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Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, September 16, 1949
To: 6345 Engineers
From: Jay W. Forrester

1.0 SYSTEMS TESTS

1.1 Whirlwind I System Test

(N. H. Taylor)

Test Program Number 2 which includes all 19 orders currently used in WW has successfully been run for short periods of time. The computer using test storage is essentially complete and the work remaining will deal with marginal checking and the improvement of reliability in the 3500 tables and circuits now being used.

The addition of Special Display equipment to the system made possible the plotting of several simple curves on an oscilloscope. As the computer solved the value of discrete points on a family of parabolas, each point was plotted on the display oscilloscope. This display demonstrates an important means of output and a very effective method of using a digital computer to give essentially continuous information to an observer. The same technique was employed to display powers of x . The speed of WWI is notable in these demonstrations. The parabolas were plotted in about $1/30$ th of a second and 3 powers of x in $1/60$ th of a second. Some 500 points were plotted for each sweep of the scope totaling respectively 15,000 and 30,000 calculations and plots per second for the two problems.

(H. F. Mercer)

The following failures of electrical components have been found since September 2, 1949:

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1.1 Whirlwind I System Test (Continued)

CRYSTAL RECTIFIERS	QUANTITY	COMMENTS
D-358	1	Drift of crystal in Toggle Switch Storage Switch, Panel #1 caused poor operation - crystal failed after approximately 750 hours of operation.
TUBES	QUANTITY	COMMENTS
7AD7	2	Both tubes in Step Counter Panel #1 were flip-flop tubes and were sticking and had very low margin of 5V on flip-flop screens. Total hours on tubes were: Filament hours 1412.0, Plate hours 1253.

1.2 Storage Tube Reliability Tester

(R. Sisson)

Because of vacations and the large number of visitors during the past week, this equipment was used mostly for demonstrating the storage tube under high-speed conditions. Operation was good for short periods of time.

Testing will continue on the effect of pulsing the HV grid above zero, and of increasing V_K .

1.3 Five-Digit Multiplier

(E. S. Rich)

During the past two weeks a single error in the multiplier's operation was recorded on September 15th. Because of the urgency of other work at the time no attempt was made to determine the cause of the error. This makes a total of eight errors during a two-month period, two of which were due respectively to a city power failure and a local thunderstorm.

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2.0 CIRCUITS AND COMPONENTS

2.1 Circuits by System Number

104 Control Switch

(J. A. O'Brien)

The test specifications on all of the control switch components with the exception of the chopper panel have been written, but are untyped as yet.

412 In-Out Control Synchronizer

(H. S. Lee)

The assembly has been completed and the panel is now in the Inspection Department.

810 ES Control

(R. W. Read)

ES Control has been operating during the past two weeks mainly for the purpose of testing and examining the prototype panels in the Digit Column. No difficulties have been encountered in ES Control, but a check on its reliability waits installation of marginal checking. Pulse amplitudes are being investigated thoroughly to assure the degree of reliability existing in the WWI system.

820 ESD Deflection

(L. J. Nardone)

Tests have been run on the ESD Decoder Panel Ser. No.1. Both this panel and the ESD Output panel Ser. No. 1 were put into operation Sept. 7. By means of standard test equipment, the decoder panel has been made to operate as a counter. No faults in the decoder panel were detected.

The special display decoder was also tested in the same setup and found to be satisfactory. The ESD Decoder Ser. No.1 is now being used temporarily with the special display panel.

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820 ESD Deflection (continued)

The ESD Decoder Panel Ser. No. 2 was put into operation Sept. 14 and is at present being tested. A 7AD7 with open filaments had to be replaced before operation could be obtained.

Waveforms observed at the input of the transmission line indicate that all the voltage amplitude increments from 0-31 are very nearly equal. Voltage waveforms will be checked at the end of the line and at several points along the line.

831 Storage Tube Mount

(R. Shaw)

Revisions to storage tube mount mechanical drawings have been completed except the main assembly which will be finished by J. Wilson on his return from vacation. Issue of revised prints is being postponed until the drawings have been reviewed by those interested.

