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Memorandum M-669

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Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, MassachusettsSUBJECT: BI-WEEKLY REPORT, PART II, OCTOBER 29, 1948

To: 6345 Engineers

From: Jay W. Forrester

6.0 MATHEMATICS

(P. Franklin)

Studied methods of numerically integrating a known function. In addition to design problems for storage tubes and test problems, the mathematics section is considering the general problems of sorting and solving partial differential equations.

(H. Deniloff)

Mathematical studies of the modes and frequencies of natural vibrations of the grid of the E.S. Storage Tubes under various conditions have been made and the following Engineering Notes, covering the work already done, issued:

- E-156-1: Natural frequency of vibration of grid of E.S. Storage Tube.
- E-157: Natural frequency of transverse vibration of square grid of E.S. Storage Tubes.

Another Engineering Note on the same subject is in course of preparation.

(T. W. Hildebrandt)

Investigation was made of several small algebraic problems with a view to using them in initial testing under the limitation of 27 toggle switch and five flip-flop registers.

Preliminary work was begun on coding an aircraft problem previously solved on the Reeves Analog Computer and described in a report from Reeves. The particular problem under consideration is a servomechanism stability problem leading to a fifth order linear system of ordinary

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differential equations with constant coefficients. It is well-suited to solution by the Runge-Kutta method.

(P. Rabinowitz)

Codes have been drawn up for finding the maximum and minimum of a group of N numbers. Work has been started on a code for arranging N numbers in a monotone sequence. In these codes, the order 20 (add one) proposed in M-649 was found to be very convenient and time saving.

(E. Reich)

Since the publication of Engineering Notes E-148, "The Solution of Systems of Linear Algebraic Equations by Successive Approximation," two papers with which I was previously unacquainted have come to my attention, one by Cesari in Accademia Nazionale dei Lincei, Rendiconti (1937), and one by Bodevig in Nederlandsche Akademie van Wetenschappen, Proceedings (1948). Both these authors reached the same conclusion as I, namely that, in general, Seidel's method is the optimum iteration method.

The work on partial differential equations is continuing.

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7.0 INPUT AND OUTPUT7.4 Magnetic Recording

(G. Cooper)

The intermittent failure of the recording amplifier alluded to in the last report has been found to be caused by the gated multivibrator. The amplitude of the triggers supplied by the gated multivibrator was just barely sufficient to drive the trigger tube of the recording amplifier. When the gated multivibrator was adjusted to increase the amplitude of the triggers, the symptoms disappeared. No new difficulties have appeared as yet.

The pickup amplifier was tested - and found to have sufficiently wide frequency response to pass the waveform of the recording amplifier with little distortion. However, there was entirely too much noise voltage present in the output. It was discovered that the circuit was quite microphonic. It responded quite excellently to both sound and vibrations. A search for a non-microphonic tube to be used in the circuit was started. So far the 6AG5, 6AR6, 6AJ5, 6AK5 and the CK605CX have been investigated - all have been found to be excessively sensitive to vibration for use in the pickup amplifier.

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8.0 STORAGE TUBES8.1 Tube Construction and Testing8.11 Tube Construction and Processing

(E. S. Prohaska)

Most drawings for the new filtered air room were completed. The glass bench, piping, and electrical layouts are the only incomplete drawings. Almost all material has been ordered and received. The room should be ready for occupancy by December 1st.

Rough sketches of the polariscope have been started and the general design decided upon.

(R. Shaw)

An improved beryllium strip tube is under construction. A dummy signal plate assembly has been made for preliminary measurements of leakage resistance in this tube. It was required that the signal plate in this dummy be glass in order to have the highest possible resistance. The mechanical design of the assembly was therefore modified to simplify the shape of the glass.

In the construction of beryllium-on-mica storage surfaces, aluminum has been substituted for nickel as material for the backing plate which supports the mica. This is considerably easier to machine and can be anodized to provide insulation.

Drawings are now completed of a research tube having a series of concentric rings as anodes. This will be used for current density measurements of the high velocity electron beam.

