Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

SUBJECT: BI-WEEKLY REPORT, June 6, 1952

To: Jay W. Forrester

From: Laboratory Staff

1.0 SYSTEMS OPERATION

1.1 Whirlwind I System

(D. Morrison)

Operation

The following is an estimate by the Computer operators of the usable percentage of assigned operation time and the errors due to the Computer. This covers the period 23 May through 5 June 1952:

Number of assigned hours	121
Number of transient errors	15
Number of steady state errors	9
Number of intermittent errors	48
Percentage of assigned time usable	76%
Percentage of assigned usable time since March 1951	84.1

(S. H. Dodd)

Storage Row reliability has been particularly good during the last few days of this bi-weekly period. The records of storage tube failures which have been kept for the last two months have begun to indicate enough statistical evidence to be substantial aid in the adjustment of storage tube operating parameters.

Several instances of loss of holding-gun current have been experienced during the past few weeks. The particular tubes which exhibited this trouble are installed in Digits 0, 8, 13, and 16. The loss of holding-gun current in Digit 8 was traced to an intermittent Nobleloy resistor in the third anode lead. This resistor has been shorted out and the Nobeloy resistor in the second anode, third anode and collector circuits will be

1.1 Whirlwind I System (continued)

(S. H. Dodd) (Continued)

replaced in all storage tube mounts with 220-ohm composition resistors.

The holding-gun current failure in Digit 0 was inventigated, and all evidence on this trouble indicated that it is in the storage tube itself.

The difficulties in Digits 13 and 16 have not as yet been tracked down, although the characteristics of the trouble in these tubes seem to be similar to that exhibited by Digit 0.

Analysis of vacuum-tube records for all failures of 7AK7's, 3E29's and 715's is nearing completion. This analysis is being made in an effort to divide the tube failures into two groups. Group 1 is the type of failure which could be found by marginal checking in a final design machine operating on a 24-hour-a-day basis. Group 2 is of the intermittent or sudden type of failure which could not be predicted by marginal checking.

(N. Daggett)

A number of Nobleloy resistor failures have occurred in the last two weeks. In all cases the resistors have increased in value to a very high resistance without sign of overheating. From the nature of the circuits it appears that the failures were probably caused by some arcover or short circuit resulting in an extremely heavy overload current.

Another case of arcover between adjacent lugs on a phenolic panel has occurred, again on a check register panel located at the bottom of the rack next to the air conditioning outlet.

(H. Ziegler, A. Roberts)

The rate of Nobleloy-resistor failures has increased sharply during the past week with a large percentage of the failures occurring in the same mount - STM #19 in digit 8B. These failures now include metering resistors as well as the deflection - circuit resistors previously noted. Reasons for these failures have not been determined as yet but, as a precautionary measure, all Nobleloy resistors now used for metering purposes are being replaced by the WWI Standard Allen-Bradley resistors.

Computer reliability has been about average with several tubes being replaced because of poor operating margins or, rather, too

1.1 Whirlwind I System (continued)

(H. Ziegler, A. Roberts)

small a range of operating margins.

Investigation of optimum conditions for Read and Rewrite will be resumed in the coming weeks after having been temporarily shelved because of vacations.

System Test

Component Failures in WWI

(L. O. Leighton)

The following failures of electrical components have been reported since May 23, 1952.

Component	No. of Failures	Hours of Operation	Reason for Failure
Crystal			
D-358	2	10328	1-Drift 1-Low R_b
Tubes			
6Y6	1	11022	Low I_b
6SN7	1	10949	Mechanical
7AK7	1	10862	Mechanical
7AD7	2	5180	1-Mechanical 1-Low I_b
3E29	1	10852	Interface
	1	11019	gassy

Storage Tube Failures in WWI

The following Storage Tube Failures were reported during this bi-weekly period:

ST-508 was rejected after 1616 hours of operation because of inadequate operating range.

1.1 Whirlwind I System (continued)

(L. O. Leighton)

ST-506-1 was rejected after 1583 hours of operation because of Low HV Gun current, and bad spots on the surface of the tube. Poor margins.

ST-535-2 was rejected after 86 hours of operation because of non-uniform array. Failure to write on several points of surface. Secondary emission fatigue.

Storage Tube Complement in WWI

Following is the storage tube complement of Bank B as of 2400 June 5.

Digit	Tube	Hours of Installation	Hours of Operation
0	RT-233	4722	3218
1	ST-521	7059	881
2	RT-247	5198	2742
3	ST-537	7758	182
4	ST-516	6641	1299
5	RT-237	4714	3226
6	ST-534-2	7469	471
7	ST-540	7937	3
8	ST-505	6176	1764
9	ST-519	6624	1316
10	ST-536	7736	204
11	ST-520	6639	1301
12	RT-258	5207	2733
13	ST-517	6493	1447
14	ST-524	7313	627
15	RT-255	5150	2790
16	ST-533	7801	139

ES Clock hours as of 2400 June 5, 1952 - 7940

1.2 Five-Digit Multiplier

(C. N. Paskauskas)

On 23 May the multiplier started making errors which were finally traced to a shorted grid crystal which was putting a 120 termination on the High Speed Carry line.

1.2 Five-Digit Multiplier (continued)

(C. N. Paskauskas)

Over the week-end, 31 May - 1 June, intermittent periods of errors appear to have been due to line voltage fluctuations which could not be handled by the filament voltage regulator.

During the period of this report the following were replaced as a result of marginal checking:

1	6AS6	Gate tube	(10996 hrs in service)
1	7AD7	Buffer	(25469 hrs in service)
1	7AD7	Buffer	(6898 hrs in service - 3698 hrs of which were in WWI)

2.0 CIRCUITS AND COMPONENTS

2.1 Circuits by System Number

2.14 Input-Output

(R.H. Gould)

The interconnections of the 19 plug-in units that make up Display Control have been sketched up. Wiring waits upon the arrival of the plug-in unit mounting panels.

Several modifications have been made on In-Out Control Panels to provide for block diagram changes and additions. It is hoped that the electronics has caught up with the logic.

Plug-In Units

The plug-in units which will be used in Whirlwind will consist of four (at the moment) standard types (FF; GT-BA, BA-BA and SWT) and a number of non-standard types with only a few identical units in each type. To keep the situation from becoming chaotic, a strict system of unit numbering, designation and drawing reference will have to be set up and followed. I am writing a memo giving a suggested procedure. Any suggestions on controlling the use of plug-in units in WWI and in test equipment will be accepted. Plug-in units must be kept versatile to fulfil their function but order must also be maintained.

