Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, Project 6345, November 10, 1950

To: J. W. Forrester

From: Project Whirlwind

## 1.0 SYSTEMS TEST

### 1.1 Whirlwind I System Test

(S. H. Dodd, R. R. Everett, N. H. Taylor, R. Read)

ES Row has been readjusted in order to overcome the reading beam registration and spot interaction troubles encountered recently. By Friday night the entire row was operating satisfactorily on static read and spot interaction tests. Next week we expect to try the computer with test problems inserted in electrostatic storage from paper tape.

Several major steps were taken in the last two weeks.

1. Readout failures due to glass charging have been reduced to a negligible factor as far as present tests can tell.

   a) $A_2'$ potential was reduced to that of $A_2$, from 1000 V to 40 V with respect to H3 cathode.

   b) An erase circuit using a signal plate gate instead of an $A_3$ collector gate has been installed.

   c) It has been discovered that several minutes' normal operation must be allowed after each use of the TV to allow the tubes to reach a steady-state deflection condition.

   d) Changes in write minus gate length, writing gate amplitudes and focus voltage have resulted in larger and more uniform positive spots, a better ratio of beam diameters in writing and reading, and, therefore, in less sensitivity to reading beam registration. The write minus gate length has been increased to 32 microseconds.

1.1 Whirlwind I Systems Test (Continued)

2. Spot interaction has been greatly reduced.

It has been discovered that spot interaction is very dependent on $A_3$ potential. Interaction effects are very pronounced for $A_3$ voltages near or below collector and much reduced for $A_3$ voltages more than 20 volts above collector. $A_3$ has been run at 5 volts above collector, on a very steep part of the curve, thus accounting for the considerable variations in spot interaction that we have been measuring. All $A_3$'s are now tied to +250 in the mount which is about 70 volts above collector. The improvement has been remarkable.

(H. F. Mercer)

Component Failures in WWI - The following failures of electrical components have been reported since October 27, 1950:

| Component | No. of Failures | Hours of Operation | Reason for Failure |
|---|---|---|---|
| Crystals | | | |
| D-357 | 3 | 3503 | Low back resistance. |
| D-358 * | | | All clamp crystals and all failed because of drift unless noted otherwise. |
| | 9 | 1000-2000 | |
| | 6 | 2000-3000 | |
| | 4 | 3000-4000 | |
| | 7 | 4000-5000 | 2-Low back resistance. |
| Pulse Transformer | | | |
| 1:1 (6.193-7) | 1 | 4573 | Intermittent |
| Tubes | | | |
| 6AG7 | 1 | 371 | Low $I_b$ |
| 6SN7 | 1 | 1733 | Burn-out. |
| 7AD7 * | | | All flip-flops, except 2, and all failed because of low $I_b$ unless noted otherwise. |
| | 1 | 0-1000 | |
| | 5 | 1000-2000 | 1-mechanical |
| | 4 | 2000-3000 | 1-mechanical |
| | 2 | 3000-4000 | 3-mechanical |
| | 14 | 4000-5000 | 1-gas |

* All of the D-358 crystal failures and all of the 7AD7 tube failures were found as a result of Flip-Flop Complement testing accomplished during the previous bi-weekly period.

### 1.2 Five-Digit Multiplier

(E. A. Guditz)

During the period of this report the multiplier has made no errors. The last error occurred on October 17th.

The following tubes and crystals were replaced as a result of marginal checking:

1 6AS6 gate tube -- 5533 hrs.
1 6AS6 check gate tube -- 4865 hrs.
1 2C51 indicator tube -- 15,632 hrs.
1 D358 -- 334 hrs.
1 D358 -- 1014 hrs.
1 1N34 --- 11,554 hrs.
1 1N34 -- greater than 15,238 hrs.

## 2.0 CIRCUITS AND COMPONENTS

### 2.1 Circuits by System Number

#### 400 Input-Output Element

(J. A. O'Brien)

Circuits for the Input-Output Switch have been designed, and sketches of some of the layouts have been completed. Breadboard models of these circuits will be constructed and tested before proceeding much further with the final design.

Orders have already been sent out for the tubes, crystals, and precision resistors that will be required in the final units.

#### 820 ES Deflection

(R. L. Best)

A second breadboard of the ES Deflection Output Panel, Model II, is to be built, so that the pair may be tested in actually driving one of the deflection bus pairs in Whirlwind. This circuit is to drive the line as a lumped capacity rather than as a terminated line, and is to have greater linearity at the expense of rise time.

