Tech

Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, October 28, 1949

To: 6345 Engineers

From: Jay W. Forrester

1.0 SYSTEMS TESTS

1.1 Whirlwind I System Test

(N. H. Taylor)

In an effort to improve the efficiency of the Systems operation, a schedule of days for demonstration of WWI with Test Storage has been arranged. The machine will be running for demonstration one half day in each bi-weekly period starting Tuesday morning, November 1st, and then each succeeding second Tuesday.

The systematic review of all circuitry in WWI to date is continuing at a satisfactory pace. The work could be speeded considerably if automatic marginal checking could be installed; however, this seems to be about a month away from installation.

Input-Output equipment is approaching a point where we will soon be reading 16 digit numbers from the EK units to the In-Out Register with the associated In-Out Control. This should begin in the next 2 week period.

(G. C. Sumner)

System testing has been concerned with two main problems in the past two week period, test storage and control pulse output mixing. The test storage drivers have given considerable trouble ever since they were installed. After making several small changes, each of which improved operation

1.1 Whirlwind I System Test (Continued)

somewhat, it became evident a few weeks ago that a major change was necessary. The problem was carefully considered, and calculations made mainly by W. Papian showed that the 2C51 driver stages could probably be eliminated. This change, described in greater detail in 2.1 has been installed and results look extremely promising. It was thought that this change might, at the worst, require sacrificing time allowed for the TS switch matrix to switch. But apparently any time lost due to increased load resistors can be recovered by inductive peaking.

The solution for equalization of pulse amplitudes when two or more CPO units are cascaded using their ungated inputs is yet unfound. The amplifier in those units has a voltage gain considerably less than unity when working into a 93-ohm load. Several circuits in addition to the one previously proposed by McVicar were tried, but all have the disadvantages of high power consumption and large number of physical changes involved.

(R. H. Gould)

The problem of resetting the program counter, control switch, flip-flop storage, etc., is being investigated. It seems desirable to have the PC end carry pulse and the output pulse of the special display scope independently controllable as to which registers each resets. Also useful would be a switch arrangement (perhaps 58-position switches) that would enable one continuously to increase the value to which a FFS register is reset from minimum to maximum in 2^{-15} steps. This would make for more impressive demonstrations using special display. Comments and other ideas are welcome.

(H. F. Mercer)

The following failures of electrical components have been found since October 14, 1949:

CRYSTAL RECTIFIERS	QUANTITY	COMMENT
D-357	2	1 was a "one-side" clamping crystal in the "Eight's Increment" section of the SDD and it showed excessive drift after 390 hours of operation.

1.1 Whirlwind I System Test (Continued)

CRYSTAL RECTIFIERS	QUANTITY	COMMENT
		1 was a clear mixing crystal in (FR2)15 and showed low back resistance and drift after 1139 hours of operation.
D-358	5	4 were clamping crystals in MSDD Serial Number 1. All failed after approximately 250 hours of operation. Two showed low back resistance, one excessive drift and the other had no back resistance.
		1 was a "one-side" clamping crystal in (FR2)11 and showed excessive drift after 1139 hours of operation.
TUBES		
3B29	1	BA in TFDO. Change in characteristics -- two halves unbalanced after 1604 hours of operation.
6Y6	1	BA in FS06. Tube became gassy after 1145 hours of operation.
RESISTOR		
220 ohms 1 watt	1	Plate decoupling resistor in FS06 burned out due to gassy 6Y6.

1.2 Storage Tube Reliability Tester

(J. Hanson and R. Sisson)

One storage-tube rack was rewired. A modified form of the new HV gun protective circuit was installed. This circuit was then tested. It gives satisfactory protection and still allows control over the beam current. The protective circuit may be switched out, if desired.

1.2 Storage Tube Reliability Tester (Continued)

The testing of ST 110 was carried further. Spot-size was measured as a function of focus and of HV write time for a negative spot on a positive background. The result indicates that it takes about 15 μsec to write a well-defined positive spot (at the beam current used) and that the spot was about 0.1" diameter at best focus.

The deflection decoders were modified to conform with the system described in E-203. This system works as proposed.

A switch and relay system was installed so the HG beam may be turned off from a front panel.

1.3 Five-Digit Multiplier

(E. S. Rich)

Incorrect operation of the multiplier has occurred during two different periods in the past two weeks. On October 15 there was one failure in which three error-counts were recorded and on October 25 there were two failures about one minute apart, each of which caused one error count. A total of six tubes have been replaced. Two of these were from a flip-flop in the accumulator and the others were gate tubes and buffer amplifiers. A marked decrease in the margins had shown up over a 24 hour period in some of the circuits in which these tubes were located. It is thought that the errors might have originated in circuits which became marginal as a result of drift in the supply voltages. These supplies require readjustment about once a week. The circuits referred to had shown steadily decreasing margins for several weeks so probably the recurrence of similar failures can be prevented by setting higher values for the minimum safe operating margins.

2.0 CIRCUITS AND COMPONENTS

2.1 Circuits by System Number

200 Test Storage

(W. N. Papian)

Test Storage has been operating very close to the margin for the last few months, resulting in a good deal of trouble, particularly from slight deterioration in 2C51 characteristics with age. The following changes have been semi-permanently installed in the endeavor to obtain greater long-term stability of operation.