(A. Werlin)

The three panels for testing the plug-in units are now being constructed in the shop and should be completed this week. Modification has been made in the Gate-Buffer Amplifier unit for the insertion of delay lines and for providing for mixed input. These changes will be necessary in the control element of the drum terminal equipment.

2.2 Vacuum Tubes and Crystals

2.22 Transistors

(D.J. Eckl, R.J. Callahan)

The primary control unit for the test accumulator has been received. This is a motor driven unit used to provide two pulses 1.5 seconds apart at different output terminals. Considerable difficulty was encountered with bouncing contacts on the microswitches used to provide the pulses. As a result, a new trigger circuit is being built. A temporary setup is now in use.

2.22 Transistors (continued)

(D.J. Eckl, R.J. Callahan)

The partial sum register of the test accumulator is operating in a marginal fashion. The main difficulty appears to be in the common emitter coupling of the transistor gates. Plans for isolating these gates are now under way.

A new group of RCA transistors are working well in the two-transistor flip-flops. Eight flip-flops are now in operation employing 8 Bell 1698 transistors and 8 RCA 165 transistors.

Final design work was completed on a low voltage power supply for the test accumulator and construction has been started. This work was carried out by Leo Riley.

(N.T. Jones)

The major part of the past bi-weekly period was spent in measuring the large shipment of GE transistors, and processing the data. The data records for all transistors on hand at the present time are being brought up to date by Schmidt, Smith and Pribble.

Schmidt assisted S. Schwartz with Lincoln in Building 22 in the measurement of the frequency response of alpha of several of our GE and RCA transistors. The results of these measurements will be correlated with the similar measurement made by Dr. Rediker and group and our own rise and fall time measurements.

A panel was completed by Pribble with which the point measurements may be made on ten transistors simultaneously, thus speeding up the measuring process.

A visit was made to Mr. Cassellini of Kemtron in Salem along with Bradbury and Ryan of AFCRC. The group discussed Kemtron's production of transistors, but the results were not encouraging.

Engineering Note E-441-1, Standardized Transistor Parameter Measurements, was completed. This is an extensive revision of the report written several months ago.

(R.H. Gerhardt)

The first week of this bi-weekly period was spent attending the Indoctrination Course.

Work on the circulating pulse system of bit-storage is continuing. Considerable difficulty in finding transistors that will work has been experienced and thought has been given to a different circuit in hopes this difficulty may be overcome. Thought has been given to test equipment and plans are being made to build an

2.22 Transistors (continued)

(R.H. Gerhardt) (continued)

arithmetic element about the same aize as the present transistor 4-bit arithmetic element.

(I. Aronson)

Five days of the past bi-weekly period were spent attending the Indoctrination classes.

The remaining four days were devoted to studying and simplifying the transistor d-c point tests. This work has progressed to the point where a semi-skilled person can be trained sufficiently in one week to perform most of our d-c tests. An instruction sheet has been written in rought draft form, and further simplification is in process.

(A. Heineck)

RCA transistors have been found to work very well in the oscillator, gate, and flip-flop circuits. Unfortunately, those we have received are still laboratory models.

A new flip-flop circuit is under investigation. It is hoped that a combination of two single-transistor flip-flops plus two gates will work as well as the present two-transistor flip-flop and yet allow a relaxation of transistor specs.

2.3 Ferromagnetic and Ferroelectric Cores

(E.A. Guditz, W. Ogden)

The rewrite operation was modified to include Z-axis inhibition. This reduced the minimum read-rewrite time from six to four microseconds.

A study of the problem of driving many cores in series is in progress. An approximate equivalent circuit of long lines of memory cores was obtained.

A program to improve the driving current waveforms as a means of widening the operation margins is in progress.

A test cycle was built into the equipment which automatically checks a storage pattern of alternate columns of 'ones' and 'zeros'. An alarm circuit was included to indicate when an error occurs and to give the address of the error.

2.3 Ferromagnetic and Ferroelectric Cores (continued)

(B. Widrowitz)

16 x 16 Metallic Array

The problems of driving a large metallic array with an Olsen switch are being considered in an analytic manner. Use will soon be made of available cores and equipment to check the equivalent circuits derived for the metallic switch core and memory line.

(G.R. Briggs)

Work is continuing in an attempt to make a workable magnetic-core gating circuit. Materials are being sought with lower hysteresis loss and residual induction, but no great success has been yet attained. Samples of Ferramic "I" are being prepared for investigation; this ferrite seems to show the best promise to date. Possibility of using powdered iron is under consideration, but the low permeability is a bad problem. It would probably be no better than a ferrite core with an air-gap. Many different schemes of circuit design using the present ferramic "H" cores have been tried in an attempt to avoid the difficulties due to the hysteresis loop of the material; these have so far failed, but all the possibilities have by no means been exhausted. A scheme under consideration is touse a gating-core time pulse of long rise and fall time, so that the voltage output of the gating core is small compared to the pulse voltages present across the various winding of the stepping-register cores. This does not slow down the speed of the register, if the driving pulses are staggered.

(P. Baltzer)

Magnetic-Core Testing

A core life tester has been designed which will handle 12 cores, and is now being constructed. It is planned to place 12 ceramic memory cores, body MF1118 fired January 14, 1952, on life test.

Effort has also been made toward the design of a test jig, which will enable us to rapidly place individual unwound cores under pulse test.

(A. Katz)

A study, both analytical and experimental, is being made of a video probe designed by Dick Best. After this has been completed, we shall use the probe in the investigation of the storage arrays and matrix switches.

2.3 <u>Ferromagnetic and Ferroelectric Cores</u> (continued)

(J.H. Baldridge)

A sample of manganous carbonate for use in preparation of ferritic materials has been assayed and a repeat analysis of a sample of magnesium oxide is being performed. A systematic analysis of a sample of the mineral Franklinite is being carried out.

2.4 <u>Test Equipment</u>

(L. Sutro)

The Test Equipment Committee has completed its survey of the use of standard test equipment, that is, standard Whirlwind and Burroughs panels, and commercial test equipment such as synchroscopes and oscilloscopes. A chart prepared by the committee shows how many of each kind of panel and each kind of scope are used by each group, how many have been ordered and how many more will be needed after the present orders are delivered. There are approximately 500 standard test panels of 30 different types in use and 500 of 14 different types on order. There are 20 synchroscopes and 27 Tektronix scopes in use and 19 Tektronix scopes on order. The committee is considering orders to meet the additional needs.

