Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART I, MARCH 19, 1948

To: 6345 Engineers

From: Jay W. Forrester

1.0 WHIRLWIND I COMPUTER ELEMENTS

1.1 Listed by Block Diagram Number

102 Program Counter

(H. Fahnestock)

Grade II circuit schematic of program counter has been released to Sylvania for layout of prototype.

103 Program Register

(H. Fahnestock)

Grade II circuit schematic of program register has been released to Sylvania for layout of prototype.

104 Control Switch

(J. A. O'Brien)

The block and circuit schematics of the control switch will be modified to provide the facility to set the control switch to any operation by means of switches at the operator's console.

106 Time Pulse Distributor Control

(H. Kenosian)

The block and circuit schematics are being revised. The restorer and push-button pulse generators are about to be constructed in breadboard form so as to be sure that the schematic is optimum.

(D. R. Brown)

Circuit schematics are being prepared and some breadboard work will be done before these are completed. Errors have been discovered in the block diagram necessitating some revision.

107 Operation Timing Matrix

(J. A. O'Brien)

A circuit to simulate the performance of the operation timing matrix has been constructed at the Sylvania plant, and tests on this circuit, using the original model of the 32-position switch as a driver, have indicated a switching time of less than a quarter microsecond.

Extensive changes have been made on the block diagram of the computer control and work is at present concentrated on the design of a suitable package unit to include the gate and buffer tubes on the timing matrix outputs.

The operation timing matrix has been enlarged by the addition of the functions of the program timing matrix, but its design remains basically the same.

108 Program Timing Matrix

(D. R. Brown)

The program timing matrix is being combined with the operation matrix, 105, and the operation timing matrix, 107. Instead of 30 program timing matrix outputs and 80 operation timing matrix outputs, 110 identical output-units will be available which can be connected in any manner. A thirty-third wire may be added to the operation matrix.

(J. A. O'Brien)

Recent action by the Block Diagram Group has removed the program timing matrix as such from the computer and assigned its functions to the operation timing matrix.

The buffer amplifiers which were designed to drive the PTM will now be redesigned to drive half of the operation timing matrix outputs.

202 Toggle Switch Storage

(R. E. Hunt)

A seemingly suitable layout for toggle switch storage has been made. This layout fully indicates when a toggle switch is on, but keeps the vertical and horizontal spacing of the switches as small as would be feasible with the switches alone.

A prototype of a section of two registers has been built, and is in circulation for the inspection of those concerned.

202 Toggle Switch Storage (Cont'd)

(H. R. Boyd)

I have been interested in the toggle switch proposed by General Control. My understanding is that it was dropped because of the high cost - ($50.00). The present toggle switch array with mechanical indicators designed by Bob Hunt looks very good also. I would suggest, if possible, that the switch decision be made in terms of an outside supplier. It is usually more economical and quicker to use established specialists when available as in this case than to make our own designs with their consequent construction problems.

203 Flip-Flop Storage

(H. Fahnestock)

Sylvania's layout of flip-flop storage register has been approved, and we expect final drawings for the prototype April 10.

(D. R. Brown)

Flip-flop storage control is being changed to provide facility to clear or read in only right-hand-eleven or all sixteen digits.

300 Arithmetic Control

(N. H. Taylor)

The AC Zero Digit of the accumulator is being considered as a portion of the arithmetic control, and work is progressing to determine the best physical arrangement of parts in the construction of this panel. As soon as possible we will decide whether construction will be at MIT or Sylvania, depending on the extent of the departure of this AC Zero panel from a standard accumulator panel.

(G. C. Sumner)

The circuit schematic of point-off control E-31717 is undergoing final stages of drafting. It will be available for distribution in a few days. This will complete the schematics for arithmetic control proper. Layout work will be begun shortly.

301 A-Register

(H. Fahnestock)

Prototype drawings of A-register due from Sylvania March 18 were delayed for lack of drafting help. They are promised for March 23.

302 Accumulator

(N. H. Taylor)

Work is proceeding on the harnessing of power cables for the prototype accumulator, and many mechanical details are being worked out. As most of the problems in construction will be of a mechanical nature, C. W. Watt will be in charge of making all decisions which apply to these construction problems. Every effort will be made to conform with the specifications which have been agreed on for WWI construction.

