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Engineering
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MASTER

AN INSPECTION DATA LOGGING SYSTEM (DLS) (U)

RELEASED FOR ANNOUNCEMENT
IN NUCLEAR SCIENCE ABSTRACTS

W. A. Groppe
W. W. Lee

UNION CARBIDE CORPORATION
NUCLEAR DIVISION
OAK RIDGE Y-12 PLANT

operated for the ATOMIC ENERGY COMMISSION under U. S. GOVERNMENT Contract W-7405 eng 26

**UNION
CARBIDE**

OAK RIDGE Y-12 PLANT
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UNION CARBIDE CORPORATION
Nuclear Division

Y-12 PLANT

Contract W-7405-eng-26
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ABSTRACT

Automation techniques have been applied to the collection of position and error data from inspection machines. The system provides a rapid and accurate method of obtaining data from these machines. Data are collected in a form suitable for use with digital computers.

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CONTENTS

SUMMARY.	7
INTRODUCTION.	9
LOGGING SYSTEM FOR INSPECTION DATA.	11
Description of the System	11
Statistical Evaluation	14
Principles of Operation	15
REFERENCES.	17
APPENDIX A	19
Details of the System Logic.	19
Inspect Sequence Circuit	20
Crossbar Driver	21
Synchronizer Circuit.	22
Punch Driver	23
Parity	24
Zero Detector.	24
S Register	24
S' Register	25
B and B' Registers	26
Crossbar	27
Tape Input Circuit.	28
M10-EOB Identification Circuit	28
Crossbar Output Inverter	29
Letter Identification Circuit.	29
Relay Subchassis.	30
Function Switch	30
Rotary Table Connections	31
Panel Lights	31
TOL to DVM Amplifier	31
DVM Connections	32
"Go" Button Relay.	32
APPENDIX B.	33

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SUMMARY

The dimensional-inspection process consists of three essential steps: setup, inspection, and reporting of results. The introduction of numerically controlled inspection machines provides significant improvements in the inspection process in that the gage head is accurately positioned in a much shorter length of time. A system has been built to collect data which, when used with a digital computer, can help reduce to a minimum the alignment time and inspection errors. A computer program has been developed by personnel at the Oak Ridge Y-12 Plant to use the data collected with the DLS.

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INTRODUCTION

The dimensional-inspection process consists of three essential steps: setup, inspection, and reporting of results. The introduction of numerically controlled inspection machines is improving the actual inspection process in that the gage head is accurately positioned in a very short period of time, and high confidence levels are obtained from the results. Equipment and procedures have been developed that have as their goal an improvement in the remaining parts of the inspection process; namely, setup and reporting of results.

A major portion of the setup time is taken in manually aligning some reference axis on the part with the axis of rotation of the inspection machine. Previous efforts to automatically align the parts mechanically⁽¹⁾ and electrically⁽²⁾ have been successful.⁽³⁾ Mathematically speaking, the inspector is transposing the coordinates of the part to correspond with the proper machine coordinates. The other phase of inspection, where considerable improvement is needed, is in data reduction and judgment as to part disposition.

It is apparent that a digital computer provides a powerful tool in both the areas of coordinate transposition and data reduction.^(3, 4)

It is the purpose of this effort to apply the power of a digital computer to the problem of bettering the remaining areas of the inspection process.

In order to present the data in the most economical form to the digital computer, it should be obtained directly in a form readable by EDPM equipment. This report discusses the equipment used to acquire the data in digital form on punched paper tape for inspection-data reduction.

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LOGGING SYSTEM FOR INSPECTION DATA

DESCRIPTION OF THE SYSTEM

Figure 1 shows a basic block diagram of the system. Information in the output tape has three sources: (1) the command tape associated with the inspection machine, (2) identifying information supplied by the operator through thumbwheels, and (3) inspection data. Multiplexing of the several data sources is accomplished by a high-speed crossbar switch. Logical functions of the data logging system are shown in Figure 2, an overall view of the equipment is shown in Figure 3, and a detailed view of the control panel is presented in Figure 4.

Figure 1. INSPECTION DATA LOGGING SYSTEM.

The output paper tape is punched in the standard EIA format in order to facilitate the transmission between installations and to assist in equipment and command-tape debugging. The command tape serves as a source of information for three items: (1) Y and Z coordinates of each latitude, (2) the angular interval in which readings are to be made at that latitude, and (3) detailed instruction to the data processing computer regarding the format of the information. Thirty-nine thumbwheel switches are mounted on the front panel (see Figure 4) for entering part, process, operator, and machine-identifying information. Inspection data consist of deviations from nominal and of a rotary table coordinate at which the deviation was made. The number of inspection points is determined by the part programmer and coded into the machine-

Figure 2. DATA COLLECTION SYSTEM. (Logic Block Diagram)

113584

Figure 3. DATA COLLECTION SYSTEM. (Overall View)

113584

Figure 4. DATA COLLECTION SYSTEM. (Control Panel Detail)

tool command tape. The data logging system takes readings at equally spaced intervals in accordance with the coded command.

In addition, the logic performs certain editing functions to delete redundant information in the several data sources. A detailed explanation of the system logic is presented in Appendix A.

STATISTICAL EVALUATION

Repeatability at various rotary table speeds and induced centering errors were made. The greatest deviation occurred at the maximum rotational speed (8 1/2 rpm) and at the greatest centering error ($\pm 0.010''$). This result is as might be expected. Under these conditions, only three out of several hundred points checked varied more than 70 microinches. None varied more than 80 microinches. The statistically derived average was about 60 microinches for this worse case. At rotary table speeds of two to six rpm (which is still faster than present inspection speeds) the average was estimated at about 35 microinches.

