Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, February 3, 1950

To: 6345 Engineers

From: Jay W. Forrester

1.0 SYSTEMS TESTS

1.1 Whirlwind I System Test

(W. H. Taylor)

Operation of the system with test storage has been noticeably improved since the recent shutdown. This is due mainly to circuit improvements in the Register Drivers. The daily turning-on of the system now occurs without any warming up period. Correct operation is immediate with hot filaments and the application of power.

In-out equipment is progressing satisfactorily. Several films have been made under the control of the In-Out Control system. These operations have led to the need for some further refinements in equipment and this is now under way.

Storage Row testing has been confined to the stabilizing of the Control and Deflection Systems. The addition of a storage tube to this system will occur in the next bi-weekly period. Some of the problems encountered have been a result of tying the Storage Row into the final Whirlwind power setup and integrating the Storage Test Equipment in the Control Room.

(G. C. Sumner)

Cabling for the proposed storage selection control system was added to the WWI system. It was found that the proposed system delayed the "read out of storage" command

1.1 Whirlwind I System Test (Continued)

too much to be workable. On several orders storage read out is ordered on time pulse 8. Transfer check occurs on time pulse 8.5. Thus numbers from storage must reach the check register via the main bus and set CR flip-flops in less than 0.5 microsecond. This timing is already tight without the addition of lengthy cables and several stages of storage selection control. After a conference with the block diagram group, it was decided to always order a read out of TS no matter which storage is being used. According to previous block diagrams, the TS switch is cleared during ES operations. Thus if register zero of TS is left containing zero no digits will be read from TS when ES is used. To further increase time margins, a method of increasing read-in gate lengths is being considered.

An interesting incident of marginal checking occurred last week, when a resistor of changed value was located. In routine voltage variation tests, the margin on line 100 (gate tube screens of repetitive units) was found abnormally low. Investigation showed that a gate tube plate resistor had changed value because of being overheated. The resistor, nominally 680 ohms, had decreased in value only to 520 ohms (cold) when removed. Good sensitivity on that marginal checking line is thus indicated. The cause of the overheating is unknown, but was probably that excess voltage had been applied in early experimentation of voltage variation by faulty relay operation or otherwise.

(R. Read and C. Rowland)

The major effort of the past two weeks was directed toward observing the effects of supply ripple on the ES deflection output amplifiers. The 250, -150, and increment supplies drive such low impedances that their ripple, which is in the order of .2%, should not be a cause for concern. Voltage variation on the 150 (screen) supply showed that a 50 volt variation is necessary to move the beam about 0.1 inch. Later tests will be necessary to determine the transients caused by switching the guns and the signal plate.

Some trouble is present in test control, due probably to the asynchronous restorer pulses which are being used. Occasional complementing causes erratic cycling. When the trouble is located and removed, a storage tube will be placed in operation, and more extensive marginal checking will commence.

1.1 Whirlwind I System Test (Continued)

(H. F. Mercer)

The following failures of electrical components have been reported since January 20, 1950:

CAPACITOR	QUANTITY	COMMENTS
0.001 MFD (Mica)	1	In Comparison Register serial number 20, replaced after 543 hours because of intermittent operation caused by unsoldered internal pig-tail connections.
CRYSTAL RECTIFIER		
D-358	1	Switch crystal in horizontal section of ESD Decoder serial number 1 replaced after 406 hours because of very low back resistance.
RESISTORS		
680 ohms 1 watt	2	Plate resistors of Flip-Flop Storage Output panels serial numbers 3 and 11 replaced because they showed overheating probably due to a short. The failures were found through Marginal Checking. Tests revealed the resistance of the resistors dropped from 680 ohms to about 500 ohms. They were replaced after 1709 and 1673 hours respectively.
TRANSFORMERS, PULSE		
3:1 (193-7)	2	One was in Register Driver Type I panel serial number 10; it was replaced after 1668 hours because of open secondary.

1.1 Whirlwind I System Test (Continued)

		One was in Register Driver Type I panel serial number 8; it was replaced after 1683 hours because of intermittent open in secondary.
5:1 (193-8)	1	In Register Driver Type I serial number 10 replaced after 1653 hours because of open primary.
TUBES		
3E29	1	Register Driver 2 tube in Register Driver Type I panel serial number 5 replaced after 2423 hours because of low output due to change in characteristics.
7AD7	5	Three were buffer amplifier tubes in Operation Matrix Driver panels serial numbers 1, 2, and 3. All were replaced after 1781 hours because of change in characteristics.
		One was a flip-flop tube in the Write Rewrite Timer. It was replaced after 653 hours because of change in characteristics.
		One was a gate-generator tube in Register Driver Type I panel serial number 5. It was replaced after 2409 hours because of change in characteristics.
7AK7 *	1	Gate tube in Control Pulse Output unit serial number 42 replaced after 467 hours because of mechanical failure. The key in the metal base was loose.

* The 7AK7 reported as a failure in the last bi-weekly, gate tube in ESCC#4 replaced after 619 hours due to change in characteristics, actually failed because of an open weld to the plate. The open was revealed when the tube was opened to investigate the cause of failure.

