6345
Memorandum M-850

Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART I, MAY 13, 1949

To: 6345 Engineers

From: Jay W. Forrester

1.0 SYSTEMS TESTS

1.1 Whirlwind I System Test

(N. H. Taylor)

Clock pulse control and time pulse distributor panels have been installed and preliminary tests indicate that satisfactory performance may be expected from these units.

At the time of installation, the system of restoration was changed to a fixed frequency basis. There are still a few problems of timing to be worked out with this system, but indications are that it will be superior to the system previously used.

(G. C. Sumner)

The past two-week period has seen the integration of a large part of WWI central control into the system, including the arithmetic element and test control. The following WWI units were added to the system: Pulse Generator, Frequency Divider, Clock Pulse Control, and Time Pulse Distributor. All of these units perform satisfactorily according to expectations. Clock pulse control includes recent modifications to provide "constant frequency" restorer pulses. This restorer system seems to have marked advantages over the old system. For the few days that it has been operating, restorer pulses have not been lost as was not infrequent with the former system. On a few occasions the system has stopped in the "stop clock" position, but restorers have continued permitting rapid determination of the cause from the indicator lights.

Complete marginal checking facilities are installed for the parts of central control now in the system. As originally designed, the Frequency Divider had low margins of gate tube

1.1 Whirlwind I System Test (continued)

screen and control grid bias variation. These margins have been greatly improved by loading the flip-flops in the Frequency Divider.

Three 7AK7 tubes have been removed from the Time Pulse Distributor. These tubes gave low output apparently because of very high frequency oscillations. Moreover, oscillation was observed in these tubes on the tube tester. It was since leared that other 7AK7's of the same lot have been rejected for WWI use because of tendency to oscillate. The matter has been referred to the committee on tubes.

A study is being made to determine the optimum length of corrective delays that should be placed in various parts of central control. It has been found the allowable frequency range of the master clock is limited by the total time given to restoration. The maximum allowable percentage deviation from 2mc. is given by $\frac{0.5}{\delta} \times 100$, where δ is the total time allowed for restoration. In normal operation this is of no importance, because the clock frequency can be held to quite close tolerances.

System testing was discontinued 12 May for further power wiring installation. Testing will be resumed 23 May.

1.2 Storage Tube Reliability Tester

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

Testing proceeded on the problem of crosstalk between spots, that is, the effect that writing on one spot has on the readout signal of nearby spots, especially where the holding gun is off much of the time.

All the data taken has not yet been analyzed, but some general conclusions can be made. Writing negative on a spot results in lowering the potential of a positive spot 0.2" away by as much as 25 volts. The holding gun was not given time to act in this case.

Writing negative on a positive background at 10 or 20 kc for 10 seconds makes an area 0.15" dia. negative with the HG on 74% of the time, whereas a single shot under the same conditions writes an area 0.075" dia. Decreasing the HG time to

1.2 Storage Tube Reliability Tester (continued)

17% results in a negative spot 0.3" dia. with the 10 second test.

The first part of these tests was performed on ST67. An attempt was made to cycle patterns through a 16 x 16 array on this tube, for demonstration purposes. This could not be accomplished, so ST68, which has a more uniform surface, was placed in the tester.

Later tests concerning the area written by negative spots with little HG on time were made on ST68.

Tests were made to determine the effect of V_{A_3} on spot size, and the effect of turning the HG on before completing a write operation. Conclusions have not been reached on these matters.

Two reliability runs were made on ST68 with a 16 x 16 array at the rate of one read- write operation every 50 microseconds. One went 43 hours with one error. The second consisted of one negative spot amid 127 positive, and one positive spot in the center of 127 negative. The background was also negative. This test, considered to be a severe one, ran for 15 hours without any error.

(L. J. Nardone)

Planning is under way for the expansion of the storage-tube reliability tester into a tester containing five storage tubes. The additional space and equipment required are being procured. The change-over from the one-tube setup to the five-tube setup will be gradual and will not interfere with tests being conducted with the storage tube reliability tester.

(J. A. DiGiorgio)

Five signal plate gate amplifiers have been completed for the additional storage tubes which will be added to the tester.