A typical chart of data taken in this manner is presented in Table 1. The run was made using a four-inch-diameter master ball at a total indicated runout of eight thousandths of an inch. The horizontal columns are the various rotary table speeds; the last column is a repeat of the run at two rpm. This run was made to show if the ball moved due to starting and stopping the rotary table. The resolution of the system is 10 microinches. The rotary table degrees noted are where each reading was taken with respect to a rotary table zero degree.

Reliability checks were also conducted, although not statistically evaluated. These runs showed that the entire system (including the inspection machine) typically erred in one out of the approximately 100 to 150 latitudes run in an eight-hour shift.

Table 1
 REPEATABILITY AT VARIOUS ROTARY TABLE SPEEDS
 (Readings Are in Thousandths of an Inch; Maximum Deviation Is 40 Microinches and Occurs in Three Places)

Degrees	Table Speed (rpm)							
	2	3	4	5	6	7	8 1/2	2 (repeat)
0	+ 3.40	+ 3.40	+ 3.39	+ 3.40	+ 3.39	+ 3.40	+ 3.39	+ 3.39
30	+ 3.92	+ 3.93	+ 3.93	+ 3.93	+ 3.93	+ 3.93	+ 3.92	+ 3.93
60	+ 3.41	+ 3.41	+ 3.42	+ 3.42	+ 3.43	+ 3.43	+ 3.43	+ 3.42
90	+ 1.99	+ 1.99	+ 2.01	+ 2.00	+ 2.01	+ 2.01	+ 2.02	+ 2.01
120	+ 0.03	+ 0.02	+ 0.05	+ 0.04	+ 0.05	+ 0.06	+ 0.06	+ 0.04
150	- 1.94	- 1.92	- 1.92	- 1.93	- 1.90	- 1.90	- 1.90	- 1.91
180	- 3.38	- 3.37	- 3.37	- 3.38	- 3.36	- 3.35	- 3.35	- 3.35
210	- 3.91	- 3.93	- 3.91	- 3.92	- 3.90	- 3.89	- 3.88	- 3.89
240	- 3.42	- 3.42	- 3.42	- 3.42	- 3.41	- 3.40	- 3.40	- 3.41
270	- 2.01	- 2.01	- 2.01	- 2.02	- 2.00	- 2.00	- 2.00	- 1.99
300	- 0.05	- 0.05	- 0.05	- 0.06	- 0.06	- 0.06	- 0.06	- 0.04
330	+ 1.91	+ 1.92	+ 1.90	+ 1.90	+ 1.91	+ 1.91	+ 1.91	+ 1.93

These errors are all attributed to the inspection machine control unit, specifically the command-tape reader, and had been noted prior to installation of the DLS. These errors are easily identified because the slides go to the "off-part" limit switches. It is a simple matter to negate the erroneous information and restart the run.

A computer program to reduce the data acquired by the DLS has been tested extensively, and results so far are successful. Complete results are to be published.⁽⁵⁾

PRINCIPLES OF OPERATION

The operational procedure is described assuming that the normal preinspection routines have been done. This method includes allowing 15 minutes for the system to warm up, proper calibration of the readout instruments, establishing a zero plane for each axis, and having the proper command tape in position on the inspection machine.

The following steps are necessary for complete part inspection using the DLS:

1. The part is centered on the rotary table so that all points of the part fall within the gaging range of the transducer. Accurate centering is not necessary.
2. Operator information is placed properly on the thumb switches and entered on tape by pressing the "go" button with the function switch (S1) in the identification

(ID) position. This step enters information such as computer code, operator number, machine number, date, and part number on the tape.

3. The function switch is now placed into the "inspect" position and the "go" button is pressed. This action causes the command tape to be read by both the inspection machine and the DLS. The inspection machine information arrives first on the tape and is ignored by the DLS. Then the DLS information arrives and is ignored by the inspection machine. By using an inspection machine with EIA coding, the machine and DLS information could be one and the same. The information to the machine is the normal position information, and that for the DLS includes computer code, position information, tolerance, degrees between error sampling, and part type. The part type appears only on the first latitude; the remaining information appears at every latitude.
4. The inspection-machine slides move to the commanded position and clamp. The clamp signal causes the rotary table to start. As soon as the table passes a reference zero point, the DLS starts to copy the error information, punching it into the tape. This information includes both angular location and the error, read to the nearest 10 microinches, at that rotary table angle. Several error readings are made as the rotary table progresses, the number depending upon how many degrees between readings were programmed. When the rotary table passes zero the next time, all action stops. One latitude is now inspected.
5. Pressing the "go" button starts the sequence described in Steps 3 and 4 again. This repeat operation is done for as many latitudes as are programmed on the command tape. At the end of the inspection of the last latitude, the command tape will rewind and the inspection machine will return to a load position.
6. The function switch is now placed into the end-of-part (EOP) position and the "go" button is pressed. This operation enters an EOP code into the tape.
7. At the end of a shift, or when all the parts are inspected or at any time the inspector desires to end the tape, the function switch is placed into the end-of-tape (EOT) position. Pressing the "go" button enters an EOT into the tape.
8. If for any reason, such as movement of the part, the system errors, or the operator desires to delete the information collected on a part, it is necessary to depress the "no-go" button and push the "go" button. This operation is performed in the EOP position of the function switch. It enters a code on the tape which tells the computer to ignore all the information collected after the finish of the last part.

