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Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART II, April 15, 1949

To: 6345 Engineers

From: Jay W. Forrester

6.0 MATHEMATICS

(P. Franklin)

The mathematics group is completing discussion of the ballistic and ship control problems and studying the basis of the air control problem. Input-output procedure with film equipment is being given consideration.

(E. Reich)

P. Rabinowitz and I are completing the coding of a procedure for multiplying two 50th order square matrices, a problem requiring the use of input-output film equipment.

By making more efficient use of film reading time, both during forward and reverse operation, it now appears that in this particular case the time required for communication with input-output will be of the same order of magnitude as the computation time. Also, it does not seem practical to intersperse computation between "reads".

(T.W.Hildebrandt)

Conference note C-103, "A Code for the Ballistic Problem", was completed and distributed.

I have turned my attention to the Air Traffic Control problem and have been reading about the different systems which have been proposed in order to get an idea of what sort of data we will have to work with.

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6.0 MATHEMATICS (cont.)

(M. Daniloff)

The serviceability of Willer's method of successive approximations for obtaining real roots of transcendental equations (in particular - of the "frequency equations" of eigen-value problems) was investigated. The method possesses the advantage that it is not necessary to calculate the derivative of the given function (as in the method of Newton). This property is valuable in case of empirical functions. On the other hand, the convergence tends to become erratic as a root is approached.

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7.0 INPUT AND OUTPUT

(E. S. Rich)

A method has been worked out for reading binary numbers from a punched teletype tape into the IO register from which they may be recorded on film or transferred into the computer. The equipment required for this consists of a teletype transmitter-distributor, an auxiliary relay, and several pulse generators and synchronizers to obtain control pulses synchronized with the computer restorers. The system was considered in detail at a conference of interested staff members and several suggestions were made for its improvement. The principle discussion was on methods of checking the operations involved in preparing takes and transferring numbers into the IO register in order to reduce the probability of human as well as machine errors.

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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)

Previous test results and the examination of a dissected storage tube indicated that foreign material between the screen and the mosaic of the storage surface was producing the small positive spots. Our tube construction procedures were re-evaluated and changed to produce lint-free tubes. Toward that end ST80-1, ST81 and ST82 in the Be mosaic-on-mica series were constructed and processed. These tubes seemed to be free of lint but all of their storage surfaces had low surface leakage resistances. Therefore our processing and construction procedures were evaluated to find out how a thin conducting film on the storage surface might have been introduced. Another Be mosaic-on-mica tube ST83 was constructed with the same "lint-free" precautions; in addition argon gas was allowed to flow through the tube during all of the glass-working stages (Cambridge gas produces a carbon film). The head of argon gas was used to prevent a film of carbon from depositing on the storage surface.

ST82 was dissected for examination. Its storage surface resistance was measured with the electrometer designed by J. J. Nolan. The surface of ST82 had a lower surface resistance than the surface of ST75 which had satisfactory storage properties. However, the leakage resistance of ST82 was not so low as we anticipated from our test results.

(M. I. Florencourt)

Engineering Note E-223 has been issued on the construction, processing and initial testing of ST81. Notes are in process on storage tubes ST82 and ST80.

Temperature curves have been plotted to compare thermocouple and pyrometer readings on evaporation cups made of tantalum, and to compare calculated and pyrometer readings on tungsten heaters in evaporation tubes. For the tungsten heaters, the pyrometer readings follow the calculated temperature readings well, up to the point where the viewing

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8.11 Tube Construction and Processing (Cont'd)

window becomes coated with evaporated beryllium; then the pyrometer readings no longer have meaning; this however does not occur until some time after evaporation has started. The thermocouple and pyrometer readings on the tantalum evaporation cups do not agree absolutely over any part of the temperature range because of a temperature gradient between the cup and the thermocouple welded to it. The indicated temperature difference which exists (over the meaningful range of pyrometer readings) is, however, constant; but this constant has an apparently random value and varies from tube to tube. Therefore from the evidence outlined above, the better absolute indication of temperature would seem to be the pyrometer reading. It is expected that the introduction of some type of shield for the viewing window will mean that pyrometer readings will be good during the entire evaporation process. More tests of the kind mentioned here are planned before a decision is made on temperature-indicating devices.