For the test equipment now on order the committee is ordering test racks to bring the total to 70, power strips for each rack, 200 power cables, 1800 video cables, 1000 terminators and 2000 T connectors. For isolated racks the committee has ordered one 3/4-ton Burroughs Power Supply Type 9001A and two of the smaller Type 9101A.

3.0 STORAGE TUBES

3.1 Construction

(P. Youtz)

All of the efforts of the construction group during this last bi-weekly period were directed toward producing 600-series storage tubes as replacements for Bank B. The 600-series tubes were designed to give closer collector-to-mosaic spacing than the 500-series tubes by the use of a smaller mica target and a new type of collector-to-mosaic spacer. The tubes which did not have buckled mica targets had satisfactory margins. However, our tests have indicated that it is necessary to process these tubes at 400°C instead of 450°C in order to prevent the mica from buckling.

No research tubes were scheduled during this period because of the needs of ES Row.

All of the work on the new vacuum systems was completed this past week. The new activation units and the new ion gauge control units, under construction in the electrical shop, continue to be delayed because of the vendor's failure to deliver the meters on schedule.

3.2 Test

(R. E. Hegler)

During this bi-weekly period five tubes were available for pre-test, listed as follows: ST541-1, ST542, ST543-3, ST544-1 and ST545-2. Four of these storage tubes were tested; two were satisfactory and two were marginal.

ST543-3 and ST544-1 were marginal because of a buckling mica. Both of these tubes were very hard to W⁻ in this area.

ST541-1 and ST542 were satisfactory. ST545-2 is still available for pretest but has not been tested as yet.

(T. S. Greenwood)

During the past bi-weekly period, RT316-R1 was completed in an attempt to use a Type "L" cathode in a storage tube. This initial effort was not particularly successful. No appreciable emission was noted with E_f below 11.0 volts, and even with E_f= 14.0 volts the maximum beam current obtained was only 20 μa. At this latter filament voltage, the transfer characteristic was so flat that a change in bias from 0 to -200 volts caused only a 35% reduction in beam current. In addition the emission proved

3.2 Test (Continued)

(T. S. Greenwood) (Continued)

quite unstable, and at the end of the bi-weekly period (after about 200 hours of life) the maximum beam current had fallen to 2 μa.

The two type "L" cathodes on life test have continued to have constant emission.

(C. L. Corderman, T. S. Greenwood)

A total of six tubes were examined in the STRT during this period. Two were new tubes, ST540 and ST541-1. Both these tubes had good margins and were sent to Whirlwind for installation. Three tubes had been rejected from Whirlwind, ST503 and ST506 due to weak high-velocity guns, and ST504 because of poor margins. The remaining tube was RT318-1 which has a new type of collector screen with a cross-section similar to an "egg-crate".

In the tubes rejected from Whirlwind to date, there seem to be three distinct types of failure. First, the high-velocity beam current simply falls off to a low value ($<$ 10 μa). If the heater voltage is raised, the maximum beam current available changes very slightly (i.e., 10 - 15 μa as E_f is raised 6.3 - 8.3 volts) and the peak current is obtained not at zero bias but at a net bias of -20 to -30 volts. In at least one tube, RT230-R2, a severe a-c modulation of the beam current resulted from raising the HV heater voltage above 7.0 volts. In addition, whenever the heater voltage is above normal, another effect which may result, and which is designated as the second type of failure, is that of an extreme dependence of pulsed target current upon duty cycle. This is a relatively short term ($<$ 1 sec.) change compared to the usual activation and deactivation observed, and is reversible within this period. The data below taken on ST506-1 summarizes the effects of heater voltage and net bias upon this duty-cycle variation, using a 28-μsec. video gate.

Net Bias During Gate	Heater Voltage Volts		Repetition Rate in c.p.s. 330	8000
-15 volts	6.3	Beam Current=	35 μa	24 μa
	7.5		52 μa	28 μa
-35 volts	6.3		23 μa	21 μa
	7.5		29 μa	23 μa

3.2 Test (Continued)

(C. L. Corderman, T. S. Greenwood) (Continued)

As is observed, lower currents are obtained as the duty cycle is raised; and, the droop is accentuated at higher heater voltages and higher gate amplitudes, as if the cathode was operating in a temperature-limited range. This current droop has been observed in many receiving-type tubes, as reported by H. B. Frost, and has been noted previously by monitoring storage tube readouts in Whirlwind as a function of duty cycle.

The third type of storage tube failure is evidenced by "low margins" which refers to the permissible excursions in the W^+ and W^- gates to the high-velocity-gun grid, and the W^- signal-plate gate, while running a spot interaction program. Since, over a period of time, the gate amplitude is related to the pulsed target current in only a qualitative manner, a pulsed current curve is always taken at the STRT when the spot interaction area (W^+ gate vs W^- gate) has been determined. Thus, changes in the spot interaction area (I^+ vs I^-) between WW installation and rejection are felt to be significant. Such changes in most of the rejected tubes have appeared as a reduction in the permissible range in I^- for a given I^+. For good tubes, this range might be from 10 to 40 μa I^- over a range in I^+ from 5 - 60 μa, while in bad tubes the range in I^- is rarely greater than 10 μa. The reasons for this decrease are not understood at present and an attempt is being made to determine whether a change in the surface secondary emission, holding-gun density, or high-velocity beam current-density distribution is responsible.

In testing RT318-1, an unexpected variation in lower switching voltage from 180 to 54 volts was observed. Within a small uniform area in which spot interaction tests were run, the results were not significantly different from those obtained on tubes having a normal collector screen. Another tube will be made, in which the copper screen will be given a different cleaning procedure.

(J. Jacobowitz)

Approximate calculations, similar to those outlined in the last bi-weekly report, have resulted in order-of-magnitude answers to the following important questions.

1. How long must the holding gun be left on in order to produce enough ions to deflect the high-voltage beam by a measurable amount?

2. How much time is required, after the holding gun has been cut off, for the ions to disperse to such a degree that they are no longer an important factor in deflecting the high-voltage beam?

3.2 Test (Continued)

(J. Jacobowitz) (Continued)

Using the geometric simplifications described in the last bi-weekly, and assuming that all holding-beam electron collisions with gas molecules create positive ions, the minimum holding gun ON-time that will produce a 2-mil deflection of the high-voltage beam is about 10 μseconds.

Assuming, 1) that the ion flow is equivalent to space charge limited current flow under the condition of a few volts applied potential; 2) that the flow is purely radial; and, 3) that the average molecular weight of the ions is 30, the estimated time for complete dispersion of the ion cloud becomes about 60 μseconds.

A great deal more remains to be done on this theoretical approach. In particular, a more realistic geometry should be considered and account made of the diffusion of the ions.