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- (4) Gilson, J. D.; "Computer Corrects Gaging Bias", The Tool and Manufacturing Engineer, pp 61-63; March 1963.
- (5) Bookhart, T. W. and Fowler, A. H.; A Computer Program for Removing Part Alignment Error in Inspection Data (Preliminary), Unpublished.

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APPENDIX A

DETAILS OF THE SYSTEM LOGIC

The following is a description of each logic block and how it fits into the overall block diagram of the Data Logging System. The reader should refer to the complete set of prints assembled in Appendix B in order to understand the description. A list of the prints is given in Table A-1 and discussions of the more significant circuits follow.

Table A-1
CIRCUITS AND COMPONENTS OF THE
DATA LOGGING SYSTEM

Drawing Number	Description
B-I-25845	Go Button Relay
B-I-25846	DVM Connections
B-I-25847	Tol to DVM Amp
B-I-25848	Tape Input Circuit
B-I-25849	RT Conn and Ligats
B-I-25850	M10-EOB Identification
B-I-25851	Crossbar Output Inverter
B-I-25852	Letter Identification Circuit
B-I-25853	Relay Sub Chassis
B-I-25854	S1 Connections
C-I-30841	Inspect Sequency Circuit
C-I-30842	Block Diagram
C-I-30843	Crossbar
C-I-30844	Terminal Board No 1
C-I-30845	Terminal Board No 2
C-I-30846	Terminal Board No 3
C-I-30847	Terminal Board No 4
C-I-30848	Crossbar Driver
C-I-30849	Synchronizer Circuit
C-I-30850	Punch Driver Circuit
C-I-30851	Parity and Zero Detector
C-I-30852	S Register
C-I-30853	S' Register
C-I-30854	B and B' Register
C-I-30855	Y-Z Adapter

Inspect Sequence Circuit (Drawing C-I-30841, Page 43)

This circuit controls the logic sequence during the "inspect" position of the function switch (S1). Normally, the flip-flops (250-11) are reset; that is, with zero volt at their reset (bottom) side. The sequence of operation is approximately as follows:

1. An M10•EOB is recognized from the command tape, the inspection machine sets, and clamps. Both inputs of Gate 151-1H go to zero volt. The output goes to -6 volts. This signal sets flip-flop (f-f) 250-11A. Part of the synchronizer circuit is also enabled. The set output of f-f 250-11 (Pin 6) goes to zero volt. This action allows Relay Driver 301-8A to conduct, driving the output (Pin 9) to nearly ground. The relay driver current comes from a -24 volt source, goes through the relay in the rotary table control, energizes it, and starts the rotary table.
2. The rotary table turns and passes a reference zero. There a microswitch is momentarily energized. At this time both inputs of Gate 151-6G go to zero volt. This action sets f-f 250-11B. The signal from 151-6G also starts Single Shot 202-4A.
 - 2a. The output of Single Shot 202-4A is a negative-going -6 volt pulse of approximately 2 milliseconds duration. This pulse does several things:
 - a. Sets f-f 250-11D.
 - b. Transfers the B value to the B' register.
 - c. Transfers the S value to the S' register.
 - d. Grounds Pin T of the DVM, enabling it to take a reading.

Flip-flop 250-11D having been set, enables one input of Gate 151-1C; f-f 250-11B having been set, enables another input of the same gate. Pulses coming from the synchronizer can now get through this gate and to the crossbar driver.
3. When the crossbar reaches Point G3, Gate 151-5B is qualified, resetting f-f 250-11D.
4. S' overflows, causing Single Shot 202-4A to pulse again, repeating Steps 2a and 3.
5. Step 4 repeats through 360 degrees.
6. The rotary table has completed 360 degrees from the 0-degree reference. It again energizes Gate 151-6G (the microswitch qualifying gate). This action

resets f-f 250-11C, which resets f-f 250-11B, which resets f-f 250-11A. This sequence stops the rotary table and waits for the next sequence (Step 1).

Crossbar Driver (Drawing C-I-30848, Page 50)

This circuit provides the control logic and power to drive the crossbar to any one of 90 points. It also contains a preset circuit to select many of the points for special purposes. To understand this circuit best, the operation of the crossbar should be understood. It is explained on Page 27 of this report. The sequence of operation is approximately as follows:

1. The "hold" coils of the crossbar are driven by Relay Drivers 301-4A through 6B. These circuits provide the control for energizing the hold coils. They become approximately a short circuit when all of the inputs go to zero volt.
2. The "hold" coils relay drivers are controlled by the BCD counter consisting of f-f's 250-9A through 9D and associated gates. The BCD equivalent of the number of input pulses is always present at the f-f output. Inverters 151-3E, 151-5D, and 151-5E are used to provide additional power to control the relay drivers. They are needed because any module should only drive about five other modules. To follow the circuit, it is necessary to pay strict attention to the letters A, $\bar{A}$, A', $\bar{A}'$, D, $\bar{D}$, etc.
3. The select coils are controlled by a binary counter consisting of f-f's 250-10A through 10C. This counter advances once for each overflow of the BCD counter (every tenth input pulse from the inspect sequence circuit). The select coil relay drivers are 301-6C - 301-7C.
4. The select part of the crossbar must energize before the hold part. To accomplish this, 12-volt coils operated on 24-volt supplies are used for the select coils. Upon energizing, the coils have a resistance placed in series with them to drop the voltage to 12 volts. The hold coils are 24-volt coils operated on 24 volts.
5. One of the preset conditions is to go from Point G3 to Point F3. In this case, the hold coil never releases and the select coil cannot properly make Point F3. A signal originating in the inspect sequence circuit at Point G3 causes Single Shot 202-5A to pulse, releasing Hold Coil 3 long enough for Select Coil F to properly energize.
6. Several preset conditions exist. They work by either driving certain points on the f-f's to ground (forcing them to set or reset) or by grounding Points 10 and 26 of the f-f's which resets them. The grounding of Points 10 and 26 of the f-f's is done through Power Inverter 157-1C.