1.3 Five Digit Multiplier

(N. H. Taylor)

The five-digit multiplier is still plagued with intermittent troubles which occur usually in the late evening or

1.3 Five Digit Multiplier (continued)

early morning hours. These isolated failures are very difficult to locate. However, we are still finding poorly soldered joints, loose connections and tubes with internal shorts when subject to light tapping.

An extensive campaign is underway to improve these marginal conditions so that some really useful reliability tests can be made on this unit.

(R. Read)

Reliability tests continue on the multiplier. Shock testing is being used in conjunction with marginal checking to locate causes of failures. Eighteen tubes of various types have been retired during the last two weeks. A number of other failures, mechanical and electrical, have been corrected, but reliability is still not as good as it has been. A five-day run is the best recorded in the past two weeks.

2.0 CIRCUITS AND COMPONENTS

2.1 Circuits by System Number

102 Program Counter

(C. W. Watt)

Aluminum Panels are complete. Final Assembly is due to start in June.

104 Control Switch

(K. E. McVicar)

Preliminary tests have been made on the control switch panel and the control switch matrix panel. Further, more extensive, tests will be made in conjunction with the control switch when the latter is completed.

104/201 Control Switch/Test Storage Switch

(J. A. O'Brien)

The switching panels for the Control Switch and the test Storage Switch have been tested and found to perform satisfactorily.

The matrix panel for the Control Switch was tested, using the switching panel and it functioned as was intended.

105 Control Matrix

(J. A. O'Brien)

It is expected that the tests on the complete control matrix will begin within the next bi-weekly period. The timing diagram for the crystal connections in the matrix is being completed, wires are now being installed in the computer room connecting the Operation Matrix drivers to the Control Matrix and the switch matrix. It is also expected that the power wiring for these racks will be installed next week.

105 Control Matrix (continued)
(R. E. Hunt)

The Control Switch Matrix Panel is complete, and has had its shop tests, and has been delivered to the System Engineers for final test.

Its Associated Output Panel is complete and awaiting shop test.

106 Time Pulse Distributor

(N. H. Taylor)

Time pulse distributor panels showed a low margin of operation in certain pulse sequences. Delay lines have been installed which will improve this margin.

(J. A. O'Brien)

The Time Pulse Distributor has passed the preliminary tests and has been installed in the computer. The drawings of the unit have been brought up to date and are being distributed.

Same trouble was encountered that appeared to be due to oscillations in two of the gate tubes. This will be investigated to determine its cause since it may be that the trouble could occur in other units.

Since the unit was installed in the computer short delay lines have been added to the trigger inputs to the flip-flops to increase the time between the appearance of a pulse at the control grid of a gate tube and the appearance of a flip-flop switching transient at the suppressor grid. This will allow a little more tolerance on the timing of restorer pulses by allowing the rise time of the matrix to be increased without trouble due to coincidences of pulses and transients. The delay lines are not permanently installed but they may be later on.

109 Clock Pulse Control

(R. H. Gould)

The clock pulse control panel was placed in rack C13

109 Clock Pulse Control (continued)

last week and cabled into the system. So far the panel has operated satisfactorily although some difficulty has been experienced in the timing of the control pulses. The clock pulse control panel will be removed from the system next week for completion of the modifications and further testing.

The drawings of clock pulse control are being brought up to date.

110 Frequency Divider

(N. H. Taylor)

In testing the frequency divider panels in Whirlwind I system, marginal checking indicated that the frequency divider was very sensitive to small changes in the bias voltage. This fault has been corrected by slowing the rise time of the flip-flops so as to discriminate against the unwanted pulses in the frequency division.

201 Test Storage Switch

(R. E. Hunt)

The Test Storage Switch Matrix is about 85% complete in the assembly shop. It should be complete about 5-18-49.

Its associated Output panel is complete and awaiting shop test.

202 Toggle Switch Storage

(C. W. Watt)

Assembly is about 75% complete.

404 Comparison Register

(H. S. Lee)

Final assembly and wiring is approximately 50% completed.

404/601 Comparison Register/Check Register

(C. W. Watt)

Mechanical assembly of panels is progressing. Wiring has begun. This work is about 1 week ahead of schedule at this point.