Since the machine shop in Bldg. 32 has capacity available for this project, work orders have been placed to increase our inventory of frequently-used parts.

(F. H. Caswell, T. F. Clough and P. Youtz)

The first large ST with a beryllium mosaic on mica storage surface was processed and turned over to the test group. Tests on this tube indicated two changes should be made on the second tube of this series. In the first tube the storage surface of mica, which was .007 inches thick, was backed up with a nickel signal plate. This signal plate

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8.11 Tube Construction and Processing (Cont'd)

could pick up considerable current from stray electrons. In the second tube the mica plate will be coated on the back with silver paint to provide uniformity and will be backed with an aluminum plate which was anodized on its back. The second tube with these two changes was constructed and put on the exhaust system. This tube will be processed and turned over to the test group 3 November 1948.

Two storage surfaces were prepared for future tubes. One was another beryllium mosaic on mica. The second was a beryllium mosaic on glass. This glass surface will be saved until it can be put in the new storage assembly which has recently been redesigned.

Work on the new beryllium strip tube for stability studies, which utilized only mechanical pressure to maintain contact between the beryllium surface and the loads, has been progressing slowly.

(H. Klemperer)

Spot Welder

A synchronous thyatron cycle-control panel for the a-c 1KVA spot welder has been designed and is ready for construction. It will make the a-c spot welder applicable for welding of heavier constructional parts in storage tube assembly.

Storage Tube Design

The storage plate-collector assembly of the 5" storage tube has been redesigned to incorporate a stainless steel ring to support a storage plate of either glass, mica or aluminum. Advantages should be that friction encountered in applying tension to the collector screen is reduced, the insulation between both elements is increased, and the electrostatic shielding of the signal plate against stray electrons is complete without help of aquadag coating on the glass envelope. The structure is reusable for new storage plates after the tube has been cut open in the middle section. The same assembly, leaving off the electrostatic shielding plate, will be used to hold target and screen in the evaporation tube.

(W. J. Nolan)

Construction of the vacuum system protective equipment has been stopped on two occasions because of lack of parts.

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8.11 Tube Construction and Processing (Cont'd)

Substitutions have been made, however, so that at least one of the units can be put in operation next week.

Testing and construction of the scheduled beryllium strip tubes and concentric ring tubes is approximately a month behind schedule. This has been due to difficulties in construction and to other tubes being given higher construction priority. Total progress in this line is not quite so far behind because considerable work has been done on a memo describing the tests on the one tube satisfactorily constructed.

A rough draft of a memo has been written on the effect of non-uniform holding beam velocity. This memo presents difficulties because at present some of the calculations are at variance with observed data.

The design of equipment for modifying the RF bomber has been completed and the parts ordered. The circuit uses thyratron control of plate voltage. This is not the best circuit but it is probably the cheapest and it achieves the desired result with a minimum of space and increase in weight of the unit.

8.12 Tube Testing

(A. H. Ballard and J. S. Rochefort)

The vibration of the collector of ST 29 was investigated more thoroughly. Approximately 400 positive spots were written on the negative background and curves of frequency and amplitude of oscillation vs. collector voltage were run. Data was obtained within the range of collector voltages between 350 and 650V. In general, as collector voltage was increased, the frequency decreased, and the amplitude of oscillation increased. With an even spot distribution over the storage surface, the frequency of oscillation appeared to be a pure sinusoid.

(J. S. Rochefort)

A memorandum covering the testing of ST 32 has been completed and will be issued in the near future.

(J. H. McCusker)

Forward and reverse curves were run on RT 38, a beryllium strip tube. $V_k = -200$. $V_{gk} = 0$. V_{coll} is variable.

Triggering did not occur during the forward curve as V_{coll} was raised to approximately 700 volts above cathode.

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8.12 Tube Testing (Cont'd)

However, during the reverse curve the surface triggered from collector to cathode when the collector was 50 volts above cathode. Fifty volts is approximately twice the crossover voltage. Curves were taken of the restoring current versus surface voltage at various collector voltages. These indicated that the restoring current would charge the surface to cathode potential when the collector was 50 volts or less above cathode.

