Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART II, FEBRUARY 20, 1948

To: 6345 Engineers

From: Jay W. Forrester

6.0 MATHEMATICS

(P. Franklin)

Methods of lessening round-off error reported in M-239. A possible new order was defined in M-240. A comparison of possible methods of curve-fitting with the interpolation methods previously used has been started.

(C. W. Adams)

A study of the orders so far adopted for WWI has been completed and M-217 giving the results should soon be available. To a brief description of each order (taken from M-137) has been added a statement of what remains in AR, BR, AC and SX after the operation is completed. An indication is given of the method used to handle sign and to check for overflow, and small peculiarities of some of the orders are noted. M-217 also includes several orders which have been recently adopted and not heretofore described.

Coding of double length arithmetic operations is now being undertaken. This should lead to an estimate of the increased storage space and computing time involved in working with double length numbers.

(Edgar Reich)

Memorandum M-239 entitled "Order of Combination of Arithmetical Operations for Minimum Round-Off Error" has been distributed to the Mathematics and Block Diagram groups. It summarizes results obtained by von Neumann and Goldstine regarding s-place arithmetic.

The study of iterative methods for the solution of systems of linear algebraic equations is being continued.

6.0 MATHEMATICS (Continued)

(M. Daniloff)

Studies reported on in the last two reports were continued. New results are:

I. The equations of motion of the aeroplane (Cf. rep. of January 23, 1948) still contain two functions which must be stored, namely: the sine and cosine of the effective angle of attack. These equations have now been modified, so as to avoid the necessity of storing these two functions. This has been achieved by the introduction of two auxiliary equations and variables, so that $\sin\alpha$ and $\cos\alpha$ are automatically calculated for the instant of time under consideration.

II. 1) In simulating aerodynamic coefficients by polynomials fitted by least squares it has been found that all coefficients of the first terms of the normal equations can be calculated once and for all and stored, provided the independent variable is normalized as a preliminary step. The dependent variable need not be normalized. The scheme results in a very appreciable saving of orders and time of calculation. (This procedure is not identical with the method of spherical harmonics).

2) It has been found that least squares fits over the entire range of the functions give a larger error (up to 13%), than partial fits through critical values of the function (4%). Consequently, in future attempts, functions will be approximated over partial ranges.

3) Simulation of $f_1(\alpha, \delta F, T'_{\alpha_2+\chi_c})$ given on B-28000-G to B-28002-G started, with $0 < \alpha < 10^\circ$ (according to M-6); partial result:

$f_1(\alpha,0,0) = 0.029 + 0.0855\alpha - 0.005\alpha(\alpha - 2) - 41.667 \times 10^{-6}\,\alpha(\alpha-2)(\alpha-4) + 15.625 \times 10^{-6}\,\alpha(\alpha-2)(\alpha-4)(\alpha-6) - 4.427 \times 10^{-6}\alpha(\alpha-2)(\alpha-4)(\alpha-6)(\alpha-8)$

(α - in degrees) Maximum errors: = 0.9% at $\alpha=5^\circ$, = -0.5% at $\alpha=9^\circ$.

While the order of the parabola used (5-th) may, at first glance, appear excessive, the magnitudes of the errors indicate that a lower degree parabola might not achieve the desired degree of approximation in the simulation ($\leq 1\%$). Experiments are currently being conducted to determine the lowest degree of a parabola which will satisfy the requirements as to the accuracy of the simulation.

7.0 INPUT AND OUTPUT

7.1 Eastman Kodak Recorders

(H. R. Boyd)

P. Crawford at Special Devices is working on the contract with Eastman for the film units, and we reviewed the specifications with him this week. Eastman is being asked to provide for the use of WWI voltages and marginal checking methods where possible.

