Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, Project 6345, October 13, 1950

To: J. W. Forrester

From: Project Whirlwind

1.0 SYSTEMS TESTS

1.1 Whirlwind I System Test

(S. H. Dodd, R. R. Everett, N. H. Taylor, R. Read)

A full complement of 16 individually tested and adjusted storage tubes are now operating in ES Row and tests on the complete row are now in progress.

The preliminary selection, due to the new pretest in the Storage Tube Laboratory, greatly increased the efficiency of ES Row testing by reducing the rejection rate. 10 out of the last 12 tubes delivered to ES Row were accepted. The entire complement of 16 tubes had been tested by Wednesday, October 11, although 1 additional tube has since been rejected in row-wise testing.

As mentioned in the last Bi-weekly, a considerable improvement was made in the RF distribution system by adjusting the line terminations. Since then we have checked the outputs of all columns and readjusted the RF amplifier gain where necessary. Practically no change in output signal amplitude was found in those tubes which were adjusted since the RF changes. RF phase reference amplitude was checked and RF connectors tightened in all columns resulting in a substantial reduction in unbalance. All tubes were initially lined up using the optimum RF phase angle for each particular column. These optimum phase angles have been remeasured and a median value chosen. Adjustments in the mounts were made to correct any optimum phase angle that differed from the chosen value by more than 10^{o}. It was discovered that most of the phase shift variation was in the mounts and not in the digit columns.

An overvoltage protection circuit was built and installed in the high-voltage line so that the entire bank of tubes can now be safely run at one time. Margins have been measured on the entire bank according to Section Z of M-1077-3 to determine whether output amplitudes, noise, feed-through and

1.1 Whirlwind I System Test (Continued)

writing currents have changed since the lineup of the individual tubes, and changes have been investigated and corrected. 16 test equipment probes, one in each column, have been installed to provide an improved TV display in the test control room.

We expect to run the electrostatic storage with WWI on test problems next week. Some preliminary row-wise testing remains to be done including setting up rewrite timing. The Storage Tube Laboratory will now take over the task of lining-up storage tubes in mounts for replacement in ES Row. Changing a storage tube in the row will require the physical installation of the mount, setting writing and signal plate gate amplitudes to the previously determined values, and possible readjustment of RF amplifier.

(H. F. Mercer)

Component Failures in WWI - The following failures of electrical components have been reported since September 29, 1950:

Component	No. of Failures	Hours of Operation	Reason for Failure
Crystals			
D-357	1	1089	Low back resistance.
Potentiometer			
10K 2 watt	1	932	Burn-out.
Tubes			
6Y6G	4	3715	Mechanical
7AD7	24	1380-1575	19 Low I_b
			5 Mechanical

Note: Regarding the 23 7AD7 failures in Gun Driver panels, reported in the last bi-weekly, it was erroneously reported that the majority of the failures were below WWI specifications when installed in the panels. The statement should have been that 4 out of the 23 were below specifications.

1.2 Five-Digit Multiplier

(E. A. Guditz)

During the period of this report the multiplier made errors only once. This occurred on October 9th at 0220. The cause of the errors was not determined.

No component replacements were made during this period.

2.0 CIRCUITS AND COMPONENTS

2.1 Circuits by System Number

820 ES Deflection

(R. L. Best)

The sweep generator has been completed, and installed in Whirlwind. Operation appeared to be satisfactory, after the gain had been slightly increased. Individual mosaic squares on the storage tube surface could be seen without an expanded sweep.

2.5 Tubes and Components

(H. B. Frost)

A simple check on the effect of adding a shield to a 5687 operating at high temperature was made during this last period. The bulb temperature rose from about 155° C to greater than 230°C. It would appear that this could be generalized somewhat to a rule that miniatures which are running at maximum rated bulb temperature should not be shielded. As mentioned previously, in the last bi-weekly, it has been found that 150°C, although within the manufacturers rating of 200°C max., is too hot when the tube is operated with one section normally on and the other off.

The analysis of crystal failures, although it is not complete, has yielded a rather interesting result. The population under study consists of the clamp crystals of the five-digit multiplier. Separating the crystals into two groups--one usually with back voltage applied and another usually with no back voltage--reveals that service with no back voltage applied seems to be more severe than service with back voltage applied. This cannot be considered conclusive at this stage, but the rates of failure appear to differentiate the two services quite sharply.

2.7 Three-Dimensional Magnetic Storage

(W. N. Papian)

Preliminary operation of the 2 x 2 x 1 array of cores has been accomplished. Perfectly successful storing and cycling of information throughout the array is indicated. Time will be spent at first, however, locating and removing sources of marginal operation in the equipment setup.

