

6345
Memorandum M-209

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Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART I, JANUARY, 9, 1948

To: 6345 Engineers

From: Jay W. Forrester

Date: January 12, 1948

1.0 WHIRLWIND I COMPUTER ELEMENTS

1.1 Listed by Block Diagram Number

101 Master Clock

(H. Kenosian) The preliminary schematic for the W.W.I. clock has been drawn up. Certain features may be added, depending on the requirements of time pulse distributor control, but it is felt that the circuit drawn will not be modified to any extent. As drawn up, the circuit provides 2 mc and 1 mc clock pulses.

102 Program Counter

(D.R.Brown) The check print of the program counter has been corrected and delivered to the drafting room. The revision should be completed January 12. The completion date, January 5, given in the last bi-weekly report was not met because the decoupling circuits has to be redesigned.

103 Program Register

(D.R.Brown) The check print of the program-register circuit schematic was received today. The revision should be completed January 12. The completion date January 9, given in the last bi-weekly report has not been met because longer drafting time was required than was anticipated.

203 Flip-flop Storage

(D.R.Brown) The circuit schematic should be completed January 16, as stated in the last bi-weekly report.

(J.A.O'Brien) I have recently started to work over at the Sylvania Plant with John Terzian on testing the prototype Flip-flop Storage rack. Sufficient test

equipment is now on hand to enable us to do a fairly thorough job of testing on this element. It is expected that this work will carry on well into next week, and when it is completed, decoupling circuits may be installed in the panels and a few in the test procedure will be repeated to observe any change in performance.

300

Arithmetic Control

(G.C. Sumner) Design of individual panels of arithmetic control is continuing. Block schematic diagrams of these two panels are well underway. The subject of independent control for the arithmetic element was discussed in a conference of Everett, Taylor, Brown and Sumner. It was proposed that this independent arithmetic control be placed in a rack near the operators positions. Placed here the arithmetic independent control could become a permanent part of the trouble location and test facilities. The question arose when plans were begun for an arithmetic control which would provide control pulses and indicators for the arithmetic element completely independent of main control. It is felt that such facilities are indispensable for the setting up and testing period.

(N. Daggett) A block schematic and a circuit schematic for the multiply-shift control are in the drafting room. A block diagram for the divide control offering two, three and four-position switch operation is under consideration.

301

A-Register

(C.W. Watt) The schematic of the A-Register will be redrawn to include the latest circuit changes and should be finished by Friday, January 16. It bears drawing No. D-31276. It must be redrawn:-

- a) To accord with A-46
- b) To include modified Decoupling and to remove trigger tube and bus driver.

(N. Taylor) Schematic has been modified and is being redrawn. No more engineering changes are known of at the moment.

302

Accumulator

(C.W. Watt) The schematic of the accumulator will be redrawn and will be finished by Friday, January 23. It must be redrawn:-

- a) To accord with A-46

- b) To include the "Whiffle Tree" switch
- c) To remove bus drivers
- d) To remove "O-Reset" gate
- e) To include modified decoupling

It bear the number E-312275.

The layout of the accumulator is showing progress.

- a) A good layout of the "Whiffle Tree" switch has been achieved.
- b) The tubes that have been removed ease the crowding in the panel. Most of the extra space gained by removing these tubes will, however, be reserved to take care of future expansion.

(N. Taylor) All engineering decisions on this unit have been made.

303 B-Register

(C.W. Watt) The schematic of the B-register will be redrawn and will be finished by Friday, January 16. It bears the number D-31277. It must be redrawn.

- a) To include modified decoupling
- b) To remove trigger tube and bus driver
- c) To accord with A-46

601 Check Register

(D.R. Brown) The circuit schematic, due today, is still in the drafting room. Estimated completion January 15.

1.2 SYSTEM ENGINEERING

1.22 Power Cabling

(H.R. Boyd) Informal discussions with Watt, Forrester, and Proctor. Decision on power cabling during the past week. Decision was made to obtain a staff member to carry on this work, some prospects are being considered.

