SUBJECT: BI-WEEKLY REPORT, PART I, FEBRUARY 18, 1949

To: 6345 Engineers

From: Jay W. Forrester

1.0 WHIRLWIND I COMPUTER ELEMENTS

1.01 Production Report

(H. P. Mercer)

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

- Arithmetic Element (complete)
- Bus Driver, Arithmetic Element (complete)
- Program Register (complete)
- Fixed Voltage Switching Panels (complete)
- Fuse Indication Panels (complete)
- Restorer Pulse Generator (complete)
- Time Pulse Distributor Output
- Bus Driver, Flip-Flop Storage (complete)
- Register Driver, Type I (complete)
- Digit Interlock Panels (complete)
- Frequency Divider
- Operation Matrix
- 3 Flip-Flop Storage Output Panels
- 9 Fuse Panels
- 87 Control Pulse Output Units

1.02 WWI System Tests

(N. H. Taylor)

Significant progress in stabilizing the operation of the arithmetic element has been made in the last two weeks.

Introduction of a checking system has enabled the operation of a given multiplication, division, addition or subtraction to be carried on in a manner nearly analogous to Whirlwind I conditions. This type of operation has resulted in some new problems associated with the frequency response of the circuits involved. Work is now underway to improve the circuitry so that pulse amplification...
1.02 UNI System Tests (continued)

tude tolerances will be as wide as possible.

We are considering the introduction of pulse standardizing circuits in certain parts of the system as a means of improving over-all reliability. It is recommended to those designing new equipment that the pulse standardizing circuit be used generously whenever possible. This is especially desirable in circuits working at high repetition rates.

(G. C. Sumner)

By February 10 reliable high-speed division was obtained. A small design change was necessary in the accumulator to prevent incorrect operation of the carry operation. Division is now being done with 1\(\mu\) second spacing between the carry and divide-shift-left pulses. Apparently the operation can be speeded-up to 1 microsecond spacings between those pulses. As yet the timing tolerance in that case has not been determined.

The shift right, shift left, and scale factor operations were tried and operated successfully without incident.

All of the basic operations of the arithmetic element having been established, a new phase of testing was started. Up to this point a single operation was performed followed by a long wait (of the order of 1000 microseconds) to permit reading of the solution from indicator lights. During the wait period all circuits had ample time to recover from any possible effects of the short high-speed operation. The next logical step in testing was to perform a series of high-speed operations before the waiting period. To do this it was first necessary to provide a means of checking the results of each solution of a series. This was done by reading each solution into the program register via the bus and applying a check pulse to the proper gate circuits of the PR. A pulse passed through the PR indicated an error and was used to stop computation or to feed an error counter. This temporary means works well but requires reabling when the problem is changed.

When a series of multiplications was first tried, it was found that four multiplications one after the other could be done correctly. Incorrect operation was obtained on the fifth. It should be realized that the conditions of this test are more exacting than would ever be encountered in normal operation of UNI. Nevertheless, an undesirable p.r.f.
1.02 WWI System Tests (continued)

sensitivity was thereby uncovered. It was found that this p.r.f. sensitivity was in the add channel. A thorough study of this channel was made in conjunction with C. A. Rowland, and several helpful changes made. A later test showed that it was possible to multiply on each cycle of the TPD with no waiting period. During a noon-hour test 150,000,000 multiplications were made without error.

In addition to the type of testing described in the preceding paragraph, a study of signal amplitude and timing of each operation has been started. This will eventually lead to maintenance specification for WWI.

1.1 Listed by System Number

102 Program Counter

(C. W. Watt)

Mechanical drawings will be made in the drafting dept. beginning February 28. The video layout will be used as received from Sylvania.

105 Operation Matrix

(R. E. Hunt)

These panels are progressing satisfactorily.

1. The sub-aluminum panels are complete.
2. The aluminum montg.-panels are 60% complete. These panels are being held in the sheet metal shop pending modification. The silk screens have been ordered.
3. All miscellaneous mechanical components have been ordered.
4. Assembly of the phenolic panels should start in about a week. Parts lists have been made up and procurement started.
5. Drafting on the power cabling harness and final additions to the general layout should commence in a few days.
6. The scheduled completion date (4-10-49) should be met.
109 Clock Pulse Control
(C. W. Watt)

Production drawings are complete, and a construction requisition has been issued to the shop. Sheet metal work will be done next week.

(R. H. Gould)

Final assembly and cabling drawings of the WWI clock pulse control panel are being checked. They should be delivered to the shop for start of construction within the next two weeks.

The experimental model of the clock pulse control has operated satisfactorily in the test control set up but it has been necessary to feed the high frequency time pulses through a pulse standardizer because of the uneven output amplitude from clock pulse control. This is probably caused by interaction between the high frequency and low frequency time pulses. Tests will be made next week to make sure of this and it can easily be remedied if it is the cause.

