

6345
Memorandum M-389

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Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART I, APRIL 30, 1948
TO: 6345 Engineers
FROM: Jay W. Forrester

1.0 WHIRLWIND I COMPUTER ELEMENTS

1.1 Listed by Block Diagram Number.

(D. R. Brown)

Control. The master clock now includes the following:

101	Pulse Generator.
106	Time-Pulse Distributor.
109	Clock-Pulse Control.
110	Frequency Divider.
111	Synchronizer.
112	Restorer-Pulse Generator.
113	Delay Counter.

Interconnection of these units is discussed in E-113.

101 Pulse Generator

(H. Kenosian)

The WWI pulse generator is being revised to include a cathode-coupled variable frequency oscillator for PRF control.

103 Program Register

(H. Fahnestock)

Video Layout of the program register was received from Sylvania and approved for making production drawings.

106 Time Pulse Distributor.

(H. Fahnestock)

Sylvania's circuit schematics of the counter panel and the output panel of the time pulse distributor have been approved by MIT. Sylvania will proceed with layout.

109 Clock Pulse Control

(J. A. O'Brien)

A breadboard model of the clock pulse control unit (formerly time pulse distributor control) has been completed. At present there are no gate tubes in stock, but testing of the unit will begin on Monday without the gate tubes.

It is planned to furnish Sylvania with circuit schematic and layouts by June 1.

110 Frequency Divider.

(H. Fahnestock)

Sylvania has been provided with a Grade II sketch of the WWI frequency divider from which they will make layouts. A finished circuit schematic will be furnished later.

(H. Kenosian)

A buffer was inserted in the output of the 16:1 frequency divider (SR 31729) to enable the unit to feed two lines instead of one as originally planned.

112 Restorer Pulse Generator.

(H. Fahnestock)

Sylvania has been provided with a Grade II sketch of the WWI restorer pulse generator from which they will make layouts. A finished circuit schematic will be furnished later.

(H. Kenosian)

The breadboard model of the WWI restorer pulse (SD 31909) generator operates satisfactorily.

203 Flip-Flop Storage Register.

(H. Fahnestock)

Complete drawings of flip-flop storage register panel were received from Sylvania and approved for construction of prototype.

300 Arithmetic Control.

(N. H. Taylor)

The engineering work on the circuit schematics of arithmetic control has been completed. Graded drawings on step counter and divide error control are still in drafting.

(G. C. Sumner)

Panel layout design of the ACC carry and special add memory panel has been completed and checked. There remains a power cabling drawing to be made before construction can begin.

302 Accumulator.

(H. Fahnestock)

The accumulator prototype was completed at MIT April 29. It will be turned over to Sylvania about May 22 after three weeks testing here. They have received such preliminary drawings as exist and they will make final drawings from the prototype.

(N. H. Taylor)

The accumulator preliminary test specification is now being written and will be issued first in memorandum form. After comment and modifications, as needed in the prototype tests, the specification will be issued more formally for use at Sylvania.

305 Step Counter.

(N. Daggett)

The step counter circuit schematic (D-31813) is in the drafting room.

1.2 System Engineering

1.21 Power Control and Distribution

(C. W. WATT)

Progress continued on all phases of the power problem.

1. A meeting between Everett, Forrester, Rich, Wieser, and Watt greatly clarified the connection of marginal checking with check problem and trouble location problem operation of the computer. An alarm pulse from the computer must stop the marginal checking sequence as well as stop the clock, and provision is being made in the control circuits to operate a relay when an alarm occurs.
2. A meeting between Forrester, Hunt, Lee and Watt, resulted in general agreement on power cabling methods and on general design of the power distribution racks. Detail design is proceeding as fast as possible.
3. A meeting between Forrester, Anderson of Sylvania, Watt, Fahnestock and Boyd, resulted in Anderson presenting a preliminary layout of the voltage variation panels. Several changes appear necessary, and are tied in with the kinds of relays to be used. During the next two weeks a new layout will be prepared and presented, and relays will be ordered.

