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SUBJECT: DISCUSSION OF MAGNETIC DRUM SYSTEMS AT ENGINEERING RESEARCH ASSOCIATES, AUGUST 14 & 15, 1952

To: J. W. Forrester

From: E. S. Rich and C. W. Watt

Date: August 26, 1952

Abstract: E. S. Rich and C. W. Watt visited Engineering Research Associates, St. Paul, on August 14 and 15 to discuss construction features of the Auxiliary Drum system and to investigate details of the power control circuits for the two drum systems now under construction. Some changes in power control were agreed upon which will permit satisfactory integration of the drums with the WWI system. Certain details of circuits and block diagrams were also discussed to clarify questions that had come up regarding system operation. Work on the units appears to be progressing according to the revised schedules stated in a recent phone conversation between Butler of ERA and Rich of this laboratory.

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1.0 INTRODUCTION

C. W. Watt and E. S. Rich visited Engineering Research Associates, St. Paul, on August 14 and 15 to discuss the magnetic drum systems under construction for this project. The principal purpose of the visit was to obtain detailed information on the power control system needed with the Auxiliary Drum so that it can be properly integrated with the expanded power system for the WWI computer. J. L. Hill, W. W. Butler, L. Reid, Wayne Aamoth, and R. Eulberg from ERA participated in the discussions.

2.0 PRESENT STATUS

2.1 Auxiliary Drum

At the time of our visit the chassis mounting panel was being wired. Most of the power wiring had been completed and the twisted pair signal wiring supported by poles remained to be done. Chassis were being assembled in their assembly shop and magnetic heads were being mounted and moulded into their holders. Work was also progressing on the mounts for filament transformers, wireways and miscellaneous components, and the power control and the electronic control panels were being laid out. They are proceeding according to a time schedule stated in a phone conversation from Butler to Rich on August 7. According to this schedule they expect to finish assembly by October 15 and to finish their systems testing so that the unit will be ready for delivery by November 15. In the phone conversation it was stated that all parts would be received from their shops by October 1 provided certain components not yet on hand are delivered by their promised dates. On the mounting panel wiring and the plug-in chassis assembly, personnel at present are working 25% overtime in order to speed the work.

2.2 Buffer Drum

Since many of the repetitive units to go into the Buffer Drum are identical with those of the Auxiliary Drum, such units are being constructed along with those for the Auxiliary Drum. For this reason progress on the Buffer Drum seems to be satisfactory to meet the presently estimated completion date of January 15, 1953. No attempt was made to analyze the actual status of the work on this system. It was stated, however, that no phase of the Buffer Drum construction appears to be behind schedule at the present time.

3.0 POWER DISTRIBUTION AND CONTROL

ERA's schematic for the Auxiliary Drum power control system (ERA drawing no. XD68900) was discussed in detail and several questions which have been raised as a result of our plans to integrate this control with the WWI control were brought up. The location of switches, pushbuttons and indicator lights on control panels as well as their circuit connections were considered. Satisfactory changes were worked out to provide both the local and remote control facilities which are felt to be necessary. These changes were made on their drawings and revised copies were obtained for our use. A parts list for the components used in the power control system was obtained so that plans can be made for locating and wiring those parts such as circuit breakers, start-stop switches and connectors which are outside of the main drum cabinets. Dimensions of the bed for the motor-generator set were also obtained so a mounting for this set can be prepared. A detailed summary of the changes to the power control system which were agreed upon is given below.

(a) Starting Contactors. For use in our Power Supply Control System the coils of the various contactors supplied by ERA must be changed from 220 v. A-C to 115 v. A-C. The contactors affected are K9 of ERA drawing XD68900 (the M-G set starter, a Cutler-Hammer Bulletin 9586-H1686 across-the-line switch) and K8 of XD68900 (an Allen-Bradley Bulletin 709, Size 0 across-the-line switch). ERA will deliver the drums with 220 v. coils in the contactors, and we will order 115 v. coils and change them here.