110 Frequency Divider
(H. Kenosian)

Tests on the WWI frequency divider will be made this week.

111 Synchronizer
(H. S. Lee)

The circuit schematic has been completed and layout of the panel has been initiated.

112 Toggle Switch Storage Switch Panel
(C. W. Watt)

Video layout has begun and will continued for the next four weeks.

202 Toggle Switch Storage Output
(C. W. Watt)

Video layout of the panel is complete, and detailing has begun. This should be done by March 6.
204 Electrostatic Storage Control

(H. Fahnestock)

A meeting of the Electronics Group was held February 18 to discuss the electronic circuit design of electrostatic storage control. Present were H. Fahnestock, N. H. Taylor, J. A. O'Brien, and E. S. Rich.

There have been a number of proposals made for the design of electrostatic storage control. One contemplates a modification and use of already designed or existing panels such as step-counter, accumulators, B-registers, etc. Another proposal is to use a matrix type of control based on the clock pulse control philosophy and requiring d-c flip-flops. The first can probably be made to work, but is using brute force methods and will result in a design which may be uneconomical of tubes and equipment. The second is probably more elegant but uses a number of ideas which have not yet been as fully tested as the rest of existing computer design.

The Electronics Group, with the information at hand, does not feel justified in following either of these approaches to the exclusion of the other. Both designs will be worked on concurrently and a decision on which to build into W71 made at a later date. Taylor and O'Brien will work together on both approaches, with Taylor emphasising the existing-equipment approach, and O'Brien emphasising the clock-pulse-control approach. The clock-pulse-control method requires further investigation of more recently designed circuits. Beginning between now and March 1st, Best will make an evaluation of several promising d-c flip-flop designs. The design which turns out to be most desirable from the standpoint of performance and tolerances will then be put in a life-test rack similar to the tests previously made by J. J. O'Brien and Horton. Between April 3rd and April 10th the final W71 clock pulse control panel will be available. This will be given very careful and rigorous tests by Gould.

After sufficient results have been obtained from the work of Gould and Best, a decision will be made on which type of circuit elements to put into the W71 electrostatic storage control.

204 Electrostatic Storage Control

(J. A. O'Brien)

Some preliminary block schematics have been drawn
204 Electrostatic Storage Control (continued)

up for EST control using a matrix switch, d-o flip-flops and crystal gates. Investigation of the idea is continuing.

601 Check Register

(C. W. Watt)

Mechanical drawings of the panel and cable are being made and should be complete by February 25. The video layout is being used as received from Sylvania.

(H. S. Lee)

Check Register Check - The panel is now at Laminated Sheet Products Co. for engraving. A construction requisition has been forwarded to our shop for fabrication and assembly of the phenolic panel. The "Power Cable" drawing for this panel has been returned to the Drafting Dept. for revision in accordance with paragraph 4 of WTI Specification S1.111.

700 Operator's Console

(G. G. Roberg)

Test Control - An R-series report has been prepared which describes the purpose, operation, and present status of test control.

Engineering responsibility for this equipment is being turned over to G. G. Sumner.

(A. K. Susskind)

Design of an alarm indicator circuit has been nearly completed. A breadboard has been constructed which contains two separate alarm indicator circuits, a master indicator circuit which is connected to both alarm signal inputs, and a buffer amplifier which sends the alarm signals to CPC. Because delivery of required three-winding pulse transformers has been delayed, completion of the construction and final testing remain to be done, but it is expected that performance will be fully satisfactory. The completed breadboard will be used in test
700 Operator's Console (continued)

control where its use will also serve as a reliability test of the circuits employed.

Requirements for the WJ alarm indicator system are being compiled and following their establishment the WJ alarm indicator unit will be drawn up, with the above alarm circuit serving as the basic building-block.

1.2 System Engineering

(R. E. Hunt)

Installation - Installation drawings for the control bay are progressing satisfactorily.

Rack installation drawings are complete for racks C12, C14 and C15.

Drawings are complete, except for cabling, for racks C8, C9, C10 and C11.

Racks C5 and C7 are in process at the present time. These, plus Rack C6 (Toggle Switch Storage) will complete the control bay for the present.

(C. W. Watt)

During the period of February 7-18, power was shut off three full days to permit work on the power supplies and in the dangerous portions of the computer racks to proceed. During the rest of the time three men have been at work installing wiring in the flip-flop storage racks.

(U. S. Lee)

The preliminary planning for the Interphone and Synch. Pulse distribution systems has been completed and it is anticipated that it will be given to the Drafting Dept. for layout within the next week.