An arrangement has been suggested by R. Mayer which allows the scope to look at the sensing output from the array (or part of the array): (1) each time a selected piece of information is being handled; (2) each time a selected core handles information. The piece of information in (1) or the core in (2) may be selected by push button; any pattern of information may be cycling through the array while these observations are occurring.

A small material-development program in the magnetic ferrites is being organized; it will involve Professor Von Hippel's Laboratory, a small development firm in New Jersey (the Glenco Corp.), and ourselves. The goal is a cheap, high-resistivity, ferromagnetic, material which has a hysteresis-loop shape that will make it a good coincident-current memory medium. Also under discussion are the potentialities of the ferroelectrics, a group of dielectric materials which have hysteresis loops in the qv (charge voltage) plane analagous to the ϕH hysteresis loops of the ferromagnetics.

3.0 STORAGE TUBES

3.1 Construction

(P. Youtz)

Six tubes, RT173, RT174, RT175, RT177, RT178, and RT179, for WWI were processed this period. These tubes were identical with the 100-series storage tubes for WWI except the mosaics were lined up with the deflection plates and the mica spacer was redesigned to give uniform spacing between the screening and the mosaic surface. In two of the tubes, RT177 and RT179, a light fixture was used to align the axis of the high velocity gun with the center of the storage surface.

(R. Shaw)

A fixture for locating deflection plates in 5U guns has been completed and tried out using a "dirty" gun. This fixture, SD-36101 was designed for a spacing of .109 inch between both pairs of deflection plates. Calculations have indicated that such a spacing is adequate to permit the gun to sweep the target of a "stubby" storage tube without interception of any part of the beam by the deflection plates. New spacer blocks can be made to obtain different spacing if this is required. The first tests with the "dirty" gun resulted in a spacing varying between .110 and .118. By merely filing off the high spots opposite the spot welds on the deflection plates and then reassembling, it was possible to improve the spacing to between .110 and .113. Some means of improving the flatness of the plates is evidently required. The number RT-184 has been assigned to a tube to be used for testing a gun assembled with this fixture.

Parts for the annealing oven, mentioned in the last bi-weekly report, are under construction.

3.2 Test

(W. F. Mann and A. Stein)

Pretests as outlined in M-1077-3, Sections B, C and K were carried out on the television demonstrator unit.

The following tubes were pretested and passed:

ST173, ST177, RT161, RT163, RT164, RT168, RT170, RT172, RT173, RT174, RT177.

ST141 was passed marginally; since the holding beam had very

high cut-off, necessitating V_B' of -10 volts for dense coverage. The desireable operating V_{NG} of 133 volts is somewhat high.

The following tubes were rejected due to high surface leakage: ST139, ST163-2, ST170-1, ST174 and RT171.

ST135 was rejected due to I_k' at 0v. bias being less than .5 ma. The holding density is very low; at 0v bias the holding beam only barely covers the surface.

ST103-R1 was rejected due to surface leakage. Furthermore, H.V. Cathode emission is very erratic; it reactivated to some extent if gun was biased off.

(C. L. Corderman and H. J. Platt)

Preparations are being made for checking out storage tubes in the STRT, following the test schedule of M-1077-3. Cable changes and programs for each section of the tests have been listed in M-1110 for future reference and a modified block diagram prepared. After several tubes have been completely checked, and a procedure established, a form will be set up to standardize and expedite the testing.

One of the ST monitor scopes has been released by adding a 4PDT relay to change from error display to an expanded TV presentation. This scope is now being modified for use as an RF monitor, similar to the one used in ES row.

Testing of WWI tubes should be underway on Wednesday, October 18th.

(H. B. Frost)

During the first two days of this period, additional high-velocity gun tests were run using ST 146. These tests will be summarized elsewhere. The remainder of the time in this last period was spent in much-needed maintenance and repair of various pieces of non-standard test equipment in the STRT. In addition, modifications of the block diagram were made to facilitate testing of storage tubes completely prior to installation in WWI.

(C. L. Corderman and A. Stein)

RT-176, a research tube having a modified 5UP gun in a 5" CRT envelope, has been examined under d-c conditions in the new test set-up. Because of the enlarged A_2 and G_2 apertures, this gun gives ratios of target to cathode currents of ≈30% instead of the 8-10% obtained from normal 5UP guns. However, the apparent spot size is greater than 100 mils for all currents above 25 μa. Further life tests and comparison data from RT104 are necessary to assess the value of this modified gun in 100 series storage tubes.