832 ES Output

(W. J. Nolan)

Work on power supplies has been suspended for a week in order to devote the time to the development of a fast-acting A.G.C. circuit for the r-f amplifiers. Such a circuit would eliminate the difficulty caused by varying output signals when reading. Progress so far has shown a good range of control is possible but severe distortion of the output pulse occurs.

A minor modification of the amplifier circuit will apparently permit limiting in the phase detector circuit and make the A.G.C. circuit unnecessary. This should be checked more carefully though.

833 Signal Plate Driver

(C. W. Watt)

Aluminum panels are complete for these repetitive units. Final assembly of 18 panels is due to start Sept. 26.

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Memorandum 899834 Gun Driver
(C.W.Watt)

A construction requisition has been written for 18 Gun Drivers. Sheet metal work will begin Sept. 21. Drafting is complete.

835 RF Pulser
(W. J. Nolan)

Tests have been completed on the r-f pulser and the unit has been installed in the racks. As a result of tests made after the unit appeared to be working satisfactorily, quite a number of changes were made in the original circuit in order to reduce the load on certain tubes and to make the characteristics of the unit independent of tube replacements.

2.5 Vacuum tube studies

(H. B. Frost)

Pulse and d.c. tests of all 7AD7 and 6AG7 tubes in the life test racks show very little change in the last 1000 hours. Tubes with cathode sleeves containing relatively high percentages of silicon, (599 and 799 alloys) are showing consistent formation of an apparent cathode interface in both normally on and normally off conditions. Other cathode materials are indeterminate or negative in this respect at present. A group of production 7AD7 tubes which have been operated 4000 hours with 8 Volts on the heaters have been retired.

A sample of 4 special 5687 tubes which were received from Tungsol and life tested for 1000 hours has proven superior to any received previously. However, one tube has developed apparent interfaces on both cathodes. (Both sides have operated 500 hours on, 500 hours off.) The other three tubes have shown some emission poisoning effects which may be peculiar to the life test conditions. Five new production tubes are being tested at present.

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<u>2.2 WW1 Drawing List</u>	<u>Block Diagram</u>	<u>Block Schematic</u>	<u>Circuit Schematic</u>
System	B-37071-6		
Control	B-37098-6		
Master Clock	B-37159-5		
101 Pulse Generator	B-37155-4	B-32385	E-32333-5
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 <u>Control Switch</u>			
Input Panel	B-37066-5	B-34321-1	
Matrix Panel	B-37066-5	C-33843-2	R-32722-4
Switch Panel	B-37066-5	B-34100	Z60CS00-2-G
Output Panel	B-37066-5	B-34101	Z60CS00-F
105 Operation-Matrix Driver Panel		S600M00-B	Z600M00-1-G
105 <u>Control-Matrix</u>			
(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 <u>Time-Pulse Distributor</u>			
Counter Panel	B-37068-6	T60PDC0-3-D	T60PDC0-E
Output Panel	B-37068-6	T60PDC0-4-C	Z60PDC0-1-G
109 Clock-Pulse Control	B-39817-5	C-32642-5	E-31916-8
Clock-Pulse Control Delay	B-39817-5	A-34446	D-34416
110 Frequency Divider	B-37154-4	B-32264-1	R-31729-3
111 Synchronizer	B-37172-2	C-33485	R-33486-2
112 Restorer-Pulse Generator	B-37160-3	B-32209-4	D-31909-9
200 Test Storage	B-37156-3		
201 Test-Storage Amplifiers	B-37121-3	C-32855-4 C-33768	D-33706-2

