Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, May 26, 1950

To: 6345 Engineers

From: Jay W. Forrester

1.0 SYSTEMS TESTS

1.1 Whirlwind I System Test

(N. H. Taylor)

Progress in testing the WW Storage Row has been encouraging during the last period. On several occasions it has been possible to run all 16 storage tubes in synchronism on a cycling test. This has been achieved on an array 16 x 16 as well as an 8 x 8 pattern. A method of adjustment is gradually evolving from these tests which will allow each tube to be operated under optimum conditions. At present the study is continuing to account for the behavior of certain tubes when the stored pattern is changed.

In-Out Testing has reached the point where a tie-in with the Whirlwind System for both reading and recording operations is about to take place. Problems of intermittent operation and prf effects on the triggering circuits have delayed this tie-in somewhat. It will commence in the next period.

WW1 testing on the computer with test storage has concerned itself mainly with a study of low margins and automatic marginal checking. The system has now been improved so that a routine check on a majority of the circuits can be run in less than 10 minutes. The immediate plans for this part of the system call for its use as a test-set for In-Out equipment for the next period and later as a testing ground for ES Row. For the next 2 to 3 months the main computer will be subordinate to each of these two functions and receive less attention than has been the case up to this point.

1.1 Whirlwind I System Test (Continued)

(H. F. Mercer)

The following failures of electrical components have been reported since May 12, 1950:

Component	Numbers of Failures	Hours of Operation	Reason for Failure
Capacitor (Mica)			
0.001 MFD	1	217	Open
Crystals			
D-357	7	2000-2500	Drift
D-358	6	1000-1500	Drift
	4	2000-2500	Drift
Tubes			
3E29	1	275	Gassy
6SN7	1	2412	Mechanical
7AD7	3	2500-3000	2-Mechanical 1-Change in characteristics
	4	3000-3500	2-Mechanical 1-Gassy 1-Change in characteristics
7AK7	1	2438	Gassy

1.2 Five-Digit Multiplier

(E.S. Rich)

One unexplained error in multiplier operation occurred on May 18 following a 12-day error-free run. During the last two weeks, three tubes were replaced because of low outputs. No difficulty was experienced in returning the system to operation after the power shutdown over the weekend of May 19 and May 20.

2.0 CIRCUITS AND COMPONENTS

2.5 Vacuum Tubes

(H. B. Frost)

Pulse tests of a new lot (C-9674) of SR1407 tubes (developmental improved 7AD7's) show that high values of plate current can be maintained to low values of plate voltage by use of beam-forming plates instead of a suppressor grid. This is desirable for buffer-amplifier operation and to a lesser extent for flip-flop operation.

Pulse characteristics of the 3E29 are available as A40525 and A40526. Also, pulse tests of 3E29 tubes retired from WWI show definite interface formation. Thus, care should be taken in the application of 3E29's.

3.0 STORAGE TUBES

3.1 Construction

(P. Youtz)

Two storage tubes with 40 mesh mosaics (ST161, ST162) for use in WWI were processed.

Two research tubes were processed. The first tube, RT148, was designed to test a special British electron gun (Electron Tubes, Ltd., Mod. 88) which we have had for several years. This gun was reported by its inventor, H. Moss, to have high current density in a small spot with sharp cutoff of the beam edges. RT148 has a fluorescent screen and a Faraday cage for examination of the beam structure. During the processing of RT148, the heater burned out. The gun was cracked from the tube for examination. Since the cathode was old and had been activated, we decided to dissect this gun and draw a schematic of its parts so that the electron optics of the gun could be studied.

An RCA heater was put into another Mod. 88 gun and the tube was reprocessed as RT148-1. We used the envelope from RT148 for this tube. RT148-1 processed satisfactorily and awaits an opportunity to be tested.

Since the British gun, Mod. 88, is larger than the RCA 5U gun, we mounted it on one of our 18-pin stems. This increased our experience with these stems. We have now sealed five of our 18-pin stems into tubes with no difficulty. W. E. Pickett believes that we need expect only small difficulties in using our 18-pin stems.

At the start of this bi-weekly period, vacuum systems #1 and #2 were dismantled, thoroughly cleaned and reassembled.

R. Shaw has made a survey of the various storage assemblies that have been made or proposed during the past two years, and he reported this in M-1044.