The output amplitudes from the crystal switching matrix have been raised. These higher amplitudes now drive the grids of the 6Y6 cathode followers directly; the cathode followers, in turn, drive the gate tube suppressor grids directly. Eliminated, as a consequence, have been two stages of amplification and three a-c interstage coupling circuits. Minor changes in FF Storage Drivers have been necessary to accommodate them to the new circuits.

Results thus far are encouraging. Detailed amplitude, timing, and marginal checking measurements remain to be taken, followed by more permanent installation.

410 In-Out Control

(J. A. O'Brien)

A small amount of testing has been done on the IOC equipment, but in order to complete more adequate tests, test equipment is being assembled that will permit simulation of most of the functions of the film units and the computer as they pertain to the IOC elements.

810 ES Control

(R. Read)

During the past two weeks the test control associated with ES Control and digit column has been modified to improve reliability and flexibility. A push-button synchronizer has been added to allow manual slow-speed operation. Rowland is improving reliability throughout the ES setup and handling circuit problems in general. Circuit changes have been made in ES Control at his suggestion.

820 ES Deflection

(L. J. Nardone)

The ESD Decoders have been temporarily modified to operate as counters in the ES Row. The counting operation can either be at high speed or at push-button rate.

Sweep generators have been installed in the ES Row to obtain a TV scan for observing the surface of the storage tube. These generators feed the ESD Output Panels. The TV scan is observed on a 208 scope.

All prints of the ESD Decoder Panels are being marked up to conform with the proposal in E-302.

831 ST Mount

(R. E. Hunt)

All components and sub-assemblies of the ST Mount are now being constructed except for the "Signal Plate Coupling Chassis."

This coupling chassis will go to the shop in a day or two. On the whole, this job seems to be about on schedule and should be available about December 26, 1949.

834 Gun Driver

(C. W. Watt)

As discussed in section 3.2, it may be necessary to have the HV gun cathode draw current for a large percentage of the time. This requires that the flip-flops in the Gun Driver be restored. Accordingly, restorer inputs were added to the panel, and other minor changes to simplify video cabling were put in. All of these changes may hold up production time about a week. Work has begun on phenolic panel assembly, and the modified aluminum panels have been sent out for screening.

2.5 Tubes and Components

(H. B. Frost)

Almost all tube shop time during this period has been spent in preparing and issuing tubes for the signal plate drivers and gun driver panels. This work is now nearing completion. Time during the next period will be concentrated on preparation of

2.5 Tubes and Components (continued)

tubes for replacement use to build up reserve stocks. Three life test checks were made during the last period, and two tests are coming up for the next period. The tests made during this period were of forty-five 6AG7 tubes, twenty 6AN5 tubes, and nine 5687 tubes. WWI tube records are now caught up.

The 6AG7 tubes mentioned above are a lot of special RCA tubes with various cathodes which have gone 3000 hours. These tubes show quite definitely that RCA N32-A cathode material (active type) is very prone to form apparent cathode interface resistance. All tubes with this material show apparent interface formation, while no tubes with N109 (normal) and N81 (passive) cathodes have shown any apparent interface formation.

The twenty 6AN5 tubes have been on test for 3000 hours with very little change. However, tubes operated with no plate voltage and cut off have shown some gas formation and are prone to have grid 1 emission. Grid 1 emission appears to be more prominent than gas, but is not high enough to interfere with use as specified by Raytheon. Twelve 6AN5 tubes in two flip-flop life test panels are to be tested next week.

The 5687 tubes tested are of two lots: an engineering sample lot and a 3229-26 production lot. The engineering samples (4) are fairly satisfactory, although one tube has developed an apparent cathode interface. Other tubes in the engineering sample lot are a little low in emission, but have not shown interface. The five tubes from 3229-26 production are showing some interface formation on all but one tube after 500 hours. Even so, these tubes appear to be approximately of the same quality as 3228-52 production, the best previously received, which is quite satisfactory for test equipment use, although not for computer use.

Pulse tests made on various tubes from the life test racks have failed to show the "blackout" described in M-908 and M-913. However, a somewhat similar effect has been noted in certain of the special 6AG7 tubes noted above (3 N81 tubes operated 3000 hours with E_f = 7.5 v., cut off). When pulsed with single one millisecond pulses, these tubes show a considerable rise in primary temperature-limited emission during the pulse. Preparations are being made to test 6AN5 and 7AD7 unrestored flip-flops with a single trigger pulse after 24 hours or more in one position.

2.6 Test Equipment

(R. L. Best)

Low Speed Binary Counter - Three "binary scalers" have been received from G. E. These are plug-in flip-flops which will operate up to 200 KC, using a 12AT7 tube. A breadboard is being constructed to test these units.