410 In-Out Control

(J. A. O'Brien)

Some consideration has been given the problem of adding the facilities for double reading and recording to Input-Output control. The details have not been worked out as yet, but from the surface it appears that additional equipment might be lessened by obtaining double recording by means of programing it as suggested by R. Everett. For double reading, there will have to be two memory units, one to remember whether the reader is working on the first or second word of a pair of words, and one to remember whether the first word checked or not while the reader is working on the second word.

Since the memory facilities of the flip-flops in the present In-Out control are all used this means that two additional flip-flops will be required.

In order that the computer can ignore a word read into the In-Out register we may require quite a few mixers and amplifiers to perform the functions of preparing I-O control for another word without assistance from the main Operation Control.

412 In-Out Synchronizer

(A. K. Susskind)

The design of the In-Out Synchronizer has been started. A preliminary design has been drawn up consisting of two d.c. flip-flops, four gate-tubes, and one buffer amplifier. The d.c. flip-flops are those recently developed by R. Best. A breadboard model will be constructed to evaluate the performance of contemplated circuits.

602 Alarm Indication

(H. S. Lee)

All drawings have been completed and a construction requisition forwarded to the shop for fabrication and assembly. Fabrication of the aluminum panel and terminal board has been scheduled to start this date.

800 ES Circuits

(S. H. Dodd)

Although the 17 mc ES output system has many strong advantages, progress has been recently slowed by difficulties associated with marginal checking. At a conference between Ely, Everett, Nolan and Dodd, it was decided to construct an interim 10 mc system which would be adequate for operation in WWI but would be inferior to the proposed 17 mc system since it would have slower operation, unstabilized gain, and poorer marginal checking facilities. The 10 mc system can be designed and a prototype ES output panel constructed with little additional engineering time. The 17 mc system will be worked on during the latter part of 1949 and included in WWI if possible. New schedules are being made.

(G. G. Hoberg)

Drafting has begun for the phenolic assembly of the digit prototpye of the signal plate driver.

Preliminary circuit designs have been completed for the following:

(1) read gate generator (non-repetitive)
(2) holding gate generator (non-repetitive, almost identical with (1))
(3) holding gun grid gate amplifier (repetitive)
(4) high-velocity-gun-grid gate generator and amplifier (repetitive)

A breadboard has been constructed for a gun driver panel containing (3) and (4) above. Preliminary tests indicate that operation is satisfactory except for minor difficulties caused by spurious

800 ES Circuits (continued)

oscillations and the need for better decompiling of the gate generator from the power-supply lines.

(H. Kenosian)

Phase-Shift Amplifier - This unit has been completed and installed in the ST Reliability Tester. It provides phase reference voltage for the phase detector in the r-f readout system. Phase shift is accomplished with a lumped delay line.

RF System - An r-f amplifier has been aligned for use as a spare for the ST Reliability tester. All coils for the 10 mc system have been designed, except for the two coils between the signal plate and r-f amplifier input.

(C. H. R. Campling)

R-F Pulser and Phase Reference Generator - The difficulties mentioned in the last report have been eliminated, and this unit is now ready for use. The phase-reference output measures about 55 volts peak-to-peak across a twinax line terminated in 100-ohms. There is very little variation of amplitude with phase-shift and the waveform is excellent. The pulse output has an amplitude variable up to about 100 volts peak - again measured across the 100-ohm termination of a twinax line.

A similar circuit which is to be capable of driving a bank of ST's is now in the breadboard stage. According to present plans this unit will also operate at 10 mc. Preliminary design of several of the coils has been checked and revised.

810 ES Control

(C. W. Watt)

A black schematic of ES Control is under way in drafting. This will show the subdivision of circuits by individual panels, and indicate the necessary

810 ES Control (continued)

video cabling between panels. The layout is in accord with Engineering Note E-219, modified by subsequent discussions. The rough draft of this diagram should be done next week.

820 ES Deflection
(R. E. Hunt)

Gate Panels - Two panels have been fabricated by the sheet metal shop and sent out for painting. The phenolic panels have been made and assembly will start shortly.

Decoders - Drawings are complete. Construction will start Monday 6-16-49.

General - It is possible that both of these panels may be held up somewhat in the shop because of relatively low prioritys.

830 ES Sections
(C. W. Watt)

Signal Plate Gate Amplifier - A prototype layout has been started, and component problems generally settled. Watt is following this job for the production group, and Hoberg is the design engineer.