(H. Kenosian) Material prepared for talk on decoupling. Summary of talk and preliminary decoupling schemes written up for distribution. (see M-207)

1.23 Video Cabling

(J.O. Ely) Cables made up using the new solid metallic braid clamp were delivered to me by R.H. Murch. These cables are identified by typewritten labels, and have been distributed among various engineers' workbenches. It is requested that any failure, incipient failure, or unfavorable characteristics of any of these cables be reported to me or to C.W. Watt. More cables using the new clamp may be constructed by Sylvania. Any failure of a cable incorporating the solid metal clamp will be investigated with the view of finding and remedying any defects in the design.

1.3 Auxiliary Equipment

1.31 Power Supplies

(H. Fahnestock) Revised power estimates have been furnished Anderson of Sylvania. He will summarize totals.

(H.R.Boyd) The procurement of motor generators is generally recognized as being a most urgent problem. Lyman Dawes, retired MIT Professor of Electrical Engineering will consult with us on this problem. Proctor, Fahnestock, and myself will give as much time as we can to getting work started and a full-time engineer will be assigned as soon as a suitable one can be located.

1.32 Air Conditioning

(H. Fahnestock) Checked Carried Corp. Proposal for air conditioning system and found proposed system and data to be correct and in line with good engineering practice. This system, however, still involves a great number of unknowns (mainly ductwork) which will be clarified at a latter date.

Fire Protection System

Checked Kidde Co's proposal for Automatic CO₂ Fire protection and found it to be excessive in cost and apparatus for the protection afforded for our application. It is still undecided whether any such system will be included.

1.33 Cabinets

(C.W. Watt) A meeting was held Jan. 8 to review the proposed Sylvania Cabinet rack design. Present were Wainwright, Fallows, and O'Hearn of Sylvania; and Forrester, Everett, Fahnestock, Boyd, J.A. O'Brien, Proctor, Brown, Watt, and Hunt, of MIT. Wainwright had drawings of a rack and cabinet arrangement that in general seemed good. Discussion brought out many possible variations, but it was decided that Sylvania would make new proposals including

- a) Double reinforced doors on each cabinet, hinged top and bottom and easily removable.
- b) A universal drilling pattern for the racks to permit flexibility in mounting various panels and installing cables and transformers.
- c) Simplified built-in horizontal cable ducts at top of cabinet.
- d) Adjustable dampers for the air intake openings, and screen over such openings.

These ideas will be incorporated in new proposal drawings which will be submitted soon.

1.4 Unclassified

Mechanical and Wiring Specifications for WWI

(C.W. Watt) A meeting was held with Sylvania December 31 at which comments on E79 were discussed, and a final form of specification was approximated.

Later, specification numbers were assigned to the various specifications already prepared. These are

- 7,500 Definitions
- 7,501 System standards
- 7,502 Layout Standards
- 7,503 Wiring Standards
- 7,504 Markings
- 7,505 Diagrams

The text of these specification is being revised, and they should be ready by Friday, January 16.

A new specification 7,506 general component specifications, is being prepared and should be ready by Friday, January 16.

2.0 WHIRLWIND I RESEARCH

2.1 Circuits

2.11 Flip-flop Design and Stability

(A.B. Horton) The thesis report on the capacitively-coupled flip-flop to be submitted to the E.E. Department is now being written. All photographs, both of physical equipment and voltage waveforms, have been taken with satisfactory results. Good progress has been made regarding preparation in the drafting room of the necessary drawings and graphs. Typing of the text has been started. This thesis is due in the E.E. Department on January 16, 1948.

During the coming week, all attention will be given to completing the thesis report and getting it in on time. When this is done, attention will be given to further testing of the a-c flip-flop with other circuits and equipment.

(J.J. O'Brien) Most of my time is being given to the investigation of "sticking" in the present flip-flop circuit. The main work is on a flip-flop test circuit. The flip-flop life test rack is being set into operation in the Multiplier room to build up more hours on its tubes and to observe any "sticking" that will result. A group of 6AG7 tubes are being run under different conditions for long periods of time by Ray Ellis to see if operation in the flip-flop circuit, or what would shorten life in these tubes. Separate screen supplies have been installed in one panel of the Multiplier, for marginal testing of this "sticking".