Details of an electrical nature such as rerouting of wires, positions of sockets, tubes, etc., should be referred to G. Summer and he and Watt will make the decisions on these points.

(C. W. Watt)

A schedule for the building of the accumulator prototype was approved. Construction will be begun March 22nd, and it is expected that the completed prototype will be finished by April 17th. A cable layout has been completed by Dan Mach.

303 B-Register

(H. Fahnestock)

Sylvania's B-register layout has been approved and final drawings for prototype are due March 24.

601 Check Register

(D. R. Brown)

A new read-out gate tube, connected to the zero side of the flip-flop, is being added to increase the usefulness of the check register. Also, the check register control is being changed so that either the right-hand-eleven digits or all sixteen digits will be read in from the digit-transfer bus. Circuit schematic has been released to Sylvania.

1.2 System Engineering

1.21 Power Control and Distribution

(C. W. Watt)

Work on the power supply and distribution system proceeded to the proposal stage. The various subdivisions of this work as defined in Memorandum M-262 have progressed as follows:

1. Power supply and voltage regulators -- H. R. Boyd and C. R. Wieser. Schedules have been made, power supply proposal No. 1 (Memorandum M-285) has been issued, and contact with one possible supplier has been made (see letter of March 15th from H. R. Boyd to the Power Equipment Company of Detroit, Michigan).

1.21 Power Control and Distribution (Cont'd)

2. Voltage variation panels -- Anderson of Sylvania. A schedule has been received and a preliminary proposal has been made (see Sylvania memorandum "Preliminary Proposal for Power Distribution Panels and Fuse Loss Indication Circuits" from Anderson dated March 16, 1948).

   Certain information that Sylvania lacked has been supplied by Watt in Memorandum M-269 and Memorandum M-302.

3. Stepping relays for marginal checking -- E. S. Rich. A schedule has been made and a proposal has been submitted (see Memorandum M-294 "Proposed Panel Selection Circuit").

4. Cabinets, terminal strips, and fuse mounting -- Wainwright of Sylvania. A schedule has been received, and proposal drawings were submitted for inspection. Certain information that Sylvania lacked has been supplied by Watt in Memorandum M-269 and Memorandum M-302. Drawing SD-39606 illustrating one possible way of installing the terminal strips and fuses in the racks was submitted to Sylvania for their consideration.

5. Inter-cabinet power cabling -- C. W. Watt. A schedule has been made and a power cabling proposal has been written. It will be issued March 22nd as Memorandum M-312.

Investigation of components to be used in all of these various parts of the power distribution system is proceeding. It is expected that during the next two weeks the various proposals will be acted upon, and by April 2nd the power distribution system should be completely defined.

(H. S. Lee)

An investigation was made to determine the number of power control panels the current load on each panel and the number of terminals per rack for the arithmetic elements and flip-flop storage-input-output registers. This information was given to F. Anderson, E. Hanke and H. Wainwright of Sylvania in order that design of the power control panels could be initiated and the rack design finalized.

In addition, E. S. Rich and C. R. Wieser have been furnished with data pertaining to their respective areas of interest in connection with the design of the power control and distribution system.

(H. R. Boyd)

Considerations on the console during the past week would indicate that a standby-on switch should be provided for power control at the console. In addition to this, two power panels seem to be desirable; one to be located on the second floor with the computer and the second in the power supply room in the basement. These panel boards would be duplicates and include volt-

1.21 Power Control and Distribution (Cont'd)

meters and ammeters for each voltage plus means for turning off each supply independently. A built-in oscilloscope for measuring ripple and provisions for starting the synchronous condenser and a 400-cycle alternator might be desirable but do not seem necessary.

1.22 Power Cabling

(H. S. Lee)

An analysis and calculation has been completed covering the wire sizes and amounts required for interconnecting the power control panels with the arithmetic elements and flip-flop storage input-output registers. Also coordination has been effected with R. Hunt with a view to selecting and specifying the wire, terminals, connectors and other equipment needed for the installation of the power cabling.

