Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART I, DECEMBER 10, 1948

To: 6345 Engineers

From: Jay W. Forrester

1.0 WHIRLWIND I COMPUTER ELEMENTS

1.1 Listed by Block Diagram Number

(H. F. Mercer)

The following WWI panels (production units) have been received from Sylvania to date:

1	106	Time Pulse Distributor Output
1	112	Restorer Pulse Generator
1	301	A-Register, Digit 0
33	301/103	A-Register, Digits 1-15/Program Register Digits 0-15
1	302	Accumulator, Digit 0
16	303/403	B-Register/In-Out Register, Digits 0-15
2		Digit Interlock Panels
15		Fixed Voltage Switching Panels
8		Fuse Indication Panels

111 Synchronizer

(A. K. Susskind)

A push-button pulse synchronizer circuit has been developed which appears to be satisfactory. Switch chatter has been corrected by a compensating network. A breadboard consisting of five synchronizing units and a blocking oscillator is currently being made up in the shop and will allow final testing.

112 Restorer Pulse Generator

(J. A. O'Brien)

The restorer pulse generator is undergoing modifications and testing for the purpose of eliminating the special restorer lines and doubling the number of normal restorer lines.

300 Arithmetic Control

(G.G. Hoberg & W.N. Papian)

Testing of the step counter will be completed this week.

Remaining work on arithmetic control includes only:

1. Testing of step-counter output.
2. Retesting of point-off control.

Unless the step counter is needed in the computer room it will be retained on the test rack for the point-off and step-counter-output tests.

302 Accumulator

(N. H. Taylor)

In testing this unit spurious oscillations in cathode followers have prompted an addition of a suppressor resistor in the grid circuits of cathode followers and trigger tubes and also grounding of 7AD7 shields. These changes will be made at M.I.T. as units are received from Sylvania.

305 Step Counter Output Panel

(J. A. O'Brien)

The step counter output panel has been completed and it is waiting for testing.

404 Comparison Register Checking

(J. A. O'Brien)

Some thought has been given the problem of checking the data transfer between the in-out register and the readers and recorders, as it concerns the auxiliary equipment that must be added to the input-output and comparison registers. A preliminary block diagram of this additional equipment (to be named Comparison Register Check) has been drawn and is now under review by the Block Diagram group.

601 Check Register Check

(J. A. O'Brien)

The video layout and the cable assembly drawings of the check register check panel have been completed and are ready

601 Check Register Check (continued)

to be checked. The drafting of the aluminum panel assembly has been started.

(K. E. McVicar)

Test Specifications for the check register have been written and submitted for approval.

700 Operator's Console

(R. H. Gould)

The experimental breadboard of the time pulse distributor has been rehabilitated for temporary use in the testing of the arithmetic element until the WWI TPD is ready. Fair success has been achieved, but performance goals are not being set too high because of the temporary use for the unit. It is now being tested with the breadboard clock pulse control to ensure that they will operate together.

The breadboard model of the clock pulse control has been tested for use until the WWI unit is available. The control matrix has been rearranged to follow the latest block schematic, C-32642-2, but the spare tubes shown on this drawing are not all being provided. The unit is now being tested with the breadboard TPD to ensure correct operation of the two units together.

(C. W. Watt)

The a-c and d-c wiring to the temporary console were completed. Two Fixed Voltage Switching Panels will be used as a master d-c switch for the console, and the relays are controlled by a toggle switch on the console. A-c master control is provided by a circuit breaker on the console.

Interphone wiring (temporary) between the console room and row A of the computer has been made and installed.

1.2 System Engineering

(W. S. Rogers)

A. Installation - The following work was completed:

1. All wiring for preliminary A rack testing was completed, except for minor additions in racks AD, A7, AX7 and AX8, for which wiring schedules were just received.

1.2 System Engineering (continued)

2. All wiring and controls for these tests were checked out and recorded, except for relay circuits.

3. Service strips (AC) in the A racks were connected temporarily. The balance of these service strips are wired but not cut in until permanent unregulated power is available.

4. WWI power control panel and lab power panel were installed.

5. Cables for unregulated AC power from power room to computer room were run.

B. Work to continue or to be started:

1. Twist lock and lab power circuits where air-in ducts permit.

2. Regulated AC for computer room needs.

3. Lumiline lighting circuits.

4. Wiring in "C" row as schedules permit.

C. 1. Men available for computer installation 8

2. Men available for power room installation 2

3. Students also available 2

1.21 Power Control & Distribution

(R. E. Hunt)

The following drawings are in process at the present time.