Some exploratory, experimental work has been undertaken on these problems using the spot-size tester. Preliminary results indicate quite a large deflection shift when the access time (i.e., the time between cutting off the holding gun and reading) is below 10 μseconds, and essentially no shift after approximately 20 μseconds access time.

The distortion of the high-voltage beam as evidenced by the change in apparent spot size is also indicated by these early tests. As one decreases the reading access time, one finds that the spot appears continually smaller. These results place a fundamental limitation on the speed of the electrostatic storage system. However, in the next bi-weekly period, I intend to explore several very simple ways of eliminating this difficulty.

Somewhat outside the scope of my present work -- but nevertheless worthy of note -- is the fact that I am now using a readout system that employs neither r-f modulation of the high-voltage beam, nor gating of the collector or signal plate. Fairly reliable positive and negative readouts are obtained, but these vary somewhat with the age of the tube. It is believed that this type of readout is due to the difference in upper stable potentials established by the holding gun and the high-voltage beam. This difference depends on the secondary emission and the velocity distribution of the secondaries but has not been explained quantitatively as yet.

Some thought was given to the design of a Faraday-cage tube for measuring ion and electron distributions of the holding beam. It is hoped that it will be possible to use most of the target structure which was constructed for a tube used by John Ely in his experiments.

3.2 Test (Continued)

(A. M. Stein)

RT318-1 which employs a special collector screen made of copper, the cross section of which has the appearance of an egg-crate, was investigated this bi-weekly period. The collector-to-surface spacing is approximately 5 mils. It was found that the r_{el} of the spot size v_s W⁻ time characteristic has a value of 18.6 mils. Tubes using conventional collector screens have a r_{el} of 25 mils at the same collector-to-surface spacing as RT318-1. The lower, more desirable value of r_{el} of the "egg-crate" type collector is ascribed to the greater dispersion of high-energy secondaries from this screen so that fewer of these electrons reach the surface. It should be pointed out that in order to obtain a r_{el} of 18.6 mils with conventional screens, a collector-to-surface spacing of 3.5 mils is required.

Some time was spent in instructing J. Jacobowitz in the proper use of the spot size test set-up.

The second half of this bi-weekly period was spent on vacation beginning with the month of June. I have joined the staff of CBS-Hytron in a production-engineering capacity.

(A. J. Cann)

The first week of this bi-weekly period was spent becoming familiar with the Alignment Demonstrator, and attempting to operate it. Some progress was made. It was found that in one whole rack -30v and -150v were interchanged. Correcting this difficulty cured some free-running flip-flops that had been giving trouble.

The second week was spent on vacation.

4.0 TERMINAL EQUIPMENT

Photoelectric Tape Reader

(F. Irish)

The photoelectric tape reader control panel has been video checked, and the test specifications are being written. Rack wiring for locating the panel in AX-5 has been requested. The wiring and the panel will be ready in time for installation with the final in-out system.

4.1 Typewriter

(P. W. Stephan)

A block diagram has been made of the paper tape recorders and printers as they are connected in the final in-out system of WWI. It is more detailed than that on SC-51149, Block Diagram of Printers and Paper Tape Units.

I am now investigating the way in which the Ferranti photoelectric tape reader can be connected to the WWI in-out system.

4.2 Interim Magnetic Tape System

(S. Ginsburg)

The Magnetic Tape System may be used at any time with the computer. During the day, a member of the Magnetic Tape Group should be contacted. Several of the system technicians are familiar with the manner in which power is applied to the system, and they should be consulted during the evening.

The system has been operating without error during the past bi-weekly period. Occasionally, a breaker trips in Room 226, but this will be remedied whenever a larger capacity breaker is installed. This fault can be prevented if the Rack Power Units are turned on in the proper sequence and each relay allowed to operate before another rack power unit is turned on. The two rack power units opposite the Tape Unit, against the wall, should be turned on first.

(E. P. Farnsworth)

Instructions for use of the interim magnetic tape print-out equipment have been compiled and will be distributed to Group 61 and the Mathematics and Applications Groups as memorandum M-1516.

4.0 TERMINAL EQUIPMENT (Continued)

4.2 Interim Magnetic Tape System (Continued)

(E. P. Farnsworth) (Continued)

Schematics and preliminary layouts for three of the four final print-out equipment panels to be installed permanently in the computer rooms are ready for scheduled drafting.

(K. McVicar)

Preparations are being made to install those panels for the final magnetic tape system which have been received to date. They will be integrated with the interim system as far as possible to permit some system testing of these panels. It is planned to gradually substitute the final tape system panels for those of the interim system so that a minimum of work will be necessary when the entire in-out system is installed in a few months.

Arrangements have been made to have racks installed in the computer control room for the five tape units which will eventually be used. Work on the power for these racks and the tape system racks in the computer room is progressing.

4.4 Magnetic Drums

(J. A. O'Brien)

Some thought has been given to the problem of testing the magnetic drums and circuits when they arrive. By the time the first drum system is delivered we should have a good supply of plug-in units for the multiple input equipment. The plug-in units could be assembled to provide a 16-digit register and a few control elements and with these the entire drum system can be given some rather thorough tests.

5.0 INSTALLATION AND POWER

5.2 Power Supplies and Control

(R. Jahn)

a) -48 VDC Regulator
A new regulator has been installed on the -48 VDC power supply

b) -300 VDC Supply
A temporary -300 VDC power supply has been installed to provide bias for the DC coupled Flip-Flops.

5.0 INSTALLATION AND POWER

5.2 Power Supplies and Control

(R. Jahn)

c) Commutation Factor Measurements
Measurements are being made of the +250 VDC commutation factor with two commutation factor chokes in place to determine the optimum air gap setting of these chokes.

(G.A. Kerby)

Continued with the procurement of equipment for the new filament supply for WWI.

Started construction of the power supply extension for WWI.

6.0 BLOCK DIAGRAMS

(J. H. Hughes)

The new Consolidated timing diagrams, which list the commands making up each operation in order of their occurrence, have been sent to the drafting room to be drawn up and reduced to a B-size drawing. The old "Timing Diagrams" of R-180 will be obsoleted when the new ones come out.

I am working on a simple (I hope) block diagram of test control.

8.0 MATHEMATICS, CODING, AND APPLICATIONS

8.1 Programs and Computer Operation

Progress during this bi-weekly period on each general applications problem is given below in terms of programming hours spent by laboratory personnel (exclusive of time spent by outsiders working on some of the problems), minutes of computer time used, and progress reports as submitted by the programmers in question.