A proposal, covering the system design and equipment specifications, will soon be published in a memorandum. Although the proposal will encompass the tentative design and specifications for the entire WWI power cabling installation a determination of wire sizes and amounts for the entire system must be held in abeyance pending more detailed information on circuit design and marginal checking requirements for the other elements of WWI.

The analysis cited in the first paragraph above indicates that interconnecting the three elements (Power Control Panels, Arithmetic Elements and Flip-Flop Storage--Input-Output Registers) will require approximately fourteen (14) miles of wire.

(R. E. Hunt)

An investigation in conjunction with H. Lee is in progress, on cabling wire, connectors and wire coding devices.

The selection of cabling wire has been narrowed down to two types of wire which are:

1. Boston Insulated Wire Co's, Radio Hook Up Wire, a neoprene insulated wire with a woven fabric cover with a coating of fireproof lacquer. This wire is considered superior to all others of this type by the M.I.T. Wire Testing Lab.

2. Rockbestos, Aircraft or Radio Hook-up Wire. These wires are insulated tape wound, with an asbestos firewall, and rayon or cotton covered with a coat of fireproof lacquer.

The Rockbestos Wires are superior to the B.I.W. type on every count excepting that of abrasive resistance qualities. The cotton covered Rockbestos, however, has very good abrasive resistance qualities, but is slightly stiffer than the B.I. W. wire.

1.22 Power Cabling (Cont'd)

An investigation of terminal connectors is still in progress. A suitable tee connector has not yet been found.

An investigation of wire code marking systems and machines to code mark plastic sleeves is in progress; also a tentative wire code has been worked out.

1.23 Video Cabling
(C. W. Watt)

Sylvania presented another method of installing video cables for our consideration which seemed considerably better than the method which was criticized in Memorandum M-265 and which showed that design progress is being made.

1.24 Driver Panels
(N. H. Taylor)

The bus driver panel schematic is being drawn, and should be available by March 21st for delivery to Sylvania. It has been decided to make two types of bus driver panels, one for the use in the arithmetic rack, and the second for use in the flip-flop storage rack. Sylvania will make the video layouts for these panels.

1.25 Time Schedules

(R. A. Osborne)

Following is a list of the Whirlwind I Time Schedules, together with their number, the name of the person responsible for the schedule, and the name of the coordinator.

Schedule Title	Number	Person Responsible	Coordinator
Repetitive Elements (Sylvania)			
A-Register	C-31638	N. Taylor	
B-Register	C-31639	N. Taylor	
Accumulator	C-31640	Watt	N. Taylor
Flip-Flop Storage Register	C-31641	D. Brown	
Flip-Flop Storage Output	C-31642	D. Brown	
Bus Drivers	C-31643	Rowland	N. Taylor
Program Register	C-31644	D. Brown	
Program Counter	C-31645	D. Brown	
Check Register	C-31646	D. Brown	
Input-Output Register	C-31647	D. Brown	
Comparison Register	C-31648	D. Brown	
Non-Repetitive Elements (Sylvania)			
Control Switch	C-31649	J. A. O'Brien	D. Brown
Operation Matrix	C-31650	J. A. O'Brien	D. Brown
Program Timing Matrix	C-31651	J. A. O'Brien	D. Brown
Time Pulse Distributor	C-31652	J. A. O'Brien	D. Brown

Register Drives Summer Taylor.