## 2.6 Test Equipment

(R. L. Best)

Slight changes have been made in the circuit and testing technique for gate and delay units, resulting in increased stability. As these units return to Nickerson's group for servicing, he will incorporate these changes.

## 2.7 Three-Dimensional Magnetic Storage

(W. Papian)

A preliminary test on the 2X2X1 array indicates that non-selecting noise does tend to be cancelled out when sensing-coil polarities are alternated properly.

A senior student, Robert Evans, is starting his thesis here; it will consist of the design and construction of a piece of equipment for scope presentation of ferroelectric hysteresis loops, with the object of assessing their potentialities as binary-storage media.

## 3.0 STORAGE TUBES

### 3.1 Construction

(P. Youtz)

Only two research tubes were processed successfully this period. The tests in ES row on the problems of spot interaction showed an effect which could be ascribed to glass charging within the storage tube. Several research tubes were designed to minimize the drift of the high velocity beam resulting from the charged glass surface. In RT-187-2, all of the glass was dagged except the windows around the storage surface. The high velocity gun was insulated from the dag. The holding gun had a half-inch diameter metal $A'_2$ cylinder. In RT-188, the dag was continuous through the body and both necks. The high velocity gun was insulated from the dag. The holding gun had a 1 1/2 inch diameter metal $A'_2$ cylinder.

Two more research tubes are planned for this next period. To minimize the drift of the high velocity beam caused by the charged glass surfaces in these tubes, the $A_2$ and $A_3$ dags will be separated by a quarter-inch window. There will be a metal shield over the separation between $A_2$ and $A_3$ to prevent the glass window from charging. The holding guns will have a 1 1/2" diameter metal $A'_2$ cylinder.

### 3.2 Test

(A. Stein)

Pretests were carried out on the television demonstration unit.

ST-196 was pretested and passed.

RT-188 was pretested and passed marginally. It was noted that at a $V_{HG}$ of about 160 volts the collector would actually touch the surface, and consequently cause the negative surface to switch positive. This tube had a thinner mica surface and closer screen to surface spacing than most tubes.

Additional pressing tests were carried out on previously pretested tubes in order to determine whether gas pressure had not increased during two weeks of shelf life.

Tubes tested and passed were:

| | |
|---|---|
| ST-192 | ST-194 |
| ST-193 | ST-197 |

3.2 Test (continued)

(C. L. Corderman, H. J. Platt)

At the beginning of the last period, after the variable HG time circuit was installed (in the STRT), it was noticed that for certain values of HG time, a 60~ripple was observed in the deflection display. Considerable time was spent in searching for ripple in the deflection voltage generator. A power supply filter was added in the +150 line, the only one which showed appreciable ripple. Very little improvement was achieved, however, and by elimination, the predominant cause for the 60~display scope ripple was felt to be magnetic deflection from the 100 amp 3 phase power line feeding the STRT.

Friday afternoon, November 10th, the STRT was shut down so that the incoming power lines could be put into conduit.

A pulsed slide-back voltmeter and a voltage regulator were designed and built. The voltmeter is for use in the FG Restoring Current tests.

(C. L. Corderman, A. R. Tanguay)

Completion and testing of the revised Restoring Current Tester brought to light a phenomenon heretofore unobserved. During the operating cycle of the Restoring Current Tester, the signal plate sweep voltage swings the surface potential from holding gun cathode to some value far above collector potential. In the region above collector potential ($V_{HG}$), the restoring current attempts to keep the surface at collector potential. Obviously, when the holding gun is biased off during the signal plate sweep, no restoration occurs. However, when the holding gun is pulsed "on" during a very short interval, a small change in surface potential occurs. If one assumes leakage to be negligible during the cycle period (approximately 15 milliseconds), the accumulated negative charge should remain on the surface until the end of the signal plate sweep gate. At this time, the surface assumes zero potential plus the potential caused by the accumulated charge.

In this case the charge is negative so that the surface is actually below holding gun cathode, drawing no restoring current, during the "between cycle" holding gun "on" time. If we assume that the negative restoring current is fairly constant for surface voltages much greater than $V_{HG}$, then we can say that the negative charge on the surface will build up at a rate depending on the duty cycle and the length of the holding gun "on" pulse.

3.2 Test (continued)

However it is observed that there is a limit to the surface potential buildup. An equilibrium is reached at some negative surface potential when some "unknown" charging current integrated over the holding gun "on" cycle equals the negative restoring charge added during the HG "on" pulse.

