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Memorandum H-706

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Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, MassachusettsSUBJECT: BI-WEEKLY REPORT, PART I, NOVEMBER 26, 1948

To: 6345 Engineers

From: Jay W. Forrester

1.0 WHIRLWIND I COMPUTER ELEMENTS1.1 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
32	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

111 Synchronizer

(A. K. Susskind)

A push-button pulse synchronizer suggested by J. A. O'Brien is being developed. Imperfect switch action (chatter) has been found troublesome. It is hoped that either a better switch can be obtained or a compensating network designed. The latter appears promising but has not yet been investigated fully.

203 Flip-Flop Storage

(R. H. Gould)

The test specifications for the flip-flop storage register and flip-flop storage output are finished and awaiting final approval.

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300 Arithmetic Control

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

Testing of the divide control panel has been completed.

An omission has been discovered in the point-off control portion of the block diagrams. As indicated in H-705, an extra tube is now required on the point-off control panel. Drawings are being modified.

Testing of the step counter is progressing satisfactorily.

(N. H. Taylor)

An effort to start testing on the arithmetic element and its control during the next two to three weeks necessitates the early completion of all video cables and power supply wiring directly associated with this portion of the computer. Wherever this is not possible compromise wiring and cabling will need to be provided.

601 Check Register

(J. A. O'Brien)

Testing of the prototype of the check register is under way and the unit should be released for production the first of next week.

(K. E. McVicar)

Test specifications for the check register panel are being written and should be ready for approval next week.

700 Operator's Console

(C. W. Watt)

A conference was held Monday, November 22, at which it was decided to postpone indefinitely any consideration of the final operator's console, as such. This is covered in memorandum H-699.

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1.2 System Engineering

(C. W. Watt)

WWI Installation -

- A. The following work was completed:
1. All A-registers and B-registers were installed.
 2. All preformed d-c cables in the arithmetic element were installed.
 3. A -register video cabling was installed.
 4. Temporary wiring in rack P1 was installed.
 5. Twisted pair a-c wiring to rows, A, E, & F was installed.
 6. All fixed voltage switching panels were installed.
- B. The following work will continue:
1. Interlock and indicator wiring to the racks.
 2. Lumiline light wiring.
 3. Wiring of main power supplies.
- C. The following will begin:
1. Power wiring to temporary console.
 2. Permanent wiring of power racks.
- D. Eight men worked on system installation last week. Two men worked on the power supply installation, and two students were available.

1.21 Power Control & Distribution

(R. E. Hunt)

Filament Power Sequencing - Layout work is now being done on the filament power sequencer for power-supply control.

The majority of components have been located and ordered. Layout and drafting will probably require another two weeks.

Power Supply Control - This design is now being checked and minor drafting changes are being made. Construction will start in another day or two.

1.23 Video Cabling

(C. W. Watt)

1. A-register video cabling has been installed.
2. A numbering system for cabling schedules has been set up. See Memo H-703.

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1.23 Video Cabling (continued)

(R. H. Murch)

The video cabling block schematic SR-40182 has been revised to agree with the new panel locations in racks C7 to C15. Video cable master schedules for cables shown on this drawing are being revised. Measurement of the lengths of video cables required will be completed by next Wednesday.

Information for the construction of the main bus cables between flip-flop storage and the arithmetic element is being sent to Sylvania today.

1.3 Auxiliary Equipment

1.31 Power Supplies

(C. R. Wieser)

WVI Filament Power - A 100 H.P. synchronous motor suitable for driving the plate alternator has been received by the vendor and should be delivered here next week. Since this motor is somewhat smaller than the one originally specified, it will be necessary to make adaptors for mounting it and coupling it.

The 300-ampere contactor has been modified for use as a normal-emergency switch and set in place.

The drive-motor panel and starting compensator have been mounted.

Installation of the emergency transformers and the drive motor will proceed as manpower permits.

(J. J. Gano)

Synchronous Motor Regulator - Stock d-c relays were tested for use as undervoltage and overvoltage devices and found satisfactory for temporary use. A protective circuit using the d-c relays is being assembled and should be connected to the control circuit of the motor sometime next week. The regulator can then be kept in constant operation to maintain a constant voltage for the 115 volts a-c laboratory supply.

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1.32 Air Conditioning

(J. C. Proctor)

All piping has been completed and tested. Lining up the compressor motors and charging the system with Freon is all that remains to be done before putting the refrigeration system into operation. However, it has been suggested by Carrier that this might well be left until spring, as we should be able to get adequate cooling with outside air during the winter months.

The control wiring has been started, but is now held up pending receipt of a corrected drawing from Carrier.

The duct work is complete except for the connection of the main duct to the air-in ducts, which have not yet been installed by Arlex.

The work of sealing up the pent-house is under way, and will be completed as soon as possible.