7.2 Analog to Binary Conversion

(W. K. Linvill, C. R. Wieser)

Conversion of shaft position to binary data by means of commutators has been studied further. This method has been examined particularly as a means of obtaining coarse and fine binary position signals from a servo driven shaft. These signals would be subtracted from computor coarse and fine signals to obtain coarse and fine servo error signals (binary numbers). The fine error signal would be decoded and used to control the servo motor under normal operating conditions, and the coarse error signal would be used only to make the system self-synchronous. This system seems feasable with commutators of reasonable size and angular resolution, and further study will be made.

7.3 Binary to Analog Conversion

(E. W. Sard)

The large dependence of the output of the four digit serial binary coder on the shape and amplitude of the input trigger was remedied by using a gas-tube (suggested by H. Kenosian) as the first stage instead of an R-L-C peaker.

However the Bell Labs decoder (more accurately known as the Shannon-Rack decoder) is still dependent on shape and amplitude of the coded input digit pulses. A decoding circuit in which a delay line with proper terminations replaces the Shannon-Rack decoder seems to be much less sensitive to coded pulse shape and amplitude and equally accurate. Less sensitivity to coded pulse shape and amplitude may be obtained in theory by forming standard gates from each of the coded pulses using a flip-flop reset through a delay line, with the two plate voltages clamped to regulated power supply voltage. The standard gates are then fed to the delay line of the decoding circuit through a cathode follower.

7.3 Binary to Analog Conversion (E.W.Sard, Continued)

All the previous methods of decoding mentioned have been converting pulse code modulation to pulse amplitude modulation. However, conversion of pulse code modulation to pulse width modulation seems to offer much greater possibility of accuracy, and also to be practicable because of the long intervals of time between successive decodings in the computer application. A tentative block diagram of a method of conversion from pulse code modulation to pulse width modulation has been drawn up.

7.4 Magnetic Recording

(Edwin S. Rich)

Data to show the variation of output-pulse length and amplitude with changes in input-pulse length and amplitude for a Vicallon recording medium has been obtained. Plots of this data indicate some significant characteristics ofthe recording process. The results are described in some detail in my Thesis Progress Report #5.

An investigation of the resolution of recorded pulses is now being conducted.

7.5 Unclassified

(J. A. O'Brien)

Decimal-Binary Conversion. Work on the decimal to binary converter has been discontinued, and the present plan is to allow the computer to do the conversion.

7.6 Output Printers

(F. A. Foss)

An investigation of the relative merits of different types of output printing equipment is being conducted. Methods of obtaining the different printing machine functions are in the design stage.

8.0 STORAGE TUBES

8.1 Tube Construction and Testing

8.11 Tube Construction and Processing

(R.Shaw) The following work is being done on the storage assembly for the five-inch tube:

Fixtures for production of mesh support ring will be completed February 21. A signal plate assembly is being made for mechanical testing, using parts that are unsuitable for use in tubes. A usable assembly is being made concurrently.

Tests on warpage of signal plate during de-gassing should be completed February 24.

(J.McCusker) Research tube mod. 5 was processed with Barta Building facilities. This tube will be used to study the secondary emission properties of caesium.

The following anodized 2 S aluminum targets were vacuum fired with RLE facilities.

1-3/8" Dia. - S18, S20, S22, S23

4-1/8" Dia. - LS1, LS2

Tests were run on both vacuum systems in the Barta Building. Both systems are vacuum tight, but the NRC ion gauge was found to have bad electrical leakage.

A series of reports on vacuum tube processing based on our past year's experience with RLE facilities and library research is being prepared.

(F.H.Caswell) The following tube elements were constructed and envelopes coated with "Dag" for:

R.T.5)Tubes to study properties of caesiated silver
R.T.6)
R.T.11 Tube to study focusing properties of new secondary emmisaion tube.
R.T.12 Tube to study current density of new type holding gun.

Photographs of tube elements and tubes are kept up to date as the tubes are constructed.

Parts for future tubes are always under construction, such as modified electron guns, various elements for future assembly and alumimum surfaces for anodizing.

