanisms		2	4-21-49	J.E. Pierson
A-84	Precautions in Handling Beryllium		1	4-15-49	J.C. Proctor
C-96	Explanation of the Applications Study Group		3	4-20-49	W.G. Welchman

Library Files

.004 European Scientific Notes, 1 March 1949, 1 February 1949,
15 February 1949

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Reports and Publications (Continued)

<u>No.</u>	<u>Title</u>	<u>Author</u>
42	Modification of the Model-5 Synchroscope for Increased Sweep-Speed Operation; by K. N. Hemmenway; 9-20-48	(Cambridge Field Station Lib of Congress
47	Technical Information Pilots; Numbers U2077-2520	
52	Progress Report for WWI Electronic Digital Computer for Period April 9, 1949 - April 22, 1949	Sylvania
161	Meteor; Pulse-Code Modulation Method; by B. D. Smith, Jr.; Guided Missiles Program; December 1948	MIT
162	Report on the Performance of the German Magnetophone; Air Materiel Command Report; March 13, 1947	(Brush Development Co.
302	A Universal Resonance Curve for Parallel T R-C Null Networks; Air Materiel Command; 19 April 1948	U.S. Air Force
559	Technical News Bulletin; December, 1948	Nat Bur of Stand

11.2 Standards Committee

(H. B. Morley)

Revision of minimum stock levels was continued at the last Standards meeting.

New standards issued or assigned:

S7.411-8	Program Counter (assigned)
S7.411-9	Multiply Shift Control
S7.411-10	Comparison Register Check (assigned)
S7.412-2	Flip-Flop Storage Register and Flip-Flop Storage Output

11.3 Purchasing and Stock

(H. B. Morley)

The discoloration of type UG-290/U coaxial connectors used in WWI is apparently caused by the chemical action of the flux used in silver soldering the parts of the connector together. It has also been suggested that sulphur compounds in the atmosphere may be a cause of this discoloration. A sample of this type connector made from solid stock is available for examination in the Procurement Office.

The last shipment of Micarta "Blue Line" linen bakelite received is a much different color than any received previously. We have been assured by the manufacturer that it will darken with age to the same color as the other. In the meantime, a substitute grade of linen bakelite was procured in a darker color.

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11.3 Purchasing and Stock (Continued)

IPC submitted drawings of the high voltage multi-pin connector, and an order has been placed, subject to approval of samples. This connector has been tentatively assigned Spec. No. S6.043-7 and -8. Specification will be written and issued when samples are received and final drawings prepared and approved.

(R. Fairbrother)

A record shipment of 193 pulse transformers, 3:1, has arrived from New England Transformer, which has completely relieved the danger of a shortage of this item.

A list of equipment which is surplus to the project has been prepared, and will be forwarded to the ONR representative for disposal of the property.

The draft of the schematic parts list for E.S. deflection gate panel has been completed.

11.4 Electronic Construction

(A. Taylor)

All Whirlwind work is going on schedule.

Work on phenolic panels has been considerably speeded up by the use of a trepanning tool designed by Loren Prentice. This tool makes possible the cutting of the tube access holes in one-eighth the time required by previous methods, and leaves very little burr.

(A. R. Curtiss)

The following units were constructed:

A gate generator for an RF pulser. A 10 mc phase shifter amplifier. A 20 mc crystal controlled oscillator (breadboard) and a storage tube RF adapter.

Additional circuitry changes were completed in one TV set.

Work is progressing on the assembly of the Polariscope, and a -300 volt regulator (breadboard) is being constructed.

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11.5 Drafting

(A. M. Falcione)

Mrs. D. Sheahan is undergoing an operation and will be out on sick leave through May 15th.

The work load on the drafting room is steady. A slack period is expected in the near future. The storage tube schedule may change it however.

Personnel progress forms were accomplished for all drafting personnel together with suggested changes in the form. I am in agreement with this periodic system of personnel evaluation and recommend it.

A summer vacation schedule for drafting personnel is now being made.

11.6 Unclassified

(L. Prentice)

Machine shop - The work load for the past 2 weeks has been light. We are continuing the work on dies for the sheet metal shop. We have some repairs to make to the 13" lathe.

Sheet metal shop - We have completed all scheduled WWI panels with the exception of the alarm circuit. By the 30th all phenolic panels will be complete. The trepanning tool, 1-3/4" diameter, suggested by A. Taylor has now cut some 2000 holes without resharpening. These cutters were made from 52100 series chrome steel in our own shop.

We have installed an air regulating valve on the punch press to reduce the work hazard to personnel and prevent damage to the dies.

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12.0 General

Non-Staff Terminations

Helen R. Branning

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