4. Floating Point and Extra Precision Interpretive Subroutines (Programmed Arithmetic, PA): Frankovich, 12.5 hours; WWI, 31 minutes

The (39,6,0) programmed arithmetic interpretive subroutine was satisfactorily tested on the computer this week and is available in the library of subroutines. Programmers using this subroutine can assume that Whirlwind is a floating binary point computer which performs arithmetic and logical operations upon numbers greater than or equal to 2^{-64} and less than 2^{+64} with 39 binary digit precision. However, the subroutine has the two disadvantages of occupying twice the storage space and requiring about 50% more time per interpreted instruction than the corresponding (24,6,0) subroutine.

8. Magnetic Flux Density Study: Helwig, 1.5 hours; WWI, 86 minutes

11. Point-by-Point Scope Plotting of Alpha-Numerical Characters (Output Camera, OC 1): Kopley, 11.5 hours; WWI, 22 minutes

A (24,6,0) MRA display program is being tested.

An instruction display program has been successfully run and it is hoped that this program will be used for post-mortem purposes so as to reduce typing time.

21. Optical Constants of Thin Metal Films: Neeb, 9 hours; WWI, 48 minutes

The results from the main program check with those obtained by hand calculation. The program for infrared radiation on gold blacks is now being tested.

24. Matrices, Determinants, and Systems of Linear Equations: Aronson, 14 hours; Carr, 12 hours; WWI, 189 minutes

A (24,6,0) program has been written, and is currently undergoing tests. This program inverts a matrix by a method due to Shur-Shultz (often called the escalator method). The procedure inverts a matrix by successively inverting main diagonal minors of increasing order. In addition these inverses are improved by perodic iterations (no more than 2 or 3 times). This method has two decided advantages: 1) the matrix need not be symmetric or positive definite but only non-singular; 2) the periodic iterations reduce the round-off error to that obtained in the last iteration plus that due to the remaining inversion operations. A disadvantage is that storage space for two matrices of the given size are needed by the program.

8.1 Programs and Computer Operation (continued)

26. Subroutine Orientation Procedures: Frankovich, 6.5 hours; WWI, 4 minutes

28. Ambipolar Diffusion: Gilmore, 4 hours; WWI, 370 minutes

This problem's present program operates at high speed for fifty minutes without reference to any output before it finally prints its solution. We have had the misfortune of electrostatic storage failing after forty to forty-five minutes of operation. This was causing a great loss in useful computer time and as a result steps were taken to punch out certain constants of the program on paper tape in 5 minute intervals. This enabled us to save enough information so that when a failure occured our only loss was five minutes since it was possible to erase storage, read in the program, the parameter being used, and the lost set of data on the punched tape, and then continue.

We are now in a position to finish the parameters requested by Prof. Allis within the next two weeks.

30. Digitally-Controlled Milling Machine Program: Frankovich, 4.5 hours; WWI, 70 minutes

Mr. Runyon has nearly completed the "point-by-point" program which will convert the coordinates of the "corners" of a rectangular surface into a sequence of punched tape instructions in the milling machine code. Tests on the new tape preparation program are continuing.

39. Subroutine Library Editing: McQuillan, 6 hours

40. Input Conversion Using Magnetic Tape Storage: Frankovich, 25.5 hours; Gilmore, 8 hours; Helwig, 23.5 hours; Kopley, 1 hours; Combelic, 10 hours; WWI, 42 minutes

A definite procedure has finally been established for the magnetic conversion program, and the actual programming lies before us. The first program will incorporate floating addresses and preset parameters with a flexible notation system. It will also record a program's logical as well as binary information on magnetic tape so that it will be possible for post mortems to print out any of those registers which have changed and in the same form that the register's contents were referred to initially.

45. Crystal Structure: Aronson, 8 hours; WWI, 37 minutes

46. Torpedo Depth Response: WWI, 20 minutes

47. Partial Differential Equations of Engine - Part I: Carr, 4 hours; WWI, 247 minutes

During the past two weeks the program for the computation of the dynamic effect of an inlet pipe of a single-cylinder engine has been further tested. It was found that the results as displayed on the oscilloscope were very satisfactory with regard to both the accuracy of computation and the speed with which a relatively large quantity of

8. 1 Programs and Computer Operation (continued)

47. (continued)

information was obtained. It has been decided, therefore, to use the oscilloscope for all future computations.

Of the six or seven runs made thus far all except one yielded results in fair agreement with values obtained experimentally. For the one unsatisfactory run, the program seemed to go into a loop after a certain condition was reached, and no answer could be obtained after that. It is suspected that the built-in iteration process is not convergent under certain conditions.

To remedy this situation, and to make the oscilloscope display program work better, the present program has been modified. In the modified version, the iteration procedure is removed. This should cause negligible loss of accuracy, and in fact should shorten the time of computation--if indeed the iteration process was causing trouble. The new tape now awaits testing.

48. Gust Loads on Rigid Airplanes in Two Degrees of Freedom: Helwig, 17 hours; WWI, 181 minutes

50. Lattice Analogy Applied to Shear Walls: WWI, 72 minutes

51. Magnetic Tape Programming: Kopley, 20.5 hours; WWI, 51 minutes

Several magnetic tape read and record programs are being tested and a magnetic typewriter subroutine is being tested. (24,6,0) MRA magnetic tape read and record subroutines are being written.

52. Oil Reservoir Depletion Analysis by Iteration: Kopley, 23 hours; Porter, 19 hours;

The coding for the analysis utilizing an averaged iterative procedure has been completed. This procedure will be tested on WWI as soon as possible.

54. Optimizing the Use of Water Storage In a Combined Hydro-Thermal Electric System: Demurjian, 7.5 hours; WWI, 215 minutes

The new program was tested without obtaining satisfactory results. The delay subroutine for magnetic tape caused spot interaction in the electrostatic storage tubes. This was remedied by using FFO as the counter register.

The rerecord routines for magnetic tape will be checked to find the cause for the program alarm that is appearing.

56. Determining Pupil Dates and Two Dramatic Aberrations in Optical Lens Systems: Helwig, 1.5 hours; WWI, 14 minutes

57. Runge-Kutta Differential Equations: Aronson, 1 hour; WWI, 20 minutes

8.1 Programs and Computer Operation (continued)

58. Determination of Energy Levels of Oxygen Molecule: Carr, 8 hours; WWI, 137 minutes

The "Givens" tridiagonalization technique has gone through a successful performance. The procedure was applied to the tortuous matrix designed by Lanczos (et al) of the Nat'l. Bureau of Standards, and it seems to come through with negligible round-off. The program yields a tridiagonal matrix whose roots can be calculated by an iterative scheme applied to the three term recursion relationships implied by the tridiagonal matrix. With a desk computer, three roots of the tridiagonalized Lanczos matrix have been computed and they agree perfectly with the known roots. This iteration scheme is now to be programmed for Whirlwind.