1.21 Power Control and Distribution

(R. E. Hunt)

Power Supply Control - The power supply control panel is now complete. Steps have been taken to insure its installation during the power shutdown next month.
1.21 Power Control and Distribution (continued)

As much work as is possible will be done in the interim.

Marginal Checking - Marginal checking control panel has been completed. Marginal checking supply and control cabling is about 80% complete. One technician will be assigned to this system until March 4. It is planned to install temporary marginal checking supply in the basement and run preliminary tests on the whole system this month.

(H. S. Lee)

Auxiliary Relay and Bias Interlock Panel - The assembly of this panel is approximately seventy-five percent complete and progress is satisfactory.

Voltage Variation Panels - Six panels of the original lot of ten have been completed and are being tested and inspected by Nickerson.

A construction requisition has been forwarded to the shop to expedite modification of the remaining 83 panels. The required modification is an enlargement of the holes through which the relay contacts protrude. This requisition is intended to fill in slack periods in the sheet metal shop.

1.22 Power Cabling

(H. S. Lee)

Drafting has been completed on the power cables for Rack C12, the revised cables for Rack C15, and the FF Register Driver Rack. These cables will be sent to our shop for fabrication by February 23 and will be installed in racks during two week power shutdown of March 4.

Gavitt has verbally informed us that the delivery of the power cables for flip-flop storage will be delayed one week. Hence, we should receive these cables on or about February 23. The cables for the voltage variation racks will arrive as scheduled, February 28.

Drafting and detailing of cables for Rack C13 will start Wed., February 23.
1.23 Video Cabling (R. H. Murch)

Mock-ups are being made of all panels in Racks C4 to C13 incl., having video connections. This will make it possible to measure about 90% of all video cables going to those panels and have them made within the next few weeks.

1.24 Driver Panels (R. E. Hunt)

Manufacture and assembly of four of these units is proceeding ahead of schedule.

1. The phenolic panels have been manufactured. Assembly will begin in the next few days.

2. All components are on hand or have been located and will be ready for final assembly.

3. The scheduled completion date on these panels is March 17. We hope to have these panels ten days early.

1.25 Time Schedules (R. A. Osborne)

The new time schedules are still in the process of being drawn up.

1.3 Auxiliary Equipment

1.31 Power Supplies (C. R. Wieser)

**TWI Filament Power** - The filament power motor-generator set has been aligned and coupled. Work on the regulator for the alternator will be started soon.

**TWI D-C Power** - New timers for the -15 and -30 volt supplies are being installed. Anode R. F. chokes are still being built and installed as time permits.
1.31 Power Supplies (continued)

The power supply control panel is complete, and plans for its installation are nearly completed. The control wiring will be distributed in the existing wireways after slight modification.

(J. J. Cano)

Test Power for Computer - R.F. chokes for transient elimination in the d-c power supplies have been tested for heating at maximum load conditions. Chokes for the +150, +120, +90 and -150 volt supplies are being installed. Chokes for the +250 and +150 supplies are being wound and should be installed next Friday.

Synchronous Motor Regulation - Drawings of the new panel have been completed. The slate panel is to be machined outside and should be delivered in time to install during the computer shutdown.
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2.0 WHIRLWIND I RESEARCH

2.1 Circuits

(J. A. O'Brien)

Crystal Gates - Some tests have been made with a crystal gate circuit with the purpose of testing it for possible application in E.S.T. Control. The circuit is the same as the connections of an output line of a matrix switch except that an additional crystal has been added and instead of it being connected to the output of a flip-flop, it is connected through a resistor to a bias voltage. The pulse to be gated is then applied across the resistor and cancels the effect of the bias; if that particular output line had been selected by the flip-flop then a pulse will appear at the output load. An inductance in series with the output load resistor is used to peak the output pulse.

(K. E. McVicar)

A three stage counter was constructed with the crystal gates and d.c. flip-flops and is currently being tested.

2.11 Flip-Flop Design and Stability

(R. L. Best)

Using the circuits on the B-register prototype, measurements are being made to determine the desirability of making any changes in the set and clear inputs of the flip-flop. Preliminary results indicate that the present circuit is satisfactory.

2.2 Components

2.23 Vacuum Tube Studies

(H. B. Frost)

During the last week, a rack of 50 7AD7's have been placed on life test. Half of these tubes are running at about flip-flop dissipation; one-half are cut off completely. Under investigation are 40 special tubes from Sylvania to uncover critical variation from L7P to B5B lots and 10 F8B WI production tubes which have not been life tested as yet.
2.23 Vacuum Tube Studies (Continued)

It has been suggested by Hytron production men that life testing for interface formation will be accelerated at filament voltages about twenty per cent high. This will be investigated, using adequate control tests.