On or about the first of August the exhaust room and glass shop will be moved to room 014. The storage tube drafting group made several proposed arrangements of equipment and facilities in room 014. A final proposal, SB-35708-2, has been submitted for the installation of the ventilation system. A final proposal for the installation of the facilities will be submitted 2 June 1950. The personnel who will use the facilities in room 014 feel it will be adequate, although slightly crowded.

3.2 Test

(M. I. Florencourt)

Three storage tubes passed standard tests: ST160-R1, ST161 and ST162. ST160-R1 later imploded. No tubes were given WWI static acceptance tests.

Using ST150, a storage tube with good guns but a poor surface, positive spot size was measured as a function of heater voltage for constant cathode currents and beam currents of 1.0 and 0.5 ma, and ~55 and ~23 μa. Spot size did not vary noticeably for heater voltages from 4 to 8 volts. Transfer characteristics (current vs. bias) and gun efficiency (beam/cathode current) were plotted for both the high- and low-velocity guns; these characteristics were approximately the same for heater voltages from 5 to 8 volts -- the only significant variations being at 4 volts heater voltage. Gun cutoff voltage was also measured as a function of heater voltage and was shown to vary not more than 5 volts for heater voltages ranging from 4 to 8 volts.

Four research tubes were tested. RT139 is a research tube with four quadrants, each of a different mica thickness; the mosaic is 40 mesh, and collector spacing approximately constant at .013". General observations:

1. Maximum operating V_{HG} increases as mica thickness decreases:

Mica Thickness	Max. Operating V_{HG}
.0138"	205
.0103"	245
.0072"	295
.0051"	400

2. Both plus and minus spot size increases with mica thickness for pulse lengths less than 50 μseconds.

3. For positive spots, size increases with mica thickness for currents from 10 to 120 μa and pulse lengths from 5 to 50 μseconds; spot size for a given beam current and mica thickness is then fairly constant above 50 μseconds.

   For negative spots, size is constant for all mica thicknesses for a given beam current and pulses above 50 μseconds.

   For graphs of spot size vs. beam current, pulse length and mica thickness, see SA-38954 and SA-38955.

3.2 Test (Continued)

4. Upper stability voltage is the same for all mica thicknesses and approximately 570 volts V_{HG}.

5. Using the holding gun for writing and varying the length of the signal plate gate, it takes the longest gate for the thinnest mica and the quadrant switching is discrete for each gate length.

RT140 is a research tube with a 40 mesh mosaic on very thin (.003") mica. The only operating characteristic different from tubes with the usual mica thickness (.007-.008") was the very high maximum operating V_{HG} (440 volts). This result coincides with results from RT139.

RT144 is a research tube with a 100 mesh beryllium mosaic on normally thick mica, but whose collector to surface spacing has been held to .0045" by mica crossbars. Maximum operating V_{HG} is about 175 volts in the center and 125 volts at the edge; this is normal for 100 mesh tubes, but these results do not corroborate those obtained initially on RT138, a tube which also had small collector to surface spacing, but which showed good negative stability at the edge (high maximum operating V_{HG}). A retest of RT138 will be necessary to see whether edge stability has decreased with age -- a phenomenon which apparently occurs with all 100 mesh tubes.

RT147 is a research tube whose storage surface, a 40 mesh beryllium mosaic on mica, was taken from an evaporation tube and placed as is in a storage tube. This implies that the collector-surface spacing is zero, which apparently was not so for the whole surface as indicated by some test results. In addition, the collector was shorted to the surface in numerous places. An interesting occurrence was observed on a positive background near lower switching -- tiny areas of the surface could be seen to go negative, then return positive, then go negative again, giving the effect of twinkling. The tube was disappointing in that the effect of zero collector-surface spacing could not be determined because of collector shifting and mica buckling which nullified the desired features of the tube.

(C. L. Corderman)

RT138, a 100 mesh-2 mil tube with a uniform collector to surface spacing of 4-5 mils, was retested after several weeks of shelf life. As described in M-1030, previous 100 mesh tubes have exhibited a deterioration of negative stability during the

3.2 Test (Continued)

first few weeks of operation, particularly around the circumference of the surface. On the retest the characteristics of RT138 had changed very little from its initial test operation.