Some time was spent with the large screen for the 5" storage assembly. Results show that we can easily fabricate a nickel ring in one piece and successfully weld the fragile 40 mesh .002" wire screen to it.

The technician work load on tube construction occupies the full time of two technicians and approximately three-quarters time of another.

(P.Youtz) Only two tubes were processed completely during this past fortnight. A number of tubes were put on the system and removed before the processing schedule could be finished. This abortive processing was caused by faults in the glass and troubles with the vacuum system.

The vibrations of the building of the forepump and fans for the diffusion pump have built up several times and caused tubes to crack. This problem has delayed our tube processing schedule. Concentrated efforts are being made to solve this problem.

Several tubes have been prepared to study the properties of evaporated films of caesium chloride and silver oxide. Only one tube was processed successfully and tested. The secondary emission ratio was below two. This evaporated film was not exposed to air for more than one hour. However, we plan to build at least three more research tubes to study the properties of caesiated silver prepared differently and exposed to air.

A storage tube with a five-inch diameter storage surface can be processed as soon as a satisfactory collector screen is constructed. Meanwhile glass and components for future five-inch tubes are being prepared.

8.12 Tube Testing.

(S.H.Dodd)

A standard 5 UP electron gun was modified by enlarging electrode apertures and deflection plate spacing and by replacing the standard control grid with a 2 mil. 40 mesh wire screen. This gun was put in a 5" envelope with willemite face to observe beam density. This tube (RT-10) had 150 μA beam current as compared with 600 μA for RT-7 under similar conditions. Other results with RT-10 are the same as RT-7. See M-238 p6 for discussion for RT-7. The low beam current of RT-10 is possibly due to cathode poisoning by metal chips during machining of G_1. To remove causes of the non-uniform current density, a new tube will be made similar to RT-7 except for removal of deflection plates.

8.13 Storage Tube Demonstration

(W. Nolan) Considerable progress has been made toward putting the E.S.T. demonstrator into operation. The switchingunit and control box have been operated and appear satisfactory. The various gates and delay times have been tentatively set up and the tube-mount has been operated.

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8.2 Storage Tube Research

8.21 Surface Material Characteristics

(H.L.Heydt) A life rack has been designed for the purpose of subjecting sample storage surfaces to conditions similar to those existing in an actual storage tube. At frequent intervals during the life tests secondary emission measurements will be made on the surfaces. If certain secondary emission properties of these surfaces do not remain within specified limits, the surfaces will be unsuitable for use in the final-type storage tube. The life-rack will not only be used to obtain the life characteristics of certain storage surfaces, but will also be used to study the variation with time and usage of electron gun characteristics, of gas in the tube, and similar phenomena. Engineering Notes E-100 discuss the life rack and its uses more fully.

A new type research tube has been proposed for making secondary emission measurements on storage surfaces. The tube is simple in nature containing merely an electron gun with deflection plates removed and a sample storage surface located approximately two inches from the end of the gun.

It is expected that secondary emission measurements may be made quickly and reliably with the new type tube since no positioning of the beam into an aperture is involved. The measurement difficulties involved when an aperture plate is placed in front of the storage surface as has been done previously, are discussed in the Master's thesis of H.L.Heydt, "Life-Testing of Surfaces suitable for Electrostatic Storage Tubes," M.I.T. 1948. Final design of the new type tube is contingent on the results obtainable from a preliminary model soon to be processed and tests on several sample tubes. In the preliminary model beam position, focus and current will be observed as a function of cathode - second anode voltage. It is hoped to obtain good beam currents at low cathode - second anode voltages by independent control of the second grid in the electron gun.

Preliminary secondary emission measurements on a caesiated silver surface on nickel have been made. The surface was tested in the existing type of research tube which contains an aperture plate preceding the surface. The beam was visually positioned into the aperture and onto the caesium surface, and D-C methods were used to obtain secondary emission curves. Results indicated that the secondary emission ratio for the surface never exceeded 1.5 for primary velocities between 0 and 2000 volts.