(I. E. Pickett)

Glass components. During this last period, storage-tube envelopes were constructed as planned and an adequate supply is now on hand for this next period.

The ten-pin stems used in the storage-tube construction are still ample for our needs.

Several small fused-quartz sleeves were constructed for use in assembling the boilers used in evaporating tubes.

The layout and planning for a vacuum-firing portable system have started. Along with the vacuum-firing system it is planned to have a hydrogen arcing bottle.

In this next period the inventory of the envelope components for storage tubes will continue to be built up as these components require much time for construction.

8.12 Tube Testing

(H. Klemperer)

Various phenomena, including read and write times, the level of background noise as well as the useful life

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8.12 Tube Testing (Cont'd)

of a storage tube depend on the condition of the storage surface and its secondary emission ratio. At this time very few data exist on the amount of secondary emission at voltages below 100V, and still less is known about the dependence of this emission on the state of the top surface layer. Because of the influence of such information upon tube design and processing procedures a number of experiments were prepared to obtain evidence on secondary emission at low primary velocities for beryllium at various states of oxidation and for a clean mica surface.

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

Three new tubes in the Be-on-mica series have been given initial tests. They are ST80-1, ST81 and ST82. The storage surfaces in all three tubes were entirely lint-free when first viewed in the TV set.

All of these tubes have a common characteristic which is undesirable in storage tubes - namely, low surface leakage resistance. There is a strong tendency for all or large portions of the surface to assume the same potential, and discrete spots can be written only by careful manipulation of writing charge and holding-gun voltage. No setting of these parameters could be found for which uniform storage over the surface was possible.

The first tests on ST82 were unsuccessful because of leakage between HV gun electrodes. This condition was corrected by rebasing. During testing, ST82 developed two small positive spots, and the tube was opened (April 15) for examination.

Sometime during the processing of ST80-1, an internal short developed between the second anode and one of the vertical deflection plates of the HV gun. Its storage performance was studied by reducing HV gun accelerating voltage to give reasonable deflection sensitivity.

Four tubes were retested in the TV read-out equipment after being left on life test for 230 hours. The pattern stored on all tubes was the same, being one with half the surface positive, the other half negative. The trends on all tubes were the same, namely, the area which had been left positive on life test now has a higher minimum V_{HG} for stability and lower output signals than the half which was left negative on life test. Further tests to investigate these trends are being worked out.

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8.12 Tube Testing (Cont'd)

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

Automatic Write-Read Unit. Data compiled for four representative spots on the surface of ST51 indicate a 40 volt stable range of V_{HG} (for write (-) signal-plate-switching amplitudes of 100 volts) for prolonged storage of spots of either polarity. As indicated in the last Bi-weekly Report, with increasing frequency (using the cycle Read, Write (-) - - - Read, Write (+)) the apparent stable range of V_{HG} increases. For example, on the average, the stable range of V_{HG} at 8.4 kc is 135 volts.

Before further tests could be performed, a high resistance leakage path of about 9 megohms developed from deflection plates to control grid of the high-velocity gun. Attempts to increase this resistance by a high-voltage discharge between the electrodes in question were unsuccessful. As a consequence of this leakage, tests on this tube were discontinued.

Life tests are being conducted on ST63. The procedure employed is to leave the tube overnight with the 5UP gun pulsed on at 25 kc frequency using 15 μ s gates on the control grid. No cutoff gate is applied to the holding gun during this life test. This tube has been subjected to these conditions for a total of 235 hours.

Completely adequate signals of both polarities are still obtained with ST63. The holding-gun cathode current has decreased by about 10%, while the decrease in the high-velocity gun current to the target assembly at zero volts bias is about 20%.

Tests on ST73 which parallel and enlarge upon those run on ST51 are underway.

(J. H. McCusker)

Work has been started on adapting a 208 TV unit to the high-speed write-read unit.

A memo is being prepared on work done on the beam-analyzer tubes.

