

6345
Memorandum M-245

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Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART 1, FEBRUARY 20, 1948
To: 6345 Engineers
From: Jay W. Forrester

1.0 WHIRLWIND I COMPUTER ELEMENTS

1.1 Listed by Block Diagram Number

102, 103, 601 Program Counter, Program Register, Check Register

(H. Fahnestock) Grade II circuit schematics scheduled for completion in the period as reported in M-237 have been delayed pending completion of basic circuit revision. They will be completed in the next week.

103 Program Register

(H. Fahnestock) Detailed comment on Sylvania's Program Register Demonstration Panel has been written up in M-241

104 to 108 Control

(D.R. Brown) The control switch, time-pulse distributor, and control matrices were discussed with Stevens, Flaherty and Slavin of Sylvania. A block diagram presented by Flaherty employs two sets of gates and amplifiers, one set to drive the program timing matrix and the other to drive the operation timing matrix. The time-pulse distributor and program matrix go on one rack. Slavin proposed a design for the other matrices which required a total of six racks, including the control switch. This design is very crowded and will probably require some re-working. The possibility of small, single-tube plug-in units was discussed.

202 Toggle Switch Storage

(R.E. Hunt) The 16 Push Button, single release switch designed for us by General Control Co., has been set aside because of prohibitively high cost. A design has now been worked out for a mechanical slide indication system to be used in conjunction with a standard toggle switch. The mechanical slide will utilize the motion of the toggle switch trigger to cover or uncover a hole in the panel. This hole may be made readily noticeable

when uncovered by several different means.

The preliminary sketches have been worked out, and proposal drawings should be available in about a week.

203 Flip-Flop Storage

(D.R.Brown) New circuit schematics of the flip-flop storage were started in the drafting room on February 17 and will be completed about February 24. The new drawings will show two flip-flop storage register digits on one drawing and a flip-flop storage register digit together with flip-flop storage output section on a single drawing.

300 Arithmetic Control

(G.E.Sumner) The circuit schematic of the sign control and divide error panel, drawing E-31619 has been completed. Design of other panels of arithmetic control continues and is nearing completion. Consideration of lessening the number of tubes required in the control line driver rack has been begun. In order to provide space for spare drivers, buffer amplifiers will have to be located off the driver rack wherever possible.

301 A-Register

(C.W.Watt) A-Register layout for AR-1 through AR-15 was received from Sylvania. A detailed check of it was made by Cook, Watt and others. A list of comments was submitted to Sylvania. The layout was very clean, and pleased everyone, with minor suggestions.

The schematic of A-Register, digit zero is complete and will be sent to Sylvania at once.

Accumulated changes in AR-1 through AR-15 were given to drafting on February 18 and new prints will shortly be issued.

302 Accumulator

(C.W.Watt) D.Mach has begun layout of a wiring harness for the accumulator from Cook's layout. On the completion of that, fabrication of the accumulator prototype will begin.

1.2 System Engineering

1.21 Power Control and Distribution

(C.W.Watt) The following informal decisions were made. (These are still subject to discussion)

1. Input power will be distributed registerwise.

2. A separate panel will be provided at the main distribution center for each voltage to each register. This panel will contain main fuses, main relays and means to insert the variable checking voltages in the lines.
3. Each voltage at each panel will be separately fused. A simple indicator system will be provided to light a trouble light when any fuse is blown. One trouble light per rack, or the equivalent will be provided at a central point.
4. Bias interlock will be provided, using 1 relay per panel and the relays already provided in the distribution panels.
5. Decoupling will be provided at each panel for the flip-flops in that panel only.
6. Relays, fuses, and decoupling capacitors can be mounted on the side brackets of the cabinets.

(R.E.Hunt) Indicating Fuses - An investigation of rack fusing has shown that an indicating type of fuse is needed.

A further investigation has shown that the only applicable and available fuse of this type is Western Electric's Telephone Type Indicator Fuse (Grasshopper). This fuse has the rather serious disadvantage to us of being awkward to mount, having one vertical and one horizontal mounting slot. To overcome this disadvantage would involve some complication.

A design of an indicating fuse has been worked out which would mount in miniature cartridge fuse clips. The sketches and prototype of this fuse has been forwarded to the Waltham Horological Company. A preliminary estimate of cost and delivery should be available in a few days for cost and application comparison.