8.22 Anodizing

(M. Florencourt) It was desired to determine the reproducibility of R and C measurements in vacuo on smooth Al samples anodized and treated by various methods. J. Ross Macdonald had previously anodized four samples and sealed two of them electrolytically. Duplicates of these samples were prepared and treated to check his results. Both sets of measurements indicated that resistivity is of the order of 10^{15} ohmcm and capacitance per unit area of the order of 250 $\mu\mu f/in^2$.

Breakdown voltage for the sealed samples is of the order of 500 volts for the unsealed samples; breakdown voltage exceeds 1000 volts. Although capacitance per unit area and resistent measurements obtained by me were slightly higher than those obtained by J Ross Macdonald, this deviation is small and on the safe side.

The first spacer ring for the 5" storage assembly has been anodized successfully.

8.23 Output System Circuits

(C.H.R.Campling) The thesis proposal which covers work on storage-tube output-systems has been completed. It will be submitted to the E.E. department as soon as Prof. Zimmermann has approved it. Word should be received from him today. The proposed outlines a program which will consist of an investigation and evaluation of several different types of output circuits.

A memorandum is being prepared which will give a proposed time schedule for this program as well as a more detailed estimate of test equipment requirements.

Work has begun on an initial study of the type of clamp circuit which has been developed by S.H.Dodd. Before satisfactory results can be obtained, however, it will be necessary to obtain a synchroscope with a video amplifier and some gate generators and amplifier.

8.25 Electrolytic Tank

(S.H.Dodd) A piece of lucite was obtained for lining of the electrolytic tank. This has been necessary because efforts to insulate the tank from electrolyte have been unsuccessful. Porcelain enamel tanks such as those used by photographers were investigated but flaws in enamel caused low resistance measurements.

8.3 Unclassified

(M. Florencourt) All photographs taken in connection with the storage tube program have been catalogued. A memo containing this list will be issued shortly.

Storage Tube
(R. Shaw)
A set of dies have been designed for the nonex vertical stem equipment. These are being manufactured in the machine shop in Building 32 and it is hoped that they will be completed during the week of Mar. 1.

Visit to Corning Glass Works

(P. Youtz) T.F.Clough and I visited the Corning Glass Works February 13, 1948. We inspected all of their Corning Factories to study their glass working and glass blowing techniques. Informative conferences were held with Corning's technical services, research laboratories and sales organization to study our present and future glass problems. We arranged to have nonex cylinders for the first group of storage tubes for WWI blown during the next nonex melt. This melt is scheduled for the first weeks of April. Plans for new molds were discussed.

Nonex Stems

This development program has proceeded slowly due to pressure of other work. Sufficient stems have been produced to assure continuity of the research tube program.

8.4 **Deflection Circuits**

(J.O.Ely) A proposed program of deflection-circuit development is outlined in M-243. Work on designing the output amplifier for the deflection-voltage generator proposed is now in progress. A former design has been discarded because it called for several power supply voltages which recently have been removed from the standard list.

Work will proceed according to the time schedule given in M-243 unless this program is disapproved. The schedule calls for schematics and layouts of the deflection-voltage generator to be completed in sketch form by March 1 and March 8, respectively.

9.0 SERVOS AND SIMULATION

9.1 Cockpit

9.11 Structure:

(E. S. Prohaska)

A preliminary layout of the breadboard model is partially finished.

Experimental records of the maximum velocity of the column and rudder pedals under no load have been received for C. E. Eaton. This information will enable us to finish the design of the breadboard model.

No information has yet been received from H.Boyd about the procurement of the set of B-29 controls from the Navy.