Other tests were run on the effect of the third anode voltage on the restoring current when the beryllium surface is at approximately collector potential. It was thought that the restoring current might be decreased when the third anode was negative with respect to the surface while the collector was positive with respect to the surface. However, the restoring current under these conditions was the same with the third anode both positive and negative with respect to the surface.

(H. Rowe)

Power Supply Tests

Testing was completed on the breadboard of the 200V power supply.

(H. Klemporer)

Model tests of the 200V supply are completed and design is ready for building of prototype. Design of the 2000V supply is completed and model is being tested.

(R. Sisson)

During most of the first part of the week beginning October 18th, ST 29 was displayed in the TV setup for several groups of visitors. It was discovered that when the surface of ST 29 was bombarded by the holding gun with 400 volt electrons for long periods of time the surface appeared to be affected. Areas maintained at the positive stable potential for long periods of time and then erased would appear slightly negative with respect to the rest of the surface. This condition lasts for several hours depending on how long the surface was maintained positive in the first place. The phenomena seemed to have no effect on storage properties of the surface.

ST 40, a 5" tube with a Be mosaic surface deposited on mica, was tested. Its characteristics as far as determined are as follows:

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8.12 Tube Testing (Cont'd)Surface stable: $V_{HG} = 57V.$ to $V_{HG} = 205V.$

Spots stable:

Positive spot on negative background: 62 to 190V.

Negative spot on positive background: 57 to 225V.

Writing of either polarity spot on either polarity background is possible at $V_{HG} = 75V.$ with a minimum write pulse of 6 μ sec. (Actually even shorter for writing positive.) Most of the surface can be used to store when the electrode voltages are properly adjusted.

More studies are to be made on ST 40 concerning storage at the edges of the surface and the amplitude of the output pulses. (Reading has been done so far using the TV set.)

(N. S. Zimbel)

I have been assigned to continue the assembly and test the automatic read-write unit. At the present time I am familiarizing myself with the equipment.

(A. H. Ballard and C. L. Corderman)

Continued tests on ST 39, a five-inch tube with an aluminum oxide surface, have shown it to be unstable for all values of holding beam velocity. Given sufficient time, usually less than 10 minutes, the entire surface assumes either cathode or collector potential, depending upon whether the holding velocity is below or above 440 volts.

The memo covering tests on ST 29 is nearing completion.

8.13 Reliability Tester

(J. O. Ely)

Block diagrams for all control functions are complete in notebook form. Some planning of installation layout and power supply has been done. Work on procurement of materials has been started.

It now appears that some items of standard test equipment, notably gate-and-delay units, rack power controls, and rack power strips may be difficult to procure by the time they are needed (November 30th).

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8.22 Anodizing

(E. S. Prohaska)

The recorder has been adjusted and is now working satisfactorily on the anodizing setup.

(M. I. Florencourt)

Mechanical difficulties encountered with the anodizing equipment during the last few weeks have been taken care of. The voltage for samples anodized as constant voltage is measured across the sample and maintained constant by varying the power supply voltage. The current to a sample anodized as constant current is controlled by a constant current control circuit. Refrigerating equipment is badly needed for anodizing the large signal plates; frequently it is impossible to maintain the temperature at the required level of 24°C even by packing the electrolytic container in ice and rock salt.

8.23 Output System Circuits

(C. H. R. Campling)

A 30-MC oscillator has been constructed for use in experimental work on the r.f. output system. This oscillator is intended to drive the grid of the high-velocity gun in the storage-tube. A pentagrid tube (6BE6) is used as a frequency tripler with a 30-MC tank in the plate circuit. The screen circuit is basically a Pierce oscillator using a 10-MC crystal. Fairly good on-off action is obtained by controlling plate current with the third grid. An amplifier stage will be added to obtain sufficient drive. Measurements have also been made of the r.f. impedance presented by the grid of a typical high-velocity gun.