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<u>WWI Drawing List</u>	<u>Block Diagram</u>	<u>Block Schematic</u>	<u>Circuit Schematic</u>
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	T60P000-8-B	
106 Time-Pulse Distributor Counter		T60P000-3-A	Y60P000-C
106 Time-Pulse Distributor Output		T60P000-4-B	Z60P000-1-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-37122-2		E-32711
202 Toggle-Switch Storage Output	C-37156-1	C-32080	E-32721-2
203 Flip-Flop Storage Output	B-37060-4	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-37061-5	D-32106	

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<u>WVI Drawing List (continued)</u>	<u>Block Diagram</u>	<u>Block Schematic</u>	<u>Circuit Schematic</u>
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	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-31576-2	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-31718-3
309 Special Add Memory & ACO Carry		C-31575-3	E-31632-1
310 Point-Off Control		C-31600-5	E-31717-3
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
WVI Power-Connector Pin Connections			B-31955-4

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Installation drawings and their status are as follows:

<u>Drawing</u>	<u>Status</u>	<u>Drawing No.</u>
1. Master Installation WWI	Up to date.	R-32129
2. Installation FO-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 AO-A15 Arithmetic Element Bay	Complete except for hardware.	E-32135
6. Installation AD Arithmetic Driver Rack	5 video troughs unknown hardware incomplete.	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

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

1. C-14
2. C-15
3. FD

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2.0 WHIRLWIND I RESEARCH2.2 Components2.23 Vacuum Tube Studies

(N. H. Taylor)

7AK7 - A modified 7AK7 has been received from Sylvania Emporium which has about 15% more plate current than previous designs. Early slump in this current leaves the tube within specifications and apparently produces a stable tube. Tests are under way to verify this design. 25 tubes are available.

(R. L. Ellis)

With the help of test equipment maintenance personnel, we will soon have all tubes used in this equipment marked and tested. Histories kept on these tubes will be useful both from the standpoint of tube studies and the maintenance of these new units.

All tubes in WWI and prototype panels are being checked before being installed to assure correct assignment and marking of tubes.

The tubes from the life test racks have been retested again. A recheck will be made on the panels and the power and the tests continued early next week.

The distribution graphs for the 600 7AD7 tubes prepared for WWI will be completed soon. A report with these graphs will then be made.

Tests on the sample shipment of new 7AK7 tubes are being continued.

We have a large backlog of work.

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Memorandum M-7062.3 Systems2.31 Five-Digit Multiplier

(E. Rich and B. Frost)

In order to obtain reasonable data from the marginal checking system on the Multiplier, the pulse amplitudes from the control panel have been reduced to approximately the values considered normal for WWI. Some minor circuit revisions were necessary to accomplish this.

Some data on the marginal checking of flip-flops has been taken. It is not sufficient to allow definite conclusions to be drawn regarding the effectiveness of the checking method (raising screen voltages on the off tubes). More information has to be obtained on the effect of trigger amplitude, tube conditions, loading, etc. A flip-flop having a badly deteriorated clamping crystal was found however by these tests. The back resistances of all clamping crystals have now been measured.

The existing relay error-counter and the new single-error counter system have been set up so they can be left on at night and over weekends.

A change in the control circuits of the Multiplier is being considered. It is proposed to use a binary counter circuit for frequency division in place of the Scope Synchronizer and to use gated clock pulses for the control pulses rather than those obtained from the present Periodic Program control. These changes will eliminate multivibrator delay circuits which appear to be a source of many errors. In addition, these changes will make it possible for problem solutions to be done at a considerably higher repetition rate.

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3.0 SPECIAL CIRCUITS

3.2 Test Equipment

3.21 Standard Test Equipment

(H. Kenosian)

Cathode Follower Probe: Special high frequency resistors have been ordered in an attempt to improve the high-frequency distortion of the probe attenuators. This distortion has been noted by other groups but no solution has yet been published. Apparently spurious capacitance between components causes the trouble.

(R.W. Read)

A three-stage D.C. amplifier has been developed to amplify and invert the gate output of a gate and delay unit. It produces an output which is variable up to 160 volts amplitude. It is insensitive to p.r.f., and to wide variations in input amplitude.

(R.L. Massard)

Video Amplifier For Model 5 Oscilloscope: Tests in the process of lining up the latest model amplifier show that it will definitely pass a 0.02 μ s, rise time and possibly better. The results are very encouraging. This betters the modified Henry Amplifiers by quite a factor. The gain is about the same in the two types. A power supply has been designed for the latest amplifier.

(R.L. Best)

A new scope synchronizer is being designed; anyone having special features they would like to see incorporated in it should contact R.L. Best.

At present writing, plans are to provide a Standard Pulse Output (30V) in addition to a synch. pulse (150 volts). The output delay is being increased to 100 μ sec. More flexibility of control and wider frequency coverage is being provided.

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4.0 BLOCK DIAGRAMS

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

Conference Note C-66 was issued for the purpose of standardizing short-hand notations in coding and symbols in flow diagrams.

Conference Note C-67 illustrates the coding of finding trigonometric functions of a number.

Memorandum M-698 proposes modification of the shift orders (sl and sr) and the introduction of a new order (ml, miscellaneous). Both suggestions make use of the address section of the orders to extend the functions of the operations. The modified shift would enable the coder to shift with or without rounding off, whereas at present these orders always cause roundoff. The "miscellaneous" order would allow one to perform a number of functions within the arithmetic element without reference to storage. The versatility of this order is great because the coder can choose the desired functions by inserting the proper address.

Memorandum M-705 changes the electronics of the point-off control so that the computer will be restarted after a scale-factor (sf) operation. In similar operations the step counter and carry provided the pulse that restarted the computer. The scale factor operation normally does not produce a step counter and carry; so it must be provided artificially.

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