Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART I, July 23, 1948

To: 6345 Engineers

From: Jay W. Forrester

1.0 WHIRLWIND I COMPUTER ELEMENTS

1.1 Listed by Block Diagram Number

104 Control Switch

(J. A. O'Brien)

The layout of the control switch is proceeding at Sylvania and a couple of sketches of the flip-flop layouts have been received from R. Slavin for our informal comments. These will be returned with favorable comments at the conclusion of Sylvania's vacation.

105 Operation Matrix

(H. Fahnestock)

Sylvania has satisfactorily completed the layout changes referred to in the bi-weekly report of June 25 and the driver layout has been approved.

109 Clock Pulse Control

(J. A. O'Brien)

The circuit schematic and the block schematic of the Clock Pulse Control are nearing completion in the drafting room. The circuit schematic is quite large and has been made on two sheets to facilitate the use and handling of it, but the unit will be built all on one panel.

109 Clock Pulse Control (Continued)

(R. L. Massard)

The clock pulse control breadboard has been modified to incorporate, as an integral part of the panel, the five buffer amplifiers on the output gate tubes and also the gate tube which is used to start the unit after the power has been turned on.

110 Frequency Divider

(H. Fahnestock)

Sylvania's revised layout of the frequency divider has been approved.

111 Synchronizer

(J. A. O'Brien)

A design proposal for the synchronizer has been submitted in Memorandum M-546. No unfavorable comments have been received, and H. Kenosian is proceeding with the design of the unit. This unit will be entirely constructed here and the time schedules for it have been made up.

(H. Kenosian)

A breadboard for the push-button circuits for the synchronizer has been submitted for construction. The remote-control delay multivibrator has been designed and tested.

112 Restorer Pulse Generator

(H. Fahnestock)

Sylvania's layout of the restorer pulse generator, including the two new tubes, has been approved.

201 Storage Switch

(M. Hayes)

The design and layout of a three-stage amplifier to drive toggle switch storage has been completed. When using 40 microsecond restorer pulses, the operation

201 Storage Switch (Continued)

was very satisfactory, either for driving the minimum impedance that the toggle switch line may present, or for driving a 100 ohm line to feed flip-flop storage. The delay in the control switch and amplifier is much better than anticipated, being less than 0.3 microseconds.

(J. A. O'Brien)

A three-stage amplifier to satisfy the requirements of the storage switch output amplifier has been successfully tested by M. Hayes. Thirty-two of these amplifiers are required and present plans are that sixteen will be mounted on the storage switch rack and the other sixteen will be mounted on the adjoining toggle switch storage rack.

203 Flip-Flop Storage

(J. A. O'Brien)

The testing of the flip-flop storage prototype has been stopped to permit the testing of the bus driver prototype. The prototype of the flip-flop storage output unit has been received from Sylvania and will be tested along with the flip-flop storage register when tests on this unit are recommenced.

300 Arithmetic Control

(G. G. Hoberg)

Testing has started on the ACO Carry and Special Add Memory panel.

301/103 A-Register/Program Register

(R. H. Gould)

Work on write-up of test procedure and specifications for A-register has been discontinued because of higher priority work on bus driver prototype. It will recommence shortly.

302 Accumulator

(G. C. Sumner)

The schematic of the ACO Auxiliary Panel, D-32602, has been issued. The block schematic to ACO is underway in the drafting room.

303/403 B-Register/In-Out Register

(R. H. Gould)

Engineering Note E-131 on the testing of the B-Register prototype is being published without waiting for Sylvania Memo 60-54 giving instructions for testing and data sheets. This will be delayed a few weeks because of Sylvania's vacation.

404/601 Comparison and Check Register

(H. Fahnestock)

Sylvania has been furnished with block schematics of the comparison register and the check register, and a circuit schematic for the panel which will perform both functions.

601 Check Register

(J. A. O'Brien)

A preliminary circuit schematic of the check register check panel has been drawn up. It contains those elements needed in the check-register register-driver rack that are not available in the standard type register drivers. A breadboard layout of the unit was started by C. Rowland and later revised and finished by R. Massard. The breadboard model will be built and tested in the near future. This unit will be built at MIT and the time schedule for it has been made.

1.2 System Engineering

1.21 Power Control and Distribution

(C. W. Watt)

WWI Installation. A meeting was held July 21 to clarify and coordinate the WWI installation problem. This meeting is covered in M-544. An installation time schedule has been made, C-32644, and will be issued shortly.

Fuse Indication Panels. A memo, M-534 was sent to Sylvania July 13 approving the prototype panel and authorizing construction of 22 panels.