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<u>2.2 WWI Drawing List (Continued)</u>	<u>Block Diagram</u>	<u>Block Schematic</u>	<u>Circuit Schematic</u>
<u>201 Storage Switch</u>			
Input Panel	B-37121-3	B-34322-1	
Matrix Panel	B-37121-3	C-32855-4	R-32722-4 D-33706-2
Switch Panel	B-37121-3	B-34102	Z60CS00-2-G
Output Panel	B-37121-3	B-34103	Z60CS00-E
<u>202 Toggle Switch Storage</u>			
Switch Panel	B-37122-4	C-33768	D-33706-2 C-33707
Output Panel	B-37122-4	C-32080	E-32721-4
<u>203 Flip-Flop Storage</u>			
Output Panel	B-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	
301 A-Register, Digit 0	B-37056-4 B-37072-9	B-31574-1	D-31573-8
301 A-Register, Digits 1-15	B-37056-4	B-31211-3	D-31276-12
<u>302 Accumulator</u>			
Digit 0	B-37173-2	D-32851-1	R-32850-5
Digit 0, Auxiliary Panel	B-37173-2	B-32492-2	D-32602-1
Digits 1-14	B-37173-2	D-31213-4	R-31275-10
Digit 15	B-37173-2	D-33964	
303 B-Register	B-37097-6	B-31212-5	D-31277-9
304 Sign Control &	B-37072-9	C-31576-3	E-31619-2
308 Divide-Error Control			
305 Stear Counter	B-37074-7	D-31828-2	D-39764-5
305 Stear-Counter Output		A-32723-1	D-32735-2
306 Multiply &		C-31532-3	E-31588-6
307 Shift Control	B-37072-9		
308 Divide Control	B-37072-9	C-31552-3	R-31718-5
309 Overflow & Special Add Memory	B-37072-9	C-31575-5	R-31632-5

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	<u>Block Diagram</u>	<u>Block Schematic</u>	<u>Circuit Schematic</u>
2.2 <u>WW1 Drawing List</u> (Continued)			
310 Point-Off Control	B-37072-9	C-31600-6	E-31717-6
400 <u>Inout-Output</u>	B-37178-1		
403 In-Out Register	B-37178-1	B-32434-2	D-31277-9
404 Comparison Register	B-37178-1	B-32578-3	E-32576-9
404 Comparison-Register Check	B-37178-1	B-33488-1	E-33515-3
410 IOC Synchronizer			D-34338-1
601 Check Register	B-39816-3	B-32577-1	E-32576-9
601 Check-Register Check	B-39816-3	B-32018-1	F-32023-3
602 Alarm-Indicator Control	B-37175-1	B-33603	E-33651-3
820 <u>ES Deflection</u>	B-37220	E-34770	
ESD Gate Panel	B-37220	A-34036-1	B-33876-2
		E-34770	
ESD Decoder	B-37220	E-34770	E-33908-2
ESD Output	B-37220	E-34770	C-34182-1
ESD Bank Selectro	B-37220	B-34232	D-34238
		E-34770	
Storage Selection Mixer	B-37220	E-34770	C-34311
831 ST Mount	B-37220		E-34040-2
832 <u>EST Output</u>			
RF Amplifier	B-37220		D-34315-1
Gate Tubes	B-37220		C-34251
833 Signal-Plate Driver	B-37220	A-34711-1	D-34029-3
834 Gun Driver	B-37220	B-34712-1	D-34181-1
835 Holding-Gate Generator	B-37220	A-34354-1	C-34060-5
835 Read-Gate Generator	B-37220	A-34355-1	C-34324-5
835 RF Pulsar	B-37220		SE-34549
Standardizer Amplifier		A-33881-1	C-33880-2
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	F-32261-10

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2.2 <u>WW1 Drawing List (Continued)</u>	<u>Block Diagram</u>	<u>Block Schematic</u>	<u>Circuit Schematic</u>
Register Driver, Type II		B-32691-2	D-32690-4
Bus Connections	B-37124-4	C-37123-3	
Fuse-Indication Panel			W60PP00-7-D
Voltage-Variation Panel			T60PP00-6-D
WW1 Power-Connector Pin Connections			B-31955-6
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)

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3.0 STORAGE TUBES

3.1 Construction

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

The storage tube construction program proceeded as it was scheduled. No new difficulties were encountered.

Three research tubes were constructed during this period. The first tube was used to study the cathode deterioration of a holding gun. The second tube had a movable "pepperpot" diaphragm which slides back and forth over the end of the holding gun to measure deflection sensitivity and distortion of magnetic deflection coils used on the beam-analyzer tubes. The third tube was used to study a new faraday cage design.