2.2	WWI Drawing List	Block Diagram	Block Schematic	Circuit Schematic
	Block Diagram Symbols	B-37001-5		
	System Numbers	B-37250		
	System	D-37071-6		
100	Central Control	B-37098-6		
	Master Clock	C-37159-5		
101	Pulse Generator	B-37156-4	B-32385	E-32333-6
102	Program Counter	B-37062-6	B-32213-1	D-31516-9
103	Program Register	B-37067-4	B-39289-3	D-33836-4
104	Control Switch			
	Input Panel	B-37066-5	B-34321-1	
	Matrix Panel	B-37066-5	C-33843-2	B-32722-4
	Switch Panel	B-37066-5	B-34100	Z60CS00-2-G
	Output Panel	B-37066-5	B-34101	Z60CS00-E
105	Operation-Matrix Driver Panel		S60CM00-B	Z60CM00-1-G
106	Control-Matrix			
	(1-40), Rack C-9	D-37192		
	(41-80), Rack C-10	D-37193		
	(81-120), Rack C-11	D-37194		
105	Control-Pulse Output Unit		R60CP00	S60CP00-1-C
106	Time-Pulse Distributor			
	Counter Panel	B-37068-6	T60PD00-3-D	Y60PD00-E
	Output Panel	B-37068-6	T60PD00-4-C	Z60PD00-1-H
109	Clock-Pulse Control	C-39817-5	C-32642-5	E-31916-9
	Clock-Pulse Control Delay	C-37159-5	A-34446	D-34416
110	Frequency Divider	B-37154-4	B-32264-1	R-31729-4
111	Synchronizer	B-37172-2	C-33485	R-33486-2
112	Restorer-Pulse Generator	B-37160-3	B-32209-4	D-31909-10

2.2 WWI Drawing List (Continued)	Block Diagram	Block Schematic	Circuit Schematic
200 Test Storage	B-37156-3		
201 Test-Storage Amplifiers		C-32855-4 C-33768	D-33706-2
201 Storage Switch			
Input Panel	C-37121-3	B-34322-1	
Matrix Panel	C-37121-3	C-32855-4	R-32722-4 D-33706-2
Switch Panel	C-37121-3	B-34102	Z60CS00-2-G
Output Panel	C-37121-3	B-34103	Z60CS00-E
202 Toggle Switch Storage			
Switch Panel	B-37122-4	C-33768	D-33706-2 C-33707
Output Panel	B-37122-4	C-32080	E-32721-4
203 Flip-Flop Storage			
Output Panel	C-37060-6	B-32269-1	E-31635-7
Register Panel	B-37057-5	B-32268-1	E-31621-7
Control	B-37061-8	D-32106-3	
300 Arithmatic Element	D-37072-10		
301 A-Register, Digit 0	C-37056-4	B-31574-1	D-31573-8
301 A-Register, Digits 1-15	C-37056-4	B-31211-3	D-31276-12
302 Accumulator			
Digit 0	D-37173-2	D-32851-1	R-32850-5
Digit 0, Auxiliary Panel	D-37173-2	B-32492-2	D-32602-1
Digits 1-14	D-37173-2	D-31213-4	R-31275-10
Digit 15	D-37173-2	D-33964	
303 B-Register	C-37097-6	B-31212-5	D-31277-11
304 Sign Control & 308 Divide-Error Control	D-37072-10	C-31576-3	E-31619-2

2.2 WWI Drawing List (Continued)	Block Diagram	Block Schematic	Circuit Schematic
305 Step Counter	B-37074-8	D-31828-2	D-39764-5
305 Step-Counter Output		A-32723-1	D-32735-2
306 Multiply &		C-31532-3	E-31588-6
307 Shift Control	D-37072-10		
308 Divide Control	D-37072-10	C-31552-3	R-31718-5
309 Overflow & Special Add Memory	B-37174-2	C-31575-5	E-31632-5
310 Point-Off Control	D-37072-10	C-31600-6	E-31717-6
400 Input-Output	D-37178-2		
403 In-Out Register	D-37178-2	B-32434-3	D-31277-11
404 Comparison Register	D-37178-2	B-32578-4	E-32576-10
404 Comparison Register Check	D-37178-2	B-33488-1	E-33516-3
412 10C Synchronizer	D-37178-2	A-34330	D-34338-1
601 Check Register	B-39816-4	B-32577-1	E-32576-10
601 Check-Register Check	B-39816-4	B-32018-1	E-32023-4
602 Alarm-Indicator Control	B-37175-2	B-33603-1	E-33651-4
820 ES Deflection	D-37220	E-34770	
ESD Gate Panel	D-37220	A-34036-2 E-34770	B-33876-3
ESD Decoder	D-37220	E-34770	E-33908-2
ESD Output	D-37220	E-34770	C-34182-1
ESD Bank Selector	D-37220	B-34232 E-34770	D-34238
Storage Selection Mixer	D-37220	E-34770	C-34311
831 ST Mount	D-37220		E-34040-1
832 EST Output			
RF Amplifier	D-37220		D-34315-2
Gate Tubes	D-37220		C-34251

2.2 WWI Drawing List (Continued)	Block Diagram	Block Schematic	Circuit Schematic
833 Signal-Plate Driver	D-37220	A-34711-1	D-34029-4
834 Gun Driver	D-37220	B-34712-2	D-34181-2
835 Holding-Gate Generator	D-37220	A-34354-1	C-34060-5
835 Read-Gate Generator	D-37220	A-34355-1	C-34324-5
835 RF Pulser	D-37220		SE-34549
Standardizer Amplifier		A-33881-1	C-33880-3
Bus Driver, Arithmetic Element		A-32297-1	D-31727-7
Bus Driver, Flip-Flop Storage		A-32296-1	D-31726-7
Register Driver, Type 1		B-32207-1	E-32261-11
Register Driver, Type 2		B-32691-2	D-32690-4
Bus Connections	C-37124-4	C-37123-3	
Fuse-Indication Panel			W60PP00-7-D
Voltage-Variation Panel			T60PP00-6-D
WWI Power-Connector Pin Connections			C-31956-6
Digit-Interlock Panel			W60PP00-8-B
Fixed-Voltage Switching Panel			T60PP00-11-B
Power-Interlock & Indication Panel			Z60PP00-12-B
Power-Supply Control		D-32017-5	D-33184-4 (cabling diagram)