1.21 Power Control and Distribution (Continued)

Fixed Voltage Switching Panel. A memo, M-536, was sent to Sylvania July 13 approving the layout and authorizing construction of 15 of these panels.

Digit Interlock Panel. A memo, M-539, was sent to Sylvania July 14, approving the layout of this panel, and authorizing construction of 5 of these panels.

Voltage Variation Panels. A prototype panel was received from Sylvania July 16.

(H. S. Lee)

D-c Filter Panel. The prototype d-c filter panel is at present being silk screened. It is expected that the assembly will be completed on or before Friday, 30 July 1948.

(R. E. Hunt)

Panel Selection Rack. The panel selection rack is progressing about on schedule. Assembly of everything but the output should be complete in about two weeks. In this state the unit will be ready for testing. The unit should be complete and tested before the 15th of September.

1.22 Power Cabling.

(H. S. Lee)

Preparation of the detail drawings of cables for WWI is progressing satisfactorily. It is anticipated that all drawings for the arithmetic elements will be completed by 30 July. Drawings of the overhead cables have been completed.

Two of the three concerns who were requested to bid on the production fabrication of the power cables have submitted their bids. As of this writing, it appears that Gavitt Manufacturing Company should be awarded the contract both from a price standpoint and from the standpoint of facilities and experience in the field.

1.24 Driver Panels

(H. Fahnestock)

Register Drivers. The incompleted register-driver prototype was received from Sylvania when they went on vacation July 16. It is being completed in our shop and will be tested next week.

(R. H. Gould)

Bus Driver. Testing of the bus driver panel prototype has been completed and write-up of procedures and specifications for production testing is underway. Engineering Note E-136 will discuss the tests made and Engineering Note E-137 will be the instructions and data sheets for production testing.

1.25 Time Schedules

(R. A. Osborne)

Prints of all time schedules posted to July 1 have been distributed.

Several time schedule conferences have been held and all schedules have been reviewed as a whole.

Sylvania has been given a summary schedule of all items on which they are working or will work in the future showing at what rate and when we would like to receive the various elements. They will review the summary and either confirm or made recommendations for changes shortly after they return from vacation on August 2.

New individual schedules are being prepared for all items and a new overall summary will appear in SR-9 for July.

1.3 Auxiliary Equipment

1.31 Power Supplies

(C. R. Wieser)

The 2-kva Sorensen Regulators have been modified and are in service on the + 150 and - 150 volt laboratory supplies.

1.31 Power Supplies (Continued)

Alignment of the WWI plate supply motor-generator set has been started. Reactors for the motor have been delivered and should be installed in about one week.

A new motor-generator set for the + 150 volt supply to the five-digit multiplier has been installed. A regulator for heater voltage on the multiplier has been constructed and installed.

(R. E. Hunt)

Generator Room WWI. Design has begun on racks and wireways for d-c power supplies in the generator room. It will probably be necessary to relocate some existing sprinkler system piping, conduit, and other piping, and therefore design is progressing slowly. Full design on these racks and wireways will probably take another two to three weeks.

(J. J. Gano)

The filament voltage regulator for the five-digit multiplier has been assembled on a panel and satisfactorily tested by Ziegler. It is now being mounted on the racks for operation.

Marginal checking. The housing for the mechanical drive of the automatic control potentiometer is being designed. Brackets for mounting the electrical components are being machined.

Polarized electrolytic condensers are being tested back to back to be used as filters in the variable voltage supply which will operate at a low frequency (one half to one cycle per second).

(H. R. Boyd)

I visited the Power Equipment Company on July 2 and again on July 12. At these conferences most of the final details of design and construction were settled. These conferences are reported in M-551. P.E.C. expects to ship the five thyrotron supplies and the 48-volt relay supply in time for installation prior to the arrival of the A-register on Oct. 3. The -15 and -30 volt supplies will arrive one or two months later and temporary bias supplies will be provided to test the A-register.

1.31 Power Supplies (Continued)

At a meeting last week (discussed by Watt in Section 1.21), Mercer was made responsible for ordering and stocking the materials needed in installation including power supplies. Corzine will help him as needed. Jewell in the drafting room will be responsible for coordinating the power supply and other installation drawings.

(W. S. Rogers)

Raytheon isolation reactors have arrived and are being installed.

The 37-1/2 kva transformers for General Building service have been received.

(L. J. Nardone)

The control field windings of the amplidyne have been reduced to one half the number of original turns plus a center tap. The operation of the amplidyne with the modified control field winding is satisfactory.

Frequency and response measurements have been continued. Modification of the control field winding resulted in an improvement. With the original number of control field turns, the phase shift between the amplidyne output and the input of the control field circuits was 120° at 35 cps. With one quarter of the number of control field turns, this phase shift has been reduced to 80°. Frequency response has also been slightly improved.