(b) Operate Relay. As shown on the original drawing of XD68900, the operate relay K14 was controlled by a pushbutton which had to be pushed before the drum circuits could be used. This relay applied plate voltage to the writing amplifiers. It is important that application of this voltage be delayed until the control flip-flops are cleared, otherwise a spurious writing operation might occur when the system is turned on. ERA has agreed to eliminate the pushbutton and replace it with a contact on the 0.5 sec. timer K11 already used in the control circuit. This will be a Kramer timer of the type we use elsewhere in WWI. The operation is now as follows: (see XD68900) as soon as the filament alternator has cycled fully on the control 115 v. A-C line feeding the drum contactors is energized; the 0.5 sec. timer (K11) and the bias contactor (K12) are energized simultaneously; and when K12 pulls in, K13, the positive voltage contactor, is energized. When the timer K11 pulls in, energizing K14, contacts on K14 clear all the drum flip-flops, and reset the drum alarm circuits. Another contact lights the operate light on the drum power control panel, and a fourth contact energizes K15. When K15 pulls in, its contact puts ≠200 v. on the plates of the writers and the system is ready to use. Thus no manual operation, except turning on the drum master switch in WWI Test Control, is required to put the drum system in operation, as the drum and M-G set motors are automatically controlled by the WWI power supply control system.

(c) Voltage Sensors for Fail Safe Operation. A circuit schematic of the voltage sensor circuits was obtained. This is ERA XD68917. These sensor circuits monitor the ≠200, ≠150, and -15 v. lines out of the regulators. Lack of any of these voltages prevents the drum system from coming on or causes it to drop out if already on. At our request an A-C sensing relay was added to the filament feed to each drum system, on the load side of the circuit breaker. A contact on this relay (it is mis-numbered K15 on XD68900, since K15 already existed on the same drawing) was put in the control line feeding the control contactors in series with the voltage sensor contacts.

(d) Local Control of Power at Drums. Two lock switches, S1 and S11, will be installed on the Auxiliary Drum power control panel and one lock switch, S11, will be placed on the Buffer Drum power control panel. These will each have two positions, NORMAL and MAINTENANCE. In NORMAL, the local pushbutton stations for the drum motor and M-G set will be overridden by the remote controls built into the new WWI Power Supply Control System. In MAINTENANCE, the remote controls are bypassed, and, so long as WWI is either at ON or at STANDBY the drum supplies and motors can be turned on and off at the drums. To permit local control of the regulators as well, a local control toggle switch S18 will also be put in the line feeding the power supply contactors. We will supply ERA with the three lock switches as soon as we get them.

(e) Miscellaneous

(1) Excess temperature indicator lights did not operate correctly in earlier schematic. A change was made, but on further study the indications still seem to be wrong. ERA is being notified.

(2) Lights have been added to the 3 voltage sensors, turning on if trouble has occurred. Other lights on the Auxiliary Drum power control panel are:

a. Door interlock bypass light.
b. High excess-temperature light.
c. Low excess-temperature light.
d. Chassis filaments on (A-C to magnetic drum tubes)
e. Regulators on (A-C to regulators)
f. Control (bias generator output)
g. Operate (positive generator output)

(3) Design of the bays was inspected to see what installation problems might be expected. Installation should be quite simple, as the bays are equipped with levelling feet, and can be rolled into place and then levelled. Attaching our overhead wireways to the bays will be no trouble. All power connections to be made to Whirlwind are brought to terminals, and all pulse connections are brought to a group of BNC Connectors mounted on an insulating panel at the top of one section of the bay.