Storage tube mount - The layout of the video section of the storage tube mount prototype has begun. It should proceed rapidly for component problems have been generally settled. Watt is following this job for the Production group, and Ely is the design engineer.

(R. Shaw)

Drawings of the storage tube mount mechanical parts are being constructed. Our shop will construct an aluminum box and an outside vendor will construct one of mu-metal.

(R. E. Hunt)

The storage tube mount box is about 20% complete in the shop.

Completion is expected to be about 5-19-49.

WWI Drawing List	Block Diagram	Block Schematic	Circuit Schematic
System	B-37071-5		
Control	B-37098-4		
Master Clock	B-37159-2		
101 Pulse Generator	B-37155-3	B-32385	E-32333-4
102 Program Counter	B-37062-4	B-32213-1	D-31516-6
103 Program Register	B-37067-3	B-39289-2	D-33836
104 Control-Switch Matrix Panel	B-37066-3	C-33843-1	R-32722-3
104 Control-Switch Switch Panel	B-37066-3	B-34100	Z60CS00-2-D
104 Control-Switch Output Panel	B-37066-3	B-34101	Z60CS00-B
105 Operation Matrix Driver Panel		S600M00	Z600M00-1-E
105 Control-Pulse Output		R60CP00	S60CP00-1-B
106 Time-Pulse Distributor	B-37068-4	T60PD00-3-A T60PD00-4-B	
106 Time-Pulse-Distributor Counter		T60PD00-3-A	Y60PD00-C
106 Time-Pulse-Distributor Output		T60PD00-4-B	Z60PD00-1-E
109 Clock-Pulse Control	B-39817-3	C-32642-5	R-31916-7
110 Frequency Divider	B-37154-3	B-32264-1	R-31729-2
111 Synchronizer	B-37172	C-33485	R-33486-2
112 Restorer-Pulse Generator	B-37160-1	B-32209-4	D-31909-8
200 Test Storage	B-37156-2		
201 Test-Storage Amplifiers	B-37121-2	C-32855-3 C-33768	D-33706-1
201 Storage-Switch Matrix Panel	B-37121-2	C-32855-3	R-32722-3 D-33706-1
201 Storage-Switch Switch Panel	B-37121-2	B-34102	Z60CS00-2-D
201 Storage-Switch Output Panel	B-37121-2	B-34103	Z60CS00-B

WWI Drawing List	Block Diagram	Block Schematic	Circuit Schematic
202 Toggle-Switch Storage Switch Panel	B-37122-3	C-33768	D-33706-1 C-33707
202 Toggle-Switch-Storage Output Panel	B-37122-3		E-32721-4
203 Flip-Flop-Storage Output	B-37060-5	B-32269-1	E-31635-4
203 Flip-Flop Storage Register	B-37057-4	B-32268-1	E-31621-4
203 Flip-Flop Storage Control	B-37061-7	D-32106-3	
301 A-Register, Digit 0	B-37056-3 B-37072-8	B-31574-1	D-31573-7
301 A-Register, Digits 1-15	B-37056-3	B-31211-3	D-31276-12
302 Accumulator, Digit 0	B-37173-1	D-32851	R-32850-3
302 Accumulator, Digit 0, Aux. Panel	B-37173-1	B-32492-2	D-32602-1
302 Accumulator, Digits 1-14	B-37173-1	D-31213-4	R-31275-10
302 Accumulator, Digit 15		D-33964	
303 B-Register	B-37097-5	B-31212-5	D-31277-7
304 Sign Control & 308 Divide-Error Control	B-37072-8	C-31576-3	E-31619-2
305 Step-Counter	B-37074-7	D-31828-1	D-39764-3
305 Step-Counter Output		A-32723-1	D-32735-2
306 Multiply & 307 Shift Control	B-37072-8	C-31532-3	E-31588-5
308 Divide Control	B-37072-8	C-31552-3	R-31718-5
309 Special Add Memory & Overflow	B-37072-8	C-31575-5	E-31632-5
310 Point-Off Control	B-37072-8	C-31600-6	E-31717-6
403 In-Out Register	D-37178	E-32434-2	D-31277-7
404 Comparison Register	D-37178	B-32578-2	E-32576-6
404 Comparison-Register Check		B-33488-1	E-33515-2