1.2 Storage Tube Reliability Tester

(H. B. Frost)

The connections of the new block diagram mentioned in the last bi-weekly were installed in the storage tube reliability tester control during the last period. Prior to recabling for the new block, the STRT was cleaned thoroughly. Operation according to the revised block diagram is satisfactory.

During the last week numerous tubes have been operated in the STRT. RT 111 and RT 112 were tested for cycling performance. These tubes were tested with a 16 x 16 array, and performance limits were obtained for stable operation.

After this, RT 113, which is an 8-inch throw tube with a split storage surface using 60 and 100 mesh mosaics, was installed and tested. This tube will operate satisfactorily using a 16 x 16 array, with half on each section of the storage surface mosaics. Perhaps the most outstanding feature of the operation of this tube is that the write plus and the write minus times are about equal, with the write minus being a little longer. This was determined with the usual negative background. In tubes with a forty-mesh mosaic, the write minus time is usually about twice the write plus time. In addition, the sixty-mesh mosaic of this tube is rather irregular according to the cycling tests. Some tests using a 16 x 32 array were made in this tube, but the results are inconclusive as yet.

Operation of RT 120 was prevented by cathode damage of uncertain origin. Further tests will be made on this tube in the near future. RT 120 is a short-throw (8-inch) tube with a one-hundred mesh mosaic.

1.3 Five-Digit Multiplier

(E. S. Rich)

The multiplier operated for the past two weeks without error. Some work was done to improve operating margins which the routine checks had shown were decreasing and as a result of this work 5 tubes and 9 crystals were replaced.

Construction of the 15-volt bias supply for the multiplier was started February 1. After its completion, it is planned to run it for at least a week on a reliability test before connecting it to the system.

2.0 CIRCUITS AND COMPONENTS

2.1 Circuits by System Number

200 Test Storage

(W. Papian)

Modification notices are in process for the following changes:

Terminating resistors for the vertical lines of the Storage Switch Matrix are being decreased slightly; small condensers are being added between suppressor and control grids of the gate tubes on the Storage Switch Output Panel; operating margins on the latter panel are expected to increase as a result.

Pulse amplitudes from the Toggle Switch Storage Output Panel, Check Bus, are being readjusted, to provide the proper amplitudes at the F.F. cathodes in the check Register, by raising Bus Driver plate-voltages and increasing the value of the output resistors.

Bias of the 6Y6 Inverter Amplifier may be raised and the degenerative cathode resistor removed on F.F. Storage Output Panels; a slight increase in operating margins results.

831 ST Mount

(W. J. Nolan)

Work on the 500 volt regulator has been suspended for a little more than a week in order to put into operation a test set up for the ST mounts. This now appears to be working.

835 ES Drivers

(R. L. Best)

Gate Generator for RF Pulser - For the RF Pulser, a gate generator has been built (SA-35246) which may easily be converted to a standard WWI flip-flop. With its buffer, it will drive 50 mmfds. with less than 0.1 micro-second rise time, and has a delay period of ¼ to 4 micro-seconds.

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-37155-4	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-33843-3	R-32722-6
Switch Panel	B-37066-5	B-34100	Z60CS00-2-J
Output Panel	B-37066-5	B-34101	Z60CS00-E
105 Operation-Matrix Driver Panel		S600M00-B	Z600M00-1-G
105 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-F
Output Panel	B-37068-6	T60PD00-4-C	Z60PD00-1-H
108 Storage Selection Control	D-37220-1	B-34230	D-34236
109 Clock-Pulse Control	C-39817-5	C-32642-5	E-31916-9
Clock-Pulse Control Delay	C-37159-5	A-34446	D-34416-1
110 Frequency Divider	B-37154-4	B-32264-1	R-31729-4
111 Synchronizer	B-37172-2	C-33485-1	R-33486-3
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-32855-5 C-33768-1	D-33706-4
201 Storage Switch			
Input Panel	C-37121-3	B-34322-1	
Matrix Panel	C-37121-3	C-32855-5	R-32722-6 D-33706-4
Switch Panel	C-37121-3	B-34102	Z60CS00-2-J
Output Panel	C-37121-3	B-34103	Z60CS00-F
202 Toggle Switch Storage			
Switch Panel	B-37122-4	C-33768-1	D-33706-4 C-33707-1
Output Panel (Main Bus)	B-37122-4	C-32080-1	E-32721-5
Output Panel (Check Bus)	B-37122-4	C-32080-1	E-35019
203 Flip-Flop Storage			
Output Panel	C-37060-6	B-32269-1	E-31635-9
Register Panel	B-37057-5	B-32268-1	E-31631-8
Control	B-37061-8	D-32106-3	
300 Arithmetic 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-31277-12
304 Sign Control & Divide-Error Control	D-37072-10	C-31576-3	E-31619-2
305 Step Counter	B-37074-8	D-31828-2	D-35049 Thru D-35057