(H. S. Lee)

The pins in the power connector have been numbered and a correlation made between the pins and circuits for each panel of the Arithmetic Elements, Register Panels, Flip-flop Storage Registers and In-out Registers. Schedules of pin assignments for each panel have been drafted and are illustrated in the following drawings: B-31894 to B-31901 inclusive and B-31910 to B-31915 inclusive. These drawings should be available for general distribution on or before 4 May 1948.

(E. S. Rich)

The design of the proposed switching circuit to be used in connection with the equipment for checking marginal operation in WWI is being changed. The revised circuit will permit all interlocking among manual controls to be done electrically by means of relays. Also manual selection of voltage variation panels will be done with a telephone type dial rather than with manual selector switches. Proposed design changes should be completed by 5 May 1948.

1.21 Power Control and Distribution (Cont'd)

(W. S. Rogers)

Power duct for known plans in power room and the run from power room to computer room has been ordered.

Computer room ceiling lighting installation will be completed as soon as needed materials arrive.

1.22 Power Cabling

(H. S. Lee)

On 23 April Lee, Watt, and Hunt conferred with Forrester in regard to the installation of the power cabling for WWI. The proposal made is illustrated in Drawings D-37561, D-37562, D-37563, D-37566, D-37567, D-37568, and D-37569. With several modifications the proposal was approved by Forrester. A memorandum will be published in the near future delineating the approved design of the power wiring for WWI.

Sylvania was instructed in Memorandum M-376 to integrate the Rack ground bus in the design and fabrication of the racks. Hence Sylvania will purchase the bus bar required for the racks.

Layout of the interrack D. C. wiring has been started. Layout and detailing of the individual cables will consume at least four weeks. It is planned to employ preformed laced cable in the interrack wiring which runs horizontally at panel height and D. Stevens has offered the assistance of Sylvania in the fabrication of these cables.

1.24 Driver Panels

(G. C. Sumner)

A summary of register driver requirements for the arithmetic element WWI appears in drawing SB-39745. This clearly points out the mixing necessary in the register drivers. This drawing is intended to assist the design of a driver panel usable for all registers.

1.25 Time Schedules

(R. A. Osborne)

The following changes have been made in time schedule titles:

Schedule No.	Old Title	New Title
C-31647	Input-Output Register	In-Out Register
C-31653	Time Pulse Distributor Control	Clock Pulse Control
C-31655	Master Clock	Pulse Generator
C-31805	Push Button Pulse Generator	Synchronizer
C-31671	Power Distribution Panels	Row Interlock Panels (Schedule also changed)

The following new schedules have been added:

Schedule Title	Number	Person Responsible	Coordinator
Video Amplifiers	C-31808	Taylor	
Operation Matrix	C-31809	J. A. O'Brien	
Control Pulse Outputs	C-31810	"	
Timing Buses	C-31829	"	
Operation Matrix Drivers	C-31830	"	
Fuse & Variation Panels	C-31831	Anderson	Watt
Indication Panels	C-31832	"	"

1.3 Auxiliary Equipment

1.31 Power Supplies

(H. R. Boyd)

For the past two weeks, R. Myer has been investigating the nature of the transient power loads in the computer. His memorandum M-380, summarizing his results is being used as the basis of a new power supply proposal which is currently in preparation. The new proposal will not consider special supplies required for storage tubes. The proposal will include power for basic circuits used with the storage tubes, on this basis, the only decision still to be made before the final proposal can be finished

1.31 Power Supplies (Cont'd)

(H. R. Boyd)

is on the type of flip-flop. The new circuit uses 250 rather than a 150-volt plate supply.

(R. P. Mayer)

Memorandum M-380, "WVI Dynamic Analysis of D. C. Load", covers the intermittent power requirements of WVI and shows that the greatest full load to "no-load" ratio on any d. c. line is only 1.8, while some lines change very little, if at all.

(H. S. Lee)

A sample filament transformer has been received from Raytheon and has been thoroughly tested.

This transformer meets the specifications insofar as secondary voltages and percentage regulation is concerned but does not quite meet the ninety per cent (90%) efficiency specification. To date a heat run has not been performed by M.I.T. but the results of such a test made by Raytheon indicate that the transformer satisfies the temperature rise specification. The technician performing the test (John De Georgio) reported that the transformer ran cool throughout the test and also was inaudible. He also indicated that altering of terminal connections could be done rapidly and without difficulty.