(R. L. Ellis)

The tube card files for WVI panels have been brought up-to-date. Card histories of all tubes for which test data have been received have been completed. Likewise, a check has been made of the panel numbers and tube serial numbers against all records.

7AK7 samples, 8, 9, 10, and 11 have been tested and the graphical report made. These samples were taken from the last shipment of 1300 tubes. Their production numbers are K3P and A3P. It was noted that better than ten per cent of the tubes in these samples exceeded the maximum control grid cut-off voltage. In some cases the cut-off was twelve volts.

Tests and cards have been completed on forty special 7AD7, thirty-eight 6AH6, seventeen 5692, one hundred 7AK7, one hundred 7AD7 and twenty-five 6AK5 tubes. One hundred-five tubes were prepared and assigned to DC Register Panels.

A report on tube failures for January is now complete.

2.24 Crystal Rectifiers

(R. L. Ellis)

The IN3½ crystal rectifiers in the 32-position matrix switch were removed and tested on the laboratory crystal checker. There were 161 crystals. Nineteen crystals or 11.8% failed to meet the laboratory standards. The failures were pretty evenly distributed between the three tests. The switch had been used by so many people that the failures are not very significant.
2.3 Systems

2.31 Five-Digit Multiplier

(E. S. Rich)

It is planned to shut down the Multiplier on February 23rd for the purpose of testing the tubes and making such alterations to the power supplies and marginal checking installation as have been indicated in the initial life-test run. This test has shown that marginal checking of flip-flops in the auxiliary equipment used for control is inadequate. It can be improved by providing a variable screen supply voltage on the test-equipment power plugs and arranging for individual flip-flop screens to be switched to this voltage rather than to -150 volts as is done at present.

Power supply alterations involve rewiring three of the generators for separate excitation and possibly providing a simple regulator for the -15 volt bias supply.

This work will require about a week's time.

(R. W. Read)

The initial life test on the multiplier accumulated 255 hours during the past two weeks. Seven errors were noted.

In the first week four errors were traced to the filament voltage regulator, and the fault corrected. During the past week three failures have been noted. It is indicated they are due to associated test equipment faults. Margins on a few circuits show a steady decline.
3.0 SPECIAL CIRCuits

3.2 Test Equipment

3.21 Standard

(R. L. Massard)

Video Amplifier - All amplifiers built so far are now lined up. The peaking circuits, once adjusted, give no trouble, even when subject to tube changes. The supply voltages and screen-dropping resistors are adjustable to make up for tube current differences so that any tubes used may be operated at optimum dissipations.

An objectionable amount of hum has shown up in a number of the amplifiers. The single-ended input stage seems to be the cause of most of this type of trouble. The push-pull stages seem to be all right in this respect. A study of this condition is now under way.

The amplifier circuit schematics with latest remissions will be completed shortly (SD-33501-2).
4.0 BLOCK DIAGRAMS

(C. W. Adams)

Consideration of division test problems for use with test control has been continued. A total of seven division problems have been written out in detail. The examples were not chosen with any plan and it is doubtful that the examples are in any sense an optimum set of tests. More work is being done on this and on other arithmetic test problems.

Short methods for converting binary numbers to decimal or rational equivalents have been described in M-788.

(R. P. Mayer)

Several omissions were noticed in the multiply check problems, with the result that a total of five problems will be necessary to check the complete operation of all digits on the multiply operation. For manual checking, this resolves into 3 problems, two of which require the manipulation of the sign digit to obtain the remaining two problems. These problems do not check intermittent failures nor PRF sensitivity very well, but provide a basis for further work in the field of checking problems.

(J. M. Salzer)

Two new block diagrams were made and sent to the drafting room: Synchronizer and AC O Carry and Special Add Memory. The block diagrams of the Time Pulse Distributor, the Check Register and the Master Clock were brought up-to-date.

To determine the required number of alarm circuits a survey was made of the possible sources of alarm. These are listed here for possible comments or additions:

1) Arithmetic Check  GT 600.04
2) Divide Error  GT 308.03
3) Transfer Check  GT 601.07
4) Check Register Check  GT 601.06
5) Input-Output Check  GT 404.07
6) Comparison Register Check  GT 404.06
7) Power

In addition, the problem of electrostatic storage is being investigated. It is possible that certain features peculiar to ES will have to be continuously checked so that their failure causes an alarm directly.
5.0 CHECKING METHODS

(N. H. Taylor)

The first meeting of a new group to consider checking and trouble location methods in the Whirlwind computer has been held.

After a discussion on the status of checking and the possible methods of approach, it was decided that more people should be acquainted with the type of problems encountered to date.

To this end, a resume of the trouble location problem in the five-digit multiplier in the Whirlwind I arithmetic element will be issued.

A second meeting of the group in three weeks will allow further discussion of these problems.