2.2	WWI Drawing List (Continued)	Block Diagram	Block Schematic	Circuit Schematic
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-31552-4	R-31718-6
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-31277-12
	403 IOR Auxiliary	D-37178-2	B-34860	E-34833
	404 Comparison Register	D-37178-2	B-32578-4	E-32576-10
	404 Comparison Register Check	D-37178-2	B-33488-1	E-33515-3
410	IOC Synchronizer	D-37178-2	A-34320	D-34338-1
	IOC Program Alarm	D-37178-2	B-34834	D-34831
	IOC Read-Record Memory	D-37178-2	B-34859	D-34830
	IOC Interlock	D-37178-2	B-34835	D-34832
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
811	Write-Rewrite Timer	D-37220-1	B-34282	D-34283
	ES Control Counter	D-37220-1	B-34359	D-34360
812	ES Pulse Distributor	D-37220-1	D-34229	R-34266
813	ESTD Selector	D-37220-1	B-34231	D-34237
820	ES Deflection	D-37220-1	E-34770-2	
	ESD Gate Panel	D-37220-1	A-34036-2 E-34770-2	B-33876-3
	ESD Decoder	D-37220-1	E-34770-2	E-33908-3
	ESD Output	D-37220-1	E-34770-2	C-34182-1
	ESD Bank Selector	D-37220-1	B-34232 E-34770-2	D-34238
	Storage Selection Mixer	D-37220-1	E-34770-2	C-34311
	ESD Termination			B-34628-2

2.2 WWI Drawing List (Continued)	Block Diagram	Block Schematic	Circuit Schematic
831 ST Mount	D-37220-1		E-34040-3
832 EST Output			
RF Amplifier	D-37220-1		D-34315-3
Gate Tubes	D-37220-1		C-34251-2
833 Signal-Plate Driver	D-37220-1	A-34711-1	D-34029-4
834 Gun Driver	D-37220-1	B-34712-2	D-34181-2
835 Holding-Gate Generator	D-37220-1	A-34354-1	C-34060-5
835 Read-Gate Generator	D-37220-1	A-34355-1	C-34324-5
835 RF Pulser	D-37220-1		E-34549-2
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 I		B-32207-1	E-32261-13
Register Driver, Type II		B-32691-3	D-32690-6
Bus Connections	C-37124-4	C-37123-3	
Fuse-Indication Panel			T60PP00-7-F
Voltage-Variation Panel			T60PP00-6-E
WWI Power-Connector Pin Connection (29 Pin)			C-31955-6
Digit-Interlock Panel			T60PP00-8-C
Fixed-Voltage Switching Panel			S60PP00-11-C
Power-Interlock & Indication Panel			Z60PP00-12-B
Power-Bay Fuse-Indication Panel			C-34473-2
Power-Supply Control		D-32017-5	D-33184-4
ESD Monitor			B-34756
LV Floating Power Supply			C-34652-5
500V Regulator			D-35031

2.2 WWI Drawing List (Continued)	Block Diagram	Block Schematic	Circuit Schematic
HG Anode Supply			D-34824-2
HV Cathode Supply			D-34977-2
600 Volt Rectifier			C-34909
Teletype Synchronizer			R-35189
Filament Voltage Control Panel			D-33098-2
Panel Selection Rack			R-39911
ES Power Supply Control Panel			D-35171
Filament Power Panel			C-32589
Regulator Video Probe Power			B-35184

2.5 Tubes and Components

(H. B. Frost)

6AG7 and 6AN5 tubes on life test were tested again this last week after a total of 5,000 hours of operation. The data has not yet been analyzed. These life tests will be continued. An accelerated life test of Sylvania special tubes SR 1407 test 9002 was completed, but the tubes have not been completely re-tested as yet. This data will be obtained next week.

A lot of 1,000 7AD7 tubes made in the Sylvania Brookville plant in December, 1949, has been received. Only 42 of these tubes have been tested thus far, but of these tubes, twenty per cent were rejects because of shorts and leaks. Previous lots of 7AD7 tubes have run about ten per cent shorts and leaks. In considering these values, it must be remembered that WWI shorts and leaks tests are much more stringent than the usual commercial tests and requirements. It is very probable that the large number of rejects mentioned above was due to the small sample used. This, of course, will be checked as a greater number of tubes is tested. Distribution curves for the first 100 of these tubes will be prepared as soon as tests have been completed.

Work on the R-report "Vacuum Tube Life" has been continued, but progress has been slowed by the very considerable activity this last week in the Storage Tube Reliability Tester.

3.0 STORAGE TUBES

3.1 Construction

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

Three storage tubes (ST202, 203, 204) with the reduced high-velocity beam length of 8" from the first pair of deflection plates to the target assembly were processed this period. These are storage tubes with a 40 mesh mosaic for WWI in the 200-series. A research tube (RT120) similar to the storage tubes in the 200-series, with the exception of the target mosaic which is 100 mesh, was processed. This tube will be used to study the effect of mosaic size on stability when the density of storage elements is increased. In order to facilitate these mosaic studies we prepared another 100 mesh beryllium mosaic and two 60 mesh mosaics. One 60 mesh mosaic will be put into a research tube, RT122, which is similar in all other respects to the storage tubes of the 200-series. The other available mosaics will be held for research tubes pending the test results on the above-mentioned RT120, RT122.