The "unknown" charging of the surface has been tentatively attributed to a flow of positive ions to the surface when it is negative with respect to the holding gun cathode. The dependence of the equilibrium HG current during the HG "on" pulse upon duty cycle and "on" pulse length is being investigated.

The relatively high power requirement of the "holding gun gate mixer-driver" results in objectionable feedback to the +300 and +500 volt power supplies. To remedy this, several Nester Electric Power supplies are being modified to provide the Restoring Current Tester with separate voltage sources.

## 4.0 INPUT-OUTPUT EQUIPMENT

### 4.1 Eastman Kodak

(J. O'Brien and D. Hageman)

We are still occupied with the problem of making satisfactory films when the CRT trace is very intense. (Our experience has been that dense exposures are necessary if the unit is to function properly as a reader.) The use of higher post-deflection accelerating voltage plus a larger intensifying pulse has had some effects which were not foreseen. Some of the symptoms have been encountered before. Hence it is to be hoped that the difficulties involved may be overcome.

### 4.2 Display

(R. E. Hunt)

A preliminary lay-out of the 16" display scope has been made and approved.

The unit will consist basically of two sub-assemblies. Number 1 includes the scope, horizontal and vertical deflection amplifiers, all controls and panel lights. The second sub-assembly consists of the power supply, regulator, sweep and blanking circuits.

These sub-assemblies fit a blonde-wood cabinet of modern design, but also each is built around a standard 26" panel, so the assemblies may be rack mounted if desired.

Camera and hood adaptors will be provided as well as provision for an illuminated grid. All controls will be illuminated red lucite for operation in the dark.

### 4.3 Typewriter and Tape Punching Equipment

(J. S. Hanson)

Performance tests on tape output equipment are continuing with added provisions for self-cycling operation to simulate repetitive cycling with WWI as well as "one-shot" or push-button-controlled operation. At first, minor difficulties were encountered with capacitive coupling of test equipment which resulted in premature random firing of 2D21 relay gas tubes by excessive transients in both a-c and d-c switching circuits. Careful grounding and de-coupling have just about eliminated this trouble, and very satisfactory data have been secured.

4.3 Typewriter and Tape Punching Equipment (continued)

Analysis of test data is expected to explain excessive delay in the appearance of the completion signal at the end of each cycle of operation which causes the tape reader clutch mechanism to disengage once each cycle and slows down the overall speed of the system by about 30%. As originally designed, this completion signal should appear early enough during the cycle so as to keep the tape reader clutch shaft in continuous rotation and thereby secure maximum speed of operation.

(C. W. Watt)

The output equipment was tied into the computer once more, this time as part of a demonstration for visitors. It operated satisfactorily.

An inventory of Clare Type J relays on hand was made, and 20 more were ordered for use with magnetic tape equipment. Relay delivery in such quantities now takes from 3 to 4 months. All relays for Input-Output equipment will be kept in assigned stock, and a running inventory will be kept.

4.4 Input-Output Planning

(E. S. Rich)

A study was made of the requirements that must be met by the new In-Out register that is to be part of the integrated terminal equipment system. Although the system design is far from complete it was felt that specifications for the 16 digit panels could be given sufficiently accurately so the layout of a prototype could be started. At a meeting of interested staff members it was decided that the present IOR and COR should be left in place and that the new IOR would be put in the presently unused space in the racks of F-row. The design and layout of these panels are being planned so that they could be adapted to other Whirlwind registers in the future if d-c coupled flip-flops were found desirable. It was also decided that no radically different packaging methods should be tried out with the panels of this register. However, in the racks of A-row which are to be used for terminal equipment circuits more compact methods of packaging may be necessary. In these racks new methods of making connections between panels may also be tried because studies indicate that the cabling density will be high.

4.4 In-Out Planning (continued)

(C. W. Watt)

As a result of the decision to build a completely new In-Out Register, a tentative block schematic and circuit schematic were sketched, and a possible layout was outlined. The drafting department will now layout a prototype panel in sufficient detail to permit one to be built. Several points in the circuitry remain to be checked experimentally, but any changes should remove parts rather than add them. An effort has been made to make this new d-c coupled register as universal in design as possible

5.0 INSTALLATION AND POWER

5.2 Power Supplies and Control

(J. J. Gano)

120-208 Volt Regulated Laboratory Power

Since this system is now associated with Whirlwind power supplies through coupling to the Plate Alternator, drawings are being brought up to date for grading.