3.0 STORAGE TUBES

3.1 Construction

(P. Youtz)

During the past biweekly period the emphasis has been on special research tubes. Three of these tubes were sililar to regular storage tubes except the target surface was modified. Two tubes had mica storage surfaces which were thicker than usual. One tube had a target surface with a different beryllium mosaic size in each quadrant. Also four research tubes were made for the cathode studies, whereas only one regular storage tube was processed this period.

In order to build up the stock pile of storage tubes available for WWI the major objective of the construction group during the month of November must be to build as many regular storage tubes as possible.

(W. E. Pickett)

Glass Components - During this last period delivery was made of the glass blanks used for evaporation tubes. A number of these glass blanks were made into evaporation tube blanks and the supply of these evaporation tube blanks on hand at the present is ample enough to take us through the next few weeks.

Because of the accelerated program of research tubes which were completed during this last period, the supply of storage tube envelopes has suffered in that time normally spent for the fabrication of these envelopes had to be devoted to building of the research tubes. Although the supply of storage tube envelopes is very low, it is hoped that during this coming period enough time can be spent in fabrication of storage tube envelopes to bring our supply up to a quantity that will not cause any delay in the planned storage tube program.

We have received a small quantity of tubulated 10-pin stems from our local vendor, which brings the supply of these tubulated 10-pin stems up to a fair condition. This relieves some of the anxiety of the glass shop over these stems and the supply should be ample for the next few weeks. The difficulties in procuring these stems still exist and it is hoped that the difficulties in building the stem will be ironed out to such a point that we will again have a normal flow of these stems from our local vendor.

In general, the construction of glass components for the storage tubes and evaporation tubes has slowed down as mentioned before due to this accelerated research tube program. It is hoped that

3.1 Construction (Continued)

enough time can be devoted during this next period to building up the supply of components necessary to build the storage tubes and evaporation tubes.

(R. Shaw)

The beryllium boiler used in evaporation tubes has been completely redrawn. Its present form permits the extensive use of tools and locating fixtures during assembly; consequently a more uniform product may be expected in future.

A research tube having a movable Faraday cage is under construction. This will permit measurement of the effect of gun-to-target distance and of deflection angle on the beam velocity-distribution.

Record drawings of RT-63 and RT-64 have been made. A considerable "backlog" of storage tube drafting remains.

(J. O. Kly)

During the past two weeks four research tubes designed for cathode study have been processed. RT78 contained three grid-cathode assemblies mounted so that their cathode surfaces could be observed microscopically during processing and cathode temperature may be measured at any time with an optical pyrometer. RT80, RT81, and RT82 are the second set in the series of tubes for study of emission and life of various coatings. Cathodes for the last three tubes were taken from the first group sprayed here, and showed good current when aged on the vacuum system. After sealoff, however, excessive gas was liberated when the targets were bombarded with high-velocity electrons. This gas caused rapid loss of emission at the higher voltages, so that these tubes are operated on life test with only 450 volts accelerating potential. In future tubes of this series particular care will be exercised in processing the targets to reduce evolution of gas from these surfaces after sealoff.

Although the first cathodes sprayed in our laboratory were apparently satisfactory, the hand spraying technique used definitely will not be suitable for production of uniform cathodes or cathodes with accurately predetermined coating characteristics. Accordingly, a comparatively simple motor-driven spray rack for producing up to ten cathodes at a time will be built in the near future. Such a rack will go a long way toward eliminating the operator judgment involved in producing coated cathodes.

A small supply of gun components was procured from Hytron at Newburyport to insure that we will be able to continue the cathode program without delays for procurement of RCA parts.

3.1 Construction (Continued)

Commercial CRT's on life test have reached approximately the 1000-hour point and will be utilized by Dana Collier in preliminary studies of the decay and recovery phenomenon.

3.2 Test

(H. Klemperer)

The phenomenon of temporary deactivation of storage tube cathodes by cathode heat while the beam is biased off was further investigated. The part of the investigation that deals with standard 5UP guns as currently applied to storage tubes has been completed and a report is being issued. The deactivation effect is absent in new tubes and develops progressively with tube age. The degree to which deactivation proceeds is a function of current that leaves the cathode under various bias conditions. For this relation it makes no difference whether the current is reduced in amplitude or pulsed in time; only the average value counts. Deactivation proceeds farther at higher cathode temperatures. The deactivation process is reversible; the low emission status is reached after a standby period of about 20 hours; reactivation with the bias removed takes place in about 7 hours. Both changes as well as the relation of the level of deactivation to the average reduction in cathode current are of exponential nature. No influence of shelf life or of vacuum in the tube (which in all tested tubes was below 10^{-6} mm) could be detected.