Storage tubes of the 200-series with 40 mesh mosaics will be processed at the rate of one or two per week until test results indicate we should change the mosaic size. Meanwhile we will prepare enough mosaics of 60 and 100 mesh and put them into research tubes for the proper evaluation of this problem.

Three more research tubes for the study of the problem of deactivation of storage-tube cathodes under standby conditions will be processed this period. This group of tubes will complete the complement of tubes needed for this study.

A research tube with a swinging and sliding Faraday cage to study the characteristics of a 3RP gun was processed. The 3RP gun was designed for a shorter throw than the 5UP gun. In many other respects it is similar to the 5UP gun. Therefore it may be a better choice for our shorter storage tubes.

(W. E. Pickett)

Glass Components - Much needed extra help and floor space has been assigned to the glass shop during this last period. L. Nelson, one of the Northeastern cooperative students, will devote his full time to working in the glass shop. It is planned that after an accelerated training course in the fundamentals of glass blowing, the student

3.1 Construction (Continued)

will relieve W. E. Pickett of some of the glass blowing duties. This should lessen some of W. E. Pickett's work load and allow him to work on glass problems which have been shelved indefinitely because of lack of time to do them. With the acquisition of more floor space, the large lathe in the vacuum tube laboratory will be set up in the glass shop. With this second lathe in operation, the efficiency of the glass construction of storage and evaporation tubes and glass components should be greatly increased. With this second lathe, it will now be possible to budget construction time better rather than trying to dovetail the sequence of all the operations to one lathe.

The supply of storage tube envelopes on hand is in excellent condition. We now have on hand 13 complete sets of envelopes for storage tubes. During this next period the storage tube envelope construction program will be temporarily slackened so that components for research tubes can be started and possibly completed.

The supply of evaporation tube envelopes is low, but no delay in the evaporation tube construction schedule should be felt because the supply is low.

Work on the 18-pin stem will be resumed again during this next period. We now have on hand in the glass shop the necessary fixtures for making the 18-pin stem. As this is the first time we have attempted to construct an 18-pin stem, the time necessary to build it will naturally be greater than if we had all the problems ironed out. When these problems have been ironed out, the extra help in the glass room will be assigned to making this stem.

No unusual difficulties were encountered during this last period and in general the work progressed much faster than planned.

(J. S. Palermo)

Mechanical Components - A graduated-spaced screen to target mockup has been made prior to the construction of RT121. The maximum depth that can be obtained at present is .033, and greater spacing can be obtained only by procuring a special plate or signal plate frame.

The demountable cup assembly has been suspended until necessary data can be obtained from a vendor.

3.1 Construction (Continued)

The camera mount for the Filtered Air Room has been installed and to date pictures have been taken of several targets.

The inventory of all storage tube and evaporation tube target components remains very good. An additional 24 signal plate frames will be delivered before the next report.

The silver evaporated target inventory remains well ahead of schedule and therefore any necessary preparations required by the setting up of the new evaporator will not infringe upon a scheduled construction program.

A drying unit, composed of 4 infra-red lamps, has been received and is being used in order to eliminate the use of individual infra-red lamps scattered over the various bench tops in the Inspection Room.

(J. O. Ely)

Glass lathe #2 has been put into operating condition and will be moved to the glass shop Saturday, February 4th.

A preliminary design of a mount putting both high-velocity and low-velocity guns in a single 3 1/2" neck has been made. One such mount has been completed except for mounting on an 18-pin stem.

Vacuum system #4, a DPI Model LC1-12A demountable lens-coating system, was received February 1st. This system was set up and preliminary testing was begun February 2nd. After fifteen hours of intermittent operation a pressure of 10^{-5} mm of mercury was obtained. This is the rated ultimate pressure for the system, and it is expected that we eventually will be able to produce pressures of the order of 5×10^{-7} mm of mercury. Fixtures have been constructed for the evaporation of silver signal plates on mica and it is expected that we will be able to carry out these evaporations by February 15th on system #4.

(R. Shaw)

Sample electron guns of types 3RP and 7JP have been measured and important dimensions have been recorded. It is planned to issue a tabular summary of available information on these and other commercial electron guns on which we have data.

Consideration is being given to the design of an annealing oven to supplement the one now in the glass shop.

3.1 Construction (Continued)

A study has been made of means of making a storage assembly with varying screen-to-mosaic dimension. A tube incorporating this feature will probably be made in the near future.

Drawings of research tubes 75 to 80 are being made for record purposes. These tubes are used for the investigation of cathode deterioration.

3.2 Test

(M. I. Florencourt)

Three new storage tubes passed static tests satisfactorily. They are ST201, ST202, and ST203 in the new series with short beam throw.

RT120, a short-beam throw tube with a 100 mesh beryllium mosaic surface, was also given standard tests. Static tests showed that a high minimum holding beam velocity was needed for holding small positive spots and that a low maximum operating voltage for large positive spots existed. Under these worst conditions therefore, this tube apparently has a narrow range of V_{HG} for stable static operation.

WWI Storage Tube Static Acceptance Tests were run on nine tubes of various types. Accepted were ST103, RT109, RT110-R1, RT111, RT112, ST200 and ST201. Rejected were ST111 and ST116; it was recommended that ST111 be reprocessed.