(W. E. Pickett)

Glass Components - During the short week of this last period, the two vacuum systems used for processing tubes were taken apart, cleaned and reassembled. No difficulties were experienced in cleaning the systems and the help of the chemical cleaning room aided in getting these systems back together on time.

The prints for a spare vacuum firing bell jar have been drawn up and a spare bell jar will be constructed to have on hand in the event of an accident to the bell jar now in use.

On hand in the glass shop are enough envelopes for storage tubes to take us up to September 23rd. All available time during this period will be spent on the construction of envelopes for storage tubes.

The envelopes used for the construction of silver evaporation and beryllium evaporation are low and it is planned during this coming period to construct several envelopes of this type.

In general, no unusual difficulties were encountered during this last period, and the work load on the glass shop still remains the same.

(J. S. Palermo)

Mechanical Components - The new Be evaporation boiler expected before this report, has not materialized. However, L. Prentice, R. Shaw and myself met this morning to discuss the final assembly, so that the boiler should be ready within a few days.

A new type of label for window masking the Storage Tube envelope

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has been tested and the results were not too encouraging. However Bromley and Co. through their representative, have been extremely cooperative and I feel have solved our problems.

The general status of our inventory is in exceptionally good shape. We have 20 Storage Tube signal plate assemblies ready for final assembly and 8 signal plate target assemblies ready for Evaporation Tubes. The latter assemblies are continually being re-used in successive E.T.s. Three sets of daggged Storage Tube envelopes are also ready in the I.R.

(R. Shaw)

All storage tube drawings are being examined, and brought up to date where necessary.

Storage tube drafting is somewhat behind schedule and several recent research tubes have been constructed without the aid of drawings.

3.2 Test

(M. I. Florencourt)

The three latest storage tubes were tested during this bi-weekly period. ST115, ST116 and ST117 all proved satisfactory for computer operation. Their surfaces were uniform and leakage low. High-velocity beam current can still be improved. Eight tubes in succession have now proved satisfactory.

(A. Ballard and J. S. Rochefort)

The high-speed, write-read unit was converted to r-f readout and checked out satisfactorily. Preliminary tests were begun to determine the minimum operation durations for reading and writing spots on ST102. Results indicated that minimum operation times were largely determined by the signal-plate switching transients passed by the r-f amplifier used with the unit. This amplifier is an earlier model and its design was not worked out to the extent of those designed for Whirlwind. Accordingly, testing has been temporarily suspended and effort is being made to adapt the Whirlwind input circuit to this amplifier.

(C. L. Corderman)

Static life tests on storage tubes have been temporarily suspended in order to study the decay of high-velocity gun current under pulse conditions.

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4.0 INPUT-OUTPUT EQUIPMENT4.1 Eastman Kodak

(E.S.Rich)

The first Reader-Recorder was delivered to the laboratory on September 13. It has been given some preliminary tests by the designers, who have been in Cambridge this week to attend the Harvard Symposium, and it has been determined that its operation in most respects is the same as before shipment. Some realignment of the optical system seems to be necessary, however, in order to get proper reading.

4.2 Display

(E.S.Rich)

The special-display system was installed in WWI on Friday, September 9. No difficulties were encountered in the functioning of the system and only minor adjustments were required in order to get proper display patterns. The patterns first obtained made it obvious that a 6-digit decoder does not give a sufficient number of increments in vertical deflection to trace smooth curves. For demonstration purposes an ESD decoder panel has been temporarily connected into the system to give 5 additional digits of accuracy. This is more than are needed and tests will be made in the near future to determine the minimum number required so that the necessary equipment can be added to the system.

(J.A.O'Brien)

Working with Ed Rich the range of the special display unit was increased by adding another 5 digit decoder panel in series with the original one. The series connection was made through an attenuating network to obtain the proper weight. A few resistor adjustments resulted in a fairly smooth display presentation in which the increments are much smaller than the spot size. The limiting factors of the system are now the linearity of the scope sweep, the low frequency limits of the amplifiers and the problem repetition rate.

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4.2 Display (cont)

In the work of increasing the range of display we made two attacks on the problem. The first is mentioned above, and the other was to use test equipment register panel to add two more digits to the original decoder. To accomplish this a breadboard was built containing two cathode followers and two current switching circuits using thermionic diodes. This panel was not used, but it is available and presumably will be used when the second decoder panel is returned to the storage tube group.