Synchronizer Circuit (Drawing C-I-30849, Page 51)

The purpose of this circuit is to provide 4 1/2-millisecond pulses at the appropriate time to the correct circuits. The sequence of operation is approximately as follows:

1. Position 1 of S1 (identification)

Upon pressing the "go" button, Single Shot 202-4B pulses and sets f-f 250-10D. This action enables one input of Gate 151-2B. When the "go" button is released, a second input is enabled. The remaining input is already at zero volts, so the gate is qualified. This position starts Single Shot 202-1A, the output of which goes to -6 volts for 4 1/2 milliseconds. This pulse does many things:

- a. The trailing edge starts Single Shot 202-1B.
- b. The trailing edge advances the S counter, if the inspect sequence circuit is in the correct state.
- c. The leading edge causes the tape punch to operate.
- d. The trailing edge sets the S register if that circuit is in the correct state (X points).
- e. The trailing edge advances the crossbar driver counter.

2. Single Shot 202-1B pulses for from 17 to 30 milliseconds depending upon the speed of punchout desired. Upon the trailing edge of this pulse, Single Shot 202-1A is pulsed again, repeating Step 1a.

3. This sequence continues until one of the points on the crossbar, which has -6 volts on all contacts, appears. This sequence sends a pulse through the crossbar output inverter circuit and resets f-f 250-10D, stopping the 4 1/2-millisecond pulses.

4. The operation is the same as in Steps 1, 2, and 3 for Positions 3 and 4 (end of part, end of tape) of S1.

5. Relay K4, which is the low-tape relay, will not allow a new part to be started. It inhibits the identification position of S1. If a part has already been started when the tape becomes low, that part can be finished because the relay does not affect Positions 2, 3, and 4 of the switch. K4 relay closes again when a new tape is installed.

6. In Position 2 (inspect) of S1, f-f 250-10D has no effect. The 4 1/2-millisecond pulses are started and stopped by the inputs to Gate 151-2C. If either input goes

to -6 volts, the two single-shot multivibrators start the normal sequence of pulsing (Step 1a). They continue to pulse until that input to Gate 151-2C returns to zero volt.

Punch Driver (Drawing C-1-30850, Page 52)

The purpose of this circuit is to supply the control for the tape punch. The sequence of operation is approximately as follows:

1. A hole will be punched in the tape when all inputs to any of the relay drivers controlling a channel are at zero volt. This action causes the relay driver to become approximately a short circuit, which allows current to pass from a -24 volt power supply through the solenoid coils, to ground through the relay drivers. It is important that these solenoid coils do not have continuous current through them since they burn out rather easily. The recommended duty cycle is for them to be on for 4 1/2 milliseconds and off for a minimum of 17 milliseconds.
2. The inputs to the relay drivers for Channels 1, 2, 3, 4, and 7 come from the crossbar output inverters. The input for Channel 6 comes from the zero detector and the input for Channel 8 comes from either an EOR (end of record) signal or the tape input circuit. The input for Channel 5 comes from the parity circuit. Additional inputs for all channels plus the feed and sprocket hole come from the synchronizer circuit. A last input to Channels 1 through 7 comes from the EOR circuit.
3. When the crossbar output circuit has a zero at any channel, and there is no EOR, that channel and the feed and sprocket will be energized by the 4 1/2-millisecond pulse from the synchronizer.
4. When a Channel 8 appears on the tape input circuit, that channel will be energized by the synchronizer circuit along with the feed and sprocket solenoids.
5. When an EOR appears on the crossbar output, all relay drivers except the Channel 8, feed, and sprocket are inhibited.
6. A buzz button is mounted on the punch driver. When this button is pushed, it energizes a relay (K2) which allows the feed, sprocket, and Channel 5 to be energized by pulses from Inverter 151-5H. The voltage from the buzz button, in addition to energizing Relay K2, charges a 20- μ f capacitor. When the voltage across this capacitor reaches about 3 volts, the Schmitt Trigger Circuit 205-1B fires, causing Single Shot 202-3B to pulse for about 4 1/2 milliseconds. This action causes the "buzz"; that is, advances the tape with only a parity punched in it.
7. The low-tape Relay K4 is located on this print.

Parity (Drawing C-I-30851, Page 53)

The purpose of this circuit is to assure an odd number of holes on any one row of tape. The sequence of operation is approximately as follows:

1. The various inputs on this circuit are arranged so that any even combination of voltages representing holes to be punched in the tape causes the Relay Driver 301-8C output to go to zero volt. This action allows Channel 5 of the punch driver to be energized.
2. The inputs come from three places:
 - a. Channels 1, 2, 3, 4, and 7 along with $\bar{1}$, $\bar{2}$, $\bar{3}$, $\bar{4}$, and $\bar{7}$; and Channels 6' and $\bar{6}'$, which represent the digit "0", come from the crossbar output inverter circuit.
 - b. Channel 8', which represents a Channel 8 due to either a tape-reader Channel 8 or an EOR, comes from the punch driver.
 - c. Channel $\bar{8}'$ comes from the zero detector.