1.25 Time Schedules (Cont'd)

Schedule Title	Number	Person Responsible	Coordinator
Non-Repetitive Elements (Sylvania) cont.			
Time Pulse Distributor Control	C-31653	H. Kenosian	D. Brown
Master Clock	C-31655	H. Kenosian	D. Brown
Flip-Flop Storage Gate Driver	C-31656	C. Rowland	D. Brown
Arithmetic Gate Drivers	C-31657	C. Rowland	N. Taylor
Input-Output Gate Drivers	C-31658	C. Rowland	N. Taylor
Toggle Switch Storage	C-31662	J. A. O'Brien	D. Brown
Storage Switch	C-31663	J. A. O'Brien	D. Brown
Trouble Location Racks (and TSS Control)	C-31664	C. Watt	D. Brown ?
Operator's Console	C-31665	C. Watt	R. Everett
Input-Output Register Control	C-31666	D. Brown	
A-Register End Digit	C-31667	N. Taylor	
Accumulator End Digit	C-31668	Summer	N. Taylor
Others			
Arithmetic Control	C-31654	Summer	N. Taylor
Storage Tube Construction, Full Size 5"	C-31669	Dodd	J. W. Forrester
Storage Tube Research	C-31685	Dodd	J. W. Forrester
Storage Tube Deflection Circuits	C-31683	Ely	J. W. Forrester
Storage Tube Output Circuits	C-31670	Campling	J. W. Forrester
Summary of Power Installation	C-31688	C. W. Watt	
Power Distribution Panels	C-31671	Anderson	C. W. Watt
Power Supplies (subcontract)	C-31672	H. R. Boyd	C. W. Watt
Power Cabling (intercabinet)	C-31674	C. W. Watt	
Stepping Relays (marginal checking)	C-31675	E. S. Rich	C. W. Watt
Video Cabling	C-31676	C. W. Watt	
Racks (cabinets)	C-31677	Wainwright	C. W. Watt
Input-Output (Eastman)	C-31678	H. R. Boyd	J. W. Forrester
Air Conditioning of Computer Room	C-31681	Proctor	J. W. Forrester
Preparation of Computer Room	C-31682	Proctor	J. W. Forrester
Test Equipment	C-31679	R. Everett	J. W. Forrester
Trouble Location Methods	C-31684	Hoberg	R. Everett
Servo & Simulation Research	C-31680	Wieser	J. W. Forrester

1.3 Auxiliary Equipment

1.31 Power Supplies

(H. R. Boyd)

The power supply requirement for Whirlwind I is proving more difficult than originally anticipated. The problem revolves around the fact that in the computer the load goes from substantially no-load in many circuits to full-load in a few microseconds. The need for high-speed response has caused an abandonment of motor generator sets as rectifier means, at least for the high-current circuits with several load variations. At present, consideration is being given to getting line isolation by means of a 400-cycle, 3-phase alternator and doing the rectification with a 6-phase grid-controlled thyratron rectifier.

1.31 Power Supplies (Cont'd)

Discussions on this matter are being carried on with the Power Equipment Company of Detroit who built the IBM Calculator supplies and are also a regular supplier for Western Electric and Bell Laboratories. Their experience would indicate that the filter needs to be almost entirely capacitative. These factors indicate that the ripple and regulation requirements for the high-current supplies should be relaxed as much as possible, and that power requirements for deflection circuits in storage tubes should be considered as a separate problem. The power supply problem is now being pursued along these lines.

(C. R. Wieser)

Reconditioning and delivery of the 75HP synchronous motor has been delayed by lack of a purchase order.

Preliminary study of the problem of regulating and filtering d-c machines for power supply indicates that ripple and regulation specifications cannot be met without using prohibitively large filter capacitance.

(H. S. Lee)

Subsequent to the previous Bi-Weekly Report, Engineering Note E-105 has been published. This summarizes the results of the analysis of the AC and DC power requirements for WWI.

(N. H. Taylor)

The test equipment committee has under consideration the problem of power supplies at Sylvania and the resultant effect of their design on test equipment performance.

Sylvania will study the existing situation on AC line voltage variations. Regulation of some sort will be needed to perform adequate tests of the WWI equipment. Sylvania already has procurred one 250 volt 20 ampere rotary machine 150 volt low current generator. They also have a 150 volt 10 ampere electronic supply available.

1.33 Cabinets

(C. W. Watt)

Drawings showing cabinet construction were made by Wainwright of Sylvania and looked very good. Detailed design is proceeding at Sylvania.

A question has arisen whether or not special racks will be required for use with permanent installations of WWI standard test equipment in the computer itself. Some decision should soon be reached by the test equipment group as to the size of panel that will be used for the standard test equipment. If 19" panels are used, permanent installation of such test equipment in parts of

1.33 Cabinets (Cont'd)

of the computer will not be uniform in appearance with the rest of the machine and laboratory size racks rather than the computer size racks will be required for mounting them.