60. Calculation of Deuteron Energy Levels: Combelic, 20 hours

The program has been operated successfully. For one set of the two parameters successive trial eigen values converged to the true eigen value (plus or minus 2%) in ten trials. The entire process, including the printing of the potential and wave function, required 55 minutes of computer time. This inordinately long time will be reduced in the following ways.

1. Use of magnetic tape for auxiliary storage will require calculation of the potential function only once for every ten sets of parameters.
2. Whether the trial eigen-value is correct can be detected earlier in the integration.
3. Heretofore the amount by which an incorrect trial eigen-value was changed to give a better value has been on the basis of a "split the difference" method. The new trial eigen-value can be better estimated by noting the magnitude of the error in the wave function caused by the last incorrect value. This scheme should require less trials before the correct eigen-value is reached.
4. Now that the magnitude of the eigen-value as a function of the two parameters is known approximately, a better first approximation can be made to the eigen-value as a function of new parameters.
5. Use of number display for output will be much faster than typing the output data.

It is believed that by incorporating the above modifications into the present slow program the time required to find one eigen-value can be reduce by approximately a factor of 20. By further modifications, the program can be used to find higher order wave functions using the same basic method.

63. M. I. T. Seismic Project: WWI, 116 minutes

67. A Method for Obtaining the Characteristic Values of Symmetric Matrices by Direct Diagonalization: WWI, 25 minutes

The eigen-value program is still being tested and corrected. A short note on methods for obtaining the characteristic values of matrice is being

8.1 Programs and Computer Operation (continued)

67. (continued)

prepared with the idea in mind of providing useful information on this topic to people who would put such problems on Whirlwind.

70. Correlation of Solvolysis Rates: Demurjian, 6 hours; WWI, 43 minutes

The program was modified and new values were inserted in the lattice but even then a divide error alarm occurred within the interpretive routine.

72. Master Output Routine: Demurjian, 15.5 hours

This problem was originally introduced under problem #38. The routine will include flexo and punched tape output, oscilloscope and camera output, magnetic tape and error diagnostic routines. The various output modes that are now written as separate subroutines will be combined. By the use of the master output routine one may select any one or several of the optional types by setting preset parameters and the use of an interlude.

The output group consisting of Helwig, Kopley, Frankovich and myself had a meeting where methods and modes were discussed. A trial routine for (15,0,0) numbers will be written.

73. Demonstration Tape: McQuillan, 37 hours; Mackey, 34 hours; WWI, 50 minutes

This problem consists of revising the present demonstration tape to eliminate all manual intervention. No flip-flop settings will be necessary and each successive program will be automatically read-in after the previous program has gone through a definite number of cycles. Two of the programs have been completed and work continues on the remaining programs.

76. Polynomial Roots: Carr, 4 hours; WWI, 10 minutes

79. Ray Tracing Thru a Microwave Lens: Combelic, 17 hours

A. F. Bartholomay of the Lab for Electronics has submitted the following problem.

It is desired to trace rays thru each of a set of 125 spherical lenses in order to decide which lens design meets two requirements: 1). The angle of the final refracted ray with a given characterizing line is 90°; 2). The path lengths (from source point to characterizing line) for all rays thru a given design must be equal. Silberstein's book (1918) "Simplified Method of Tracing Rays Thru Any Optical System" supplied the motivation for setting the problem up in terms of vectors, using an intrinsic co-ordinate system. The great value of this method is not realized in this particular set-up, for its value lies in the fact that skew rays and rays thru a whole system of optical lenses can be traced much more simply than by scalar methods. The final formulae in our case were reduced to straightforward algebraic equations involving the 4 basic arithmetic operations and a square root operation. Because of the large range of the numbers involved the (24,6,0) number system will be used.

8.1 Programs and Computer Operation (continued)

TOTAL COMPUTER TIME USED FOR PROGRAMS: 40 hours, 15 minutes

TOTAL COMPUTER TIME USED FOR CONVERSION: 4 hours, 3 minutes

TOTAL COMPUTER TIME USED FOR DEMONSTRATIONS: 22 minutes

TOTAL COMPUTER TIME USED: 44 hours, 40 minutes

TOTAL COMPUTER TIME AVAILABLE: 65 hours, 36 minutes

USABLE TIME PERCENTAGE: 68.7%

TOTAL # OF PROGRAMS OPERATED: 157

8.2 Subroutine Library

Below are listed all subroutines which have been suggested, worked on, or completed during this bi-weekly period.

Completed

LSR #	Tape #	Title	Programmer
EX 200.1	T 1216-1	(24,6,0) e^x subroutine (slow)	Helwig
HF 207.1	T 1217-1	(24,6,0) sinh x-cosh x subroutine (slow)	Helwig
OC 2.2	T 788-6	Display C(ES) as Octal Fraction Sign, Octal Point, D-or F-scope Layout	Kopley
OC 2.4	T 863-6	Display C(ES) as Decimal Fraction No Roundoff, Decimal Point, Sign, D-or F-scope, Layout	Kopley
PA 4.1	T 1180-1	(39,6,0) Interpretive Subroutine	Frankovich
	Being Tested		
AD	T 1246	Single Step Extrapolation of n Simultaneous 1st order differential equations by Runge-Kutta	Frankovich
MT	T 1249-3	Magnetic Tape Record	Kopley
MT	T 1250-3	Magnetic Tape Read	Kopley
MT	T 1272	Magnetic Typewriter Output	Kopley
MT	T 1300	Moving Magnetic Tape Backward	Kopley
MT	T 1301-1	Read Magnetic Tape	Kopley
OC	T 850-6	Octal Instruction Scope Display	Kopley

8.2 Subroutine Library (continued)

OC	T 891-2	Octal Integer Display	Kopley
OC	T 939	(24,6,0) MRA Decimal Display, Layout	Kopley
PA 2.3	T 1182	(24,6,0) Interpretive subroutine with minimum time per interpreted instruction and with facility of working in the (30,15,0) number system	Frankovich

Being Written

MT		(24,6,0) MRA Magnetic Tape Read-Record	Kopley
MT		(15,0,0) Magnetic Tape Read-Record C(AC)	Kopley

8.3 Procedures

(J. Gilmore)

The mathematics group has increased its operation in an attempt to increase WWI operation efficiency. A meme (M1513) has been issued which lists all the utility programs which are available to a WWI operator. This should be helpful to new programmers and outside people who are programming their own problems.