1. Filament Sequencer - laid out. Is now in drafting departmen about 50% complete. All parts have been ordered.
2. Filament Sequencer Schematic - done but not yet checked.
3. Power Supply Control Panel Details - done and are now being manufactured.
4. Power Supply Control Schematic - now being revised in drafting department.
5. Cabling Diagram - Power Supply Control - ready for drafting.

1.21 Power Control & Distribution (continued)

Other drawings being laid out at present:

1. Cabling diagram - Plate voltage supply and control.
2. Schematic - Plate Supply Alternator Regulator.
3. Schematic - Plate Normal - Emergency Contactor.
4. Schematic - Filament Normal - Emergency Contactor.

1.23 Video Cabling

(R. W. Murch)

All video cables for arithmetic control, except those from central control have been measured and information sent to Sylvania for their construction.

Central control cables to arithmetic element register drivers are being added to drawing SR-40182. These will be measured along with central control cables to arithmetic control as soon as enough information on central control becomes available.

Assembly drawings for all cables measured have been made.

We have received all B-register and A-register horizontal video cables from Sylvania. Installation of these will be completed as soon as power wiring in racks A7 and AD is finished.

1.3 Auxiliary Equipment

1.31 Power Supplies

(J. J. Gano)

Synchronous Motor Regulator - The regulator for the 115 volt a-c laboratory supply is now in continuous operation with breadboard control and protective assemblies. If the overvoltage, undervoltage or overload setting is exceeded, the controls shut down the motor and short the line reactors, giving the laboratory unregulated voltage.

WWI Filament Power - Provision has been made to supply the filament power from one phase of the alternator intended for the plate supplies. The voltage may be raised gradually by manual operation of exciter field rheostats located in the power room. At full voltage it is regulated. This source

1.31 Power Supplies (continued)

for the filament power will be maintained until the alternator and drive motor intended for that purpose are installed. Meanwhile the plate supplies will receive their power from the 208 volts, 3 phase unregulated line.

(C. R. Wieser)

Test Power for Arithmetic Element - A-c and d-c power connections have been made to the +250, +150, +120, +90, and -150 volt supplies. These connections are permanent.

A Raytheon 10 amp unregulated supply has been temporarily connected to furnish +48 volt relay power.

Work is under way to build a regulator to drop the -150 to -15 volts (500 ma) for temporary bias supply. A similar -30 volt supply (100 ma) will follow.

WWI Filament Power - The exciters for motor and generator of the permanent filament motor generator set will be belt driven from the 100 H.P. motor since this is the most compact arrangement. Drawing for mounting plates are being made.

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-32385	E-32333-3
102 Program Counter	B-37062-4	B-32213-1	D-31516-4
103 Program Register	B-37067-2	B-39289-1	D-31276-8
104 Control Switch	B-37066-3	T60CS00-4-C	Z60CS00-A W60CS00-1-A Z60CS00-2-A
105 Operation Matrix		S600M00	Z600M00-1-C
Control-Pulse Output		R60CP00	S60CP00-1-B
106 Time-Pulse Distributor	B-37068-3	T60PD00-8-B	
106 Time-Pulse Distributor Counter		T60PD00-3-A	Y60PD00-C
106 Time-Pulse Distributor Output		T60PD00-4-B	Z60PD00-1-B
109 Clock-Pulse Control	B-39817-1	C-32642-2	R-31916-3
110 Frequency Divider	A-37154-1	B-32264-1	R-31729-1
111 Synchronizer	---	---	---
112 Restorer-Pulse Generator	A-37160	B-32209-3	D-31909-6
200 Storage	C-37156-1		
201 Storage Switch	B-37121-1	B-32855 T60CS00-4-C	Z60CS00-A Z60CS00-2-A E-32830-1 R-32722-1
202 Toggle-Switch Storage	B-37122-3		E-32711
202 Toggle-Switch Storage Output	C-37156-1	C-32080	E-32721-2
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	A-37061-6	D-32106-1	