Zero Detector (Drawing C-I-30851, Page 53)

The purpose of this circuit is to supply a Channel 6 punch when a zero is to appear on tape. The sequence of operation is approximately as follows:

1. The input to Inverter 150-6C comes from the punch driver; it represents either a Channel 8 from the tape reader or an EOR.
2. Inputs $\bar{1}$, $\bar{2}$, $\bar{3}$, $\bar{4}$, $\bar{6}$, and $\bar{7}$ come from the crossbar output inverter.
3. When Inputs $\bar{1}$, $\bar{2}$, $\bar{3}$, $\bar{4}$, $\bar{7}$, and 8' are in that voltage state which represents no hole, the voltages from Gate 151-5F and Inverter 150-6B are proper to show a hole to be punched in Channel 6.
4. When Input $\bar{6}$ is present, regardless of the other inputs, the outputs of Gate 151-5F and Inverter 150-6B are proper to show a hole to be punched in Channel 6.

S Register (Drawing C-I-30852, Page 54)

The purpose of this circuit is to identify an S from the input (command) tape and store the following three digits from that tape. The sequence of operation is approximately as follows:

1. The inputs to Gate 104-1A are coded to represent an S. When all the inputs go to zero volt, the output of the gate goes to -6 volts. The input comes from the tape input circuit.

2. The output of this gate does two things:
 - a. It clears any previous S value stored in f-f's 250-1D, 250-2A-D, and 250-3A-D. A second input is sent to Power Inverter 157-2C, which supplies the power to reset these flip-flops. This input prevents any stray pulses coming from the tape reader between characters from resetting the flip-flops.
 - b. It enables Gate 150-1B, sending its output to zero volt.
3. Gate 150-1B output being at zero volt allows the next 4 1/2-millisecond pulse from the synchronizer to set f-f 250-1A. The outputs of f-f's 250-1A and 250-1B are now such that the Inverter 150-1C output is at zero volt. This position allows the X signal from the synchronizer to set f-f 250-1D to whatever state the third input (from the tape input circuit) requires.
4. The next 4 1/2-millisecond pulse resets f-f 250-1A and sets f-f 250-1B, causing the output of Inverter 150-1D to go to zero volt. This action allows the X signal to set f-f's 250-2A through 2D to whatever state the third input requires.
5. The next 4 1/2-millisecond pulse sets f-f 250-1A and sends the Inverter 150-1E output to zero, allowing f-f's 250-3A through 3D to be set as in Steps 3 and 4.
6. The next 4 1/2-millisecond pulse resets f-f's 250-1A and 250-1B and thus causes the output of Inverter 150-1B to go to -6 volts, inhibiting any further change of state until the next S appears.

S' Register (Drawing C-1-30853, Page 55)

The purpose of this circuit is to load the S register value and count down from it to zero, where a take-a-reading signal is generated (S' overflow). The register advances one count for each degree of rotary table rotation. One pulse per degree is generated by the rotopulser and fed to the S' register. The sequence of operation is approximately as follows:

1. Flip-flops 201-1A through 5A (or gated f-f's) form a backward BCD counter of a 199-count capability.
2. Upon a signal from the inspect sequence circuit, whatever value is stored in the S register is loaded into the S' register. This action does not destroy the value in the S register.
3. Pulses from the rotopulser cause Inverter 151-5A (which is used for impedance matching) to change state. This step causes the Schmitt trigger circuit (which is used to generate a sharp pulse) to go to -6 volts output. The pulse is inverted again in Power Inverter 157-2B and drives the backward counter. The counter

counts down from the S value until all reset outputs are at zero volt. This action qualifies Gate 150-1F and that output goes to -6 volts, which is the S' overflow and the take-a-reading signal.

4. Another signal is generated in the inspect sequence circuit to load the S value into the S' register again. The sequence starts over.

B and B' Registers (Drawing C-I-30854, Page 56)

These registers are on the same print and work directly with each other, but they will be described separately.

B Register - The purpose of this register is to keep a continuous account of the location of the rotary table with reference to an established zero point. The sequence of operation is approximately as follows:

1. Flip-flops 250-4A through 4D, 250-6A through 6D, and 250-8A and B comprise the B register. They are a BCD counter capable of storing a maximum of 399 counts.
2. Pulses generated from the rotopulser come from the S' register to the input of the B register. The counter (or register) advances once per pulse from the rotopulser. Each rotopulser pulse is equivalent to one degree of table rotation.
3. Any time the rotary table passes the zero-degree reference point, a pulse is generated from a relay (K1) driven by a microswitch mounted on the rotary table. This pulse resets all the B register flip-flops to zero.
4. When the rotary table goes past 360 degrees (zero for the second time), the S' register tries to overflow; this action is stopped by the microswitch inhibiting the inspect circuit, but usually time is sufficient for one pulse to get through, causing one erroneous row on the tape to be punched. For this reason, 359 degrees are decoded in the B register and fed to the S' register to inhibit the S' overflow at 360 degrees. Upon passing the microswitch or receiving an M10·EOB signal, the flip-flop which inhibited the S' overflow (201-5B) is reset.