3.2 Test (continued)

(A. R. Tanguay)

The last two weeks we spent attempting to remove the bugs from the "Miller" sawtooth generator. This generator is intended to be used in the restoring current tester.

The desired sweep voltages are as follows: First, a linear positive sweep of 10,000 μsec. duration and 300 volts amplitude is required. This sweep must have superimposed on it a small negative gate to delay the zero voltage point of the sweep beyond the non-linearities produced when the sweep is differentiated. The intent is to use the differentiated sweep as an axis from which to measure pulses which will not be differentiated by the circuit.

Secondly, a negative sweep with amplitude and duration comparable to that of the positive sweep is needed.

Thus far, both positive and negative sweeps have been obtained. Mixing the small negative gate with the positive sweep, however, without causing a non-linear sweep, nor parasitic oscillations in the mixing circuit, remains to be accomplished.

4.0 INPUT-OUTPUT EQUIPMENT

4.1 Eastman Kodak Film Units

(J. A. O'Brien, D. Hageman)

The reference marker light source suggested by Eastman engineers during their recent visit was modified in order to circumvent a difficulty which had not been foreseen. The change merely amounted to changing the position of the lamp so that light from the source passes through only the "non-splitting" half of a beam-splitting prism.

The modifications on the reference marker light source and the phototube circuits were tested when the modified E. K. unit was operated as a reader reading into the computer. The tests were very encouraging in that the film unit appeared to read without errors. There were many errors present during the reading operation, but trouble shooting by marginal voltage variation indicated that the source of the errors was in the In-Out Control equipment. With a marginal voltage set into the computer we were able to read a loop of film, on which were recorded alternate positive and negative zeros, without error for several successive cycles of the loop. At the end of this time errors would occur which seemed to be caused by a faulty flip-flop in In-Out Control.

4.3 Typewriter and Tape-Punching Equipment

(C. W. Watt)

Input Tape Reader - The input tape reader and associated relay and video circuits have been tested with the computer for several hours and have performed satisfactorily. Three test programs were used. Two of these caused information on tape to be checked, against the same information in Toggle Switch Storage. The first caused the computer to operate continuously, checking periodically to see what had shown up in the input register (Flip-Flop Register 3). Under these conditions the reader itself is cycling continuously in the

4.3 Typewriter and Tape-Punching Equipment - Input Tape Reader (Cont'd)

"Free Running" mode. The second comparison test program caused the reader to be started by a command from the computer, cycle once, and send a completion pulse back to restart the computer. Both of these test programs operated satisfactorily, although some crosstalk exists between the lines from the relay panel to the synchronizer. This affects only the Free-Running mode and should be easy to eliminate when time is available to do it. Normal operation is not affected.

The third test program is very similar to the actual initial program to be used for reading sexadecimally coded binary information into WWI. It uses a checked sexadecimal tape, and the program checks each word against its complement and builds up a 16 digit word in storage out of four 4-digit words. The numbers placed on the tape for the test provided successively groups of 1, 2, 3, and 4 ones which shifted from right to left across the Test Control Indicator lights, giving a pattern that could be visually checked. Using the second of the above programs, the reader ran continuously under computer control for over an hour without an alarm due to incorrect reading. During this time about 400 groups of 20 numbers each were read in and checked. The third program was run continuously for about half an hour without a reading mistake. This was equivalent to filling 256 registers of Electrostatic Storage about 6 times. These are the only extended runs that have been made.

4.3 (C. W. Watt)

Flexowriter Equipment - Much time has been spent in determining further requirements for the maintenance of the tape reader and punch. As a result of tests made with the output equipment it was found necessary to increase the throw of the cam-actuated contacts of the readers, which required a major change in the readers. A technician is spending full time on the adjustment of the Flexowriter equipment. We should soon have complete maintenance and adjustment standards for all this equipment.

4.3 Typewriter and Tape-Punching Equipment (Cont'd)

(C. W. Watt)

Output Printer and Punch - Tests have been made on the bench of the complete output tape punch and printer assembly. Operation in all ten possible combinations of conditions has been achieved, and considerable time has been spent in checking relay timing, arc suppression, and response of the system to unusual or transient conditions. It is hoped that the equipment can be tied into the computer next week for system checking.

4.4 (E. S. Rich)

Input-Output Planning - A preliminary block diagram has been worked showing functional interconnections between an in-out switch, an in-out control, and several different types of terminal equipment. This diagram made it possible to visualize more clearly some of the engineering problems involved in the design of the in-out switch. These problems are now being studied in more detail to determine in what form the in-out switch will contain the least equipment.