A method of obtaining the holding-beam restoring current curve directly on a scope is now being tried. This curve has been found previously by graphically differentiating a plot of spot potential, as measured with the high-velocity gun and a variable read signal plate gate, versus holding beam on time.

The system being tried will consist of pulsing the holding gun on for 1/2 μsec at 10-50 μsec intervals, while a sawtooth of voltage covering 100 volts in ≈5000 μsec is applied to the signal plate. A video amplifier connected to the signal plate through a differentiating circuit will then pass the 1/2 μsec pulses whose amplitude is proportional to the net restoring current at the particular surface voltage. Since the holding beam is not turned on long enough to affect the surface potential, it is determined principally by the linear rising voltage on the signal plate. Also, the time constant of the differentiating circuit, while long compared to the 1/2 μsec pulses, is short enough to give a negligible output to the video amplifier from the sawtooth signal plate voltage.

(A. R. Tanguay)

Leakage tests have been run on a storage tube in an attempt to determine the time in which the surface at one potential switches to that of the signal plate. Measurements have been made only with difficulty because the leakage time seems considerably affected by the history of the surface before a test is attempted. That is, a negative surface with a positive history will switch positive in less time than a surface with a negative history.

(H. B. Frost and H. E. Rowe)

The series of spot interference tests on ST136-R1 and RT126-2 has been completed. These tests consisted of writing repeatedly in the neighborhood of the spot while checking periodically the effect on this spot. The analysis of these results will be made in the near future.

Holding gun charging rate curves for both RT126-2 and ST136-R1 are now being run. These curves illustrate the rate at which holding beam current restores the potential of a spot to one of the two stable potential levels. An effort is being made to determine the important parameters controlling these rates.

3.2 Test (Continued)

(K. E. McVicar)

The data taken for secondary-emission measurements by the method described in the previous bi-weekly report will have to be repeated. Further consideration of the problem has suggested the possibility that the accelerating voltage for the two output signals is different by a hundred volts. This is the result of switching the signal plate positive by 50 volts, which increases the beam velocity by that amount, and then switching it negative by the same increment which decreases the beam velocity by 50 volts from what it is when the target surface is at collector (ground) potential. Since it has been decided that it is preferable to take measurements of the secondary-emission ratio over a range of accelerating potentials rather than for one value, the measurements should be repeated anyway. This is currently under way.

3.4 Unclassified

(C. L. Corderman)

Checkout of the Decoder for the TV Demonstrator is nearing completion with only changes in the increment resistors remaining. The Decoder Control Unit checkout has been postponed until the storage tube test equipment has been moved to the new basement location.

A pulse inverter-amplifier has been constructed to drive the holding-gun grid with 1/2 μsec pulses.

The storage tube test equipment in room 222 will be moved to room 026. The floor and power distribution plans for room 026 have been drawn up and discussed with W. J. Nolan. He is supervising the installation of the various power supplies and regulators for room 026.

4.0 INPUT-OUTPUT EQUIPMENT

4.1 Eastman Kodak Units

(E. S. Rich, J. A. O'Brien, D. Hageman)

Work on the Reader-Recorder units during the past two weeks has been concentrated largely on efforts to improve the reliability of the system. It had been found that only very short runs could be made before an error would occur. Considerable progress was made in reducing error occurrence by using marginal checking on IOR, COR, and IOC and correcting the low margins that were found.

During the period about 150 feet of film was recorded and developed for use in future reading tests.

Some further difficulty was encountered with the reference-maker photo tube circuits so that further alteration of these circuits is necessary.

Marginal checking facilities for the Reader-Recorder are now being prepared and should be installed during the next week. It is planned that the unit will be tied in with the computer for system tests in about a week.

4.3 Typewriter and Tape-Punching Equipment

(F. A. Foss)

The engineering note on the design and operation of the tape preparation unit has been completed. The circuit schematics of the checking typewriter and tape punch have been brought up to date. The circuit schematic of the tape reader is almost completed. The arc suppression characteristics of the switching circuits are being investigated.

(R. E. Hunt)

Tape Preparation Unit - Most of my time during the last bi-weekly report period has been spent on the development of this unit.

The control panel has been designed and fabricated. It will be assembled within one week.

The relay panel has been designed and is being fabricated at the present time. This panel's completion date will dictate the completion date of the working unit (table not included).