B' Register - The purpose of this register (it is not a counter) is to store the B register reading at any time and present the value to the crossbar for punching. This value represents that point of table rotation at which a reading was taken. The sequence of operation is approximately as follows:

1. The B' register consists of f-f's 250-5A through 5D, 250-7A through 7D, and 250-8C and D.

2. Upon command from the inspect sequence circuit, the B-register value is loaded into the B' register. This command is labeled "Lock B" on the print. It occurs at an S' overflow.
3. The B' value now represents that point of table rotation where a sample reading was taken. This value is fed through Cables F4, F5, and F6 to Crossbar Points F4, F5, and F6. The points are scanned by the crossbar and punched on tape.
4. Small capacitors are present at the flip-flop's reset output to prevent the crossbar switching from resetting the flip-flops.

Crossbar (Drawing C-1-30843, Page 45)

This circuit or rack is the heart of the entire unit. All data to be punched come to the crossbar or originate in the crossbar. The sequence of operation is approximately as follows:

1. The crossbar consists of 20 solenoids. Ten are in the "hold" position and 10 are 90 degrees away called the "select" position. Typical operation is for the crossbar driver to energize a "select" and a "hold" simultaneously. The "select" must beat the "hold" energized or the contacts at that point will not make. This sequence is accomplished by using excessive instantaneous voltage on the "select" coils to make them faster than the "hold" coils (see Crossbar Driver, Page 21). Pulses coming to the crossbar driver cause one "hold" coil after another to energize, then the control of the driver causes both the "hold" and "select" coil to change. (Again the "select" beats the "hold".) This sequence will continue until the pulses stop.
2. All crossbar positions or points consist of six contacts. Eight channels are fed through Crossbar Position G9 from the tape reader by ignoring parity (Channel 5), and sending EOB (Channel 8) straight to the punch. Parity is then later reestablished. Therefore, in all points, Contacts 1, 2, 3, and 4 represent Channels 1, 2, 3, and 4 of the tape, Contact 5 represents Channel 6 of the tape, and Channel 6 represents Channel 7 of the tape. This relationship is true regardless of where the data originate.
3. Some of the data originate in the crossbar itself. That is, points which will always be the same, such as N at Point A0, Y at Point B5, and G at Points F0, H0, and I0 are wired right in the crossbar.
4. Other points originate in the logic or from the thumb wheels. These components are connected through cables which have the same number as the points to which they tie (such as Cable A5 ties to Point A5).

5. These cables are fed into connectors on top of the crossbar. Each connector serves five points. The points are marked on top of the connector, such as Connector A-E-9 contains the cables which go to Points A9, B9, C9, D9, and E9. The cables are soldered to the connector and the connector makes contact with the points.
6. No more than one point should be pulled in at a time. It is possible, through malfunction or force, to have more than one point at a time energized. This action is apt to cause a short on the -6 volt power supply and also overload the - 24 volt power supply.
7. All the outputs of the points are tied together; therefore, there is only one output cable and it goes to the crossbar output inverters.
8. The crossbar is preset to several different points, depending upon the desired conditions. In these cases the crossbar "hold" and "select" coils start from this point instead of always starting at A0.

Tape Input Circuit (Drawing B-I-25848, Page 36)

The purpose of this circuit is to convert the signals from the YZ tape reader to the proper voltage levels. The output (and input) of these inverters is fed to many places and are labeled 1, $\bar{1}$, 2, $\bar{2}$, etc. Care must be taken not to confuse these numbers with similar numbers from the crossbar output inverters. The numbers are similar because they both represent a hole or no hole in a certain channel. They are used in different places, however.

M10-EOB Identification Circuit (Drawing B-I-25850, Page 38)

The symbol "M10" means for the inspection machine to clamp and inspect the part at the point described in that block. This circuit identifies "M10" followed by the end of the block, and gives a voltage change of state at the output. This signal is used to enable a gate in the inspect sequence circuit. The sequence of operation is approximately as follows:

1. Gate 150-3D is qualified by the letter M. The output of the gate goes to -6 volts when all inputs are at zero volt. This sets f-f 201-6A (or gated flip-flop).
2. The set output of the flip-flop enables Gate 104-4C to recognize the digit "1". The output of this gate goes to -6 volts when all the inputs go to zero volt.
3. This voltage change resets f-f 201-6A and sets f-f 201-6B, the reset output of which inhibits Gate 104-4C from any further change. The set output enables Gate 104-4D to recognize the digit "0" from tape.

4. Gate 104-4D output goes to -6 volts when all the inputs go to zero volt. This voltage shift sets f-f 201-6A again. M10 has now been recognized and the circuit is inhibited from any further change due to other digits "0" and "1" appearing on the tape.
5. The set outputs of the two flip-flops enable Gate 151-2D. Upon reception of an EOB (Channel 8) by the letter identification circuit, Gate 151-2D and Inverter 150-3H change output states to give the correct voltages for telling the inspect sequence circuit that an M10-EOB has appeared on the tape.
6. This circuit is reset the next time the "go" button is pressed in the "inspect" position of S1.

Crossbar Output Inverter (Drawing B-I-25851, Page 39)

The BCD output of the DVM is inverted from the needed voltage states to operate the tape punch. It is necessary to invert this output after it comes through the crossbar, before being fed to the punch. This sequence makes it necessary to invert all data being fed to the tape punch. Therefore, the proper voltage states of all sources of data must be closely noted.

This circuit does the inverting and also detects when all contacts on the crossbar are at -6 volts. This action qualifies Gate 150-3C which stops the synchronizer.