(C. L. Corderman)

From further investigation on RT89 and RT113, the maximum operating V_{HG} appears to be a function of the charge used in W^+ and the current or writing time separately. For Q^+ ($Q^+ = I_T T^+$) in the range from minimum writing charge to 100 μμcoul., the maximum operating V_{HG} decreases by 20 to 70 volts from that value established at the point of minimum writing charge by the particular mosaic section. For Q^+ increasing from 100-2000 μμcoul., there is no further significant drop in the maximum operating V_{HG}. These observations seem to indicate that the maximum operating V_{HG} depends upon the gradient on the surface after W^+, since for $Q^+ < 100$ μμcoul., the area being brought to its equilibrium potential by the writing beam is very small or even non-existent.

For a constant Q^+, the maximum operating V_{HG} also depends upon the position on the surface at which the W^+ operation takes place, being highest near the center of the surface. It

3.2 Test (Continued)

is not known whether this effect is due to the change of holding-beam current-density over the surface or the variation of collector to surface spacing.

Consideration is being given to an electronic deflection unit for the TV Demonstrator. This deflection could operate at much slower speeds than the ESD system of WWI. It would seem desirable to provide for a 32 x 32 array of spots together with several useful forms of cycling. Since space and power requirements are definitely limited, the feasibility of such a unit seems to hinge upon the design of a single tube flip-flop suitable for the horizontal and vertical counting circuits.

(D. M. Collier)

During the past two weeks master's thesis research was continued on the problem of deactivation of storage-tube cathodes under standby conditions. Eight special research tubes (RT80, 88, 94, 95, 96, 97, 98, 99) are now being used in this study. In order to release space for expansion of the glass shop, the life racks and test equipment have been moved from the storage tube test laboratory to room 122.

RT88, after 588 hours of operation at zero bias, was biased below cutoff for 112 hours. During this period of standby operation, the bias was pulsed to zero voltage for short periods of time after relatively long standby intervals. In this manner, the emission of the cathode, under conditions of essentially biased-beyond-cutoff operation, was observed. A slight reduction in emission (i.e. deactivation) was noted during this time. At 700 hours, RT88 was again restored to operation at zero bias. The emission after a protracted period of standby operation was somewhat less than it had been prior to this standby period. After about four hours of continuous operation, the previous level of emission was again reached.

RT88 is a specially constructed triode using a high-velocity gun cathode and grid structure. The entire assembly is particularly free from contamination in an effort to isolate the characteristics of the oxide-coated cathode itself from those characteristics which result from the surroundings of this cathode. Even in such a clean structure, deactivation effects are present, although not to such a great extent as has been noted in full-sized storage and cathode-ray tubes. These tests were conducted on RT88 to confirm that such effects are present in this type of construction.

3.2 Test (Continued)

At the present time, research tubes RT94 through RT99 are being tested in a fashion somewhat similar to RT88. Data on these tubes is not yet complete enough to report. Three additional research tubes are under construction for this study and are expected to be ready for use early next week.

4.0 INPUT-OUTPUT EQUIPMENT

4.1 Eastman Kodak Units

(E. S. Rich)

A study has been made of the timing relationships that are required in the Reader-Recorder between its output pulses and the deflection and blanking of the CRT beam. This study disclosed that a change in the method of producing blanking signals was necessary to provide a satisfactory tolerance in the delay between a shift pulse from the reader-recorder and the resulting input pulse from the IOR. After this modification was made, the film unit was connected to IOR, COR, and IOC so that the equipment was operating as a complete recording system with test equipment being used to simulate only those functions which are to be performed by the computer central control. The results were encouraging. Operation was satisfactory when certain words were being recorded but for other words there were occasional errors.

Further work is being done to improve the CRT blanking. After that, tests will be resumed on the phototube pick-up circuits making use of the IOR and COR to detect incorrect operation.

4.2 Display

(R. H. Gould)

A ten-inch cathode ray tube (10HP4) was furnished with appropriate accelerating and focusing voltages and its deflection plates were coupled to the amplifiers of the Dumont 304-H oscilloscope in special display. A fairly good display pattern was obtained with little trouble and investigations are being made of the availability of large cathode ray tubes with long persistence phosphors.

The intensifying amplifier for the special display scope has been modified and its use awaits the wiring of -30 volts into rack C1. This should greatly improve the display patterns.

(JU A. O'Brien)

A circuit for the Special Display Vertical Decoder has been worked out and a breadboard for a ten digit decoder is being built.

4.3 Typewriter and Tape-Punching Equipment

(F. A. Foss)

The Flexowriter units, the automatic perforator and the automatic typewriter, have been received and operated satisfactorily.

The equipment needed for the preparation of a corrected self-checking punched tape for input purposes is now being considered.

5.0 INSTALLATION AND POWER

5.1 Power Cabling and Distribution

(C. W. Watt)

An attempt is being made to collect the information for a maintenance handbook on power distribution in WWI. A new drawing, D-35228, "Typical Circuits, Power Distribution and Fuse Alarm System" has been issued, and a simplified schematic of the rack switching arrangements will be made. Engineering Note E-326 on the variable voltage distribution was issued.