(R. E. Hunt) Rack Power and Fusing Panel.

This panel has been laid out using Telephone Type indicating fuses, and standard Jones Strips and connectors under sketch SD-39

The proposal was accepted by M.I.T. and Sylvania and forwarde to H. Wainwright of Sylvania for further development.

A contemplated panel incorporating special indicating fuses has been more or less dropped. Waltham Horological Co. will still submit a proposal on these fuses,but unless they are exceptionally good in all respects, the panel incorporating them will not be developed.

It is felt that the use of special fuses would lead to replacement difficulties.

1.4 Unclassified

Test Equipment Truck

(R. E. Hunt)

A proposed test equipment truck has been laid out, and several proposals have been received.

A memo will be issued in a day or two setting forth the proposal.

(H. Fahnestock)

WWI Drawing List

WWI Elements		Block Diagram	Block Schematic	Circuit Schematic
302	Accumulator		D-31213-1	E-31275
301	"A" Register		B-31211-2	D-31276-3
303	"B" Register		B-31212-2	D-31277-1
601	Check Register	C-37065-2	B-39288	D-31515-1
104	Control Switch			SC-39492
308	Divide Control		C-31552	R-31718
308	Divide Error Control		B-31576	E-31619
203	Flip-Flop Storage		SD-39278-1	
203	Flip-Flop Storage (Output)	B-37060-3		E-31635-1
203	Flip-Flop Storage (Register)	C-37057-2		E-31621-1
~~400~~	~~Input Registers~~	~~A-37116-1~~		
101	Master Clock	B-37058-1		SD-39545
306	Multiply		B-31532-1	E-31588
105	Operation Matrix	C-37077-3 C-37078-2		
107	Operation Timing Matrix	C-37077-3 C-37078-2		
~~500~~	~~Output Registers~~	~~A-37117-1~~		

N.B. Study arrange - in numerical order.

403 In-Out Register C-37119 (BD)
404 Comparison Reg. C-37120 (BD)-1

(Cont.)

WWI Elements	Block Diagram	Block Schematic	Circuit Schematic
310 Point Off		B-31600	E-31717
102 Program Counter	B-37062-2	B-39291	D-31516-1
103 Program Register	B-37067-1	B-39289	D-31514-1
~~108 Program Timing Matrix~~	~~B-37075-2~~		
307 Shift		B-31532-1	E-31588
304 Sign Control		B-31576	E-31619
305 Step Counter	C-37074-4		
309 Special Add Memory		B-31575	E-31632
200 Storage	B-31150		
201 Storage Switch		C-31152	SC-39492
106 Time Pulse Distributor	B-37068-2	T60PD00-8	W60X6A00
106 Time Pulse Distributor Control	D-31387	D-31636	

2.0 WHIRLWIND I RESEARCH

2.1 Circuits

2.11 Flip-Flop Design and Stability

(N. H. Taylor)

Considerable discussions of the flip-flop circuit design haveresulted in a modification of the flip-flop circuitry on the DC flip-flop. As soon as this design is complete some models will be built and tested very thoroughly. If possible, this new design will be incorporated in WWI panels between the prototype and production models. This circuit will change the value of some of the components in the flip-flop, and will use a different voltage source. However, the present video layout should be adequate and will change the panel very little.

(R. L. Best)

A new DC flip-flop has been designed, and is being built in breadboard form. It is hoped that, in this circuit, the "on" tube will have about 2.8 volts bias, and the "off" tube about 19 volts bias. This will allow the tube to age without having its grid go positive, so that the cathode voltage will be kept more constant through cathode follower action. Both plate and screen supplies are 250 volts.

(W. P. Horton)

Preliminary tests on the AC Flip-flop rack indicate that nothing at all will be learned about reliability if the rack is operated from the regular laboratory power supply. For this reason it was decided that regulated power supplies be used as far as possible. These power supplies have been obtained and are now incorporated with the rack.