A special research tube was tested in which the beam could be suppressed in the anode structure without affecting cathode emission.

(M. I. Florencourt)

Three modified storage tubes were given standard tests during the past biweekly period: ST114-R1, RT101 and RT102. ST114-R1 consists of the same envelope and storage surface as ST114. However, the guns of ST114 have been replaced and the storage tube reprocessed as ST114-R1. A memorandum is being prepared on the method used to replace the guns and on the comparison of test results between ST114 and ST114-R1. The reprocessing was satisfactory and storage results better for the reprocessed tube than for the original. This fact may have been due, however, to the much better high-velocity gun in the reprocessed tube.

RT101 and RT102 were special storage tubes built exactly like the latest ones, but containing mica storage plates much thicker than usual -- of the order of .020" instead of .007" - .010". It was hoped to determine a variation in minimum writing and/or erasing current thereby due to the difference in capacitance between the thick and thin dielectrics. RT101 could not be tested due to a

3.2 Test (Continued)

grid-cathode short in the HV gun. RT102 was tested and found to store spots very non-uniformly in size and writing intensity. Perfect surfaces are difficult to obtain with such thick mica. It tends to peel and contain air inclusions more than thin mica. It is felt that in places the mosaic may have flaked off completely. The minimum writing and erasing currents for the surface were no lower than for the thin dielectric. This may have been due however to the fact that the spot size was larger in RT102.

(A. H. Ballard)

The high-speed write-read unit was put into working order after replacing ST102 with ST111. The former tube is suffering from reduced cathode emission, caused most likely by driving the HV gun grid positive sometime during testing. Care will be taken to avoid such occurrences in the future.

Some trouble was experienced with intermittency of output signal, which was traced to loose and corroded contacts in the HV gun base-to-socket connection. Such a condition can seriously disrupt operation of the RF system and should be kept in mind whenever tubes are being installed.

A program of minimizing both operation times and time between operations is now being carried on with ST111. At low speed, minimum times for actual writing were found to be 3 μs and 6 μs for W+ and W- respectively. Investigation showed that write-time does not vary exactly as the inverse of beam current, presumably because the two factors affect spot size differently.

At high speed, the reading operation is of most importance, since continuous writing is inherently stable. Actual reading time was found to have no influence on output signal amplitude between certain limits. The lower limit is set primarily by the rise time of the grid pulse, while the upper limit is set by triggering of negative areas. The point at which triggering occurs is affected by reading charge, HG duty cycle, and read gate amplitude.

More thorough tests are being planned to study the effect of repetition frequency on the read operation and also on the allowable range of V_{HG}.

(C. L. Corderman)

RT62-2, a research tube with four different mosaic sizes, has been received from the construction group. The surface and both guns are apparently satisfactory.

3.2 Test (Continued)

Confirming the general theory of mosaic stability under action of the holding gun, the four quadrants have upper switching voltages which are directly related to the mosaic size.

(H. Rowe)

Testing of RT66, a tube containing a high velocity gun with a section of G_2 which may be used to deflect the beam into G_2, has revealed that with this method it is possible to cut off the beam current without affecting the cathode current in the gun. In this experimental tube less voltage is required to cut off the beam current if the G_2 deflecting plate is made negative than if it is made positive. The following table contains some data as taken with RT66.

Accelerating voltage	1500 v.	2000 v.
Deflection sensitivity of G_2 deflection plate	250 v/in.	350 v/in.
Negative voltage on G_2 deflection plate to cut off beam	-131 v.	-175 v.
G_2 deflecting plate current:		
a. 0 deflecting voltage	100 μa.	135 μa.
b. Cutoff deflecting voltage	-15 μa.	-22 μa.

A memo on tests made on RT64 and RT65, modified holding gun tubes, will be deferred until other holding gun tubes have been tested.

(D. M. Collier)

During the past two weeks, a preliminary start has been made in studying the short-time (millisecond) reactivation of emission from oxide-coated cathodes in a cathode-ray gun. The rough draft of a thesis proposal for this study has been drawn and is now undergoing revision before being submitted. Current literature has been searched rather exhaustively with very little success in finding reports of similar studies elsewhere. Much general information on oxide-coated cathodes is available, as is much more rather uncorrelated data from numerous specialized studies, but very little of this pertains to the study in question.

At present, test equipment is being built or assembled for the purpose of testing cathode-ray guns for which a complete record of construction and subsequent operation is available. Such guns, at

3.2 Test (Continued)

various stages of aging, are now on hand. As soon as the equipment is assembled, an investigation of the nature of the emission-reactivation transient, its duration, shape, amplitude, etc. will be made. From this investigation, a complete program for the study will be made and characteristics desirable in tubes under study will be formulated.

(H. Klemperer)

Beam dispersion studies were continued with the aim to establish the connection between spot size, current density, vacuum and drift space in our storage tubes. In an attempt to obtain experimental data a research tube of the cathode ray tube type (RT79) was run at the pump, and the minimum beam diameter was measured as a function of vacuum while the beam current was kept constant.

Test conditions were not well controlled and results were inconclusive. There was some evidence that the spot became smaller at higher pressures.