5.2 Power Supplies and Control

(R. E. Hunt)

E.S. Power Supply Control Panel - Drafting is just about complete and a construction requisition has been issued. It is expected that this panel should be ready for installation about March 1st.

Power Control Panel - This is a new panel which combines the old "power supply remote control panel", E.S. power supply remote control, the old "master digit switches" which have been renamed "D.C. Maintenance Switches", and moved from Rack P5, and a new system of trouble indication. The panel also includes one indicator light for each power supply plus lights to show whether normal or emergency plate and filament supplies are available.

Layout is nearly complete on this panel. It is expected that it will be available about the last of March.

Power Control System - Panel schematics and cabling drawings (additional and modified) to incorporate E.S. Power Supply Control into the system are now nearly complete. The should be completed, checked, and graded by March 1st.

Installation of the E.S. Power Supply control system into the present system (modified) could be accomplished, minus E. S. Power Supply metering, upon delivery of the "Power Control Panel" or anytime after April 1st.

Work on the high voltage distribution system and metering will be started next.

5.2 Power Supplies and Control (cont.)

(J. J. Gano)

Marginal Checking Power Supply - Construction of the regulator is in process and should be completely assembled and tested within the next two weeks. The power supply for the regulator has been tested and requires only its panel to be ready for installation.

(S. H. Dodd and W. J. Nolan)

The following is a summary of the status of the ES power supplies:

1. Low Voltage Floating supplies are completed and tested.
2. HV Anode supply - constructed and adjusted. At present Nickerson has for inspection. Best will write test specs.
3. High Voltage Cathode supply construction is nearly complete. Unit is in drafting room for completion of drawings. Several resistors and an interlock switch are on order and expected in a week. These will allow completion of the supply. Best will write test specs. Operation tests should be completed in about two weeks. Unit will then go to Nickerson for inspection.
4. The 500 volt regulator construction is complete except for brackets and covers but has not been inspected. Best will make up test specs. Nolan is adjusting the regulator and testing.
5. The 600 volt rectifier construction is complete except for some transformers which have just been delivered. Operation testing should be completed in about one week.

(W. J. Nolan)

Work on the 500 volt regulator has been suspended for a little more than a week in order to put into operation a test set up for the ST mounts. This now appears to be working.

5.3 Video Cabling

(T. Leary)

The ES Restorer cables (819-827) and a group of miscellaneous cables for ES Control have been completed and installed.

5.3 Video Cabling (cont.)

The shop is now working on the R-F cables (791-804, 813-818). Next will come the remaining ES Register-Driver cables (828-833), to be followed by a group of cable changes and additions which is accumulating.

The revised WWI abbreviations list (section 57.504 of the Standards Book) has been held up because of a lack of typing time but will be forthcoming shortly.

Video-Cabling panel schedules for most of the E-row have been issued, and schedules for the C-row are being worked on.

6.0 BLOCK DIAGRAMS

(R. P. Mayer)

Memorandum M-967 proposes an "Electrostatic Storage Tube to Program Register Transfer Check" which will be included in WWI.

Storage Selection Control (108) has been connected so that two GT's prevent the reading out of Test Storage to the Bus and Check Bus when Electrostatic Storage is selected. These GT's are now being removed so that Test Storage always reads to the Buses. When Electrostatic Storage is to be used, Test Storage register 0 must be a cleared toggle-switch register. Thus, when ES is selected (TS-0 will also be selected) TS will read out "0", or "nothing", causing no interference with ES.

Block Diagrams and Timing Diagrams are being changed to include the above two revisions along with minor revisions to aid checking procedures.

The reason for the change in storage selection control is described by Sumner in section 1.1.

7.0 CHECKING METHODS

7.2 Display Programs

(C. W. Adams)

E-320: Display Program Number IV, Non-Homogeneous Second Order Differential Equation has been issued.

A very simple extrapolation procedure, motivated by the "anticipation" technique used in setting up the M. I. T. differential analyzer (the unknowns are anticipated, substituted into the equation; the result is integrated to give the anticipated unknowns), has been tried on the computer. Second order differential equations have been programmed in this way and have given good results. Startlingly good results are obtained in the case of the linear homogeneous equation, for the resulting wave maintains constant amplitude even for large values of the period. This effect occurs because the difference equations which are derived in the "anticipation" procedure have a constant-amplitude sinusoidal solution. An E-note will be written about the displays which can be obtained using this procedure. The constant-coefficient case can be programmed in only nine orders.

Results of a useful nature have been obtained from the computer this past week and these are reported in section 8.0 of this report.

8.0 MATHEMATICS AND APPLICATIONS

(C. W. Adams)

An interesting and useful piece of work was performed by the computer last week when it was programmed to plot a fourth degree polynomial with adjustable coefficients. By observing the plot, the real roots of the equation could be determined for various values of the parameters. The results were of some value to A. Orden of Project 6673 who wished to know the roots for his investigation of the stability of an aircraft control system.