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8.13 Storage Tube Reliability Tester

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

A large number of "bugs" were eliminated from the system with the result that satisfactory operation was obtained in ST67 with an 8 x 8 array and at a repetition frequency of 10 kc.

Marginal operation of ST67 with a 16 x 16 array at a repetition frequency of 20 kc was obtained.

Tests are now being performed to determine

1. What causes certain spots to read out low amplitude signals.
2. Why operation is not as good at higher repetition frequencies.
3. The effect of several variables on the reliability of storage.

(J. A. DiGiorgio, Jr.)

Some changes have been made in the a-c power setup. The tester can now operate off either of two a-c sources of power. The three phase laboratory a-c power was changed over to another power box using two phase; also two phases of the three phase .7WI filament supply were brought in.

8.2 Storage Tube Research

8.21 Surface Material Characteristics

(H. Rowe)

A tube for determining the secondary-emission characteristics of beryllium with pure and oxidized surfaces at primary-electron velocities between 10 and 100 volts is being designed. It will utilize a modified holding-gun structure as a source of primary electrons.

(W. J. Nolan)

An electrometer has been built to measure the leakage resistance of storage-tube surfaces. The instrument has two ranges, 0.1 and 0.3 volts full scale, and an input resistance of the order of 10^{13} ohms, depending somewhat on the

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8.21 Surface Material Characteristics (Cont'd)

weather. Lest anyone think this to be a remarkable figure it should be noted here that for the tube used it is not and has been accepted only because it was what could be achieved with readily available components. Also, it provides as much sensitivity as is conveniently usable. A tap switch permits various shunts to be connected across the input for measuring current. It is principally the leakage of this switch and the associated input bushing which limits the maximum input resistance. With the present shunts, full-scale ranges of from 10^{-13} ampere to 3 micro-amperes can be obtained.

8.23 Output System Circuits

(C. H. R. Campling)

Since the completion of the output amplifier for the Kay Megasweep, it has been possible to investigate the design of coils used in the r-f pulser. In general, it appears that the double-tuned circuits in this unit have been too closely coupled. The effects of coupling, tuning and loading are all made evident by very simple tests and the results have lead to the redesign of several of the coils. The performance of the pulser is much improved, and full 360-degree phase shift has been realized with the phase-shift circuit. The amplifier for the phase-reference voltage is now receiving attention.

A breadboard model of a similar circuit to meet the requirements of WWI is being constructed. A separate pair of push-pull 715B's will be used to drive each bank of ST's. The oscillator is to be a crystal-controlled doubler to operate in the vicinity of 17 MC.

(H. Kenosian)

The coils for the phase detector of the output amplifier have been designed with the aid of the "Megasweep" oscillator.

A phase-shift amplifier has been designed and is under construction to provide phase-reference voltage for the phase detector.

A gate generator has been designed for the r-f pulser and is now under construction.

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8.23 Output System Circuits (Cont'd)

(G. G. Hoberg)

Preliminary tests of a breadboard for the WWI signal-plate gate amplifier indicate that the design is basically satisfactory. Further work will be directed toward realizing the best performance under the worst possible WWI operating conditions.

8.3 Unclassified

(S. H. Dodd)

The shop has constructed fabricated parts as substitutes for the castings which are used to support the storage tube and shield. The mu-metal shield was delivered about April 8. These have been assembled and a few minor interferences fixed. The mount layout is complete, and the sheet metal details and the final assembly are being made.

8.4 Deflection Circuits

(L. J. Nardone)

The component and d-e wiring layouts of the coder section of the deflection-voltage generator were turned over to the drafting room for completion a week ago. The drafting room will also make the aluminum panel layout of the coder section.

A bracket for the support of the D.V.G. transmission line connection box has been designed (SC-33895). The assembly of the transmission line now omits the use of the transmission-line bracket (SA-33805). A complete mechanical design of the line is contained in drawing numbers SA-33804-2, SB-33806-1, and SC-33895.

Methods of carrying the transmission line across the center aisle of the computer room are being studied. The best solution mechanically and electrically requires some minor altering of the computer racks.