4.0 INPUT-OUTPUT EQUIPMENT

4.1 Eastman Kodak

(H.R.Boyd)

On Wednesday, October 26, Ed Rich and I conferred with Tyler and Cochrane at Eastman Kodak in Rochester. They have nearly completed the de-bugging of a second unit and will ship this in a week or two. Modifications on the developing unit are nearing completion, and this unit will be shipped in about a month. It was arranged that Cochrane would come here in two or three weeks to participate in the testing of the first unit with the input-output register and input-output control. We requested some writeups on optical alignment, clutch maintenance and adjustment procedures, and other performance data which Rich needs. Eastman will prepare this information and send it to us as soon as they can. The remaining four reader recorders are substantially completed and will be de-bugged and tested as soon as they can get it done. However, this will take a considerable time, and minor changes that we consider desirable will be incorporated in these units where possible.

(E.S.Rich and D.Hageman)

During the past two weeks attention has been directed toward observing the operation of the Eastman unit when used as a reader. The most rigid test is provided when each exposed spot on the film is bounded by clear (unexposed) film on every side. Then, improper alignment of the optical system is brought to light in the sense that spurious pulses may be generated by light getting through the film where it should not. Films of this sort were prepared, read, and spurious pulses were observed. They were eliminated by adjustment of the position of the reference marker scanning light so as to alter the timing of the sweep.

It became evident that enough light gets through the exposed spots on the film - unless perhaps they are very dense - to generate low-level spurious signals which result in a low effective signal-to-noise ratio. It appears that this type of noise can be eliminated by clipping the plate waveform of the reading photo tubes and by a slight change in the high-speed limiting amplifier. These modifications have proved successful thus far.

4.1 Eastman Kodak (cont)

Considerable difficulty was encountered in that the film loop was broken repeatedly. A tentative conclusion is that this is due to excessive film shrinkage (on the emulsion side) and brittleness, and that these physical changes are, in turn, due to the low ambient relative humidity (24% on Thursday, October 27). Plans are being made to provide for film storage at a more suitable relative humidity.

4.4 Unclassified

(E.S.Rich)

On October 26, Hugh Boyd and I visited the Commercial Controls Corporation in Rochester and discussed with them the Flexowriter line of automatic tape punching and typewriting equipment. Consideration is being given to the use of these machines for input and output in place of standard teletype apparatus since their construction allows much greater flexibility in the design of auxiliary circuits necessary for checking. Both the original Flexowriter modal (available in about 4 weeks) and the new model (available in about 9 months) were demonstrated to us. Both of these appeared to be satisfactory for our purposes and to be adaptable to the WWI input-output element with only minor modifications. Circuit diagrams of the units are to be forwarded to us in the near future. Details of the purchasing procedure were obtained and tentative plans made to order one set of the old model equipment.

5.0 INSTALLATION AND POWER

5.1 Power Cabling and Distribution

(H. S. Lee)

A final design of the HV Junction Box has been agreed upon by all concerned. It is expected that the production drawings can be started in drafting within the next week.

A new panel is being designed to replace the present "P" Row Fuse Indication panel. This new panel incorporates, what is believed to be, a mechanical latching relay of improved construction.

Layout of Rack MX1 will commence Monday, October 31.

5.2 Power Supplies and Control

(R. E. Hunt)

Automatic Control for Marginal Checking is at present being installed.

Modifications to the Panel Selection rack are complete. These modifications consisted of obtaining a transient block signal, i.e., a signal that would put the computer on push button operation during switching and "reset", "clear" and "restart" the computer after switching.

A temporary panel to accomplish these functions from the transient block signal supplied by the panel selection rack has been built and will be installed in the test console.

A simple scheme for checking marginal checking has been worked out in conjunction with Wieser, Taylor and Sumner. This scheme consists of setting the cycle amplitudes on each V.V. Panel into the region where an error should occur. A cam would be added to the automatic control potentiometer to sense the marginal voltage which in every case would be a fixed percentage of the whole cycle amplitude.

A sensing relay system would give an "Alarm Stop Signal" if an error occurred below the margin, and an "Alarm Stop" if an error did not occur between the marginal voltage and the maximum swing.

5.2 Power Supplies and Control

(J. J. Gano)

Marginal Checking Power Supply - Another stage of gain is being added to the breadboard amplifier in order to improve regulation and transient response.

(C. W. Watt)

A decision has been made by the storage tube group on the proper method of applying power to the storage tubes in WWI. It will now be possible to complete the power supply control system, incorporating these requirements. The design will be done and relays ordered during the next week.

(W. J. Nolan)

A design has been completed for the 500 volt regulator but because of some of the difficulties encountered in the low power analog of the system it was decided to try a full scale breadboard using a modification of the 300 volt 5 amp. regulator which supplies the storage tube lab. This modification has been completed and the circuit is being tested.

(R. L. Best)

High Voltage Cathode Supply - This unit is now on life test to determine its stability. The drawings have been given to the drafting room.

5.3 Video Cabling

(C. W. Watt)

A suggestion made by Fairbrother will simplify ES Video Cabling considerably and save several hundred dollars worth of cable fittings. The ES Digit block schematic, D-30476, was modified to include these suggested changes, and the Gun Driver panels were changed to include 2 additional jacks (this change was made at the same time other changes were made).