4.3 Typewriter and Tape-Punching Equipment (cont)

The table for the unit is being designed at the present time. It will be of hardwood construction with natural or blande finish. Initial inquiries indicate that procurement will be simple and the cost quite moderate.

(J. S. Hanson)

Relay circuits for the various output modes of tape preparation and printing are being modified in order to combine all modes of operation in the same piece of equipment and to have any mode immediately available merely by setting a multiposition switch. Several new ideas regarding mechanical modification of the tape perforator and reader are expected to simplify timing problems.

(C. W. Watt)

Some time was spent on design of the relay circuits needed for reading the previously prepared self-checking Flexowriter tape to the computer. To begin with it will be read directly to the In-Out and Comparison registers; at a later time external shifting relay registers will be provided to permit more efficient use of the high-speed flip-flop registers in the computer. Some preliminary block schematics of E. S. Rich are being expanded to cover the three desired types of reading operation, namely, Flexowriter code to IOR, straight binary to IOR, and coded binary (sexadecimal) to IOR.

5.0 INSTALLATION AND POWER

5.1 Power Cabling and Distribution

(C. W. Watt)

Cabling for marginal checking the reader recorder was installed, and the installation of equipment for this purpose will be complete by next Wednesday.

5.2 Power Supplies and Control

(J. J. Gano)

Regulator for Plate Supply Alternator - The breadboard model when tested with a pure resistance load was found satisfactory. However, when connected to the WWI +250 volt d-c supply for a brief test, the system damping, upon application of load, was poor. There appears to be interaction between the regulator of the alternator and that of the d-c supply. Some further work will have to be done in order to overcome this difficulty.

5.3 Video Cabling

(T. Leary)

During the past two weeks a great deal of progress has been made in removing obsolete and unncessary cabling and in designing permanent cables to replace temporary cables.

Permanent cabling for PC Reset (cable 849), CS Reset (cable 850), and FFS Reset (cables 851-859) has been designed and will be built as soon as schedules are issued.

Control matrix to bus cabling has been simplified by connecting the inputs of CP0116-120 directly to Timing Bus 6 instead of via CP077 and the Control Switch Driver.

Work continues on the checking and renovation of early cabling schedules.

7.0 CHECKING METHODS

7.1 Test Problems

(J. M. Salzer)

Memorandum M-1038 was written on automatic methods of checking the holding ability of flip-flops.

The task of designing a test problem for causing all possible alarms in order to check the alarm circuits proved much more difficult than it seems at first sight. Instead of an automatic test program a test procedure must be used for several reasons. First, there are certain alarms (such as the multiple-order selection alarm) that cannot be provoked in a healthy computer without manual interference. Second, before continuing after each alarm the effect of the alarm must be cancelled. In case of an alarm brought about by comparison in the check register the latter cannot be cleared by a program and manual action is necessary. Further complication arises from the fact that the time pulse following the one causing the alarm is allowed to slip through before the alarm can halt computer operation.

(G. Cooper)

Some further revisions of Test Sequence VI have been made. It is believed that the present form of this sequence will be relatively free from future changes. The massive task of tabulating the symptoms for various gate tube faults is being carried out. Of the 296 gate tubes thus far examined, only 11 are not checked at all, one set of three will yield the same symptoms, and 13 sets of two yield the same symptoms. The remaining 256 gate tubes exhibit unique failure symptoms. Thus far, only 22 of these symptoms have been checked against Whirlwind.

8.0 MATHEMATICS AND PROGRAMMING

(C. W. Adams)

An output program to convert and display or record results will be needed in most mathematical computations. Generally it can be assumed that results will consist of one or more numbers occurring in the usual Whirlwind form (16 binary digits with the binary point just to the right of the sign digit). These numbers will then generally be processed in one of the following ways:

1) the numbers may be multiplied by a scale factor (usually a power of 2 ranging from 2^0 to 2^{15}), converted to binary-coded decimal and thence to Flexowriter-coded form, and recorded on film or tape preparatory to being typewritten by a Flexowriter printer.

2) the numbers may be plotted on a scope face to form a graph, in which case calibrated axes and some identifying symbols must usually also be plotted, especially if the graph is to be photographed by an automatic camera.

3) in a few cases the numbers may be multiplied by a scale factor, converted to decimal and displayed on a scope as a series of decimal digits.