1.24 Driver Panels

(R.L.Best) - Gate Tube Driver Panel. A set of cables has been completed which will simulate the worst control line driving problem. The whole project has now been turned over to Rowland, as reported in M-220.

1.3 Auxiliary Equipment

1.31 Power Supplies

(H.R.Boyd) A 75 h.p. synchronous motor has been located and is being reconditioned. A 31.25 K.V.A 120-208 volt $\frac{3}{4}$ generator is being obtained from surplus. These units will be installed in the transformer room as soon as possible. The synchronous motor will be supplied by one of the two 75 K.V.A. transformer banks

and will act as a synchronous condenser to regulate the 110 and 220 volts supplied by this transformer bank for the testing purposes and to the d-c power supplies. This motor will also run the above generator as a source of filament power for WWI.

(H.S.Lee) Tentative specifications for filament transformers have been forwarded to five manufacturers, New England, Freed, United, Federal and Raytheon for quotations on a lot of six-hundred. Two alternative specifications were given the manufacturers:

1. A primary having four windings that can be connected aiding or opposing to provide secondary voltages ranging from 5.08 volts to 8.23 volts in increments varying between 0.07 volts and 0.19 volts.
2. A tapped primary to provide secondary voltage increments of 0.1 volts between the limits of 5.8 volts and 6.6 volts.

To date no quotations have been received from the manufacturers on the above specifications.

The analysis of D.C. power requirements for WWI is approximately seventy five per cent completed. It is expected that the analysis will be completed on or before February 25. To date the requirements are:

<u>Volts</u>	<u>Watts</u>	<u>Amps</u>
250	650	2.6
150	3159	21.0
120	401	3.35
100	39	0.39
90	102	1.15
80	13	.16
50	1	.02
Total	4365	

1.32 Air Conditioning

(J.C.Proctor) Specifications for the air conditioning of WWI have been given to York and General Electric who will both submit proposals. They both say that delivery of equipment may run as long as 90 days.

1.33 Cabinets

(C.W.Watt) An effort has been made to provide Sylvania with sufficient information to complete rack and cabinet design. A memo has been prepared and will be transmitted to Sylvania by Tuesday, February 24. The information has been transmitted by word-of-mouth to Hugh Wainwright today, February 20.

1.4 Unclassified

Computer Room

(J.C.Proctor) Layouts of the cable ducts, lighting and sprinkler system are being worked on.

Fire protection systems are being investigated and arrangements have been made to discuss the problems with the fire inspectors and the Rockwood Sprinkler Co. It appears that a system can be worked out that will be acceptable to the fire underwriters and still will not be an undue hazard to the electronic equipment.

Basic Circuits

(J.A.O'Brien) Most of the changes in the basic circuits have been completed and the new circuit schematics have been completed and distributed to the engineering files. That portion of the Design Specifications S7.502 pertaining to the former standard circuits has been revised.

John Hunt and Robert Massard have been assigned to full-time work obtaining the detailed operating specifications of the basic circuits.

A memo giving the details of the circuits changes is being written.

WWI Drawing List

(H.Fahnestock) A WWI drawing list will be issued herein periodically. Engineers are urged to check their prints against this list to make sure they are using latest revisions.

<u>WWI Elements</u>	<u>Block Diagram</u>	<u>Block Schematic</u>	<u>Circuit Schematic</u>
302 Accumulator		D-31213-1	E31275
301 "A" Register		B-31211-2	D-31276-2
303 "B" Register		B-31212-2	D-31277
601 Check Register		B-39288	D-31515
104 Control Switch		C-31152	SC-39492
308 Divide Control		C-31552	
203 Flip-flop Storage		SD-39278-1	
203 Flip-flop Storage (Output)			D-31450
203 Flip-flop Storage (Register)			D-31531
400 Input Registers	A-37116		
101 Master Clock	B-37058-1		SD-39545
306 Multiply		B-31532	
105 Operation Matrix	C-37077-2		
	C-37078-2		
107 Operation Timing Matrix	C-37077-2		
	C-37078-2		

(continued)