9.13 Control Force Loading:

(W. Linvill)

A strain gauge amplifier has been designed and built for measuring the output forces on the control column of the present control-force-loading equipment. The range of this amplifier makes it suitable for the dynamic tests of the present hydraulic valve, and it may be used with the cockpit control system for WWI proposed by E. S. Prohaska.

(C. G. Eaton)

A study of the experimental data obtained from tests of the differential-pressure regulator indicate the need for some modifications. The modifications are now being investigated.

Tests have also been conducted upon the elevator and rudder controls in order to obtain approximate data on the maximum speed and horsepower that an average man is able to feed into the control force loading system.

9.3 Unclassified

(H. R. Boyd)

Servomotors--Ten Diehl FPE-11 two-phase servomotors and two amplidynes of 150 and 500 watt capacity have been purchased from Surplus. Experiments will be made for using the motors for regulating d-c power supplies. The

9.3 Unclassified (Servomotors, H.R.Boyd, Continued)

amplidynes will be tried as power amplifiers for exciting the fields of WWI motor-generators and also the synchronous motor and a-c generator.

11.0 FACILITIES AND CENTRAL SERVICE

11.1 Publications

(J.N.Ulman, Jr.) The following material has been received in the Library, Room 217, and is available to 6345 personnel.

6345 Reports

M-224	A Method of Direct Measurement of Secondary Electron Emission at Insulations (Translations)	M.I.Florencourt
M-237	Bi-Weekly Report, Part I Feb. 6, 1948	J.W.Forrester
M-238	Bi-Weekly Report Part II Feb. 6, 1948	J.W.Forrester
M-206	Numerical Solution of Systems of Simultaneous Linear Albebraic Equations by Elimination Methods	E.Reich
M-228	WWI Preliminary Time Schedules	H.Fahnestock
M-230	Notes on Aquadag	F.H.Caswell) T.Clough)
M-231	Eastman Conferences of Dec.23 & Jan.20 & 21	H.R.Boyd
M-232	Measurement of 7AK7 Characteristics at Emporium Feb.2 & 3, 1948	D.R.Brown
M-234	Visit of Mr.R.L.Snyder	J.W.Forrester
M-235	Vacuum Tube Life Tests	J.W.Forrester
M-236	Flip-flop Storage Arrangement	H.Fahnestock
M-240	A New Order for Finding Characteristics	P.Franklin
M-239	Order of Combination of Arithmetical Operations for Minimum Round-off Error	E.Reich
M-172	The Motion of the Ionic Lattices of Dielectrics in Extreme Electric Field Intensities (Translation)	M.I.Florencourt
M-241	Comments on Program Register Demonstration Panel.	H.Fahnestock
M-242	Twin Triodes	H.Fahnestock
M-233	Meeting to Discuss Storage Tube Output Systems	C.H.R.Campling
M-244	Project W.W.Seminar Schedule Feb.6 - Mar.10.	R.R.Everett
E-98	A capacitively coupled Flip-Flop (Abstract Thesis Report)	A.B.Horton
E-99	Test Equipment. Standard Tube Test Panel	N.H.Taylor
E-101	Coupling Capacitors in Basic Circuits	C.W.Watt
E-97	Storage Tubes Requirements for WWI	S.H.Dodd
E-100	Life Rack for Sample Storage Surfaces	H.Heidt

Library Files

61	A capacitively-coupled Flip-Flop(S.M.Thesis)	A.B.Horton
52	Progress Report for WWI Electronic Digital Computer for Period Jan 16, 1948 - Jan 30,1948	Sylvania

11.2 Standards Committee

(S.R.Abbott) The following specifications (M.I.T.) have been approved and distributed since the last report:

Class 6.07	Hardware
Class 6.09	Lights
Class 6.16	Sockets, tube
Class 6.18	Terminals

The following specifications (WWI) have been approved and distributed since the last report:

Class P7.023	Capacitors - Mica - Dielectric - Fixed
Class S7.032	R.F.Chokes
Class S7.153	Resistors - Wire Wound
Class S7.193	Circuit Connections for Pulse Transformers
Class S7.505	Diagrams
Class S7.506	Component Standards