WWI Drawing List	Block Diagram	Block Schematic	Circuit Schematic
301 A-Register, Digits 1-15	B-37056-2	B-31211-3	D-31276-8
301 A-Register, Digit 0	B-37056-2 B-37072-7	B-31574-1	D-31573-2
302 Accumulator, Digits 1-14	B-37063-5	D-31213-3	R-31275-4
302 Accumulator, Digit 0	B-37096-5	D-32851	R-32850
302 Accumulator, Digit 0, Aux. Panel	B-37096-5	B-32492-2	D-32602-1
303 B-Register	B-37097-3 B-37069-3	B-31212-3	D-31277-5
304 Sign Control & 308 Divide-Error Control		C-31576-3	E-31619-1
305 Step Counter	B-37074-5	D-31828-1	D-39764-1
305 Step Counter Output		A-32723-1	D-32735-1
306 Multiply & 307 Shift Control		C-31532-3	E-31588-4
308 Divide Control		C-31552-2	R-31718-4
309 Special Add Memory & ACO Carry		C-31575-4	E-31632-1
310 Point-Off Control		C-31600-6	E-31717-4
403 In-Out Register	B-37119-2	B-32434-1	D-31277-5
404 Comparison Register	B-37120-2	B-32578-1	E-32576-2
601 Check Register	B-39816-2	B-32577-1	E-32576-2
601 Check Register Check		B-32018	E-32023
Bus Driver, Arithmetic Element		A-32297-1	D-31727-6
Bus Driver, Flip-Flop Storage		A-32296-1	D-31726-6
Register Driver, Type I		B-32207-1	E-32261-3
Register Driver, Type II		A-32691-2	D-32690-2
Fuse Indication Panel			W60PP00-7-D
Voltage Variation Panel			W60PP00-6-B
WWI Power-Connector Pin Connections			B-31955-5

Installation drawings and their status are as follows:

	Drawing	Status	Drawing No.
1.	Master Installation WWI	Up to date.	R-32129
2.	Installation F0-F15 Flip-Flop Storage	Complete except for cabling and hardware.	E-32181
3.	Installation AX-7 Arithmetic Control	Complete except for hardware.	E-32137
4.	Installation AX-8 Arithmetic Control	Complete except for hardware.	E-32136
5.	Installation A0-A15 Arithmetic Element Bay	Complete except for hardware.	E-32135
6.	Installation AD Arithmetic Driver Rack	Complete except for hardware.	E-32134
7.	Installation P1 Fixed Voltage Switching	Complete except for hardware and power connections	D-32155
8.	Installation P2 Digit Interlock Rack	Complete except for hardware and power connections.	D-32156
9.	Installation P3 Fuse Indication Rack	Complete except for hardware and power connections.	D-32157
10.	Installation P4 Fuse Indication Rack	Complete except for hardware and power connections.	D-32158

The following racks have had panels located only.

11.	Installation P7, Voltage Variation Rack	D-32161
12.	Installation P8, Voltage Variation Rack	D-32162
13.	Installation P9, Panel Selection Rack	D-32163
14.	Installation P10, Voltage Variation Rack	D-32164
15.	Installation P11, Voltage Variation Rack	D-32165
16.	Installation P12, Voltage Variation Rack	D-32166
17.	Installation P13, Voltage Variation Rack	D-32167
18.	Installation P14, Voltage Variation Rack	D-32168
19.	Installation FD, Flip-Flop Storage Driver Rack	E-32182

The following rack installation drawings are being worked on at present:

1. C-14
2. C-15
3. P-5

2.0 WHIRLWIND I RESEARCH

2.2 Components

2.23 Vacuum Tube Studies

(R. L. Ellis)

Only a few 6J6 tubes have been tested for test equipment, but these results show extreme variations. Individual tubes vary over 100%. The halves vary as much as 30%.

The highest percentage of tube failures is now among the 5687 tubes. Low emission is the most common cause for failure in circuits. Gas tests may prove a means of pre-selecting these tubes.

A report on tube failures to date will be ready in the near future.

The recent shipment of 100 6AN5 tubes are now under test. The JAN Specification tests are being used and the results thus far are very satisfactory.

420 tubes are being prepared for Test Equipment Register Panels and Gate and Delay Units.

Curves of tube characteristics for the Drafting Room collection will be ready early next week.