Subroutines to handle each of these cases are under consideration. If it is possible to make the subroutines flexible enough so that the different possible scale factors can all be handled by one general subroutine for each case, this will be done. But if such flexibility should turn out to greatly increase the length of the subroutines, separate subroutines will be written for each scale factor.

Work on an input program is essentially complete but will not be written up until the output programs are completed so that an integrated series of notes can be issued.

9.0 FACILITIES AND CENTRAL SERVICE

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
R-181	Digital Computers in Control Systems	6	4-27-50	C. W. Wieser
R-182	New Developments in Pulsed Circuit Test Equipment	6	4-27-50	R. Rathbone
R-183	M. I. T. Electrostatic Storage Tube	10	4-27-50	S. H. Dodd, H. Klemperer, P. Youtz
R-184	Computer Experience in Extending Tube Life	6	4-27-50	E. S. Rich
R-185	Marginal Checking: Preventive Maintenance for Electronic Equipment	5	4-27-50	G. C. Sumner
R-187	Digital Information Storage in Three Dimensions Using Magnetic Cores	12	5-16-50	J. W. Forrester
M-1039	Drawing Preparation for Slides	4	5-12-50	A. M. Falcione
M-1040	Bi-Weekly Report, May 12, 1950	25	5-12-50	
M-1042	Progress Report: An Investigation of the Effect of the Angle of Beam Incidence on Electrostatic Storage Tube Performance	2	5-2-50 to 5-13-50	K. McVicar
M-1041	Power Supply Changes	5	5-16-50	J. J. Gano
M-1043	Progress Report: A Co-Incident Current Magnetic Memory Unit	2	4-25-50 to 5-18-50	W. N. Papian
M-1044	History of Development of Storage Assembly for 6" Storage Tube	4	5-19-50	R. Shaw
M-1045	Data on Electron Gun Currents in M. I. T. Storage Tubes	4	5-18-50	M. Florencourt
A-108	Power Shutdown - May 19-21	1	5-16-50	H. R. Boyd

Library Files

.004	European Scientific Notes: 1 May, 1950	ONR, London
47	Technical Information Pilot: May 5, May 10, May 16, 1950	ONR, Library of Congress

9.1 Publications (Continued)

Library Files (Continued)

No.	Title	Author
178	Mathematical Tables and Other Aids to Computation: Volume IV, Number 29, January, 1950	National Research Council
180	Document Office Bulletin: May 12, May 25, 1950	RLE, MIT
297	The Number 5 Crossbar Dial Telephone Switching System. AIEE Paper (Preprint from Volume 69, 1950	F. A. Korn J. G. Ferguson
559	Technical News Bulletin: May, 1950	National Bureau of Standards
597	MIT Reports on Research: May, 1950	MIT
698	Physics Abstracts: Section A of Science Abstracts: April, 1950	Institution of Electrical Engineers
709	Experimental Investigation of Sampled-Data Control Systems (MS Thesis, 1950)	B. S. Quick
710	Digital Subtractor andDecoder for a Servomechnaism (MS Thesis, 1950)	V. H. Pomper
711	Terminology and Block Diagram Symbols for Use in Connection with Automatic Digital Computing Machines. May 2, 1950	H. D. Huskey Ntl. Bur. Standards
712	The Relations of Symbolic Logic and Large-Scale Calculating Machines (Paper given before the Association for Computing Machinery, Oak Ridge, Tenn., April 18-20, 1949): July 15, 1949	E. C. Berkeley
713	Analogue and Special Purpose Computing Machines (Paper given before the Association for Computing Machinery, Oak Ridge, Tenn., April 18-20, 1949): July 15, 1949	S. H. Caldwell
714	Optimum Size of Automatic Computers (Summary of paper delivered before Meeting of the Eastern Association for Computing Machinery, Aberdeen, Md., December 11-12, 1947): December 24, 1947	G. R. Stibitz
715	Operating Characteristics of the Aberdeen Machines (Paper delivered at the Meeting of the Eastern Association for Computing Machinery, Aberdeen, Md., December 11-12, 1947): December 29, 1947	F. L. Alt
716	Simulation of Tactical Air Control: Data Utilization Lab., April, 1950. Air Force Cambridge Research Laboratories	R. F. Nicholson

9.2 Standards, Purchasing and Stock

(H. B. Morley)

Standards - No new or revised standards were issued this period.