The transformer conforms to all mechanical specifications.

To date the other three sample transformers have not been received from the manufacturers.

(C. R. Wieser)

The 75 h.p. synchronous motor and 31.25 kva alternator have been delivered and are now being connected.

Tests are being continued on the 500-watt amplidyne generator for marginal checking.

Memorandum M-379, the Voltage Regulation Proposal, has been issued.

1.31 Power Supplies (Cont'd)

(L. J. Nardone)

A push-pull amplifier circuit with associated input circuits was constructed to supply the field current of the amplidyne for a variable voltage supply. The output of the amplidyne is made to vary in accordance with a low-frequency modulated voltage at the input of the amplifier circuits.

A temperature run was performed on the field windings of the amplidyne. A temperature rise of 1.2°C was obtained for approximately 25 μa . flowing continuously through the field windings for three hours, which is negligible.

A test will be performed to determine the frequency response and phase shift of the system.

(R. E. Hunt)

Panel Selection Rack - Marginal Checking.

Tentative layout work is being done on modification of a standard rack to house the panel selection equipment. The most plausible layout is to put this equipment in a hinged housing within a power distribution rack. The 470 odd leads would be hinged at the top of the rack and brought down into the main housing.

This tentative layout will be presented as a proposal as soon as final circuit schematics are available.

Power Distribution - Junction Rack.

Layout of this rack has commenced. Equipment here includes: Register Master Switches, an Emergency Shut-down Interlock Switch, Interlock Relays, Meters, Voltage Regulator Pots, and Grounding Equipment.

Connection of the power busses to the overhead distribution busses is also made here.

This layout is very tentative at the present and merely defines space required.

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1.32 Air Conditioning

(J. C. Proctor)

Approval for purchase of the air conditioning from Carrier has been received, and the order placed. Work should start next week on the layout and final engineering. The pent-house beds have been received, and authorization for purchase has been requested.

1.4 Unclassified
(W. S. Rogers)

The laboratory power supply system was checked for proper voltages. The -25 was shifted to -30. Most of the voltmeters on these supplies will require immediate repair.

Fire Protection

(J. C. Proctor)

Permission has been obtained from the Rating Bureau to cut off the water supply to the sprinkler system in the power supply room by installing a valve in the line outside the room. This will be done by the Rockwood Company at the time the alterations in the computer room are made.

2.0 WHIRLWIND I RESEARCH

2.1 Circuits

2.11 Flip-Flop Design and Stability

(W. P. Horton)

Investigation of the effect of a-c flip-flop parameter changes has been essentially completed. There remain only one or two phases which should be further investigated before the thesis report can be written.

The a-c flip-flop life test has been conducted for 650 hours to date. Application of a cooling fan behind the associated power supply rack causes errors to be made by the flip-flops under test. This effect will be further investigated later.

(R. L. Best)

Investigation is under way to determine the feasibility of restoring on the grids of flip-flops, eliminating the need for trigger tubes, and also eliminating the positive pips on the output of the "on" going tube.

2.16 Basic Circuits - Bus Drivers (R. H. Gould)

A standard 5:1 pulse transformer S7.193-8 was received and used to replace the experimental 5:1 transformer type 10⁴A used in the basic bus driver circuit during testing. The S7.193-8 transformer gave less output into a 47 ohm load than the type 10⁴A but using a simulated bus as load there was no difference.

Modifications of the basic circuit BA-1 have been worked out to improve its prf sensitivity. These modifications will be put forth in the memo being written on the bus driver testing.

Gate Tubes (M. H. Hayes)

A test set-up for the investigation of gate tube circuits has been completed. These tests will

2.16 Basic Circuits - Gate Tubes (Cont.)

(M. H. Hayes) (Cont.)

be made on the standard circuits using a chain of pulses.

The first investigation to be made will be to determine the affect of the Q of choke coils on pulse amplitude and shape, when these coils are used as plate loads and as shunts on the secondary of pulse transformers.