Measurements will continue to determine the origin of phase shifts and methods to reduce the overall phase shift.

1.32 Air Conditioning

(J. C. Proctor)

The steel supporting beams, the pent house floor, and the openings through the roof have been completed. The building itself is to be erected the first of next week.

1.32 Air Conditioning (Continued)

The Carrier Company is completing the working drawings and making up a work schedule for the installation. The remainder of the equipment should arrive during the next two weeks and the installation started.

Bids are being obtained for the necessary plumbing connections.

WWI Drawing List	Block Diagram	Block Schematic	Circuit Schematic
System	B-37071-5		
Control	B-37098-4		
Master Clock	B-37159-1		
101 Pulse Generator	A-37155-1	B-32585	E-32333-2
102 Program Counter	B-37062-4	B-32213-1	D-31516-4
103 Program Register	B-37067-2	B-39289-1	D-31276-7
104 Control Switch	B-37066-3	T60CS00-4-A	Z60CS00 W60CS00-1 Z60CS00-2
105 Operation Matrix		S60OM00	Z60OM00-1-B
Control Pulse Output		R60CP00	S60CP00-1
106 Time Pulse Distributor	B-37068-3	T60PD00-8-B	
106 Time Pulse Distributor Counter		T60PD00-3-A	Y60PD00-B
106 Time Pulse Distributor Output		T60PD00-4-A	Z60PD00-1-A
109 Clock Pulse Control	B-39817-1	C-32642	R-31916
110 Frequency Divider	A-37154-1	B-32264-1	R-31729-1
111 Synchronizer	---	---	---
112 Restorer Pulse Generator	A-37160	B-32209-2	D-31909-5
200 Storage	C-37156-1	B-31150	
201 Storage Switch	B-37121-1	C-31152	SC-39492
203 Flip-Flop Storage Output	B-37060-4	B-32269	E-31635-3
203 Flip-Flop Storage Register	B-37057-3	B-32268	E-31621-3
301 A-Register	B-37056-2	B-31211-3	D-31276-7
301 A-Register Zero Digit	(B-37056-2 (B-37072-7	B-31574	D-31573-2
302 Accumulator	B-37063-5	D-31213-2	E-31275-3
302 ACC Zero Digit	B-37096-5		

	Block Diagram	Block Schematic	Circuit Schematic
302 ACC Zero Aux.	B-37096-5	B-32492-2	D-32602
303 B-Register	B-37097-3 B-37069-3	B-31212-3	D-31277-2
304 Sign Control & 308 Divide Error Control		B-31576-2	E-31619-1
305 Step Counter	B-37074-5	D-31828	D-31813
306 Multiply & 307 Shift Control		B-31532-3	E-31588-2
308 Divide Control		C-31552-2	R-31718-2
309 Special Add Memory & ACC Carry		C-31575-2	E-31632-1
310 Point Off Control		B-31600-4	E-31717-2
403 In-Out Register	B-37119-2	B-32434-1	D-31277-2
404 Comparison Register	B-37120-2	B-32578	E-32576
601 Check Register	B-39816-2	B-32577	E-32576
Bus Driver, Arithmetic Element		A-32297-1	D-31727-4
Bus Driver, Flip-Flop Storage		A-32296-1	D-31726-4
Register Driver, Type I		B-32207	E-32261-1
Fuse Indication Panel			W60PP00-7-B
Voltage Variation Panel			W60PP00-6
WWI Power Connector Pin Connections			C-31955-4

2.0 WHIRLWIND I RESEARCH

2.1 Circuits

2.10 Pulse Standardising Circuit

(H. Kenosian)

Further work on this unit indicates that pulses can be standardized up to a 3 mc repetition rate. Further investigation is now in process.

2.11 Flip-Flop Design and Stability.

(R. L. Best)

Tests are being run to determine the effect of restorer prf, load capacitance, and other variables on the minimum pulse amplitude required to start, and to keep running, a stalled flip-flop.

A breadboard is being constructed to load the test flip-flop with four gate tubes, to determine the effect of feedback from the gate tubes on flip-flop operation.

(J. J. O'Brien)

A few unused 7AD7 tubes have been found to cause poor operation in the present 7AD7 flip-flop circuit. In these tubes, the knee of the plate characteristic occurs at high plate voltages. The resulting high screen current and low plate current cause the poor operation. It is not yet known what percentage of new 7AD7 tubes have this characteristic. Of 20 tubes tested, one had this characteristic.

The laboratory wall voltages have been successfully filtered to supply power to flip-flop life test racks.