WWI Drawing List	Block Diagram	Block Schematic	Circuit Schematic
601 Check Register	B-39816-3	B-32577-1	E-32576-6
601 Check-Register Check	B-39816-3	B-32018-1	E-32023-3
602 Alarm-Indicator Control	B-37175	B-33603	E-33651-2
820 E.S. Deflection			
E.S.D. Gate Panel		A-34036	B-33876
E.S.D. Decoder			E-33908
Standardizer Amplifier		A-33881	C-33880
Bus Driver, Arithmetic Element		A-32298-1	D-31727-7
Bus Driver, Flip-Flop Storage		A-32296-1	D-31726-7
Register Driver, Type I		B-32207-1	E-32261-7
Register Driver, Type II		B-32691-2	D-32690-2
Bus Connections	B-37124-3	C-37123-3	
Fuse-Indication Panel			W60PP00-7-D
Voltage-Variation Panel			W60PP00-6-C
WWI Power-Connector Pin Connections			B-31955-6
Digit-Interlock Panel			W60PP00-8-B
Fixed-Voltage Switching Panel			T-60PP00-11-B
Power-Interlock & Indication Panel			Z-60PP00-12-B

2.3 Driver Circuits

(R. E. Hunt)

Standardizer Amplifier - 8 Standardizer Amplifier panels are about 20% complete in the shop.

The aluminum panels are out to be marked, and the phenolic panels are awaiting assembly of components on them.

2.4 Basic Circuits

(R. L. Best)

Flip-Flop Tests - With filament voltage reduced to 5 volts in the 7AD7 WWI flip flop, the operation of the circuit is changed an inconsequential amount. The maximum allowable screen voltage (in marginal checking) appears to be independent of filament voltage in this range. With only 4 volts on the filaments, plate swing is only decreased 1 volt.

In the 6 AN 5 d-c flip flop, d-c coupled to the load, lowering the screen supply from the normal —15 volts is a satisfactory method of marginal checking. With good tubes, a representative marginal screen supply voltage is —40 volts. Marginal checking could also be accomplished by raising the screen voltage, but this is undesireable since it increases screen dissipation, and the screens on 6AN5's begin to glow when rated dissipation is applied.

2.5 Tubes and Components

(N. H. Taylor)

Two or three 7AK7 gate tubes have exhibited spurious oscillations in Whirlwind I system performance. This situation seems to be due to the particular tubes in question, but an investigation is underway to assure that this condition will not arise in other gate circuits.

(J. Olivieri)

The no. of preburned 7AK7s now total 365. The no. of

2.5 Tubes and Components (continued)

7AD7's preburned is 542. More time will be spent on preburning in the future. The no. of tubes that have not been preburned is as follows: 7AD7's 1060, 7AK7's 1981. Since March 5, 1949 1025 tubes have been preburned.

80 tubes for the Standardizer Amplifier were marked, tested and delivered.

48 tubes for the Control Switch, Storage Switch Matrix panel were tested and delivered.

21 6SN7's, 45 6Y6's, 90 7AK7's were tested, burned and retested.

60 Special 6AG7's having high, low and intermediate silicon sleeve's were received, mar ed and tested for B. Frost. 20 Special 6AN5's having alloy sleeves with different percentages of Barium and Strontia were tested for B. Frost.

P. Youtz and Dr. Klemperer expressed interest in bulb flourescence on the 7AK7's which appeared on the bulb of several 7AK7's.

2.6 Test Equipment

(R. L. Massard)

Standard Test Equipment. Video Amplifier - It has been found, in connection with the maintenance of video amplifiers, that the Solar metallized-paper capacitors, when subjected to d-c voltages of one-tenth or less of their rated working voltage for a period of time, develop very low leakage resistances. If the capacitors are then charged to and discharged from rated working voltage a few times, they heal themselves and become good capacitors again. It is not known whether the development of the leakage is a gradual process or not, but amplifier performance tends to indicate that it happens within a few hours. Some of the capacitors work all right for quite a length of time before developing the leak. It has not been determined how long the condensers will last after the leak has been healed.