<u>WVI Elements</u>	<u>Block Diagram</u>	<u>Block Schematic</u>	<u>Circuit Schematic</u>
500 Output Registers	A-37117		
310 Point Off		B-31600	
102 Program Counter		B-39291	D-31516
103 Program Register		B-39289	D-31514
108 Program Timing Matrix	B-37075		
307 Shift		B-31532	
304 Sign Control		B-31576	
305 Step Counter	B-37074-2		
309 Special Add Memory		B-31575	
200 Storage	B-31150		
201 Storage Switch		C-31152	SC-39492
106 Time Pulse Distributor	B-37068	T6OPD00-8	W6OX6ACO
Time Pulse Distributor Control.	D-31387		

2.0 WHIRLWIND I RESEARCH

2.1 Circuits

2.11 Flip-Flop Design and Stability

(A.B.Horton, Jr.) The Whiffle-tree switch panel for installation into the experimental multiplier digit is under construction. Upon completion, it will be installed and tested for operation with the a-c flip-flop.

The ten-unit a-c flip-flop life-test rack is nearing completion. Five of the flip-flops will use type 6AG7 tubes and the remaining five will use type 7AD7. All ten units will use type 6SN7 trigger tubes. Relays and counters for error detection will be installed upon receipt of additional relays.

(W.P.Horton) The rough draft of the Bachelor's thesis proposal on the a-c flip-flop has been submitted to the thesis supervisor and work on the phase of the research dealing with parameter variation effects has begun.

Unclassified - Basic Circuit Component Studies.

(John M Hunt) In order to facilitate investigation of basic circuit components a model flip-flop, trigger amplifier and indicator amplifier circuit was constructed. This model closely resembles the proposed production model in physical layout of corresponding circuit components; measurements will be taken to determine allowable circuit tolerances and to establish performance specifications for the circuits contained in the model.

The advisability of by-passing flip-flop heaters to ground is also being investigated. According to the existing design plans heaters are not by-passed or electrically connected to ground.

Unclassified - Basic Gate Tube Circuit Tests

(R.L.Massard) Necessary equipment and circuits for complete testing of basic gate tube circuits have been set up. Plans are to determine exactly how the circuits behave under all possible operating conditions likely to be encountered in actual use.

2.2 Components2.22 Pulse transformers

(G.G.Hoberg) A preliminary draft of receiving test specifications for pulse transformers has been made.

2.23 Vacuum Tube Studies

(M.H.Hayes) Emission tests at low fil. voltages were made on the 7AK7 tube. Data was taken so that curves of cathode current vs plate voltage for various fil. voltages could be drawn. Then according to standard specs. the ion current was measured for a number of tubes. This information was given to Nolan to aid him in making a calibration curve of tube pressure vs. ion current. Once obtained - by using an ionization gauge or a built up one - the pressure inside this tube will be readily obtained. This will be used when life runs are made on these tubes to determine cause of failure.

All this work was done in conjunction with J.J.O'Brien

Ion current tests were made on 10 good and 10 bad 6AG7's. Tests made according to ion gauge specs. No appreciable difference was found in ion current or emission at the low filament voltages, which indicates that the bad tubes are not gassy.

Emission tests will be run at normal fil. voltages to see if the cathode is poisoned, a fact not indicated at low fil. voltages.

This work was done in conjunction with J.J.O'Brien.

(R.Ellis) The following test reports are available:

Resistance at + 1 v. - 2 v. - 50 v. - 100 v. on fifty 1N38 crystal diodes.

Filament current on ten tubes each of types 6AG7, 6Y6G, and 7AD7 at rated 6.3 filament voltage.

Some work has been done in the storage of retired tubes. All available have been relabelled with marking ink and a system of storage in boxes by these identifications has been set up.

A card system for recording a cumulative record of tests and other pertinent information on individual tubes is being made. This will make tube histories more accessible and more complete.

(H.R.Boyd) Consideration should be given to the merits of lock-in bases. There is no satisfactory socket being manufactured. Manufacturers of sockets feel that the lock-in design is basically poor and going out of use. Some users report trouble. We have found some lock-in tube pins with an oxide coating of considerably higher resistance than the nickel plated octal tube pins.

2.3 Systems

2.31 Five Digit Multiplier

(J.J.O'Brien) The multiplier is being set each night with all its flip-flops in one position, and the errors are observed each morning. Because of a generator breakdown, an accidental disturbance of a power plug during the night and shut down for certain circuit changes this test has not been under full swing so there is insufficient data on stability at this time.

Locktal to octal adapters are being constructed to replace 6AG7 drivers by 7AD7's for test purposes.