Procurement and Stock - Plastic covers for the relay panels have been received. Minor modifications necessary to make them fit properly are being made by the vendor and the work should be complete in a few days.

Effective June 1 all activity relating to the procurement of material and services for the project will be transferred to this office. Orders will be originated here and all related activity will channel through this department. This will include direct contact with vendors, approval of invoices, and keeping all necessary records incidental to these functions.

In general this change will not affect procedures presently followed by laboratory personnel desiring material and services. It is requested that established procedures be followed until further notice, bearing in mind the following items which have been mentioned in previous bi-weekly reports or memoranda:

1. Submit requests on rough draft work sheets.
2. Refrain from making commitments to vendors without approval from this office, and keep this department posted on the status of any discussions or negotiations with vendors which might result in purchase commitments.
3. Allow reasonable period for procurement of material and give one day advance notice on pick-ups if possible.

As before, contacts with the Purchasing Office in Building 32 relating to previous orders should be made through this office.

Cooperation from all laboratory personnel is requested, since we will have a considerably heavier work load with no increase in personnel.

9.3 Construction

(R. A. Osborne)

Production Report - The following items have been completed and inspected since May 12, 1950:

7	R-F Amplifiers
3	Fixed Voltage Switching Panels
2	Breadboards
10	A-C Power Cords

(D. V. Mach)

The control unit for the storage tube lab decoder-counter has been completed and is undergoing debugging. The decoder-counter has been undergoing rather extensive modifications including addition of six more tubes, bringing the present total to 58.

Four storage tube mounts, which had been previously rejected by the Storage Tube Reliability Tester, have been r-f aligned with new storage tubes as follows:

STM#14 contains ST#149
STM#15 contains ST#153
STM#17 contains ST#155
STM#21 contains ST#156

These mounts are now being video aligned by E. A. Guditz, who will then deliver them to the Storage Tube Reliability Tester.

Work has been started on the storage tube laboratory d-c power control box which will be installed in the basement.

(L. Prentice)

We have ground some ceramic cores for test purposes successfully. The writer paid a visit to Professor Norton of Metallurgy to obtain additional information as to technique and type of grinding wheels to use. Orders for grinding wheels have been placed according to his recommendations. All work assigned to the machine shop in connection with the electric power changeover was completed ahead of schedule. Some preliminary work has been done to ascertain if we can successfully spin tantalum to deep sections.

The work load has been steady in the sheet metal shop. Haynes is taking one week of his vacation during the next period. If the work load permits, it is planned to paint the shear and brake during his absence and have the shear blades sharpened.

9.4 Drafting

(A. M. Falcione)

Memorandum M-1039 was issued May 22, 1950 on drawing procedure for making slides. This memo explains the basic requirements necessary to produce a good slide from proper drawing preparation.

The work load on drafting is heavy and is expected to remain at this level for some time due to revisions, changes, and additions to existing units.

The writer is expected to report for 2 weeks' active duty with the U.S. Army at Edgewood Arsenal, Maryland, on June 4, 1950. All questions on drafting should be referred to V. Savio or C. W. Watt during this period.

10.0 GENERAL

(H. R. Boyd)

Non-Staff Terminations

Flynn, Ernest P.
Freitag, Lenore H.
McCloud, Jean
Randle, Esther M.
Wagner, June A.

New Non-Staff

Helen Elizabeth Cooke
Mary P. Byron

Miss Betsy Cooke replaces Mrs. Lenore Freitag in the Storage Tube Group. Her home is in Pawtucket, Rhode Island, and she attended Wellesley College and Katharine Gibbs Secretarial School in Providence, Rhode Island.

Mrs. Mary Byron replaces Mrs. Esther Randle in the Print Room. Mrs. Byron, originally from Dublin, New Hampshire, is a resident of Cambridge, Mass. Her husband is a student at Harvard College.

New Staff

Jack D. Porter

Mr. Jack Porter of Brighton, Mass. is a new Research Assistant. He has an M.S. degree from Harvard in Communications Engineering and has worked with Bell Telephone Lab. Inc. in New York. Mr. Porter has been with MIT since December 1946, as a Research Assistant with Professor Zimmerman until September 1949, then as assistant with Professor Martin in the Mathematics Department.