8.24 Holding Gun Studies

(H. Klemperer)

An experimental 5" tube is being built with a strip of phosphor along the walls and over the target plate to study divergence and diameter of holding beam in 5" tubes. The third anode in this tube is subdivided for additional beam divergence control.

8.25 Electrolytic Tank

(H. Rowe)

Studies of the field distribution within the holding

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8.25 Electrolytic Tank (Cont'd)

gun are being made in the electrolytic tank. The original model of the gun, scaled 10:1, proved to be too small for a detailed study of the field near the cathode, and so a 30:1 model was constructed. Tests are continuing on this.

8.3 Unclassified

(M. I. Florencourt)

Several group reports have been read and commented upon prior to their issuance. These include a report on ST 32 testing from May until August 1948 by J. S. Rochefort, a report by the Test Group on the tubes tested since May 1948, and a report on S'1 which is being issued as reference material.

Two graphs were drawn up showing a comparison between stability data taken on large storage tubes and stability data taken on small storage tubes.

Section 8.13 is being changed from Storage Tube Demonstration to Reliability Tester and refers to the equipment which J. O. Ely is developing.

8.4 Deflection Circuits

(J. O. Ely)

The Deflection Circuit Demonstrator has been in operation continuously since October 21st with no component failures or operational difficulties.

A-c coupling diodes on the output of all flip-flops were replaced with selected crystals prior to the start of the extended operation test. This change has resulted in noticeably improved triggering characteristics on the trigger terminals of all flip-flops.

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10.0 TRAINING

10.1 Seminar Series

(J. M. Salzer)

The following Block Diagram seminars were held:

- Oct. 20, Restoration, R. P. Mayer
- Oct. 27, Control Matrix, J. M. Salzer

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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

<u>No.</u>	<u>Title</u>	<u>No. of Pages</u>	<u>No. of Drwgs.</u>	<u>Date</u>	<u>Author</u>
R-144	The Variable-Frequency Clock-Pulse Generator (Model 2)	11	9	9-20-48	R. R. Rathbone
E-154	Further Development of Beryllium Evaporation Tubes	4	2	10-1-48	(H. Klemperer (M. Florencourt
E-156-1	Natural Frequency of Vibration of Grid of E. S. Storage Tube	3	-	10-20-48	M. Daniloff
E-157	Natural Frequency of Transverse Vibration of Square Grid of E. S. Tubes	2	-	10-25-48	M. Daniloff
M-217-1	Description of WWI Codes	14	-	10-11-48	C.W. Adams
M-617	931-A Life Tests	7	9	9-20-48	W.J. Nolan
M-628	Cancelled				
M-629	Conferences at Power Equipment Co., Detroit, 8-13 and 9-28	2	-	9-30-48	H.R. Boyd
M-632	Correspondence; MIT and Sylvania on WWI Design	2	-	10-1-48	H. Fahnestock
M-633	Clock Pulse Control, Addition of a Tube to Circuit Schematic R-31916	1	-	10-4-48	J.A. O'Brien
M-641	Television Read-out of Storage Surfaces	5	4	10-8-48	R.L. Sisson
M-642	Elimination of Special Restorer Pulse Line	2	-	10-11-48	J.M. Salzer
M-643	Thesis Students, Project Whirlwind	2	-	10-14-48	R.R. Everett
M-644	Renumbering of WWI Operation Codes	2	-	10-14-48	R.P. Mayer
M-645	Register Driver Type II, Quantity Required	1	-	10-15-48	H. Fahnestock
M-646	Video Cabling, Conference of October 15	3	-	10-19-48	C.W. Watt

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6345 Reports (Continued)