5.3 Video Cabling (cont)

(R. Fairbrother)

The cabling for system restorer pulses is designed, and will be measured this afternoon.

The past two weeks have been spent on the restorer cables and changing and adding cables made necessary by system modifications and the addition of Clock Pulse Control Delay Panel.

6.0 BLOCK DIAGRAMS

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

The official Timing Diagrams for WWI are now being brought up to date, to include Electrostatic Storage and Storage Selection Control. There is one drawing for each of the twenty-four official Operations, and one drawing showing only Program Timing. These twenty-five drawings are numbered consecutively from B-37195 to B-37219.

All block diagrams kept in the active file of the print room have been examined and all out-dated drawings have been transferred to the obsolete file.

7.0 CHECKING METHODS

(C. W. Adams)

A program, tentatively known as Display Program Number III, has been written and successfully run on the computer. The program is intended to make the computer simulate the action of a gun-directing servo tracking a target whose range, but not elevation or azimuth, can be changed at will by changing the reset switches of one of the Flip-Flop Storage registers. More concisely, the program directs the computer to

(1) Plot the parabola $y = ax - (\frac{1}{2} + \frac{1}{2}a^2)x^2$ for $y > 0$; in which $a = \frac{dy}{dx}$ $(x = y = 0)$. The parabola can then be interpreted as the trajectory of a gun located at the origin and firing with an angle of elevation θ where $\tan\theta = a$.

(2) Plot a horizontal line $y = 0$ for all values of $x > R$. The value of R can be considered to be the range of a target, the target being represented by the left end of the horizontal line.

(3) By simply storing the value (X) of x for which y becomes negative the computer can determine the range of the "gun" for the given value of $\tan\theta = a$.

(4) After each plot of the parabola and the straight line (the frequency, controlled by the display scope, is about 25 cps) the value of $\underline{a}$ is changed by an amount Δ, the quantity Δ being itself changed by +1 or -1 depending upon whether the range of the target minus the present range of the "gun" minus the quantity Δ is positive or negative. Thus the computer changes the value of $\underline{a}$, keeping the second difference of $\underline{a}$ equal to unity, and searches for the target. Because the second difference of $\underline{a}$ is constant, the computer tracks the target with what is almost a constant acceleration. Consequently if the target is moved very rapidly the parabola moves toward the target slowly, picks up speed, slows down, and settles on the target, after overshooting and hunting in some cases. The error is fed back in this simulated servo precisely in the form

$$\Delta^2(a) = \frac{(R - X) - \Delta}{|(R - X) - \Delta|}$$

7.0 CHECKING METHODS (Continued)

(G. Cooper)

In developing a sequence for checking the Program Counter, a striking similarity between the problems involved and the problem of multiple faults became apparent. As a result, work was done on using this approach to handle multiple faults. The method has proved workable, though tedious unfortunately; a slight error at the beginning of this work requires the development of a new sequence. But the approach is still valid, though the details are not. Whether the approach is workable for portions of the computer other than the Program Counter is another question requiring further investigation, but I believe it will be answered in the affirmative.

9.0 FACILITIES AND CENTRAL SERVICE

9.1 Publications

(J. M. 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
M-256-1	Washing Procedures - Series W	17	10-17-49	T. R. Perkins, A. F. Greenlaw
M-295	Test Program No. I, Computer Complementing	3	10-17-49	C. W. Adams
M-296	Test Program No. II, Operation Matrix Check	4	10-13-49	C. W. Adams
M-297	Test Program No. III, Counting In AC	3	10-13-49	C. W. Adams
M-298	Test Program No. IV, Shifting In AC	3	10-13-49	C. W. Adams
M-300	Display Program No. I: Family of Parabolas & Powers of X	3	10-17-49	G. Cooper
M-305	Results of Tests on RT59	3	10-19-49	H. E. Rowe
M-908	Bi-Weekly Report, October 14, 1949	29	10-14-49	
M-913	Conference on Vacuum-Tube Problems at Sylvania - Emporium	3	10-20-49	E. S. Rich
M-914	Shatterproofing Storage Tubes	2	10-25-49	R. Shaw
M-915	Cycling of Power in Turning on Storage Tubes	2	10-26-49	S. H. Dodd
A-79-1	Guard, Receptionist and Operator's Schedule	2	9-21-49	J. C. Proctor

Library Files

47	Technical Information Pilot, September 15, 1949	ONR, Library of Congress
178	Mathematical Tables and Other Aids to Computation: National Research Council; 1946, 1947, 1949	R. C. Archibald, H. Bateman, D. H. Lehmer
180	Document Office Bulletin; October 14, 1949	RLE, MIT

Library Files (continued)

No.	Title	Author
361	Electrical Communication; September 1949	(Intl. Telephone & Telegraph Corp.
362	Function Unit Theory of Counting Computers	G. R. Stibitz
363	Hints to Authors	Am. Chem. Society
367	Fundamental Research on Raw Materials Used For Electron Emissivity on Indirectly Heated Cathodes: Ninth Interim Technical Report; 1 June to 1 September, 1949	(Raytheon Mfg. Co. (J. Cardell
559	Technical News Bulletin; October, 1949	Ntl. Bur. Standards