5.0 INSTALLATION AND POWER

5.2 Power Supplies and Control

(J. J. Gano)

D.C Power Supplies:

Short Range Program.

(a) Remove drift on +48 volt supply.
(b) Remove drift on -15 volt supply if it reappears. A very conservatively-loaded wire-wound resistor in the voltage divider of the feedback lead opened up internally. Whether the resistor had poor contact and was causing the drift or whether its failure was coincidental has not yet been determined.
(c) Increase the stability of the +90 volt supply. Frequency response tests will have to be conducted and a compensating circuit provided.

5.2 Power Supplies and Control (Cont'd)

(J. J. Gano)

D-C Power Supplies:

Long Range Program:

(a) Take voltage measurements throughout the circuit to facilitate trouble shooting.
(b) Determine the feasibility of a marginal checking procedure.
(c) Study the stability of each of the supplies and improve it if possible.

5.3 Video Cabling

(T. Leary)

The necessary paper work for initiating the manufacture of 42 miscellaneous video cables has been started and the shop is now working on the first of these cables.

6.0 BLOCK DIAGRAMS

(R. P. Mayer)

The "Up-to-the-Minute" drawing showing timing diagrams for all orders is now available in the test control room.

Two small changes in timing of display orders have been made: 1) "Horizontal decoder clear" now occurs on TP 7 (instead of 6) to allow the "rd sense" pulse to delay clearing it, and 2) "I-O Record" now occurs on TP 1 (instead of 3) to allow the interlock to work properly when operating display orders by push button (this change also affects order rc, but with no harm whatsoever).

An ES Block Diagram has been sketched, for S. H. Dodd, showing a proposed system for bank selection. This drawing is not generally available.

8.0 MATHEMATICS

(C. W. Adams)

Nearing completion is E-387, a much needed description of the interim terminal and central equipment and proposed techniques for using the interim equipment. Already finished is R-37291, a detailed block diagram of the interim equipment. It is being reduced to D and to B size to please all tastes.

(F. Helwig)

A final code for the solution of Papian's magnetic tape problem has been written and a tape for the computer will be prepared from it in the near future. A method for changing the values of the various parameters involved has not yet been decided upon, but the values of these parameters for the cases to be considered have been computed.

(J. D. Porter)

During the report period I have been considering the following problems: (1) A program for finding the real roots of a polynomial; (2) A method for selecting a desired subroutine library and adapting it to the main program; (3) final considerations involved in running Papian's magnetic tape problem through the computer.

9.0 FACILITIES AND CENTRAL SERVICES

9.1 Publications

(J. N. Ulman, Jr.)

The following material has been received in the library, Room 217, and is available to 6345 personnel.

6345 Reports

No.	Title	No. of Pages	Date	Author
R-192	A Coincident-Current Magnetic Memory Unit M. S. Thesis. Abstract in E-379	83	9-8-50	W. N. Papian
E-381	Dissection, Cleaning, and Reassembling of a Glass Vacuum System	5	10-6-50	W. E. Pickett, R. Shaw, T. R. Parkins
E-383	Use of Wet Slicing Machine	2	9-29-50	W. E. Pickett
M-1067	Temporary Operation of qr: Read/Shift Right	3	7-17-50	C. W. Adams
M-1094	Vacuum Tube Failures During the Month of August, 1950	2	9-5-50	H. B. Frost
M-1103	Bi-Weekly Report, Project 6345, September 29, 1950	19	9-29-50	
M-1104	IRE Third List of Definitions. FOR INTERNAL DISTRIBUTION ONLY.	8	10-2-50	C. W. Adams
M-1105	Electronic Computer Division Personnel	3	10-1-50	
M-1108	Special Display	2	10-4-50	D. A. Buck

Library Files

	Electrical Engineering. October, 1950	I. E. E.
.004	European Scientific Notes: 15 September, 1950	ONR/London
47	Technical Information Pilot: September 12, 1950	ONR/Library of Congress
150	Fundamental Research on Raw Materials Used for Electron Emissivity on Indirectly Heated Cathodes. First Engineering Report, 1 July to 1 October 1950	Raytheon Mfg. Co.
180	Document Office Bulletin: August 11, October 6, 1950	RIE/MIT
271	Machine Solution of Problems for the Office of Air Research. Progress Report No. 11. 1 June to 1 September, 1950	Computation Lab., Harvard Univ.
280	Digital Computer Newsletter: 1 May, 1 August, 1950	ONR/Washington

9.1 Publications (Continued)

Library Files (Continued)