<u>No.</u>	<u>Title</u>	<u>No. of Pages</u>	<u>No. of Drwgs.</u>	<u>Date</u>	<u>Author</u>
M-647	Bi-Weekly Report, Part I, October 15	13	-	10-15-48	J.W. Forrester
M-648	Bi-Weekly Report, Part II, October 15	16	-	10-15-48	J.W. Forrester
M-649	Some New Orders for WWI	2	-	10-18-48	(C.W. Adams R.P. Mayer)
M-650	Sylvania Correspondence with MIT	1	-	10-18-48	H. Fahnestock
M-651	Toggle Switch Storage Layout Approval	2	-	10-18-48	J.A. O'Brien
M-652	Toggle Switch Storage Output, E-32721-1	1	-	10-19-48	J.A. O'Brien
M-653	Restorer Pulse Generator	1	-	10-19-48	H. Fahnestock
M-654	Control Switch Indicator Panel, Layout Approval	1	-	10-19-48	J.A. O'Brien
M-655	Operation Matrix, Installation of Crystals	1	-	10-19-48	H. Fahnestock
M-656	Register Driver Type II Production Release	1	-	10-20-48	H. Fahnestock
M-657	Scope Photographs	1	-	10-20-48	H. Kenosian
M-661	Tube Development by the G. E. Company	2	-	10-22-48	E.S. Rich
M-662	Test Equipment Summary	2	-	10-22-48	N.H. Taylor
M-664	Video Cabling, Detail Marking of	2	-	10-26-48	C.W. Watt
M-666	Accumulator, Zero Digit	1	-	10-28-48	H. Fahnestock
A-67-1	Non-Staff Organization Chart	1	1	10-20-48	H. Boyd
A-72	Off-Hours Work	1	-	10-14-48	J.W. Forrester
A-73	Benefit Fund Committee	2	-	10-15-48	H. Boyd

Translation

E-152	Review of the Work of L. V. Kantorovich and V. I. Krylov "Methods of Approximate Solution of Partial Differential Equations" 13	-	-	10-7-48	M. Daniloff
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Library Files

.004	European Scientific Notes, 1 September 1948 and 15 September 1948				ONR, London
47	Technical Information Pilot No. U1445 - 1509				(ONR & Library of Congress)
52	Progress Report for WWI Electronic Digital Computer for Period October 9 - October 22, 1948				Sylvania
141	Planning and Coding of Problems for an Electronic Computing Instrument, Part II, Vol I, by Goldstine and von Neumann				(Institute for Advanced Study National Bureau of Standards)
559	Technical News Bulletin, October 1948				

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Library Files (Continued)

<u>No.</u>	<u>Title</u>	<u>No. of Pages</u>	<u>No. of Drwgs.</u>	<u>Date</u>	<u>Author</u>
169	Final Engineering Report on the Thermionic Emission of Various Materials				{ Battelle { Memorial { Institute
170	Gyroscope Position Pick-Off Device for Use on Autopilots, by Jackson and Steinman				{ North American { Aviation Inc.
171	Free-Flight Investigation at Transonic and Supersonic Speeds of the Rolling Effectiveness of a 42.7° Sweptback Wing Having Partial-Span Ailerons, by Sandahl				{ National { Advisory { Committee for { Aeronautics
172	Technical Data Digest, 15 June 1948				{ Air Documents { Division, U.S. { Air Force
173	Report No. 55263 on Hermes Project; Dispersion of the Hermes A3 Missile: Range Errors due to Variation in Position and Velocity at the End of Control				{ General { Electric { Company
174	Secondary Emission Amplifier Tube				{ National Union { Radio Corp.

Book

Russian-English Dictionary

{ Prof. V.K.
{ Müller

11.2 Standards Committee

(S. R. Abbott)

The following specifications have been approved and distributed:

S7.411-1 Control Pulse Output Unit - WWI
 6.092A Pilot Light Sockets and Assemblies (Revision)
 6.098A Misc. Components for Lamps
 6.078B Attachment Components (Panel)
 6.022A Capacitors, Plug-in Type (Revision)
 6.012C Panel Mtg. Assembly

The following specifications are being prepared for distribution:

S7.504-2 Records and Markings, WWI Tubes
 S7.413-2 Register Driver Type I, Preliminary Tests

Personnel are again invited to make use of the Library copy of Standard Components and WWI Specifications.