Counter relays have been received and have been placed in the circuit. After minor difficulties are corrected in the rack, a 1,000 hour life test will be conducted. It is expected that this test period will commence Wednesday, March 24, 1948.

2.13 Bus Drivers

(C. A. Rowland)

Work is progressing on the double point gate driver and the gate amplifier. Reflections have caused considerable difficulty for the double point gate driver and it may be necessary to use an 829 in the high prf (2mc) lines.

2.16 Basic Circuits

(J. A. O'Brien)

A new engineer, Robert Gould, has been assigned to the group investigating basic circuits, and he will start on the investigation of the Bus Driver circuit.

The work on basic circuits has been slowed down quite a bit because the many different ways some of the circuits, particularly gate tubes, will be used increase the number of possible tests and modification. Therefore, the present policy is to test only the circuit as it appears in the basic diagram, and to make complete test on only one application. The circuit will be modified only when it is apparent that the circuit is useless otherwise. In this way we hope to be able to run an uninterrupted test on a circuit.

(J. M. Hunt)

Investigation of basic circuit IND-1 has indicated that the current in the indicator lamps is subject to very wide variations with circuit parameter and operating condition changes. Neon lamp current in the "on" position now varies from a value providing very low light brilliance to a value which corresponds to three times the maximum current rating of the neon lamp. Details of the tests are included in Memorandum No. M-306.

A circuit in which the indicator lamps are in parallel (in the present circuit the lamps are in series) is now being tested. Preliminary measurements indicate that the performance of the parallel indicator circuit is considerably more satisfactory than that of the existing circuit.

(R. L. Massard)

A "packaged" gate tube circuit (for use in the timing control matrix) was loaded with a "packaged" buffer amplifier and compared with a basic gate tube circuit. The output of the packaged unit was generally lower than that of the basic unit due to extra lead capacitance on the gate output. ?

It has been found necessary to use regulated supplies for the binary frequency divider being used to supply the test pulses for the basic circuit tests; the output pulse amplitude would not remain constant by any means without the power supply regulation.

2.16 Basic Circuits (cont'd)

(N. Daggett)

Consideration has been given to the proper value of resistance to be put in series with crystals across pulse transformers. Indications are that a larger value of resistance would give great improvement with respect to PRF sensitivity provided the increased overshoot can be tolerated.

2.2 Components

2.22 Pulse Transformers

(G. G. Hoberg)

An experiment with a new type core in a set of standard 1:1 pulse-transformer coils did not show the increase in low-frequency response which was expected.

The core was formed by winding a continuous strip of .002" grain-oriented hipersil ribbon into the coils so as to form a core with no air gap and with a magnetic path length 30% less than that of a standard preformed core. Resulting low frequency response for 0.1 microsecond pulses was only a little better than that achievable with standard cores made from .002" ribbon, and about 10% worse than that obtained with cores of .001" stock.

Further experiments will be conducted when additional quantities of core material of different types and sizes are procured.

A specification is being written for the 5:1 pulse transformer.

2.23 Vacuum Tube Studies

(N. H. Taylor)

The latest theory on vacuum tube deterioration indicates that a resistance is being built up in the cathode material of the tubes which have aged. Preliminary work indicates this to be the case, and further experimental work is being carried on to verify whether this resistance has been the cause of flip-flop sticking. Preliminary studies indicate that there is considerable difference between the cathode surface as supplied by different companies.

2.23 Vacuum Tube Studies (cont'd)

It is difficult to draw conclusions as to what the best long range program should be as regards cathode material in long life tubes. For the time being we shall attempt to improve circuits so that these high-resistance cathodes will not be a limiting factor in Whirlwind performance. If possible, we shall obtain tubes which do not exhibit this tendency.

(M. Hayes & J. J. O'Brien)

Extensive dc. measurements are being made on 10 good and 10 poor, aged 6AG7 tubes to determine the cause of decrease in plate current after 1500 hours of operation. The data at present indicates the possibility of an effective resistor in series with the cathode rather than the control grid.

(Ray L. Ellis)

The change is completed on the tube tester so that shielded jumper connectors are now used. This change has eliminated troublesome oscillations in testing 3E29 and 2C51 tubes.