(J. M. Hunt)

A test transmission line has been constructed to simulate the electrical characteristics of the special 2-wire co-axial line which will drive the storage-tube deflection plates of WWI. L-C filter sections similar to those of the proposed

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8.4 Deflection Circuits (Cont'd)

WWI line have been inserted at appropriate intervals along the length of the test line.

The test transmission line will be used to check deflection-system-response speed and to observe the effect of the transmission line and its associated loads on the performance of the feedback amplifier which drives the 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>Classified</u>	<u>No. of Pages</u>	<u>Date</u>	<u>Author</u>
SR-16	Summary Report, No. 16	Conf.	23	1-49	
R-155	Application of Digital Computers to Simulation of the Anti-Submarine Problem (L-1)	Conf.	29	3-30-49	R.A. Nelson
R-158	Information System of Interconnected Digital Computers for Anti-Submarine Naval Group	Conf.	16	4-12-49	{J.W. Forrester {R.R. Everett
R-159	High-Speed Pulse Recording on Magnetic Tape (S.M. Thesis, Abstract in M-215)	None	123	4-6-49	E.S. Rich
R-161	Whirlwind I Test Control (Abstract in E-224)	None	15	4-14-49	G.G. Hoberg
R-162	Trouble Location in a Large-Scale Electronic Digital Computer (S.M. Thesis, Abstract in E-217)	None	70	4-12-49	G.C. Sumner
E-221	Standard Tests for Storage Tubes	None	4	3-30-49	{A.H. Ballard {C. Corderman
E-222	Low Emission 6AS6 Tubes	None	1	4-4-49	H.B. Frost
E-223	Storage Tube ST81: Construction, Processing and Initial Testing	None	3	4-5-49	M. Florencourt
M-821	Non-Standard Primary Power Connectors	None	1	3-31-49	H.S. Lee
M-824	Charts for Temperature Computations	None	1	3-24-49	R. Shaw
M-825	Bi-Weekly Report, Part I, 4-1-49	Restr.	16	4-1-49	
M-826	Bi-Weekly Report, Part II, 4-1-49	Restr.	16	4-1-49	
M-828	In-Out Orders	None	4	4-5-49	J.M. Salzer
M-831	Information on Machine Shop and Sheet Metal Shop Facilities, Barta Building	None	1	4-13-49	C.W. Watt

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6345 Reports (Continued)

<u>No.</u>	<u>Title</u>	<u>Classified</u>	<u>No. of Pages</u>	<u>Date</u>	<u>Author</u>
A-55-2	Security and Classification	None	5	4-6-49	(J.W. Forrester (H.R. Boyd
A-83	Drafting Standards S1.0 and S1.1; WVI Component Standards S7.0 to 7.29; and WVI General Standards S7.5	None	2	3-17-49	C.W. Watt
C-102-1	Decimal to Binary Conversion	None	2	4-9-49	C.W. Adams
C-103	A Code for the Ballistic Problem	None	13	4-1-49	T.W. Hildebrandt
C-104	Meeting of April 5, 1949	None	1	4-5-49	C.W. Adams

Library Files

47	Proceedings of the IRE, February and March and April 1949				Lib of Congress
52	Technical Information Pilots, Nos. 2341-2760				Sylvania
73	Progress Report for WVI Electronic Digital Computer for Period March 26 to April 8, 1949				(Reeves Instrument Corporation
128	Pre- and Post-Analyses by Reeves Analysis and Computer Group, February 20 to 24, March 1, 18 and 21				Ballistic Res Lab
134	Trajectory Data From Mitchell Theodolite Observation of Nike No. 30; 8 March 1949				A.W. Tyler
136	Eastman Kodak Monthly Progress Report No. 8				(Radiophysics
167	Logical Basis of High-Speed Computer Design, by T. Pearcey and M. Beard				(Lab, Sydney, Aust. RCA
180	Project Typhoon Summary Progress Report No. 2; 12-31-48				(Res Lab of
198	Document Office Bulletin, March 29, 1949				(Electronics, MIT
217	Interim Engineering Report on Radio Control Transmitter Model AN/ARW-55 and Radio Control Receiver Model AN/ARW- 56; Period March 1 to April 1, 1949				Collins Radio Co.
268	The Flight Signal Decoder, January, 1949				Cornell Aero Lab
304	Graphicon Conversion and Bright Display, Status Report for July and August, 1948				RCA Victor
308	Thirty-Fourth Annual Report, Administrative, 1948				(National Advisory Committee for Aero
308	Rectifier Networks for Multiposition Switching by D. R. Brown and N. Rochester				IRE