9.0 FACILITIES AND CENTRAL SERVICES

9.1 Publications

(Anola Ryan)

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

LABORATORY REPORTS

No.	Title	No. of Pages	Date	Author
M-1480	A Transistor "AND" Gate	2	5-7-52	W. A. Hosier
M-1496	Signed Ternary Arithmetic	9	5-22-52	H. R. J. Grosch
M-1501	Accounting Procedures	3	5-26-52	H. B. Morley
M-1502	Construction Procedures for Engineers	6	5-27-52	C. W. Watt
M-1503	Bi-Weekly Report	39	5-23-52	
M-1508	May 1952 Storage and Research Tube Summary	4	6-1-52	R. E. Hegler
A-134	Production Control	1	5-22-52	H. Fahnestock

LIBRARY FILES

No.	Identifying Information	Source
1853	A Magnetic Matrix Switch and its Incorporation into a Coincident-Current Memory (MS Th.)	K. H. Olsen
1854	Special-Purpose Digital Data-Processing Computers (Lab. for Electronics)	B. M. Gordon R. N. Nicola
1855	Analog-Computing Facility at the Jet Propulsion Lab., California Inst. Tech.	J. J. Wedel et al
1856	Tables of n! and $\Gamma(n+1/2)$ for the First Thousand Values of n (Applied. Math. Series No. 16)	U. S. Dept. Comm.
1857	Tables of Sines and Cosines to Fifteen Decimal Places at Hundredths of a Degree (AMS No. 5)	U. S. Dept. Comm.
1858	Empirical Sampling Distributions II (N.B.S. No. 1621)	D. Teichroew
1859	Method of Conjugate Gradients for Solving Linear Systems (N.B.S. No. 1659)	M. R. Hestenes E. Stiefel
1860	Use of Subroutines on SWAC (N.B.S. No. 1634)	R. S. Lipkis
1861	An Isoperimetric Inequality for Closed Curves Convex in Even-Dimensional Euclidean Spaces (NBS No. 1637)	I. J. Schoenberg
1862	Ternary Boolean Algebra	A. A. Grau
1863	An Experimental Investigation of the Williams System of Electrostatic Storage, Bureau of Ships	J. Kelar Eng. Rsch. Assc., Inc.
1864	Developments in Methods of Electrostatic Storage Bureau of Ships	J. Kelar Eng. Rsch. Assc., Inc.

9.1 Publications (Continued)

(Anola Ryan)

LIBRARY FILES (Continued)

No.	Identifying Information	Source
1865	Applied Mathematics Meeting in Freiburg, March, 1951	ONR/WASHINGTON
1867	On the Estimation of an Eigenvalue by an Additive Functional of a Stochastic Process (NBS No. 2286)	R. Fortet
1868	On Some Functionals of Laplacian Processes NBS No. 2280	R. Fortet
1869	Uber Die Partiellen Differenzengleichungen der Mathematischen Physik	R. Courant et al
1870	Symposium on Applications of Autocorrelation Analysis to Physical Problems, Woods Hole, June 13-14,1949	ONR/WASHINGTON
1871	Insulation Research Lab., M.I.T., Progress Report, No. XI, May, 1952	
178	Mathematical Tables and Other Aids to Computation III, April, 1952	National Rsch. Council
1131	Quarterly Report No. 5 of the Computer Components Fellowship No. 37, Oct. 11, 1951-Jan. 10, 1952	A.F.C.R.C.
1250	Research Reviews, May, 1952	ONR/WASHINGTON

JOURNALS

- Electrical Engineering, May and June, 1952
- Bell Technical Journal, May, 1952
- Oil and Gas Journal, May 26, June 2, 1952
- Electrical Manufacturing, June, 1952
- Science News Letter, May 31, 1952

9.2 Standards, Purchasing, and Stock

(H. B. Morley)

Procurement and Stock

Orders for stockroom quantities have been placed for nearly all items so far published in the new Standards Book. Exceptions are certain items in the relay and transformer groups, which are mainly specialized units, to be ordered for specific construction requisition needs.

If deliveries continue at the recent good level, the stockroom should have this new material ready to issue within 8 to 12 weeks. Immediate important needs for small quantities of the new items not in stock can, in most cases, be filled by special request on the suppliers, who have cooperated fully in recent weeks in filling small-quantity emergency needs.

As new Standards sheets are issued, orders will continue to be placed for best possible delivery to prevent shortages.

Procurement is using every means to change the answer to stockroom requests from "It's on order" to "Here it is".

9.3 Construction

(F. Manning)

Production Control

The following units have been completed since May 23, 1952.

CR No.	QTY	UNIT TITLE	ENGINEER
1492-4	3	Plug-In Dual Buffer Amp. Mod. II	Watt
1492-5	3	Plug-In Switch Unit Mod. II	Watt
1625	1	D.C. Outlet Box Modification	Platt
1637	2	Filament Supplies for Vac Tube	Palermo
1652	1	Assembly Preburning Panesl	Twicken
1659	6	Mixer Operation Matrix	Platt
1563	6	Multivibrator Frequency Divider	Taylor
1666	140	Clip Leads	Papian
1688	24	1:1 Pulse Transformers Cast	Hunt
1691	1	Chassis for Public Address System Whittemore Bldg.	Carroll
1707	6	D.C. Power Cables	McVicar

9.3 Construction (continued)

(F. Manning)

CR. No.	QTY	UNIT TITLE	ENGINEER
1711	2	Power Cables 29 pin one end. Other end 10 pins & 8 spade lubs	McVicar
1713	1	Pulse Generator (Breadboard)	Hunt
1760	1	.1 μ sec. Alarm Indicator (Breadboard)	Papian
1429	30	Lab. Bench Cabling	Hepp
1699	110	Video Cables	McVicar
1561	1	Standardizer Amplifier	Mercer
1415	5	Storage Tube Mounts	Dodd
1614	1	Vacuum Tube Process Pur Supply	Palermo
1615	2	ION Gauge Control Chassis	Palermo
1591	1	Magnetic Tape Control Block Mark Detector & Shaping Circuit	O'Brien
1560	1	Fuse Indication Panel	Mercer
1492-3	44	Gate-Buffer Amplifier Plug-In Unit Mod. II	Watt
1609	1	In-Out Switch Magnetic Tape Matrix	O'Brien
1704	2	Core Pulse Amplifier Breadboard	Brown
1492-6	32	D.C. Flip-Flop Plug-In Units Mod. II	Watt
1704	2	Core Pulse Distributors Breadboard	Brown
1608	1	Magnetic Tape Control Mode Switching Flip-Flop	O'Brien
1699	100	91 ohm Terminators	McVicar
1598	200	91 ohm Terminators	Papian
1504	500	91 ohm Terminators	Mercer
1492-10	3	Test Panels Plug-In Units	Werlin
1709	1	Filament Alternator Regulator	Kerby
1429	5	Lab Bench Cabling	Hepp
1633-3	50	A.C. Circuit Beakers	Hepp
1765	40	Video Cables	Eckl
1492-8	5	Mounting Panel Plug-In "19"	Watt
1702	1	Delay Line	Baltzer
1764	4	D.C. Power Cables	Eckl
1762	1	Core Pulse Amplifier	Brown
1763	40	D.C. Power Cables	Nickerson
1762	1	Core Pulse Distributor	Brown
1768	65	Clip Leads	Baltzer
1768	100	Video Cables	Baltzer