In connection with the polynomial plot just mentioned, techniques were worked out for plotting calibrated axes. Various forms of calibrated axes will be needed in obtaining useful plots from the computer.

Work on standard subroutines is progressing. A subroutine for the evaluation of $\sqrt{x}$ has been tried on the computer. The subroutine has two parts, one of which shifts the number left n times into the range $1/2 \leq x < 1$ and provides a suitable factor $2^{\frac{n}{2}}$ while the second part finds the square root by three iterations of Newton's method. Only the iterative steps, applied to numbers between 1/2 and 1, were tried since the test storage capacity is only 32 registers. The computer found $y \cong \sqrt{x}$ for all values of x between 1/2 and 1 (in steps of 2^{-15}, the machine's capacity), determined an error $|y^2 - x|$ and counted the number of occurrences of each value of the error. Out of the 16382 numbers tried, 9015 gave 0 error, 7226 gave 1×2^{-15} error, and 141 gave 2×2^{-15} error. The actual error in the square root y is .707 of the error determined by $|y^2 - x|$. Therefore, to give 0 error, the value of y must have been in all cases within $.35 \times 2^{-15}$ of the correct value. Since the value of y is only 15 binary digits long, it cannot be expressed more precisely than $.5 \times 2^{-15}$. Consequently, many of the values of y which gave an error of 1×2^{-15} undoubtedly were actually correct to within $.5 \times 2^{-15}$, so that an error of 1×2^{-15} is in many cases no real error at all. The truncation error in the process is less than 2^{-22}. The computer showed that the roundoff error was greater than 2^{-15} in at most 0.9% of all possible cases.

9.0 FACILITIES AND CENTRAL SERVICE

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
E-322	Tests on ST110	7	1-18-50	R. L. Sisson
E-323	Standard Operating Conditions for 100-Series Whirlwind Electrostatic Storage Tubes	5	1-19-50	R. R. Everett, S. H. Dodd
E-324	Characteristics of 5UP and 7GP Electron Guns	2	1-24-50	H. E. Rowe
E-326	Power Distribution, Variable-Voltage Circuits, WWI	14	1-25-50	H. S. Lee
E-327	Standard Tests For Storage Tubes, Second Division	4	1-25-50	M. Florencourt
M-971	Master's Thesis Proposal: An Investigation of the Effect of the Angle of Beam Incidence on Electrostatic Storage Tube Performance	10	1-23-50	K. McVicar
M-972	Graphs of Storage Tube Electron-Gun Currents	1	1-6-50	J. O. Ely
M-973	Bi-Weekly Report, January 20, 1950	32	1-20-50	
M-974	Master's Thesis Proposal: Installation and Testing of a Computer Electrostatic Storage System	13	1-23-50	R. W. Read
M-975	Master's Thesis Proposal: A Coincidence-Current Magnetic Memory Unit	6	1-24-50	W. N. Papian
M-976	Collector Interception of Electron Beam as a Function of Angle of Incidence	2	1-24-50	M. Florencourt
M-978	Electronic Computer Division Personnel	3	2-1-50	
M-979	Preparation of WWI Instruction and Maintenance Manuals	4	2-3-50	R. Rathbone

Books

Theory and Design of Electron Beams J. R. Pierce

9.1 Publications (continued)

Library Files

No.	Title	Author
47	Technical Information Pilot: Sept. 29, 1949; Nov. 30, 1949; Dec. 22, 1949; Jan. 9, 1950; Jan. 17, 1950	ONR, Library of Congress
113	The General Radio Experimenter: Jan., 1950	General Radio Company
232	Physics Today: June, 1949	American Inst. Physics
443	The Analysis and Design of Hydrodynamic Gas Bearings: North American Aviation Company, Report Al-699, Project MX-770	R. R. Weber
451	Airways Operations Training Series Bulletins, #1-8, Jan. to June, 1949	(C.A.A. (U.S. Dept. of Commerce
452	A Preliminary Analysis of Technical Problems Involved in the Development of Airport Time Utilization Equipment: ANDB Technical Memorandum #1, Dec. 15, 1949	L. R. Philpott
453	An Introduction to the Analysis of One-Dimensional Non-Steady Flow: Project Meteor Report #UAC-44. January, 1950	N. A. Hall
454	The A-12 Gyropilot: Preprint for Presentation at the SAE National Aeronautic and Transport Meeting April 13-15, 1948, New York	P. Halpert
455	A Method of Test Checking an Electronic Digital Computer -- SM Thesis, January, 1950	G. Cooper
456	Investigation of a Hydraulic-Boost Aileron Control System. Instrumentation Lab Report 6445-T-25, MIT 1949	(J. W. Barnes (F. M. Rauschenbach
457	Investigation of Aircraft Lateral Motion Performance Function By Pulse Technique: Instrumentation Lab, Report #6445-T-23, MIT 1949	(J. B. Bain (F. H. Michaelis (J. C. Wooten
458	Aircraft Response Recorder (Longitudinal Case): Instrumentation Lab, Engineering Memorandum 6445-E-26; May 1949	(Instrumentation Lab. (MIT
459	Design and Test of the Aileron Components of an Airborne Tracking System: Instrumentation Lab, Report #6445-T-12, MIT 1948	(T. E. Oliver (J. F. Healey
460	Evaluation and Analysis of Typical Dive Bombing Computers: Instrumentation Lab, Report #6445-T-11; MIT 1947	(J. I. Hardy (R. E. Rader (B. K. Lloyd (L. E. Larson, Jr.
461	An Investigation of Stabilization Techniques in Airborne Tracking Systems: Instrumentation Lab, Report #6445-T-20; MIT 1949	(W. E. Lemos (H. H. Klare, Jr.