2.16 Basic Circuits

(J. M. Hunt)

An engineering note, which describes the performance of a number of gate tube chains, is being prepared. Included in this report will be performance

2.16 Basic Circuits (Continued)

data on the basic gate circuit and the modified gate circuit (see E-132) at plate supply voltages of 150 volts and 250 volts.

Late production 7AK7's from test No. C-6400, which differs slightly in electrical characteristics from the earlier 7AK7's, will be tested in a gate tube chain. Because of the improved characteristics of the newer 7AK7's it is considered likely that the overall gate circuit performance with the newer tubes will be superior to that obtainable with older type 7AK7's.

2.2 Components

2.22 Pulse Transformers

(D. R. Brown)

The transient response of the plate load circuits using pulse transformers is being calculated. A simplified equivalent circuit of the pulse transformer is used which includes lumped leakage inductance and shunt capacitance. The response of the equivalent circuit of the plate load circuit has been calculated for a current impulse and at present is being calculated for a triangular current pulse.

The results obtained so far indicate that the leakage inductance plays an important part in determining the pulse shape but is relatively unimportant in effecting pulse amplitude. Pulse amplitude is primarily determined by the shunt capacitance.

2.23 Vacuum Tube Studies

(D. R. Brown)

A new batch of 81 7AK7's was received July 22 from test No. C-6400. The tubes in this batch are different from the 7AK7's received previously. They were made as nearly like the SR-1030, C-5245 as possible. Particular attention was paid to the geometry of the grid structure. The d-c and pulse characteristics of these tubes are being measured. The pulse measurements will show the characteristics of the tubes in the positive grid region. In addition, measurements will be made to determine the degree of the vacuum in the tube.

2.23 Vacuum Tube Studies (Continued)

(A. K. Susskind)

Measurements of plate, screen, and control grid currents of 7AK7's and SR-1030's with control grid voltages ranging from -15 to +15 volts were made using pulse methods. One tube out of a new shipment of 81 7AK7's received yesterday was measured and shown to be similar to the SR-1030 and superior to the previous type of 7AK7.

More tubes will be measured and the effect of suppressor grid voltage on the electrode currents will also be investigated.

(R. L. Ellis)

Eighty-two 7AK7's were recently received and tests on them are being checked. Some new tests are being made. Significant results were obtained from burning five tubes for two hours. The drop in plate current was more than 18% for this time.

Curves have been made on three 7AD7 tubes used in flip-flop circuits. From these curves troubles were accounted for, but it would seem advisable to revise the standard tests to predetermine trouble causing tubes.

(J. J. O'Brien)

7AD7 tubes have shown only 5% decrease in plate current in the five-digit multiplier, after 1200 hours. The 6AG7 tubes used in the same circuits decreased about 50%. This is covered by Engineering Note E-135.

2.3 Systems

2.31 Five-Digit Multiplier

(H. Zeigler)

For the past two weeks the five-digit multiplier has been operating satisfactorily.

It is at present shut down for the installation of a new positive 150 volt supply and of a filament voltage regulator.

3.0 SPECIAL CIRCUITS

3.2 Test Equipment

(D. R. Brown)

Evaluation of the work load in the test-equipment shop indicates that about one unit of each type of test equipment will be completed each week. The types are:

T-4	Coder
T-10	Pulse Mixer
T-12	Gate and Delay Unit
T-16	Scope Synchronizer
T-24	Register Panel
T-28	Delay-Line Panel
	Gate Panel

3.21 Standard Test Equipment

(H. Kenosian)

Cathode Follower Probe: Work on the prototype will be completed this week.

Voltage Calibrator: The prototype has been completed and is now undergoing tests.

Clock Pulse Generator: The calibration charts have been installed to complete the first order on these units.

"Henry" Amplifier: Four amplifiers were delivered by Sylvania. Preliminary investigation shows poor lay-out; a missing peaking choke, and excessive overshoot on 0.05 microsecond pulses.

4.0 BLOCK DIAGRAMS

(J. Salzer, R. Mayer, E. Blumenthal)

Coordination of all block diagrams is progressing satisfactorily. Nomenclature is being standardized throughout, and an attempt is being made to produce a complete, accurate set of WWI diagrams.

(R. P. Mayer)

The three EST control memos (M-521, M-522 and M-523) are available for inspection in rough draft form, but will not be issued for several weeks due to the absence of R. R. Everett.

Two ungraded block diagrams have been added or changed:

112	Restorer Pulse Generator	A-37160
202	Toggle Switch Storage	B-37122-2

Changes and corrections to the list of Grade II block diagrams are as follows:

102	Program Counter	CB-37062-4
106	Time $P_u$lse Distributor	B-37068-3