2.6 Test Equipment (continued)

(D. Hagemen)

The most recent Gate and Delay Unit (Dwg. #SC-33105-4) has been found to be unstable in the sense that the ostensibly monostable multivibrator therein tends to "free-run" when the characteristics of its tube (5687) and certain other tolerances are unfavorable.

Efforts to improve the stability of the unit and, at the same time, retain certain other desirable characteristics such as insensitivity to spurious trigger pulses, positive switching of the multivibrator when the unit is triggered by a 16-volt (nominal) standard pulse, etc., have been under way. A solution which is believed to be acceptable has (with the aid of Dodd, Ely, and Kenosian) been obtained.

Final testing of a modified unit will probably be done next week.

3.0 STORAGE TUBES

3.1 Construction

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

During the past fortnight we were able to construct three storage tubes which had very little surface leakage across the storage surface. This leakage problem had plagued us during the previous bi-weekly period. We observed carefully each detail of the storage-tube construction and were unable to discern the cause of this leakage. A number of experimental tubes were constructed to investigate several explanations for the leakage. Each experiment exonerated the suspected factor.

We also discovered that a very thin film would bloom on the nonex when it was worked. This is a well-known phenomenon characteristic of nonex that has lost its "shelf life". This phenomenon had been observed by R.L.E. tube shop and Germeshausen during the war. Germeshausen knew that the film did not cause any trouble in the hydrogen thyratrons. Ryan said it was blamed for poor cathode emission in some tubes. Nottingham had never investigated the influence of this film on leakage resistance or secondary emission of a surface. W. E. Pickett is writing an engineering note on this last series of investigations.

We will continue to investigate possible causes for the surface leakage of some storage tubes.

(W. E. Pickett)

Glass Components - As planned, envelopes for the storage tubes were constructed. The inventory for this item is still not large but ample for our needs in this period. Several ten-pin stems were made and this item will receive most of the spare-time work in the coming period.

The vacuum-firing and hydrogen-arcing bottle should be completed this next period.

The polariscope has been used, and at this time it can be said that it answers our needs. The features not usually found in a commercial polariscope but incorporated in ours should be of great help to the glass problems in this project. A memorandum will be issued in the future when time permits on the construction and use of this polariscope.

No unusual difficulties or delays were experienced above the normal work problems in the glass room.

3.1 Construction (Continued)

A memorandum M-843 was written and issued on the latest sealing procedures and techniques used in the glass construction of storage tubes.

A series of engineering notes on glassworking procedures will be started during the next period. They will describe in detail all glassworking techniques and procedures used in constructing storage tubes and evaporation tubes. It is hoped that this series will be the beginning of a series of notes for a manual on how to construct a storage tube.

(J. S. Palermo)

Mechanical Components - An endeavor to improve the chemical cleaning techniques of the mechanical components for evaporation and storage-tube target assemblies is presently in progress. Any and all suggested changes will be thoroughly discussed and evaluated prior to the actual changes. In the process of this investigation, a new system will be originated whereby all cleaning methods will be numerically designated. All cleaning methods will be described in engineering notes known as the Wash Series, while all surface coatings will be listed in the Coating Series. Completion of these series will involve considerable time and effort but can be used later in the manual that describes the construction of a storage tube.

Plans for the assignment of special tools for specific construction operations of target assemblies have been discussed. Definite decisions will be forthcoming.

The general status of mechanical components for evaporation and storage-tube target assemblies remains satisfactory.

(R. Shaw)

By means of a simple torsional pendulum, an approximate determination was made of the shear modulus of some materials that may be used for coil springs in tube construction. The following results were obtained:

Tungsten	22 300 000 lbs/sq. in.
TaW alloy (92.5% tantalum, 7.5% tungsten)	10 200 000 lbs/sq. in.
Molybdenum	16 900 000 lbs/sq. in.

3.1 Construction (Continued)

The Nichrome V recently obtained for use as a spring material is altogether too soft for the purpose. T. F. Clough has communicated with the vendor to determine whether a harder temper is available.

Modified target assemblies have been drawn for both evaporation and storage tubes. These incorporate metal backing plates to provide mechanical support for the mica.

A fixture has been designed to aid in cementing bases to storage tubes.