(H. Kenosian) An a-c coupled flip-flop has been constructed to determine its possibilities. The breadboard model has been completed. At present, tests are being made to determine the best methods of triggering and the ability of the circuit to provide a gate.

2.13 Bus Drivers

(C.A. Rowland) A bus system for the digital transfer buses and check register buses has been tried and the results indicate that the system will be satisfactory. For more details see Engineering Notes E-91 which are forth coming.

2.16 Decoupling Circuits in WWI Design

(N. Taylor) Considerable discussion took place at a meeting January 7 concerning problems and methods of decoupling. It has been decided to use video decoupling (a small resistor and condenser) to each element of the individual panels and heavy decoupling between adjacent racks. This rack decoupling will probably consist of a rather heavy choke and rge condenser. M-207 will discuss these methods in more detail.

(J.A. O'Brien) Different types of circuits are being tested in an effort to obtain a circuit that will produce a sharp gate starting with very little delay after the trigger pulse. The present standard gate generator has a delay of 0.2 microseconds and although some other circuits can better this, their recovery time is too long.

Principle difficulties are reducing the recovery time of the circuits, and predicting the performance of pulse transformers in some of the circuits.

2.2 Components

2.23 Tests and Specifications

(D.R. Brown) We received specifications from Emporium on December 30. We have recommended that a specification on suppressor-grid current be added to the present specifications. An order for 4000 tubes was initiated on December 31. We received plate and screen dissipation ratings on January 8; they are 8.2 and 2.5 watts respectively.

2.24 Tube Testing

(R.L. Ellis) Tests are being made for the study of 6AG7 tubes in flip-flop application. Retests are being made. Five tubes have been working under normal operation conditions with variations and regular testing.

Static characteristics are being taken on the 7AK7. The results will be distributed soon.

2.25 Crystal Rectifiers

(D.R. Brown) Meeting on crystal-rectifier reliability was held on January 6. Data discussed included measurements on 20 1N34's in a 60-cycle rectifier circuit which have had 11,500 hours. An additional group of 20 1N34's have had 5,000 hours in the same circuit. Data were also presented on d-c restorer life tests which Sylvania is running for Philco; this test has 740 hours. Seven different life tests of line-driver crystals having 800 to 2,750 hours were discussed. Data on crystal-rectifier life from five-digit multiplier, 6AG7 life-test rack, and flip-flop life test rack were also presented.

2.31 Multiplier

(W. Taylor)

Progress:

Modification of the multiplier as an adder is well along and will be working in the next week.

D.C. power supply wiring has been modified and will continue to be changed to accommodate rotary equipment now installed in the basement.

Separate leads are being brought on F.P. screen circuits to study marginal failures and simulate WWI checking procedures.

Problem:

a) Flip-flop sticking is still prevalent with 11 out of 20 FF going bad in 1400 hours of operation. Three types of sticking have been detected:

1. Due to low plate current when a tube ages
2. High screen current as tube changes from original condition
3. Unknown reason which may not be due to the tube basically but some other factor. This last item is receiving intense work by J.J. O'Brien. More detailed analysis of this circuit seems highly desirable to assure optimum performance in the future.

b) Whiffle Tree circuit has shown very satisfactory results and four position matrix switch has given more trouble due to tube unbalance. Rewiring of all panels to include Whiffle Tree is being considered, as it would give a life test on 7AK7-gate tubes, and also improve Multiplier Reliability.

A Report in "History and Development of the Five-digit Multiplier" panels has been started. This will include Block Schematics, Circuit Schematics, Detailed functional analysis of a typical problem being solved.

(G.G. Hoberg) The multiplier is being provided the additional circuits necessary to permit addition. Successful step-by-step addition has been performed with a temporary setup using standard push-button circuits and Single-pulse Synchronizers in a manner suggested and tested by H. Kenosian. Automatic addition has not yet been realized because of circuit difficulties. A permanent installation will be provided as soon as possible in accordance with the layout being done by D. Mach, using only existing control-panel space.

(J.J. O'Brien) The two memoranda promised in E-83 are being prepared to cover operation for the Month of December.