D-C Power Supplies 90 Volt Supply.

The adjustment of the antihunt is very critical. Stability varies with the applied load and less than twenty degrees rotation of the potentiometer will create an appreciable 20 c.p.s. oscillation on the other side. Difficulty was encountered in making open loop frequency response tests because of oscillations in the output. The source of this trouble will have to be located first.

[redacted]

(T. Leary)

Three new cables were manufactured by the shop in the last bi-weekly period.

The cabling to the CPO units has been investigated and eight unused cables removed. It has been decided to lable the CPO units more thoroughly and a complete list of the lables required has been made up by Ron Mayer and Larry Holmes. Permanent labels will

5.3 Video Cabling (continued)

be on black lamicoid and labels for CPO units being used temporarily will be typed on adhesive tape. The numbers of the individual CPO units will be stamped onto their phenolic mounting panels (component side) and the numbers of groups of CPO units will be stamped on the video troughs on the opposite side.

An investigation has been started to find out whether the changes in the RD type I gate generator made temporarily on two of the units by Herb Ziegler should be made permanently on all of them.

## 6.0 BLOCK DIAGRAMS

(R. P. Mayer)

A new "Up-to-the-minute" drawing, "Operation Matrix Crystals", shows the physical location of all crystals in the matrix.

A system for providing "CR check" on orders sp and cp has been worked out ("CR check" does not occur on any orders, at the moment). The new "CR check" would occur on Time Pulse 8, no delay, and would not include a "Transfer Check" (note that a Transfer Check occurs on TP 6 1/2, just before this "CR Check").

## 8.0 MATHEMATICS

(C. W. Adams)

E-387 has been issued for internal distribution only. It describes the interim terminal equipment and some of the techniques and programs planned using it.

Regular meetings of the new application group staff members and part-time students are being held on Thursdays from 3 to 5. At each meeting a short discussion of some general topic is held, after which one or two of the students reports on his work.

For a demonstration of WWI held November 7, a test-storage program was written to display solutions of $y'' + \lambda^2 y = 0$ for $0 \leq x \leq 1$ and to solve this eigenvalue problem which arises the boundry conditions $y(0) = y(1) = 0$ are imposed.

(J. M. Frankovich)

The program for determining eigenvalues of the differential equations described in the last report, utilizing the method suggested by Professor Kopal, has been completed. With a storage capacity of 256, the program leaves room for a potential function tabulated at fifty points. Work is continuing on the program using the Runge-Kutta method, as well as a study of various other methods that are applicable to the problem and could be programmed.

5.0 MATHEMATICS (continued)

(F. C. Helwig)

I have continued working on checking subroutines. Several versions of a "pilot subroutine" which will execute the main program order by order have been written. These will form the basis for checking subroutines which will not require any modification of the main program.

(J. D. Porter)

I have written out a procedure for automatizing the handling of subroutines using our interim punched-tape equipment. The conventions followed are those given by C. W. Adams in E-329. The procedure includes conventions to be followed in preparing the subroutine for our library, the steps to be taken in preparing the main program tape, and a discussion and coded program for adapting the subroutine automatically to the main program.

This subroutine adaptation program will make use of the input program in test storage to read in the desired subroutines, will adapt the necessary addresses to the main program, and then replace itself by a manual intervention program, checking program, or whatever else the programmer desires.

## 9.0 FACILITIES AND CENTRAL SERVICES

### 9.1 Publications

(J. N. Ulman, Jr.)

The following material has been received in the library, Room 217, and is available to 6345 personnel.

**6345 Reports**

| No. | Title | No. of Pages | Date | Author |
|---|---|---|---|---|
| E-365 | Part 1: Construction of a Collector Screen for the WWI Storage Tube. Part 2: Construction of a Mesh Mask for the Beryllium Evaporation Tube | 4 | 10-31-50 | T. R. Parkins, R. Shaw |
| E-392 | Crystal Diode Initial Investigation - Initial Results | 6 | 11-2-50 | R. Irish |
| M-1119 | Bi-Weekly Report, Project 6345, October 27, 1950 | 21 | 10-27-50 | |
| M-1122 | Electronic Computer Division Personnel | 3 | 11-1-50 | |
| M-1123 | October 1950 Research and Storage Tube Summary | 4 | 11-1-50 | M. F. Mann |