3.2 Test

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

Initial tests were made on two Be-on-mica tubes, ST88-1 and ST94-1, and on one special tube, ST95-3. ST88-1 first appeared to have leaky surface characteristics, but showed improvement with continued use and is now a satisfactory tube. Construction and processing of ST94-1 was patterned after that used in early mica tubes, and the difference in its storage stability from the latest tubes is remarkable. It is almost as stable as ST48, our best tube, although spot size is slightly non-uniform.

ST95-3 had a storage surface with Be mosaic evaporated over the whole surface but in the storage assembly the mosaic was masked with a semicircle of mica in order that the storage action of mica and Be might be compared. The semicircle of mica was observed to have a lower secondary emission at 1500V and also a lower first crossover voltage. While storage stability in the mosaic area was quite good, positive spots written on the open mica area expanded or contracted very rapidly and no stable range of V_{HG} could be found.

Investigations on ST77 and ST94-1 have given better understanding of why a negative surface will switch positive as V_{HG} is increased. The ultimate limitation in these tubes occurs at about V_{HG} = 600V, where leakage to the collector exceeds the maximum restoring current of the holding beam.

The switching voltage may be much lower if third anode to HG cathode voltage is improperly chosen. If V_{A3} is too low, increasing V_{HG} causes the holding beam to converge until the edges of the surface are not covered and switching will occur there. If V_{A3} is too high, switching will occur at very low V_{HG} because the highly diverged beam allows leakage to take effect before the collector received any appreciable fraction of the holding current.

3.2 Test (Continued)

It is planned to make comparable tests on a tube which exhibits low leakage resistance.

(J. H. McCusker)

Various tests have been made on RT50-1, a beam analyzer with a Dumont 5RP high-velocity gun and a HG3-3 holding gun. The tests and techniques are similar to those used on RT50.

The current-density distribution of the holding gun was measured as a function of negative grid bias at pressures of 2×10^{-5} mm Hg and 8×10^{-7} mm Hg. The current-density distribution was somewhat more uniform at the lower pressure, the diameter of the beam was larger, and the maximum current density was less than at the higher pressure. As the grid bias was made more negative in both cases, the beam diameter decreased while the current density in the center of the beam remained approximately constant. As the grid bias was increased below -20 volts, the current density in the center decreased.

The holding-gun beam apparently diverges when A_2 of the high-velocity gun, A_3, and the target are made negative with respect to the accelerating electrodes, A_1' and A_2'; the beam converges when the former electrodes are made positive with respect to the accelerating electrodes and also when A_3 or A_2 and A_3 are made negative with respect to the accelerating voltage.

A velocity distribution measurement indicated that the electrons in the holding beam have approximately that velocity which electrons emitted from that cathode should theoretically have.

Measurements have been made on the Dumont 5RP gun, but the results are quite variable. Further tests must be run. The beam has a diameter of approximately 1 centimeter and a maximum current density at zero bias of approximately 1500 $\mu a/cm^2$. As the grid bias is increased negatively, the beam diameter decreases but the maximum current density increases.

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

High Speed Write-Read Unit - During the period since the last bi-weekly report, an investigation of the charging time necessary for the holding-gun beam to take a spot from a voltage just below first crossover to its lower stable potential was carried out. With storage tube ST73, it was found that the charging time varied from 1500 to 1800 µs. This value is the charging time required to charge a spot from about 2 volts below first crossover (first crossover potential was found to be 25V) to a stable potential which is

3.2 Test (Continued)

5 to 8 volts above cathode potential. Calculations showed that a maximum restoring current of 0.26 µa was available during W(-) at a V_{HL} = 125V. This figure is in good agreement with results obtained by J. H. McCusker with the beryllium strip tube.

These results on ST73 were obtained from studies with three widely spaced spots. It was found that spots near the spacer bead required a longer charging time to reach the lower stable potential.

The test method used in the above was a bit different from that previously used. First of all, the cycle was altered to W(-), R----W(+), R. By using a clock which operated at a very low frequency, and varying the read delay coming after W-, it was possible to investigate spot potentials at times ≥2us after W(-) without being concerned with prf sensitivity. The other important change from our previous technique was to use a null method of measuring, which is inherently more accurate than direct readings.

Using the above method, a plot of the potential of the spot in question as a function of the time after writing (-) was obtained. As a by-product, the plot of the restoring current vs. spot potential may be derived from this curve.