Letter Identification Circuit (Drawing B-I-25852, Page 40)

The purpose of this circuit is to ignore all tab-sequence language and identify the first letter of the letter address system. The language then stays in the identification state until the block of information is completed. The sequence of operation is approximately as follows:

1. Gate 104-4A recognizes Holes 1, 2, 3, or 4 in the command (input) tape. A hole must be present in one of these channels if the character is a letter.
2. Gate 151-2F recognizes a hole in either Channel 2 or 3, the signal from either one joins a hole in Channel 4 in Gate 151-2H. This information says that the number recognized was less than 10.
3. Gate 151-2E recognizes a hole in either Channel 6 or 7. One of these holes is present in each letter.
4. If the three conditions listed in Steps 1, 2, and 3 exist simultaneously, the character is a letter and Gate 104-4B is qualified. The output of this gate fires Schmitt Trigger Circuit 205-2A, which sharpens the pulse, setting f-f 250-1C. This flip-flop output is used elsewhere.

5. Channel 8 (EOB) appearing under the tape reader means the information in that block is complete; it resets f-f 250-1C.
6. A capacitor is connected to the output of Gate 104-4B and prevents erroneous pulses from setting the flip-flop when the tape reader is in transit between characters.

Relay Subchassis (Drawing B-I-25853, Page 41)

The relay subchassis consists of three principal relays:

1. Relay K1 is a mercury relay used to give a pulse to the inspect sequence circuit and B and B' register when the rotary table passes zero reference. The relay is actuated through a capacitor which makes the relay stay energized for only about 5 - 10 milliseconds. If the relay stays energized longer than this, the B register will miss the first pulse or two from the rotopulser.
2. Relay K2 is the buzz relay and is actuated by the button on the tape punch. This relay changes the source of the input to the parity, feed, and advance relay drivers.
3. Relay K4 is the low-tape relay and is actuated by a microswitch in the tape punch which is closed when the supply of tape is getting low. This relay lights a panel light and prevents any new part from being started.

Function Switch (S1) (Drawing B-I-25854, Page 42)

The purpose of this switch is to choose that operation which is desired at a particular time. This switch connects certain points in the system and disconnects others for each operation. Three of the sections are the shorting type and the remainder are nonshorting. Four essential positions are located on the switch:

1. Position 1, Identification - This position allows the operator to punch the information from the thumb wheels into the tape.
2. Position 2, Inspect - This position is the most important. All of the YZ machine controlling, error measurement, and other functions are done in this position.
3. Position 3, EOP (end of part) - This position allows the operator to enter the end-of-part code on the tape. The "go" button pushed in this position enters a code which tells the computer that the part is finished and the run was satisfactory. The "go" button pressed with the green button held in enters a code which tells the computer that it should ignore the data as the run was unsatisfactory (eg, the part moved after the inspection was half completed). The computer then ignores all previous data from that part.

4. Position 4, EOT (end of tape) - This position allows the operator to enter a code which tells the computer that the tape, which may contain several parts, is finished.

Rotary Table Connections (Drawing B-I-25849, Page 37)

The purpose of this circuit is to automatically start and stop the rotary table, and transmit position data to the logic. The circuit consists of two principal components:

1. Relay K3, operated by the inspect sequence circuit. This relay energizes upon a "clamp" signal and deenergizes the second time the table goes past the zero reference microswitch.
2. A synchro, mounted internally in the table, which sends rotary position information to the logic by means of the rotopulser.

Panel Lights (Drawing B-I-25849, Page 37)

Certain lights are provided:

1. Lo-Tape Light - Gives a warning of a low supply of tape. Position 1 of S1 (identification) cannot be used to start a new part when the light is on.
2. DLS-Off Light - Tells the operator that the system has been switched off of the YZ machine. Operation now must be from the YZ machine only.
3. Clamp Light - Tells the operator that a clamp signal has been received.
4. Rotary Table-on-Zero Light - Tells the operator that the rotary table has stopped with the microswitch depressed. The operator should not start the system in the "inspect" position with the light turned on. He should rotate the table (either direction) a few degrees.

TOL to DVM Amplifier (Drawing B-I-25847, Page 35)

The purpose of this circuit is to provide the proper voltage for the ± 10 volt DVM from the ± 0.030 volt gage-head amplifier. Two operational amplifiers are provided in series, with "span" and "zero" controls. The limit of speed of the system is reached in this circuit.

The response time is about five milliseconds for one RC time constant. Therefore, the faster the table is rotating, the more lag there is present between the amplifier reading and the actual part reading. Filtering is necessary to prevent the DVM from jittering in the last column.

Back-to-back zener diodes prevent the output amplifier from limiting. If the amplifier limits, it takes several seconds to get it off of limit.

DVM Connections (Drawing B-I-25846, Page 34)

This circuit connects the DVM to the logic system. Pins SS, TT, UU, and VV are the BCD output for the least significant digit. (LSD is the second digit from the right on the DVM as the rightmost digit is not used.) Pins AA, BB, CC, and DD and the BCD output are for the middle digit. Pins EE, FF, HH, and JJ are the BCD output for the most significant digit. Pins KK and LL represent the sign. They are both a -6 volts for a plus sign and only LL is -6 volts for a negative sign. The output is fed through cables to the crossbar. The DVM is normally operated in the external mode. It will take a reading upon grounding Pin T.

"Go" Button Relay (Drawing B-I-25845, Page 33)

This drawing shows the connections of the "go" button to the "go" button relay driver. It also shows the various connections of the relays. The connections are also shown on prints where the relays are used.