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11.2 Standards Committee

(H. B. Morley)

At the last Standards meeting, minimum stock levels on several classes of material were reduced to conform with anticipated future requirements. This program will be continued until the entire standard stock list is revised.

New standards issued or assigned:

- 7.411-6 Control Switch/Storage Switch Output (Pending)
- 7.411-7 Point-Off Control, 310
- 7.412-1 Toggle Switch Storage Output (Pending)
- 6.13 Machine Shop and Sheet Metal Shop Facilities

S7.5 Series and S6.31 Series are being issued to all drafting personnel to supplement the Drafting Standards.

11.3 Purchasing and Stock

(H. B. Morley)

The Drake pilot lamp sockets have been received, and appear to be a satisfactory substitute for the former Dialco standard. However, it should be noted that the cap thread differs and, therefore, caps are not interchangeable, nor will the new caps fit in WWI pilot lamp brackets. A stock of Dialco caps will be maintained for these applications.

IPC has been requested to submit drawings, specifications and prices on a multi-pin high voltage connector similar in appearance and mounting dimensions to the WWI 29-pin connector.

Tubular electrolytic capacitors are now being procured from Aerovox in the new PRS series. They are somewhat smaller in size than the old PRS series, and appear to give satisfactory performance.

(R. Fairbrother)

Drafts of schematic parts lists have now been completed for the "alarm circuit", "standardizer amplifier" and "deflection-voltage generator".

A shipment of 104 1:1, 109 3:1 and 1 5:1 pulse transformers was received last week from New England Transformer Company which has relieved our shortage.

The stockroom is now engaged in an inventory of all numbered equipment.

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11.4 Electronic Construction

(A. Taylor)

With the exception of the comparison register check, all WW construction is running ahead of schedule.

(A. R. Curtiss)

A signal plate gate amplifier and a gate inverter were breadboard assembled.

4 RF amplifiers (10 mc) were completed except for the phase detector coils which have been wound and are being installed.

The electrometer circuit was chassis assembled, and a filament supply panel was constructed.

Circuit sketches were completed for the storage tube life test meter control panel, a TV adapter and "Vac" system control circuit.

A new holding gun power supply model 2, was adjusted and checked for ripple and regulation.

A high voltage power supply was serviced and a Berkshire plate transformer was installed to replace a Freed transformer.

11.5 Drafting

(A. M. Falcione)

Miss Jean Antz terminated her services with the project as of Saturday, April 16, 1949.

Mr. Henry Austin was transferred to Bldg 32 as of April 11, 1949. He was working here on a loan basis.

All Class 1 standards issued recently with A-83 together with previous standards S1 issued for "6345 Production Drawings", will be consolidated in one folder and labelled "S1 Standards" together with the persons name to whom the standards were issued. The booklets will be numbered. The distribution list will be kept in the print room for additions or revision sheets which might be added at a later date.

The drafting room is keeping pace with present scheduled requirements. The work load is steady.

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11.6 Unclassified

(L. Prentice)

Machine Shop - There is almost no load in this shop at the present time. Work in progress consists of dies and tools for the sheet metal shop.

The staking tool made by this shop is being used; 25,000 turret lugs will be set over a 2-week period.

Sheet Metal Shop - WWI panels are being made to schedule or ahead of schedule.

A method of burring phenolic panels suggested by Don Dixon is working well.

The cutter and jigs for phenolic panels have proved successful. Thirty-three panels of this type were completed this past week.

12.0 GENERAL

Non-Staff Terminations

Jeanne Antz
Herbert Ladd

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