Library Files (continued)

No.	Title	Author
462	Investigation of the Response of an Aircraft to a Finite Pulse Input: MS Thesis, Dept. Aeronautical Engineering, MIT, Sept. 9, 1948; Instrumentation Lab Report #6445-T-18	G. C. Clementson

9.2 Standards, Purchasing and Stock

(H. B. Morley)

Standards - Standards approved for issue:

7.413-7	Test Specifications -- 833, Signal Plate Driver, WWI
7.420-2	Test Specifications -- Filament Transformer, Storage Tube, WWI

New Military Specifications received:

MIL-T-27	Transformers and Inductors (Audio, Power, and Pulse)
MIL-T-3080	Tubes, Current-Regulating

Procurement and Stock - Nearly all components have been received for construction of additional S. T. Mounts and R. F. Amplifiers.

Plastic dust covers have been ordered for Voltage Variation Panels. Covers will be ordered for other relay panels as required.

Surplus stock and certain little-used equipment in the stockroom is being moved to Ft. Heath as time and personnel are available. As soon as possible a check of laboratory equipment will be made against stockroom records.

New Items - Fluid magnetic clutches for servo-mechanisms -- literature available.

Technology Instruments - sub-miniature wire wound precision potentiometers -- no literature or samples available yet.

9.3 Construction

(R. A. Osborne)

Production Report - The following items have been completed and inspected since January 20, 1950.

13	S. T. Mounts
47	Video Cables (E. S. Restorer)
32	Video Cables (Miscellaneous)
2	E. S. Gun Drivers

9.3 Construction (cont.)

(D. V. Mach, Jr.)

The WWI High Voltage Cathode Supply is approximately 90% complete pending receipt of special components.

A breadboard model of a new R. F. Pulser design was started. This will provide data for construction of a new single unit Pulser for WWI.

Component parts for a glass lathe motor control were assembled for storage tube processing.

The video testing and alignment of ST Mounts has been under way for one week. With the exception of an erratic Gate and Delay Unit or gun driver, the necessary test equipment is in working order. Test result forms have been initiated and except for deflection sensitivity specifications the test procedure is set up and operating.

Two ST Mounts have been tested and aligned with good results so far but for exception noted above.

(L. Prentice)

Machine Shop - Renovation of machine tools is still in progress; parts have been received for P&W lathe and will be installed this week. The only major item left is the teardown, cleaning, and painting of the Bridgeport Miller.

It was found this past week that we were using 110 V regulated supply in the shop. This situation will be corrected as soon as possible.

Sheet Metal Shop - 16 chassis for R. F. amplifiers were completed in addition to some breadboard panels during this period.

9.4 Drafting

(A. M. Falcione)

WWI Master Drawing List - The following progress has been made on WWI Master Drawing list since the last Bi-Weekly report.

9.4 Drafting (continued)

A drawing list has been compiled for all power supplies used in WWI and located in the basement power room. The drawing number is B-35272.

Detail drawings for the following rows have been completed: C-Row, A-Row, E-Row, F-Row, and P-Row, having drawing numbers D-35085 to D-35089 inclusive. B-Reductions are being obtained for this group.

A general drawing of the computer layout has been completed under dwg. D-35266.

The Test Equipment drawing list has been compiled but is not ready for issue.

Drafting Load - The drafting load at present is moderate.

10.00 GENERAL

(H. R. Boyd)

New Staff

Mr. William L. Poland is a new Research Assistant assigned to the WWI systems group. Mr. Poland received his B.S. degree in Electrical Engineering from the Department of Electronics of Rensselaer Polytechnic Institute in Troy, New York, in January, 1950. He has several years' experience at General Electric in test and development work on radar and television gear and in performing systems tests on servomechanisms.

Mr. Armand R. Tanguay is a new Research Assistant in the Electrical Engineering Department. He received his B.S. degree in Electrical Engineering from the University of Massachusetts in February, 1950. His electrical experience includes three years in the Army Transportation Corps and various student jobs. He will work with the storage tube group.

Non-Staff Terminations

Alden Greenlaw Ralph Jewell

Safety Committee

(J. A. O'Brien)

During the first few days of its existence, the safety committee received quite a few complaints and recommendations. Action has been taken on all suggestions received, but in many cases it will be some time before action is completed because of material procurement and work scheduling.

Complete and sympathetic cooperation has been given the safety committee by all parties involved, and this has been appreciated.

Six bulletin boards for safety posters have been put up in the building, two on each floor. Posters for these boards are being supplied by the MIT Safety Engineer. Present plans are that the posters will be rotated through the building during a month and be replaced by a new set the following month.