In preparing a reserve of tested tubes, several 2C51 tubes considered failures, were made to function properly by cleaning the pins.

In preparing this reserve, it was also found that plate current for 7AD7 tubes varied widely with the date of manufacture. The average results for basic tests on several types of tubes have been made and are available.

Five 6AG7 tubes retired for weak emission and slow drifting have been made to give nearly average plate current with very little drifting by operating them at near maximum plate dissipation for three hours.

Plate current vs plate voltage and screen current vs plate voltage curves for the average of six 7AD7 tubes are about completed. There will also be cathode current vs plate voltage curves for the same tubes used as a triode.

2.3 Systems

2.31 Five Digit Multiplier

(H. Fahnestock)

E. A. Guditz will now spend full time on the multiplier.

2.31 Five Digit Multiplier (cont'd)

Sylvania's multiplier cabling proposal has been returned for certain changes in cabling. They will re-submit it for approval before starting cable construction.

(H. L. Ziegler)

Rewiring of the digit power panels has been completed and work has started on the video cabling. The multiplier will be ready for operation as soon as the cabinets are permanently installed. However, there may be some delay if it becomes necessary to rewire the neon indicator lights and the toggle-switch storage for the new control panel.

After the multiplier is returned to normal operation, the circuit improvement program will be resumed and carried to completion.

3.0 SPECIAL CIRCUITS

3.2 Test Equipment

(N. H. Taylor)

In a meeting March 19th at the Sylvania Electric Products Company, the test equipment committee discussed the method of making marginal checks on the repetitive panels at Sylvania. The committee requested Sylvania to make a proposal with adequate sketches of their plan to provide the necessary power to the variety of panels to be tested. This proposal will include a method of switching each individual voltage as required, and also a method of varying this voltage once it has been selected. The nature of this problem is somewhat different from the WWI problem as each test set-up must be capable of providing power to a wide variety of group arrangements.

Every effort is being made to expedite the design and construction of the gate and pulse delay unit. At present we have a demand for 35 of these units to be in use simultaneously by five different groups. The breadboard model of this unit is being tested. Layout and construction will follow shortly and should have a top priority.

(R. R. Everett)

The power supply changes described in the last biweekly report have been completed.

A tube test panel design by J. J. O'Brien has been approved by the Test Equipment Committee and construction of 50 has started in Al Taylor's shop.

An investigation has started of the Sylvania test equipment requirements for WWI production test. Sylvania would very much like approval of a program within the next three weeks so that necessary construction can be completed while shop time is relatively available. Proposals covering expected test equipment requirements have been received from John Terzian. Terzian is also preparing a power supply proposal of our request.

Production test video amplifier requirements are apparently met by the circuit from the 256B oscilloscope if plate voltage on the output stage is increased to +500v. Sylvania is making a prototype of such an amplifier designed to fit in the Model 5 Synchroscope and including a single tube step charger synchronizing circuit.

3.2 Test Equipment (Continued)

(H. Kenosian)

The laboratory-built test equipment has been revised to conform with the new standard voltages.

The revising of special test set-ups, breadboards, power panels, etc. were left to the discretion of the engineers using them.

It is important that all special power panels (not including the portable disconnect boxes) using the standard multiple contact switch should be rewired, otherwise high potentials will be across the low potential contacts of the switch. This change is necessary because there are high potential and low potential contacts on these switches.

3.21 Standard Test Equipment.

(H. Kenosian)

Variable Delay Pulse and Gate Generator. A breadboard model of the unit is now being tested. The breadboard was constructed similar to the proposed final model so that a prototype can be built directly from the breadboard.

3.22 Special Test Equipment.

(H. Kenosian)

Clock-Restorer Pulse Source. This unit was completed, but tests are being held up due to a higher priority item which is now being tested.

(H. R. Boyd)

Mechanical shop is now engaged in building 50 panels for tube-life studies.