4.0 CIRCUITS AND COMPONENTS

Some details of their flip-flop and gate writing circuits were discussed in order to answer questions raised by McVicar. It was determined that the flip-flops used in our equipment will not have the '0' and '1' trigger inputs to the plates as shown on the typical flip-flop circuit of ERA drawing no. XD61158. These inputs are sometimes used by ERA for coupling to the plate of a triode trigger tube. The transformer inputs to the grids of their flip-flops are connected through a 1N52 mixing crystal with the lower side of the transformer returned to the -5 v. clamping voltage. The loads on the plates of the flip-flops are merely those of the cathode followers and the indicator circuits. Typical operation of a flip-flop results in rise times at its plates of about 5 microseconds and fall times of less than 2 microseconds. Rise and fall times out of the cathode follower, however, are deliberately slowed down to about 9 microseconds by means of shunt capacitors so that a pulse applied simultaneously to the flip-flop and to a gate tube connected to the flip-flop will pass the gate tube before the flip-flop output voltage has changed. The input trigger voltage required is somewhat less than the value of 20-24 volts quoted in a letter from Butler to Rich on July 7, 1952. The values quoted allow a considerable margin for safe operation.

It was reported to them that McVicar had observed high frequency oscillations in a breadboard of their gate writing circuit which he had constructed. These oscillations evidently were caused by some peculiarity of the tube which was used. They stated that they had not observed such a condition but would look for similar trouble when testing the units for the Auxiliary Drum.

An explanation was obtained of the source of the approximately 8-microsecond delay which is necessary in reading from the drum. About 2 microseconds of this delay occurs in the recording process since maximum recording current through the head does not occur until the end of the recording pulse. The waveform for the recording current in the head is a sawtooth shape with an exponential rise during the pulse and a sharp decay with some ringing at the end of the pulse. The remaining 6 microseconds of delay occurs in the reading amplifier. This amplifier is designed with short-time-constant coupling networks between each of its stages. These result in non-uniform phase shift for different frequencies and effectively produce differentiation of the input waveform. Since this differentiation effect is a result of a distributed action in several stages of the amplifier, it is accompanied by considerable delay. This type of circuit was chosen to minimize difficulties of circuit recovery following switching transients.

5.0 BLOCK DIAGRAMS

As a result of experimental tests on the flip-flop writing circuits to be used in the Buffer Drum, it has been determined that the delayed timing pulses which are used to clear these flip-flops and terminate the writing pulses will cause feed-through to the reading amplifiers if the pulses are allowed to come through when a group is selected for reading. A change to the block diagram of the Buffer Drum therefore was agreed upon to avoid the above condition. This change involved feeding the delayed timing pulses to groups 0A, 1A, 0B, and 1B through gate tubes connected to the group-selector-switch. Two such gate tubes were required so that pulses could be applied to the writers of field A while field B was selected for reading and vice versa. A third gate tube was added to the "write" side of the read-write control flip-flop to switch off the delayed timing pulses to the remaining groups on the drum when a reading operation is taking place in one of those groups.

What appeared to be an error in the labelling of the group-selector-switch outputs on the Buffer Drum block diagram was pointed out. The desired function of the group-selector-switch outputs in question was clarified so that ERA can continue their plans for construction. We will investigate the apparent error and make the necessary corrections to the drawing.

6.0 DRAWINGS

Copies of the drawings listed below were obtained from ERA. These supplement the drawings obtained at a previous visit listed in Memorandum M-1535.

Drawing No.	Title	No. of Copies
XD61210	Schematic - Reading Amplifier	6
XD68917	Schematic - Voltage Sensor Circuit	6
XG68923	Layout, Electronic Indicator Panel	6
XR68922	Layout, Power Control Panel	6
XD68900	Schematic - Auxiliary Power Control System	6
MXD68900	Bill of Material	6

We stated our preference for obtaining reproducible prints of all drawings furnished with both drum systems. J. Hill felt that this request could be granted and discussed the matter with Mr. Winget of their sales department. We were told that it would not be necessary to make a formal request from our purchasing office. We were told that their policy is to furnish with the equipment such drawings as are needed and helpful in performing maintenance on the system. This includes circuit schematics, wiring schedules, and mechanical drawings of the magnetic drums, but in general it does not include assembly drawings for the cabinets, panels and chassis.

SIGNED E S Rich
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