9.4 Drafting

(A.M. Falcione)

1. New Drawings:

A. Standard WWI Aluminum Panels 19"

Drawings have been completed for various sized of 19" panels which have been adopted for WWI test equipment and WWI use

19 x 1 3/4 C-51601
19 x 3 1/2 C-51603
19 x 5 1/4; 7; & 8 3/4 C-51602
19 x 10 1/2 & 12 1/4 C-51604

B. Driver for Magnetic Core Tester Mod III

Drawings for this unit are ready for grading
Circuit Schematic C-50822
Ass'y & PL D-51290 Al. Panel D-50823 Chassis C-50824

C. Magnetic Core Tester

Drawings for this unit are ready for grading
Circuit schematic C-50816
Ass'y & PL E-51291 Al. Panel C-50815 Chassis E-50814

D. Power panels for room 156

Title	Cir.Sch.	Ass'y & PL	Al Panel
Fixed Voltage Sw. Panel Mod II	D-51550	D-51551	D-51553
Voltage Var. Sw. Panel Mod II	D-51543	D-51544	D-51545
Fuse Ind. & rack Interlock	D-51547	D-51548	D-51549
Rack Fuse & Dist. Panel	none req's	D-51655	D-51656

Typical 26" WWI Rack

Drawings for the above units are completed except for checking.

E. -300 Volt Regulator WWI

Drawings for this unit are complete except for checking

9.4 Drafting (continued)

(A. M. Falcione)

Cir. Sch. D-51255
Assy & Pl E-51622 Al Panel E-51623

F. Magnetic Tape Control Unit Selector Panel

Cir. Sch. D-51428
Assy & Pl D-51429 Al Panel D-51430

Drawings for this unit are complete except for checking.

10.0 GENERAL

(J.C. Proctor)

New Staff

Thomas Walkinshaw, who has been assigned to work with O'Brien, received his BS in EE from the University of Massachusetts this month. From 1948 through 1950 he worked as a Testing Engineer with General Electric and prior to that, during 1942 through 1946, was with the US Army Signal Corps.

Channing Morrison, Research Assistant assigned to work with Taylor, received his BS in EE from the University of New Hampshire this month and is beginning his graduate work here at MIT. From June to September 1951 he worked as Assistant Engineer for the Brown Co. of Berlin, New Hampshire.

Harold Seward, Research Assistant assigned to Wieser's group, received his BS in EE from Norwich University this month and also is beginning his graduate work here at MIT at this time. During the summers of 1950 and 1951 he was associated with the Central Vermont Public Service Corp. in the electrical maintenance department.

Christopher Laspina, assigned to work with Best, received his BS in EE from the Polytechnic Institute of Brooklyn this June and has at the same time worked as a technician in sound equipment and TV for the past four years.

Jack Raffel, Research Assistant to work with Taylor, received his AB in June 1951 and his BS in June 1952, both from Columbia University. He is also continuing his academic work here at MIT. Raffel was associated with Universal Sheet Metal Corp. of New York as an airconditioning Tester during the summers of 1947 through 1951.

Joshua Hayase, Research Assistant working with Wieser, received his BS in mathematics at MIT this June. Prior to his academic training here, he worked with the Headquarters of the Far East Air Forces in San Francisco from 1945 to 1949. Hayase is beginning his graduate work here at MIT.

Richard Jenney, who has been assigned to work with Brown, received his BS in EE this month from the Institute, and will continue his academic training in September. He was, during the summers of 1948 through 1950, associated with the Instrumentation Laboratory here at MIT.

Guy Young, Research Assistant, who will work with Rich, received his BS in EE from Case Institute this month and will further his academic training here at the Institute. Young has been in continuous association with electrical installation since 1943.

10.0 **GENERAL** (continued)

(J.C. Proctor) (continued)

John Nolan, assigned to work with Wieser's group, received his BA in mathematics from Boston University this month. He plans to further his academic training in September. In cooperation with Northeastern University Nolan was associated with the Jarrell-Ash Co. of Newton, Mass. during 1947 through June 1949.

New Non-Staff

Barbara Durso is a messenger assigned to Morley's department.

Alvan Lampke is a detailer assigned to work with A. Falcione in the Drafting Room.

Arnold Levine, working with Clough, is a full-time student.

Virginia Nicholson is a senior clerk, assigned to Morley's department.

Raymond Quinn, a laboratory assistant, has been assigned to work with Wiercinski.

Dorothy Smith is a laboratory assistant working with Jacobs.

Harold Schapiro, a full-time summer student has been assigned to work with Frost.

Walter Vecchia recently began his duties as a laboratory assistant under the supervision of Arnow and Wieser.

Norman Doelling is a part-time summer student assigned to work with Watt.

Joseph P. Dankese is a full-time summer student working with Clough.

David Wiesen, a full-time summer student, has recently assumed his duties in the construction shop under the supervision of Grant.

Dennis J. Twohig is a laboratory assistant assigned to work with Adams' group.

Two new laboratory assistants have been assigned to work with Grant in the Construction Shop: Andrew C. Anderson and Edward Harwood.

Three new summer student technicians have also been assigned to Adams' group: John J. Genewicz, Joseph F. Kapczynski and Haig S. Parechanian.

10.0 GENERAL (continued)

(J.C. Proctor) (continued)

Two new laboratory assistants, Amber Cox and Mary Delaney, recently began their duties under the supervision of Youtz.

Terminated Staff

Theodore L. Roess

Terminated Non-Staff

Richard Greenwood
Martin H. Cohen
Arthur H. Ehrenberg
Noble Pribble
Carol J. Schwartz
Le Roy F. Valentine