4.0 BLOCK DIAGRAMS

(R.R.Everett)

A number of conferences on the subject of the operator's console have been held in the last two weeks. Attending at various times have been Forrester, Fahnestock, Watt, Brown, Sumner, J.A.O'Brien, Mayer, and Everett. Discussions thus far have concerned details of methods for starting the computer, details of the coincidence counters for the trouble-location function of the input-output register, and means for obtaining control pulses manually. Written discussions of these items will be forthcoming in the future.

The conferences have so far led to the following proposed changes in the block diagrams:

1. The Program Timing Matrix will be eliminated and its functions transferred to the Operation Matrix. The Program Timing Matrix generated those control pulses which were required for all operations and did not need to be under the control of the control switch. This arrangement resulted in a simpler control with reduced loading on this control switch output drivers and with many fewer crystals in the Operation Matrix. It was felt that these advantages outweighed the resulting loss in control flexibility.

No operations added to date have seriously disturbed this arrangement. The possiblilities for input-output control are, however, greatly increased by combining Program and Operation Matrices into one and thus making available alternative storage setup sequences. The large masses of crystals needed with the standard Operation Matrix arrangement can be avoided by adding 1 or 2 more horizontal lines to the matrix. These lines have their own buffers and are driven by arbitrary combinations of control switch outputs. The gate tubes for the setup pulses will be connected to these lines and will be held on by any operation in the selected combinations.

The changeover can be effected by adding a third rack of Operation Matrix in the proposed WW design. A subsidiary advantage obtained is that the number of spare control pulse lines is increased and all spares are made available for either program (setup) or operation timing.

J.A.O'Brien says that this change can be made without serious consequences to the control design schedule.

2. Provision will be made for turning off the power to the Operation Matrix thus turning off all gate tubes in the control lines. Selected gate tubes can then be turned on by dc lines from the operator's console. A single pulse source will then pulse all gate tubes, generating a standard pulse on selected lines.

4.0 BLOCK DIAGRAMS (cont.)

(R.P.Mayer)

Checking methods particularly for the check register itself are being investigated. A study is being made of the changes proposed during the operator's console conferences.

5.0 CHECKING METHODS

(N.H.Taylor)

It has been decided to utilize some functions of the In and Out register to perform as test equipment and the early stages of computer operation. Certain high-speed testing is necessary in order to locate trouble in the particular register, by the use of auxiliary counters and some minor changes in some of the circuitry of WWI panels themselves. These high-speed tests can be carried out by the computer itself. This method of testing will be effective and useful throughout the life of the computer. However, it does demand that a larger percentage of the computer be available before effective testing can be done on any one portion.

(E.I.Blumenthal)

Progress Report #2 has been prepared for the SM thesis of Hoberg and myself - "A Trouble-Location Scheme for a Digital Electronic Computer." Trouble-location problems (31 in number) are sufficient to isolate a trouble within the A-Register of the 5-digit multiplier.

The interpretation of answers to these problems is complicated by the fact that an internal short from control grid to ground within the complement or read-out gate tube does not always provide the same indication. For example, if the complement gate tube develops such an internal short, and the AR flip-flop switches from 0 to 1, a pulse will definitely appear at the gate tube output which can be depended upon to trigger a succeeding flip-flop; however, when the AR flip-flop switches from 1 to 0, the gate tube output pulse "probably" will not trigger a succeeding flip-flop.

The condition is therefore equivalent to that of a marginal failure. Suggestions from project engineers will be welcomed.

(J.W.Forrester)

Control Desk Operations: A series of discussions is being held on the operator's console and its use in checking and trouble location. The following have thus far been considered and will be provided

1. Marginal checking controls for automatically or manually sequencing the variation of supply voltages.

2. Computer Status - Indicators for all Flip-flops and important switch settings.

3. Starting controls - not yet specified.

5.0 CHECKING METHODS (cont.)

4. Input Equipment controls, not yet treated in detail.

5. Controls for manually pulsing any line or combination of lines in the computer.

6. Coincidence circuits to permit selection of:

   a. Any program order.
   b. Any time pulse.
   c. Any setting of the step counter.

   The coincidence can be used to:

   a. Trigger scopes anywhere in the computer room.
   b. Read out and check the contents of any machine register.
   c. Stop the computer.
   d. Recycle the computation from a specified beginning point.