11.3 Purchasing and Stock

(H. B. Morley)

Samples of the new Centralab ceramic wafer capacitors in .01 mfd. 600 volt size have been received and submitted to engineers for examination. They are extremely small in size, all appear to have plus tolerance in capacity, and can apparently withstand high voltage overloads. Centralab will also submit samples of an improved selector switch superior to their popular line, but not as bulky as the heavy duty type such as made by Shallcross.

Orders have been placed with Newton Engineering Service for some special transformer units having unusual characteristics. This company is equipped to do special design and engineering work of this nature.

The local distributor representative for Sylvania brought in the Sylvania Field Engineer for this area, Mr. McGuire, who conferred at length on vacuum tube problems with Messrs. J. A. O'Brien, J. J. O'Brien, E. Rich and H. Kenosian.

The sample pulse transformers from Amertran were sent to us directly from the company doing the impregnating, and therefore did not receive final inspection by Amertran. Therefore, the company is submitting new samples for further test.

Starting November 1st the monthly cost analysis of expenditures will be submitted broken down into approximately 24 classifications.

(R. Fairbrother)

The stockroom is at present engaged in a complete inventory of all standard and non-standard material. It is hoped that this will be completed by November 6.

11.4 Electronic Construction

(F. H. Caswell)

The electrolytic tank is assembled again, in room 219, and a configuration simulating the storage tube holding gun was prepared for use.

11.4 Electronic Construction (Continued)

Work continues on the vacuum system protective circuits.

Two breadboard power supplies have been built, 20-200 volt at 25 ma and 200-2000 volt at 4 ma.

A jig is under construction for making 8 mesh nickel screens.

Time allocation: one technician on storage tube jigs and parts, one technician on storage tube parts inspection and anodizing, two technicians on storage tube electronic construction and three technicians on tube mechanical component construction.

Technician load continues to be heavy.

(A. Taylor)

Now under construction are the following: rack power control units, coders, clocks, scope synchronizers, attenuators, filament panels, power strips and temporary video cables for WWI.

The marginal checking for the multiplier is being installed. All panels for this unit have been completed.

There is now a demand for two types of so-called "breadboards". One type calls for high grade construction using special terminal boards etc. and the other is the traditional rush job using available parts. We are now asking the engineer which he wants and calling them experimental or semi-permanent breadboards.

11.5 Drafting

(A. M. Falcione)

Mechanical Drafting Standards - The first section, entitled, "Drafting Practice" (Class 2.01 through 2.13), of the new Mechanical Drafting Standards will be issued during the coming week. These standards have been approved by the following committee:

Mr. J. Aitken
Mr. F. Hutchison
Mr. A. Lofgren
Mr. A. Falcione

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11.5 Drafting (Continued)

It should be kept in mind that this standards book is to be used as a guide for all mechanical drafting. Errors in the practices should be brought to my attention. Exceptions to the practices must be approved by T. Leary or myself.

The second section, entitled, "Drafting Standards" (Class 2.30 through 2.47) is nearing completion and will be issued in the near future.

Mr. A. Greaves was assigned to Storage Tube work and was moved from the drafting room to the basement. At the present time, three draftsmen are working full time on Storage Tube work. In addition to the above, Mr. H. Lovett has also been working on this program full time.

There have been some loose ends with regard to method and type of engraving to be used on power supply panels for WWI installation group. Consequently, a meeting was held with Mr. Fahnestock, Chan Watt, R. Hunt, and the writer to determine the method and lettering to be used. This subject will be fully covered in a memo now being written.

The work load on the Drafting group is steady, and we have been able to keep pace with it.

11.6 Unclassified

(A. Taylor)

The sheet metal shop is engaged in routine production of test equipment chassis and panels. The present schedule extends to December 14th. There are also a few panels for WWI and the temporary console now under construction. With the exception of the Synchronizer this will complete all work now on schedule for WWI.

Bldg. 32 now has some open machine shop time and we have been sending part of our work over there. It is hoped that we will be "breaking even" on our machine shop work by November 1st and will be in a position to take on the experimental jobs etc. that have been held up.

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