The following JAN abstracts of pertinent information have been prepared and distributed:

Class 6.023	Jan C-5	Capacitors, Mica-Dielectric, Fixed
Class 6.042	A/N specs.	R-F Transmission Lines and Fittings
Class 6.152	JAN-R-11	Resistors - Fixed Composition (Insula
Class 6.153	JAN-R-26	Resistors - Fixed-Wire Wound
Class 6.212	JAN C-76	Cable (Hook-up Wire)
Class 6.214	Jan C-17A	Cable (Coaxial)
Class 6.021	JAN C-20	Capacitors, Dielectric-Fixed, (Temperature Compensating)

11.3 Purchasing - Stock

(H.B.Morley) As of this date, there are approximately 45 orders overdue in this office. All have been reported to Purchasing for expediting, and the three or four items which are holding up jobs have been given special attention in an effort to get early deliveries. In addition to the above, there are approximately twenty-five orders which have not been placed by Purchasing due to inability to locate a source of supply. None of these are delaying any lab work.

Recently a number of requests from engineers have been received, asking that inquiries be directed to manufacturers requesting quotations on materials for which all specifications and requirements are not clearly defined. This has in turn resulted in calls from these manufacturers asking for clarification and more definite information. It is felt that there is danger of losing the good will of some of our sources of supply by this practice. It is suggested that an effort be made to present to suppliers more exact specifications and requirements, or in cases where these have not been defined, to present the problem in the form of a request for consultation to obtain suggestions

and advice, rather than a request for quotation.

It is expected that specially processed samples of impregnated chokes and transformers will soon be received from BB Chemical and will be made available for test and inspection.

A sample board has been set up in Room 155, on which will be displayed manufacturers items of special interest, as well as items on which special inquiry is received, proposed new standard items, etc.

(H.R.Boyd) Authorization has been received for the purchase of the 3500 7AK7 tubes required by WWI.

11.4 Electronic Construction

(R.H.Murch) The following jobs and Units are in the Electronic Laboratory for Construction.

1. 40 Nameplates for AC Circuit Breaker Boxes completed except for sanding edges and mounting - approximately 1 manday of work.

2. 10 sets of nameplates for portable D.C.Disconnect Boxes completed except for sanding edges and mounting - approx. 3/4 manday of work.

3. Nameplates for Multiplier Room, completed except for sanding edges - approx. 2 manhours work.

4. Nameplate strips for rooms. Engraving will be completed Feb.21.

The above jobs cannot be completed until sanding machine is set up.

5. Adapter sockets(25) - 13 have been completed
Balance cannot be completed until Amphenol shells are received. These have been ordered from factory, approx. 4 man days of work.

6. 10 D.C. Bench outlet Boxes - 6 completed.
Remaining 4 have to be painted before wiring. Order for paint has been placed approx. 2 mandays of work.

7. Restorer - clock pulse distributor. 8-32 Elastic stop nuts (clinch type) are needed for this job before any more work can be done. Nuts have been shipped but not received, approx 1-1/2 man weeks work.

8. Accumulator cabling layout - No work can be done on this until schematic is completed.

9. 5 Rack Power Control Units - Holding for approval of Test Equipment Committee. Approx. 6 manweeks of work.

10. Modifications to single pulse synchronizers. - Holding for approval of Test Equipment Committee. Approx. 2 manweeks of work.

11. Modify P-5 Synchroscope to make a 2 trace scope - Work started on this today - Approx. 2 manweeks of work.

12. Layout and construction of experimental counter. Approx. 2 manweeks of work.

13. The first 10 jobs listed are held up for the reasons stated. This leaves an immediate work load of approx. 2 weeks for two men only on the last two jobs. The other 8 men will be employed repairing coax cablesand making D.C. patch cords for next week, unless other jobs come in or some of the first 10 can be started again.