**Library Files**

| | | |
|---|---|---|
| 189 | Document Office Bulletin: November 3, 1950 | RLE/MIT |
| 232 | Physics Today: October, 1950 | American Institute of Physics |
| 271 | Machine Solution of Problems for the Office of Air Research. Progress Report Number 12, covering period 1 September to 15 October, 1950 | Computation Lab., Harvard |
| 884 | Progress Report Number 12, D. I. C. Project 6694, November 6, 1950 | Servo Lab., MIT |
| 998 | Proceedings at the Convention on Automatic Regulators and Servo Mechanisms, May, 1947. The Journal of Electrical Engineers, Vol. 94, No. IIA, Parts 1 and 2 with Index. | I. E. E., England |
| 999 | The California Digital Computer with a Compact Magnetic Memory. Preprint 26-50, September 15, 1950. U. of California, Berkeley | P. L. Morton, T. H. Meisling |
| 1000 | The M. I. T. Libraries. 1950 | M. Hazen, ed. |
| 1001 | Standards of Weight and Measure, Tests of Glass, Leather, Metals, Paper. PL 64, March, 1950 | L. of Congress |
| 1002 | Development of an Airborne Radar - Simple Radar Beacon Method of Flying Precise "Off-Set" Tracks. Final Report on Task 3. American Airlines System, 15 September, 1949 | R. W. Ayer, F. C. White, T. J. Drummy |

9.1 Publications (Continued)

Library Files (Continued)

| No. | Title | Author |
|---|---|---|
| 1003 | Development of an Airborne Radar Method of Avoiding Collisions with Terrain, Aircraft, and Other Obstacles. Final Report on Task 2. American Airlines System, 15 September, 1949 | (R. W. Ayer<br>(F. C. White |
| 1004 | Miscellaneous Bi-Products Resulting from the Airborne Radar Contract Work. Final Report on miscellaneous items not listed under the Contract Tasks, 15 September, 1949. American Airlines System | R. W. Ayer |
| 1005 | Investigation of Theoretical Accuracies of Angle Measurement with Automatic GCA. Report No. 338-2, Radar and Air Navigation Section, Airborne Instruments Lab., July, 1949 | (R. C. Wheeler<br>(G. C. Comstock |
| 1006 | Preparation of Problems for the BTL Calculating Machines. Technical Note No. 104, Ballistic Research Labs., September, 1949 | (J. C. Harrison<br>(J. V. Holbertson<br>(M. Lotkin |
| 1007 | Visual Message Presentation - and Appendix. Quarterly Progress Report July 25 - October 25, 1949 | Northeastern Univ. |
| 1008 | The Electronic Era for Business with UNIVAC | Remington Rand Co. |
| 1009 | Transient Phenomena in Waveguides. Technical Report No. 33, January 3, 1948 | RLE/ M. Cerillo |
| 1010 | Signal-to-Noise Improvement by Pulse Integration. Naval Research Labs. Report No. 3699, July 10, 1950 | C. E. Corum |
| 1011 | Rocket Research Report No. III. Vibration in the Viking No. 3 Rocket. Naval Research Labs. Report No. 3695. July 10, 1950 | (C. B. Cunningham<br>(E. E. Bissell<br>(L. H. A. Feher<br>(R. W. Stroup |
| 1012 | On Harmonic Motion of Wide Delta Airfoils at Supersonic Speeds. NAVORD Report 1234, NOTS 294, 13 June, 1950 | J. W. Miles |

Books

| | |
|---|---|
| Numerical Mathematical Analysis, Second Edition | J. B. Scarborough |

9.2 Standards, Purchasing and Stock

(H. B. Morley)

Procurement and Stock:

Shortages and long deliveries are becoming steadily worse, particularly on electron tubes. The use of priorities has at least enabled us to place orders - whether or not they will help to expedite deliveries remains to be seen.

Orders have been placed for a Photoelectric Tape Reader for Input-Output use, and for special cathode-ray tubes and associated power supplies for the general purpose display set-up.

The department work-load has increased measurably due to priorities and material shortages, resulting in the necessity for more vendor contacts and greater complexity of the ordering procedure.

Samples of IPC miniature quick-disconnect coaxial connectors were procured to be considered for possible use in equipment being built in the lab.

9.3 Construction

(R. A. Osborne)

Production Report:

The following items have been completed and inspected since October 27, 1950:

1 D-C Filter Panel

3 Video Cables

80 Clip Leads

6 Portable Lamps