Some work has been done investigating a decoder system in which all current generators use the same current, thus more units could be built with crystal diodes.

(C. W. Watt)

The computer power was shut off Friday, September 9, to permit installation of Power wiring and video cabling to special display equipment. Power was turned on before the end of the day, and the system was operative Saturday, September 10. To increase the accuracy of the display, five more digits were added Wednesday, September 14. Temporary wiring for an additional decoder panel was done Wednesday afternoon and the improved display was operative by evening.

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5.0 INSTALLATION AND POWER5.1 Power Cabling and Distribution

(H.S.Lee)

The external power cables for Special Display have been completed and installed in Rack C1. This completes the installation of this rack.

Fabrication of the external power cables for the panels in Rack C3 is progressing satisfactorily.

The drawings of the external power cables for the panels in Rack ED have been completed and are waiting checking. They have been held in abeyance pending completion of higher priority items.

Bids have been received from Gavitt Mfg. Co. and B.I.W. for fabrication of the power cables for the ES digits. As of this writing Gavitt is the low bidder. We are waiting an additional bid from Rockbestos.

5.2 Power Supplies and Control

(R.E.Hunt)

The Automatic Control Panel for Marginal Checking - is about 60% complete in the assembly shop. Mechanically only one slight modification will be needed. This panel should be complete in about one week.

During the last power shutdown the power supply control system was modified to add a filament failure buzzer. This buzzer operates if there is no filament power while the computer is on "on" or "standby".

A Temperature Control Interlock is complete and will be added to the power supply control system during the next power shutdown. This interlock will shut down all WW Power if the exhaust temperature from the AD Rack exceeds predetermined limits.

(J.J.Gano)

Marginal Checking Power Supply - R.Wiesser and I discussed amplidyne generator design with Mr. Lebenbaum, design engineer

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5.2 Power Supplies and Control (cont)

at the Lynn plant of G.E. and Messrs. Wahlstrom and Hannett of the Boston office. It was suggested that the quickest procedure for securing a generator that might satisfy our requirements, at least temporarily, would be to alter our present machine. The following will be tried in order to reduce the time lag:

- a. Removal of quadrature series field and insertion of a resistance across the quadrature axis brushes.
- b. If step (a) is insufficient, enlargement of the air gap by grinding the rotor.

Transient response tests on the generator will start at once.

(C.W.Watt)

At the request of S.H.Dodd the time sequence of power application to the computer has changed to the following:

1. - Biases
2. + 250
3. + 150
4. +120, +90

5.3 Video Cabling

(R. Fairbrother)

The cabling for Special Display is designed, manufactured and installed.

The cabling for RS Deflection is designed.

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9.0 FACILITIES AND CENTRAL SERVICE9.1 Publications

(J. N. Ulman, Jr.)

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

6345 Reports

<u>No.</u>	<u>Title</u>	<u>Classified</u>	<u>No. of Pages</u>	<u>Date</u>	<u>Author</u>
E-286	Investigation of the Stabilizing Curve of the Storage Tube With The High-Speed, Write-Read Unit	-	19	8-29-49	(J. S. Rochefort (N. S. Zimbel
E-287	Methods of Cutting Mica	-	3	8-31-49	I. Paulsen
M-894	Electronic Computer Division Personnel -		3	9-1-49	
M-897	Bi-Weekly Report, 9-2-49	Restr.	28	9-2-49	
M-898	PR: Conversion Devices For A Digital Computer	-	3	9-6-49	A. K. Suskind