(H. Kenosian) Decoupling circuits for the Multiplier are being installed and tested.

Crystal Controlled Clock for Five Digit Multiplier

(H. Kenosian)

Various decoupling schemes are being tested by E. Nickerson on the breadboard model of the clock.

3.0 SPECIAL CIRCUITS**3.2 Test Equipment****3.21 Standard Test Equipment**

(H.R. Boyd) Esterline-Argus Recording voltmeter has been ordered at N. Taylor's request to give a permanent record of line voltage for the multiplier and later WWI. Techtronix oscilloscopes have been ordered. Delivery will be approximately 60 days. This instrument which combines good video amplifiers with a 5" tube is very well liked by Dr. O'Neil at Eastman.

(H. Kenosian) Discussions have been carried out with Ely in regard to the proposed standard test equipment program.

(J.O. Ely)

- A. Preparation of second proposal is continuing.
- B. A considerably better understanding of the needs is evolving from conferences with various staff members. Study of several required control sequences is about complete and shows promise that units proposed, with minor modifications, will be able to do most timing jobs of the type considered.
- C.
- D.
- E. M-208, E-78, M-173, M-177, M-180, M-181, M-189, M-191, M-193.

3.22 Special Test Equipment**Video Amplifier, Mod. 5 Synchroscope**

(R.L. Massard) Present work consists of redesigning the phase-inverter stage to give equal output impedances so that the compensating circuits may be alike and thus eliminate phase shift difference between the two push pull sides of the following stages. The degenerative amplifier phase inverter was found to be unsatisfactory on account of its low cathode output impedance. A cathode coupled push-pull phase inverter is now under consideration. Ref. M-125.

Variable Delay Pulse and Gate Generator (3 channel)

(H. Kenosian) The prototype has been completed and sent to Sylvania. Inter-action between the adjacent channels was noted at long delays. Decoupling the adjacent channels did not help. However, the unit is satisfactory for the tests that it will be used for, so that it was delivered as is.

Variable Delay Pulse and Gate Generator (Single Channel)

(H. Kenosian) Two single channel units are being built for testing certain breadboards. These units will be constructed for rack mounting, and are not considered to be a part of the proposed standard test equipment program. The urgency of the need and availability of the unit are considered sufficient reason to warrant the construction of two of these units.

Variable Frequency Clock-Restorer Pulse Distributor

(H. Kenosian)

The frequency divider unit is still under construction, and the distributor section has been completely devised.

Single Pulse Synchronizer

(H. Kenosian)

The four additional units have been completed. At present, all five units are in use.

(R.L. Best) The pulse amplitude monitor has been tested, and found to be too sensitive of pulse width and shape. The electronics laboratory is about to build an improved version.

A frequency divider, which has an output near 4 KC regardless of input pulse, repetition frequency, is nearing completion in the electronics laboratory.

The large panel which will simulate the horizontal driving problem will be ready for test during the early part of the week beginning January 12.

4.0 BLOCK DIAGRAMS

(R. R. Everett)

The proposed block diagram revision has been extended to form an attempt to define the complete Whirlwind I system. The actual physical work of revision was postponed to allow E. Blumenthal to complete his thesis proposal and his work on timing. The increased scope of the revision will result in a completion date considerably later than first intended. The revision should be available in about two months.

4.1 Timing Studies

(E.I. Blumenthal) R-133 a timing study of WWI has been completed. Revisions of the block diagrams have been undertaken, and will be written up as an R-series report. Changes will include results of the timing study, latest information on design of computer elements; and will include in addition input and output devices, electrostatic storage, toggle-switch storage, and provisions for additional orders.

A thesis proposal has been written jointly with G.G. Hoberg on a trouble-location scheme for WWI. Following completion of block diagram revisions, thesis research will be begun.

5.0 CHECKING METHODS

(G.G. Hoberg)

A thesis proposal on automatic trouble location for the demonstration multiplier and possibly for WWI has been submitted to the E.E. Department jointly with E. Blumenthal. This thesis is concerned only with the location of steady-state failures through the use of trouble-location problems. It will not include investigations of techniques for discovering marginal and incipient failure.