(F.H.Caswell) The storage Tube Laboratory technicians' work continues at full load. Full time of two technicians and one-half time of another has been used in laboratory equipment construction and one-half time of one technician in laboratory maintenance. A life test rack is under construction - Memo E-100. The electrolytic tank will be rebuilt due to the inability to maintain sufficient high ohmic value between water and the present metal tank. Construction for the tube room includes a vacuum system support stand for use in supporting tubes being processed and a sliding metal rack for portable oven.

(H.R.Boyd) Need additional electronic construction work.

11.5 Drafting

(A.M.Falcione) In order to meet the drafting requirements of Project Whirlwind I, the services of three additional draftsmen were acquired since the last bi-weekly report. The problem of additional space requirements was handled as follows:

a) A new drafting table was immediately acquired. Four additional ones are on order.

b) Mr. G. Graff was moved from the Drafting Room to temporary quarters in Room 261 with Mr. Lovett.

c) Mr. J. Survelas was placed in Room 108 temporarily until new drafting tables are received. Will be moved to Drafting Room.

d) A plan layout of the Drafting Room was made, utilizing the present area allocation. It has been determined that two additional tables can be placed in the present area. This will take care of Mr. Survelas and an Electrical Checker when acquired. Any further increase in personnel will required additional area allocation for the drafting department.

The use of roll graph paper (10 x 10 to the inch) as a guide under the tracing paper has increased the drawing speed on block diagrams and other similar work to a great degree.

Part's Lists

(H.Fahnestock) In order to expedite Sylvania's procurement program for WWI, Mercer will daily contact several of our design engineers for information on anticipated changes involving parts lists. Appropriate information will be immediately transmitted to Brusila of Sylvania.

11.6 Unclassified

(A.Taylor) Machine shop has completed jigs for S.T.Work.

12.0 GENERAL

(Jay W. Forrester)

Add "Section 7.6 Output Printers" to Bi-Weekly Report outline.

Change the heading of Section 2.23 from "SR-1030 Tests and Specifications" to Vacuum Tube Studies" and include in this section all vacuum tube work except storage tubes.

(J. C. Proctor)

The following people have joined the 6345 staff in the last two weeks:

Louis J. Nardone, Research Assistant, working with John Ely on deflection circuits. Mr. Nardone is a graduate of Northeastern University, January 1948, B.S. Electrical Engineering. Served with the Army Signal Corps 1943-1946.

John S. Rochefort, Research Assistant, on input and output. Mr. Rochefort is a graduate of Northeastern University, January 1948, B.S. Electrical Engineering. Served with the Army Signal Corps 1943-1946.

John M. Hunt, Research Assistant, with the electronics group. Mr. Hunt is a graduate of the University of Kansas, January 1948, B. S. Engineering and Physics. He worked as a radio engineer with TWA 1940-1943 and served with the Naval Air Force as Electronics Officer, 1943-1945.

Howard Heydt is continuing with the project as Research Assistant while devoting one third of his time to teaching in the Electrical Engineering Department.

(H. R. Boyd)

Non-staff personnel hired in the last two weeks:

John Survelas is a detailer in the drafting room. He was a draftsman in the Army and with Photoswitch, Inc.

Ervin Veinot is a detailer in the drafting room. He lives in Lynn and has worked for G.E., Submarine Signal and Douglas Aircraft.

Robert Stebbins is an electronic technician working for A. Taylor. He is an MIT course VI student who is out of school for a few months and will work on WWI installation when needed.

12.0 GENERAL (Continued)

Pat Wolfe is an electronic detailer. She is an MIT electrical engineering student who is working for a time to gain practical experience.

The following people have terminated their employment:

Joel Simmons - 2/11/48
Fred Williams - 2/4/48

(A. Taylor)

The DES has been dismantled and components will be returned to stock.