(N. H. Taylor)

Some work on testing 7AK7's in the positive grid region is underway. Certain circuits have given trouble when tubes with a decreasing characteristic in the positive region are used in them. As production lots vary in this regard, a new test will be used to separate those tubes not suitable for these more critical circuits.

Thirteen 7AK7's out of a special lot of twenty-five were preburned on a rigorous basis for 140 hours to check for slump in plate current. Four tubes failed due to gas in one-half hour, two more failed at about 40 hours, the rest leveled off after thirty minutes and seemed stable at a plate current about 10% above previous production lots. We are questioning Sylvania, Emporium, on the high mortality

2.23 Vacuum Tube Studies (Continued)

rate of this lot and also what they did to achieve the higher initial plate current.

(H. B. Frost)

Some work on pulse testing of 7AK7 tubes has been done within the last two weeks. Although the results were promising, complete correlation between pulse tests using 0.5 μsec pulses and gate circuit operation was not obtained. Plans for an improved version of the present breadboard pulse tester have been drawn.

2.3 Systems

2.31 Five-Digit Multiplier

(K. S. Rich & B. Frost)

A failure of a bias generator and some changes in power distribution to the test equipment have interrupted the work on marginal checking during the past two weeks.

Some more data on checking FF's has been taken. Triggering the FF's from one position to the other at a rate of 1000 to 2000 per second seems to be the most satisfactory method. In normal operation, then, both indicator lights are equally illuminated so a sticking or stalled condition causes one light to be extinguished.

Intermittent errors were being produced as a result of positive bias being built up on a buffer amplifier by negative overshoot on its input pulses. Small changes in supply voltages were sufficient to cause large changes in this bias. It was found that raising the screen voltage on the buffer with the marginal checking equipment was effective in producing a permanent failure in this case.

The control circuits of the multiplier have been changed and the new system appears to be operating satisfactorily. A binary divider and standard test equipment are used. The multiplier can now be operated with either 16 or 32 microsecond restorer periods and a solution repetition period twice that of the restorers.

The power distribution to the test and control equipment has been changed to allow variation of the supply voltages for marginal checking purposes.

3.0 SPECIAL CIRCUITS

3.2 Test Equipment

3.21 Standard Test Equipment

(H. Kenosian)

It has been planned to insert bus driver crystals in the output transformers of all test equipment. The crystals remove the exponential decay due to pulse transformer low-frequency response, and also remove negative overshoot from the pulses. In addition, the crystals allow mixing the outputs of test equipment.

The main disadvantages are that the output amplitude is reduced by about 18%, and a d-c termination is required.

To date, all equipment with built-in pulse standardizers have crystals in the output circuit, namely the pulse standardizer, coder, delay-line panel, pulse mixer, and the modified gate and delay unit.

(R. L. Massard)

Video Amplifier: The latest model amplifier has been successfully lined up. The bandwidth is 27 mc., the gain is about 130 and it gives over 2 inches deflection. Three more amplifiers are in the process of being built and lined up.

3.22 Special Test Equipment

(R. W. Read)

A circuit is being built to study tube characteristics under saturated conditions. It is hoped that the use of this equipment will throw some light on the interface problem.

4.0 BLOCK DIAGRAMS

(J. M. Salzer)

Memoranda M-718 and M-722 are informative. The former describes a refinement in the Check Register, while the latter explains the role of Special Clear and Computer Complement push-button pulses in testing.

Coinciding with the present design of the Synchronizer, its requirements were investigated. To avoid the possibility of ambiguous operation, it was found expedient to incorporate a separate circuit for the "Change to Push-button" pulse. This necessitates the addition of one blocking oscillator to the circuit. M-720 is a full discussion of the problem.

(J. M. Salzer and R. P. Mayer)

At the initiation of J. A. O'Brien, the block diagrams of the Input-Output and Comparison Registers and associated checking circuits were investigated. The proposed plan appears to give a close check on both recording and reading with the use of a small number of flip-flops and gates. The problem of synchronization and restoration, however, is not solved yet and it promises to be a difficult one.

In conjunction with G. G. Hoberg the problem of alarm indication for the temporary test setup was investigated. It was found that the indications of the alarm circuit flip-flops would be ambiguous, even after modification of cabling. If a definite indication of the source of the alarm is needed for the operator, it will be necessary to use the alarm pulses themselves. With the use of test equipment and perhaps a matrix, a temporary setup may be put together.