(H. Daggett) Waveform cleanup is continuing. The step counter is now operating without delay lines. The shift and carry line which formerly used one buffer amplifier to drive very large numbers of tubes has been divided up with a separate buffer for each digit panel.

(H.L.Ziegler) A new type Addition Control has been tested and proved satisfactory. It is now being installed and should be in operation early next week.

The addition Control now being installed uses the present Multiply Control circuits plus a form of pulse distributor. The same push-buttons are used for either operation and the desired operation is obtained by use of a single selector switch marked ADD - MUL.

Work is continuing on circuit refinement to improve the operation and stability of the multiplier.

3.0 SPECIAL CIRCUITS

3.2 Test Equipment

(H.R.Everett) The Test equipment committee has been engaged in the following work:

1. A study of the laboratory d-c and a-c central power distribution.

The committee has given tentative approval to the following program:

- a. Voltage regulation on the a-c line by means of a synchronous condenser. This work as well as the improved regulation of the d-c supplies is under H.R.Boyd and G.R.Wieser.
- b. Replacement of the existing laboratory d-c voltages by the proposed WWI voltages with the addition of +500. The standard laboratory boxes will be used, the 12 pins in the plugs having the following voltages:

+500	-15
+250	-25
+150	-150
+120	SPARE
+90	6.3
GND	6.3

The +500 may be obtained from bench supplies. The pin numbers have not yet been assigned.

- c. The regulation on the new voltages will be improved. It is hoped to obtain voltage regulation of the order of 1% with less than 50 millivolts ripple.
 - d. Some items of laboratory equipment must be modified to operate from the new voltages. These modifications will be made at the time of the voltage changeover to cause as little trouble as possible.
 - e. The standard laboratory voltages will be supplied to the storage tube laboratory.
2. A survey of existing and proposed laboratory test equipment. Construction but not investigation of new test equipment has been stopped until the committee can formulate a program. As a step towards this program, R.Murch and H. Mercer have made a detailed inventory of existing equipment.
 3. A study of future project needs in order to formulate a program for standard test equipment. This program will be based on the studies made by J.Ely in the last few months.

Test Equipment (Sylvania)

(N.H. Taylor) At the weekly electronics group meeting February 13, Sylvania's test equipment program was introduced and discussed.

The Sylvania needs fall into 3 groups:

1. Component testing.

New test equipment for pulse transformers and tube testing must be specified and built as soon as possible. Other equipment is available.

2. Panel testing (Basic Circuits)

Specifications are being written in such a way as to use existing Sylvania's equipment. Some additions will probably be made.

3. Final testing (Functional)

This will require new and more elaborate equipment than Sylvania has at present. However, most circuits needed have been designed and will be available very soon.

3.22 Special Test Equipment

Clock-Restorer - Pulse Source

(H. Kenosian) The frequency divider section has been completed and is being tested. It has been found that the output of all except the last gate put out uneven pulses, i.e. every other pulse has less amplitude than the pulse immediately preceding or following it. The trouble seems to be coupling from a following flip-flop and gate tube through the suppressor grid to control grid capacitance on the 7AK7. The effect is being further investigated because it is felt that a fundamental defect may be located, which defect will probably be present in WWI, especially in the light of the fact that basic WWI circuits are used throughout on this unit.

The distributor section is under construction

Variable Delay Pulse and Gate Generator

(H. Kenosian) The second unit has been tested and is in use at present. The unit seems to be quite critical as to layout. With a few changes it is felt that this unit can be improved so that it will work at higher frequencies, (megacycle) have a better resolving time, and be less critical as to layout.

Tube Life Test Rack and Tube Ageing Rack for Sylvania

(J.J.O'Brien) The design of the panels is completed and the layout will be finished by Drafting about February 24.

4.0 BLOCK DIAGRAMS

(E. Blumenthal) Revisions to R-127 are nearly complete. The Drafting Room has sent all drawings out for reduction with the exception of a few currently being drawn up: Step counter, bus connections, system block diagram, main control and program timing. (The revisions to the Step counter are discussed in E-102). The operation timing matrix will soon be completed, leaving only the details of Input-Output and Electrostatic Storage incomplete.

The recent arrival of Rollin Mayer to the Block Diagram group has expedited the task of revision and gives me opportunity to consider the problem of trouble-location.