At the present time, the feasibility of using this method to study the charging time in taking a spot from just above first crossover to collector potential is being considered.

Life tests on ST63 are continuing.

(H. Rowe)

Circuit schematics and block diagrams for the TV Demonstrator equipment have been brought up to date to include the r-f readout equipment recently added.

3.3 Research and Development

(H. Rowe)

A sketch for a rubber model to be used to determine the electron trajectories near the storage surface has been given to the shop for construction.

3.4 Unclassified

(M. I. Florencourt)

Engineering Notes E-236, E-237, E-238 and E-240 have been issued on the construction, processing and initial testing of ST87, ST88, ST94 and ST95.

4.0 INPUT-OUTPUT EQUIPMENT

4.2 Display

(Edwin S. Rich)

Consideration has been given to the selection of an oscilloscope which can be used for the special display and to the requirements for amplifying the output of the decoder and intensifying the CRT beam. Since the decoder is to be located a considerable distance from the oscilloscope it appears that the best method for transmitting the signals is to use a 100-ohm terminated line with the necessary amplification being done within the scope. It is possible that a regular scope amplifier can be used for this purpose without redesign since a relatively long rise time is permissible. Several methods are available for accomplishing the beam intensification. Since in certain codes two display orders may be separated by only 16 microseconds, it will be impractical to synchronize the intensification with the restorer pulses. It is therefore planned to use a method in which the CRT is blanked during restoration.

5.0 INSTALLATION AND POWER

5.1 Power Cabling and Distribution

(H. S. Lee)

Voltage Variation Panels

As of this date, 71 of the 73 panels have been assembled and inspected and we have received from Gavitt the 15 additional external power cables for these panels.

Power Cabling

Drafting of cables for rack C4 has been completed. Fabrication of power cables for racks C5, C6, C7, C9, C10 and C11 has been completed.

The installation of internal power cables and wiring in Rack C7 is complete; Rack C5 50% complete and a start has been made on Rack C6. The installation of cables and wiring in Racks C9-C10 and C11 is partially complete but has been deferred pending receipt of filament transformer mounting panels from Sylvania.

On this date the computer was inactivated until 23 May to allow installation of all power wiring necessary for operation of the "C" Row (Central Control). The target date for com-

5.0 INSTALLATION AND POWER

5.1 Power Cabling and Distribution (continued)

pletion of the installation is 12:00 Noon 19 May. This will allow two days for testing and checking the installation effected up to that date. When the installation is complete it will be possible to vary the following circuits in the racks indicated:

1) Racks C4 through C15 inclusive, all circuits which are designed to be variable, see Memorandum M-835

2) Racks Ax7 and Ax8, same comment as in previous sub-paragraph.

3) Racks A0 through A15 inclusive,
   + 250 BA Plates and Screens
   + 120 FF Screens
   90 GT Screens.

4) Rack AD
   + 250
   + 150
   + 120
   + 90
   - 15
   - 30

5.2 Power Supplies and Control

(C. R. Wieser)

During the WWI shut-down period, May 13 - May 19, the thermal time delay relays in the d-c power supplies will be replaced by motor-driven timers. This will allow the computer to be switched from "Stand-by" to "On" without the present five-minute delay.

If time permits, the Filament Alternator Control Panel and Filament Alternator Regulator will be installed. These two units are almost complete, and their installation would allow full-automatic operation of the power-supply control system.

(J. J. Gano)

115 Volt, A.C. Laboratory Supply Regulator

The new breadboard assembly of the output voltage rectifier

5.0 INSTALLATION AND POWER

5.2 Power Supplies and Control

(J. J. Gano) continued

has been connected to the system and is operating satisfactorily.

With the regulator in operation, the effects on the output voltage due to sudden load disturbance and sudden supply voltage disturbance were measured by means of a Brush Oscillograph. A balanced three phase resistive load of 7KW created a transient of .5 volts that was damped in .2 seconds. The starting of the building elevator, the motor for which is connected directly to the commercial service, disturbed the supply voltage sufficiently to create a transient of .7 volts that was damped in .2 seconds.

5.3 Video Cabling

(R. H. Murch)

The modified video cables for the check register listed on Sylvania Memorandum 60-139 have been received.