No.	Title	Author
500	Air Materiel Command Standard and Suppliers Directory of Requirements for Electronic Equipment Parts, Materials, and Processes. MCREES-G-1 August, 1950	Air Materiel Command
822	The Aerovox Research Worker: September, 1950	Aerovox Corporation
961	Report on the National Bureau of Standards Western Automatic Computer. August 26, 1950	F. E. Swain
962	Response Time of Magnetic Amplifiers. Preprint of AIEE Paper 50-177. From AIEE Transactions Vol. 69, 1950	E. L. Harder W. F. Horton
963	Signal Corps Electronic Computer Research and Development. Quarterly Progress Report No. 2, 4 April to 3 July, 1950. Research Division Report 51-2	Moore School of Electrical Engineering U. of Pennsylvania
964	Inverse Computation for Long Lines: A Non-Iterative Method Based on the True Geodesic. Technical Report No. 7. August, 1950	Army Map Service
965	Computation of Tape Orders for the Milling of Wing Panels and Templates on the Parsons Numerically Controlled Milling Machine. Engineering Memorandum No. 18, September 8, 1950	R. J. Cypser Servo. Lab., M. I. T.
966	Progress Report No. 11, D. I. C. Project 6694. October 9, 1950	Servo. Lab., M. I. T.
967	Matrix Methods Applied to the Solution of Simultaneous Linear Equations. 28 October, 1949	H. E. Fettis Air Materiel Command
969	Arithmetic in a One's Complement Computer. Division in a One's Complement Computer. September 11, 1950	R. A. Leibler
970	Direct Current Nozzle Drive Transfer Valve. Cornell Aeronautical Lab. Report ID-389-S-4	W. C. Moog, Jr.

Books

Proceedings Scientific Computation Forum, 1948	International Business Machines, H. R. J. Grosch, ed.

9.2 Standards, Purchasing and Stock

(H. B. Morley)

STANDARDS: No new or revised standards issued or received this period.

PROCUREMENT AND STOCK:

As mentioned in previous bi-weekly reports, deliveries of material are becoming worse. The point has been reached where vendors' promised delivery dates are seldom met on factory orders. On most critical items deliveries will range from six months up. Raw metals, particularly stainless steel, tantalum, nickel, etc., are apt to be hard to locate, perhaps not available in some sizes. It is reported that one company is allocating aluminum. Coaxial connectors from IPC are now 90 days minimum.

The stock room has experienced considerable difficulty keeping track of tools signed out on the daily sign-out sheet, mainly because some of these tools are kept out for weeks or even months. Hereafter, at the discretion of the stockroom foreman, and in the absence of justifiable reason, tools held longer than two weeks or temporary loan may be transferred to the personal tool list of the employee having them.

Again it should be mentioned that the problem of salvage should not be considered 100% a stockroom function. Engineers and technicians can aid immensely by observing the following suggestions when turning in salvage:

(1) Discard components which are obviously useless.

(2) Separate hardware from electrical components.

Much of the salvage being brought into the stockroom has the appearance of being just the sweepings from bench tops.

9.3 Construction

(R. A. Osborne)

Production Report

The following items have been completed and inspected since September 29, 1950.

5 Mixers, Operation Matrix

1 External Power Cable for HV Protective Circuit

1 Magnetic 2 x 2 Selector Modification of TV Sweep Generator Breadboard

9.4 Drafting

(A. M. Falcione)

1. Ditto Paper: Because of the difficulty in obtaining ditto paper, it may be necessary for us to procure paper from other sources than the present one. We are now in the process of testing various other makes of paper in the event it should become necessary.

2. New Drawings (New WWI units)

A. Complete drawings and Parts List for the HV Protective Circuit panel are in the process of being checked.

B. Drawings for the Regulator, DC Plate Supply Alternator; and the Bias Interlock panels are now nearing completion.

10.0 GENERAL

(J. C. Proctor)

New Staff

Charles H. Gaudette of Lowell will work with Mr. Welchman's group on coding and applications. He received a Bachelor of Science in Mathematics from MIT in June.

New Non-Staff

Robert E. Costello has replaced John W. Essigmann in the drafting room. He is a graduate of Franklin Technical Institute and has detailing experience. His home is in Norwood.

Four MIT students have joined the project as mathematicians. They are Paul H. Cootner, Lonnie Cross, Peter E. Ney, and Berthold Schweizer.

Francis B. VanWyk, an MIT student, is working with Mr. Welchman's group on coding.

New students working with the storage tube group include Donald J. Eberle, an MIT graduate student, and Bernard A. Leslie from Northeastern University.

Non-Staff Termination

John W. Essigmann transferred to Supersonic Wind Tunnel.