Flip-Flops (J. M. Hunt)

Attempts to photograph an oscillogram of the plate voltage wave shape of a flip-flop during the starting cycle (i.e., immediately after the application of restorer pulses to a flip-flop at d-c equilibrium) have not been successful because of extreme difficulty in timing the synchroscope sweep to permit observation of the plate voltage wave shape at the exact moment at which the flip-flop starts. Occasional oscillograms of the starting cycle have been observed and have confirmed the assumption that starting occurs by accumulation of coupling circuit condenser charge by a number of discrete steps.

Report E-114, which outlines the results of the investigation of Basic Circuit FF-1, will be released in the near future.

2.2 Components

2.22 Pulse Transformers

(G. G. Hoberg)

The first shipment of production-model pulse transformers has been received from New England Transformer Company. Test performance of samples was satisfactory.

A conference was held with a representative of N.E.T. to discuss minor improvements in transformer manufacture and the rejection of poorly made hipersil cores. N.E.T. will examine all cores and return to us those which do not meet dimensional specifications or are otherwise unsatisfactory for inclusion in transformers.

2.22 Pulse Transformers (Cont.)

(G. G. Hoberg) (Cont.)

About 600 hipersil cores so far received from Westinghouse show evidence of poor quality-control during manufacture. Arrangements are in progress for a meeting with the local representative of the company.

The codemarkings on pulse transformers are to be interpreted as follows:

<u>NUMBER</u>	<u>TURNS RATIO</u>	<u>PULSE DURATION</u>
S7.193-6 (NET 504)	1:1	0.1 μ sec
S7.193-7 (NET 505)	3:1	0.1
S7.193-8 (NET 506)	5:1	0.1
S7.193-10	5:1	0.4

Production of the transformers marked S7.193-2 (1:1, 0.1 μ sec) and S7.193-3 (3:1, 0.1 μ sec) has been discontinued.

2.23 Vacuum Tube Studies

(N. H. Taylor)

M-374 "Test Procedures for WWI Tubes" has been issued to start the tube program for WWI proper. The specifications 7.400-1 and 7.400-2 attached to this memo may change as the need arises. Standards books will be kept up to date but other copies will not be automatically renewed.

(J. J. O'Brien)

E-112, listing failures of vacuum tubes in 2500 hours of operation in the Five-Digit Multiplier has been issued.

The first group of tube life tests, described in M-361, will commence shortly. The construction of a gate generator must be completed.

Measurements of new 7AD7 tubes and those with 500 hours of operation in the Five-Digit Multiplier show no increase in gas pressure.

A very rough check on the marginal testing method for flip-flop tubes in the Five-Digit

2.23 Vacuum Tube Studies (Cont.)

(J. J. O'Brien) (Cont.)

Multiplier shows that reducing the screen voltage to 90 v. may be too great a drop. This work will be continued when the multiplier is back in operation.

(Ray L. Ellis)

Shorting and leakage tests have been made on 6L6's. No shorts were found. The leakage current averaged 62 μ a. This, however, decreased substantially with time. It varied for tubes from 49 to 68 μ a. JAN maximum is 75 μ a.

7AD7 tubes tested in the 6AG7 adapters were found to oscillate rather consistently in the 140 mc range. This prevents tests from being made with adapters of this type.

Better results have been obtained in pulse testing tubes by using a prf of 5000 cycles and a duty factor of 1/6.6. Pulse tests are being made this way unless otherwise requested.

One hundred tubes for the life test and one hundred 6AG7 tubes for WWI pre-ageing have been tested and file records are being made.

The tube checker schematics have been rechecked precedent to the construction work on the new checker. The model #2 crystal tester has been repaired and is in good operating condition again.

2.3 Systems2.31 Five-Digit Multiplier

(N. H. Taylor)

A system of counting errors during life test of the multiplier has been worked out. A mechanical counter will be actuated each time the unit makes a mistake when running repetitively at 1000 cps rate.

(H. L. Ziegler)

A WWI type Whiffle-Tree switch has been installed in #2 Digit panel and two more switches of this type

2.31 Five-Digit Multiplier (Cont.)

(H. L. Ziegler) (Cont.)

have been built for Digit panels #3 and #4. They will be installed as soon as more 7AK7 gate tubes are available.