Books

	Waveforms; Radiation Lab. Series, Vol. 19	B. Chance, et al
	Loran: Long Range Navigation; Radiation Lab. Series, Vol. 4	J. A. Pierce, et al
	Radar Beacons: Radiation Lab. Series, Vol. 3	A. Roberts, et al
	Radar Aids to Navigation: Radiation Lab. Series, Vol. 2	J. S. Hall, et al
	Cathode Ray Tube Displays: Radiation Lab. Series, Vol. 22	T. Soller, et al
	Vacuum Tube Amplifiers: Radiation Lab. Series, Vol. 18	G. E. Valley, et al
	Theory of Servomechanisms: Radiation Lab. Series, Vol. 25	H. M. James, et al
	Electronic Time Measurements: Radiation Lab. Series, Vol. 20	B. Chance, et al

9.2 Standards, Purchasing and Stock

(H. B. Morley)

Standards - Weekly meetings of the Standards Group have been resumed, and all laboratory personnel are invited to present any problems concerning standards to the Committee at these meetings. It is the intention of the Standards Group to prepare Standards reference sheets on all components built into WWI.

New Standards Issued:

6.195-3 Filament Transformer,
Storage Tube, WWI 10-26-49

A new Armed Services Standard List of R.F. Coaxial Cable Connectors has been received and is on file in the Procurement Office.

9.2 Standards, Purchasing and Stock (continued)

Procurement - WWI Transformers #6.192-1, -2, -4, 6.195-4, and -5 will be ordered from Sperry Products Co. The latter company is a new source of transformers to us, and appears to be capable of designing and building a high quality product, with promise of better delivery time than our present sources of transformer supply. The types to be ordered from them are considered the more critical of the WWI Storage Tube transformers.

All engineers and technicians are requested to carefully check the stock room before ordering non-standard items. Many such items, or suitable substitutes, are available in stock. Attention is also directed to the stock of salvage parts which has been accumulated, containing many serviceable items of both standard and non-standard stock.

Orders for the S. T. Mount Box and Split Shield have been placed with the James Millen Co.

A trial order for silk screen marking has been placed with another vendor in an effort to secure better quality work and faster service.

Work load of the department has increased considerably with the addition of stock room supervision, parts lists, etc. The number of requisitions and the money value of orders placed is expected to be much higher this month than any month since early this year.

9.3 Construction

(R. A. Osborne)

Production Report - The following items have been completed since October 14th:

8	Voltage Variation Panels
5	Program Register Modifications
59	Terminating Resistors (93 ohm)
20	Meter Leads
7	Check/Comparison Registers
60	Video Cables
6	External Power Cables
1	Breadboard

9.3 Construction (continued)

(A. R. Curtiss)

During the last period a pair of 0-500 V regulated power supplies were completed.

A high voltage reference regulator was breadboard assembled and a voltage regulator was modified.

A video amplifier and a voltage regulator control amplifier were constructed.

Coils and components for the WWI RF amplifiers are now being worked on.

(L. Prentice)

Machine Shop - Work completed during the last period:

24 Stand-offs for L.V. floating power supplies
1 Alignment fixture
5 Jigs for S.T. Mount Phenolics
1 Set castings for S.T. Mount prototype
1 Fixture for above castings
1 Punch and die set for Amphenol connectors
2 Punch and die sets for lead clamps
12 Support rings
1 Faraday-Cage assembly
1 Special grid aperture

Work now in Progress

24 Target bases
1 Standard louvre punch
78 Castings (S.T. Mount)
48 Handle assemblies (S.T. Mount)

Sheet Metal Shop - Work completed during the last period:

15 RF amplifier chassis
6 Panels for L.V. floating power supplies
48 Phenolic panels for S.T. Mount
20 Video-trough brackets
12 Panel adapters
18 Revisions to Al. Panel (Gun Driver)
18 Revisions to Phenolic panels (Gun Driver)

9.3 Construction (continued)

Work Now In Progress

24	Sets of partitions (S.T. Mount)
24	Panels for S.T. Mount
144	Brackets
72	Phenolic strips (S.T. Mount)
100	Lead clamps for S.T.

9.4 Drafting

(A. M. Falcione)

The mail distribution system has changed in recent weeks due to the termination of our page girl. Four rounds are conducted per day - 2 by the Print Room personnel and balance by the Procurement group. Any constructive criticisms should be addressed to either W. Hodgion or the writer.

The work load on the drafting department is quite heavy at this time especially with reference to change notices on block diagrams and circuit schematics.

9.6 Time Schedules

(R. A. Osborne)

All Time Schedules are in the process of being posted through October 31.

10.0 GENERAL

(J. W. Forrester)

Because of the pressure of one's own duties, it is probably difficult for staff members to keep up to date on the general work being done in the laboratory. However, because of the increasing number of visitors, as well as for the individual training of each member of the group, some effort should be made toward being familiar with the work in various parts of the laboratory. To facilitate this, Mr. Proctor will probably make arrangements soon for a schedule of inspection periods in the various parts of the laboratory, during which time all staff members should make an effort to familiarize themselves with the equipment and work which will be explained.

(H. Fahnestock)

Computer Demonstration - The computer will be operating on demonstration problems alternate Tuesday mornings beginning November 1. Visits are to be encouraged at those times rather than others.

(H. R. Boyd)

Non-Staff Terminations

Roger Emerson
Nathalie Foss