Library Files

.004	European Scientific Notes, 1 and 15 June, 1949				London ONR
47	Technical Information Pilot, Numbers U4186-4260 & 4381-4445				(ONR, Library (of Congress
134	Eastman Kodak Monthly Progress Report No. 13, Photographic Digital Reader-Recorder				A. W. Tyler
180	Document Office Bulletin, September 1, 1949				RLE, MIT
299	Report of the Ninth Annual Conference on Physical Electronics, April 7-9, 1949: Department of Physics & RLE				MIT
300	The Development of a Six-Channel Strain-Gauge Amplifier and Balancing Network: Northrup Aircraft				W. P. Larson
312	Temperature Telemetering Amplifier for Resistance Thermometers in Northrup Missile MX-775A: Northrup Aircraft				J. V. Flowers
313	Field Pattern and Polarization of Turnstile Antenna: North American Aviation, Inc.				R. T. Gabler
314	Vibration Amplifier for Telemetering: Northrup Aircraft				J. V. Flowers
315	Boeing Magazine, April, 1949				Boeing
338	Telemetering Engine Speeds for Subsonic Test Missile MX7775-A: Northrup Aircraft				W. Larson
339	Interim Report on the Further Development of a System for Airport Traffic Guidance and Control				Sperry Gyroscope Watson Labs
340	Automatic Radar Target Identifiers				
341	Fundamental Principles and Operating Characteristics of the TRICON System of Air Navigation and Traffic Control				Gen. Electric

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9.2 Standards, Purchasing and Stock

(H. B. Morley)

Standards - New standards issued, revised, or assigned:

Corrections for 7.504-4, WWI Abbreviations
7.411-16 Frequency Divider - assigned 9/14/49
7.411-17 Pulse Generator - assigned 9/14/49

A complete review of all standards and specification sheets issued has been made with a view toward bringing obsolete material up to date and making whatever changes and improvements seem necessary and justified. The distribution list will be revised and all standards books checked for completeness and accuracy.

Procurement

The order has been placed with UTC for the HV Filament Transformer (Spec. 6.195-3).

An order has been placed with Sylvania for 1000 Type D-357 germanium crystals. Selection beyond a quantity of 300 will be held up pending decision whether specifications are to be changed.

Salvaged delay lines returned to the stockroom are being tested and marked. If serviceable, they are returned to stock. Anyone having delay lines not in use or not scheduled for use should return them to the stockroom. Millen standard delay lines are now furnished in impedances of 1350 and 550 ohms, instead of 1100 and 400 ohms as formerly supplied.

The cost of replacement power transformers for Sylvania P5 Scopes is felt to be excessive. A copy of the design specs of this transformer has been requested from Sylvania with a view to submitting it to one of our transformer vendors for a better price and possible improvement in design.

Two power transformer failures have been experienced recently in Tektronix scopes. The local manufacturer's representative will be contacted to ascertain whether these failures may be due to faulty transformer design.

9.3 Construction

(C. W. Watt)

Production Report - The following items have been completed since September 2:

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9.3 Construction (Continued)

39	91 ohm Terminators
71	68 ohm Terminators
8	Video Cables for Special Display
1	820 ESD Decoder
1	820 ESD Decoder, Modified for Special Display
1	410 IOC Read Record Memory (Modified A-Register)
1	410 IOC Program Alarm (Modified A-Register)
1	Check/Comparison Register
7	External Power Cables for Special Display

(L. B. Prentice)

The machine shop is now engaged in making jigs and dies for a new type boiler for storage tubes and machining parts for a two-panel rack for computer racks. Marginal checking panel is ready for wiring.

The sheet metal shop is now engaged in fabricating parts for extra rack for computer room. This work should be ready for assembly this coming week.

Work schedule for the next two weeks will be heavy.

(A. R. Curtiss)

Assembly and wiring of the high voltage regulator noted in the last report has been completed.

A cable terminator and monitor and a CRT life test rack were constructed.

A 19" x 60" relay cabinet has been received and the power supply units now temporarily installed for use with the WTI ST mount will be shifted to this cabinet. The high voltage cable will be run in conduit.

9.5 Drafting

(A. M. Falcione)

Our library files and tracing files contain many drawings which have long since been obsoleted. It would be greatly appreciated if all engineers would check into the problem and advise of any drawings which could be removed from the files. This would eliminate all our "dead load" drawings in the files and give us more room for active drawings. Drawing file space requirements will increase as time goes on, and if we could clean house now it would greatly help later.

Drafting load is moderate and steady.

~~RESTRICTED~~

UNCLASSIFIED