Separation of flip-flop screen grids into zero side and one side groups has been completed. A toggle switch for each group provides a choice of +120 volts or +90 volts for testing purposes.

Control of the Periodic Program Control has been transferred to a selector switch on the regular control panel. This switch permits selection of single or repetitive operation of the multiplier.

Work has been started on bringing up-to-date all drawings that apply to the Five-Digit Multiplier.

2.4 Unclassified

(H. Kenosian)

Experimental Binary Counter. Tests made with the experimental binary counter indicate that the grid of an "off" gate tube is a greater load than the grid of an "on" gate tube. It was found that insertion of a 220 ohm resistor in series with the grid of the gate tube was of value, but it is not a cure-all. Further investigation will be made by the basic circuits group.

3.0 SPECIAL CIRCUITS

3.2 Test Equipment

(N. H. Taylor)

Power Distribution Panel design for Sylvania is being delayed until a final decision on wiring all WWI panel power connectors interchangeably can be made.

Such a standardization would simplify these panels immensely.

(R. R. Everett)

The following items of test equipment are active and have been assigned to test equipment committee members for follow-up as noted. Forms and time schedules will be issued as soon as they are ready.

David R. Brown responsible:

Tube Tester
Redesigned Clock
Cathode-follower Probe
Register Panel

Stephen H. Dodd responsible:

Gate and Delayed Trigger Generator
Gate Amplifier
Scope Synchronizer
Amplifier Calibrator

Norman H. Taylor responsible:

Video Amplifier
Tube Test Panels
Sylvania Power Distribution Panel
Sylvania Pulse Transformer Test
Trigger Mixer

Robert R. Everett responsible:

Rack Power Control Unit
Filament Power Panel
DC Power Distribution Strip
Coder
Variable Frequency Clock-Restorer Pulse Source
Standard Laboratory Voltages

3.2 Test Equipment (Continued)

3.21 Standard Test Equipment

(H. Kenosian)

Gate & Delay Unit. The prototype is complete and is now undergoing test. It is estimated that tests will be completed by May 1.

Variable Frequency Clock Pulse Generator, Model 2. Ten new clock pulse generators are being constructed. These units will deliver a standard pulse (0.1 micro-seconds across 93 ohms) at frequencies from 200 kc. to 5 mc. Band switching (4 bands) is provided, thus eliminating the need for plug-in coils. The unit will be constructed on a 3-1/2 inch panel for rack mounting.

(D.R.Brown)

Cathode-Follower Probe. Design of a cathode-follower probe using a subminiature triode is nearing completion.

Flip-Flop Register. A flip-flop register for use as a standard piece of test equipment is being designed. The design will include a flip-flop, read-out gate tubes, and possibly buffer amplifiers. Comments are requested.

(R.L.Massard)

Power Supplies for Sylvania Testing. Modifications have been made on Servo-Lab Power Supplies (regulated W.E., RCC P-1, and RCC P-3) in order to supply the correct voltages and corresponding current requirements needed for one of Sylvania's six test setups. The modification schematics, the modified supplies for one setup and the unmodified supplies for the other five setups (to be modified by Sylvania) will be sent to Sylvania in the near future.

3.22 Special Test Equipment

(D.R.Brown)

Tube Tester. A tube tester similar to the one we now have is being constructed as described in M-375. The console is being redrawn in our drafting room; the drawings will be ready by May 3. The power supplies are being constructed and will be complete in about a week.

4.0 BLOCK DIAGRAMS

(R.P. Mayer)

In block diagrams, blocks serving "identical" purposes are numbered the same; as: Readout gates are all ".02."

In order to distinguish between identical parts of different digit columns, it has been suggested that the digit number be placed in front of the complete, present, designation.

Thus, the readout (.02) gate (GT) of the B-Register (303) in digit column 14 would be designated as:

"14 - GT303.02".

This designation-system should be revised if any difficulty is likely to occur.

5.0 CHECKING METHODS

(E.I. Blumenthal)

Currently engaged in writing thesis report on "A Trouble-Location Scheme for a Digital Electronic Computer" - and supervising drafting of figures for report.