DWG NO	ITM	QTY	MATERIAL	DESCRIPTION
				<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>SYNCHRONIZER -6v</p> <p>YZ ADAPTER</p> <p>CROSSBAR DR.</p> <p>CROSSBAR DR.</p> <p>CROSSBAR DR.</p> <p>INSPECT SEQ.</p> </div> <div style="width: 45%;"> <p>MIO-EPB ID.</p> </div> </div>
<p>GREEN "GO" BUTTON</p>				
<p>GO BUTTON RELAY CONTACTS</p>				

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ENGR. DIV.	1966	SECTION HEAD	1965	BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED.
ENGR. DEPT.	W.W. LEE	DESIGNED	W.A. GROFFE	TOLERANCE UNLESS OTHERWISE SPECIFIED:
PROJ. ENGR.	B.B. GLO	CHECKED		FRACTIONS ±
				DECIMALS ±
				ANGLES ±
DRAWN		M.A. GROFFE		SCALE ~
REVISION		BY APP. DATE		BLDG.

Y-12 PLANT OAK RIDGE, TENN.

DATA LOGGING SYSTEM

22	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
<p>ISOLATE GO BUTTON RELAY</p>																											

B-I-25845

DWG NO	ITM	QTY	MATERIAL	DESCRIPTION																														
<div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;"> <p>FRONT OR REAR CONNECTOR</p> </div> <div style="text-align: center;"> <p>TO CROSSBAR OUTPUT</p> </div> <div style="text-align: center;"> <p>CROSSBAR, SECTIONS & CABLES</p> </div> </div>																																		
<p><i>Handwritten notes:</i></p> <ul style="list-style-type: none"> TOL. TO DVM AMP OUTPUT FR. INSPECT SEQ. 157-1A-9 J1004 (DVM CHASSIS) N° -6V FOR HOLE DVM CONNECTIONS 																																		
<p><i>Legend:</i></p> <ul style="list-style-type: none"> L.S.D. (Left Side Drive) M.D. (Middle Drive) M.S.D. (Middle Side Drive) SIGN (Sign) 																																		
<p><i>Pin Connections:</i></p> <ul style="list-style-type: none"> B, T, SS, TT, UK, VV, AA, BB, CC, DD, EE, FF, HH, JJ, KK, LL Connections to: G1, 60, F9, F8 																																		
<p><i>Legal Disclaimer:</i></p> <p>NO REPRESENTATION OR WARRANTY, EXPRESSED OR IMPLIED, IS MADE THAT THE USE OR DISCLOSURE OF ANY INFORMATION CONTAINED HEREIN MAY NOT INFRINGE PRIVATE RIGHTS OF OTHERS. LIABILITY IS ASSUMED WITH RESPECT TO THE USE OF OR DISCLOSURE RESULTING FROM THE USE OF ANY INFORMATION CONTAINED HEREIN. THE DRAWINGS ARE BEING MADE AVAILABLE FOR INFORMATION TO BIDDERS WHO ARE NOT TO BE USED FOR OTHER PURPOSES, AND ARE TO BE RETURNED UPON REQUEST OF FORWARDING CONTRACTOR.</p>																																		
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										LETTER ID. CIRCUIT																			
REVISION										BY		APP		DATE		36		I		Q		S		SCALE ~		SHEET		OF	
DRAWN W.A. GROFFE										APPROVALS		W.A. GROFFE				36		40		41		45						B-I-25852	
CHECKED										13.12.1966		24				BLDG.													

DWG NO		ITM	QTY	MATERIAL	DESCRIPTION	
<p>SYNCHRONIZER</p> <p>TB. 4-64 YELLOW SID → TB. 4-63 ORANGE</p> <p>YZ ADAPTER</p> <p>BR/W SIE → TB. 4-70 BLACK</p> <p>YZ ADAPTER</p> <p>TB. 4-33 OR/W SIF → TB. 2-44 4-72 RED/W</p> <p>INSPECT SEQ.</p> <p>TB. 4-69 WHITE SIA → TB. 4-68 GRAY</p> <p>TB. 4-67 PURPLE</p> <p>SYNCHRONIZER</p> <p>TB. 4-66 BLUE SID → TB. 4-65 GREEN</p> <p>GRAY/W TB. 4-18</p> <p>SYNCHRONIZER</p> <p>TB. 4-62 RED SIC → TB. 4-17</p>						
<p>MID-EOB</p> <p>TB. 4-59 R/W/G SIG → TB. 4-58 GRAY/W</p> <p>CROSSBAR DR.</p> <p>TB. 4-57 PUR/W SIH → TB. 4-56 BLUE/W</p> <p>CROSSBAR DR.</p> <p>TB. 4-55 GR/W</p> <p>TB. 4-54 YEL/W</p> <p>TB. 4-53 OR/W</p> <p>CROSSBAR DR.</p> <p>TB. 4-52 R/W SIJ → TB. 4-51 BR/W</p> <p>TB. 4-50 BLACK</p> <p>TB. 4-49 WHITE</p> <p>CROSSBAR DR.</p> <p>TB. 4-48 GRAY SIK → TB. 4-47 PURPLE</p> <p>TB. 4-46 BLUE</p> <p>TB. 4-45 GREEN</p> <p>CROSSBAR DR.</p> <p>TB. 4-27 PURPLE SIL → TB. 4-26 BLUE</p>						
<p>CROSSBAR DR.</p> <p>TB. 4-25 GREEN SIM → TB. 4-24 YELLOW</p> <p>CROSSBAR DR.</p> <p>TB. 4-23 ORANGE SIN → TB. 4-9 WHITE</p> <p>CABLE H2-1</p> <p>BROWN SIO → RED</p> <p>YELLOW -6V</p> <p>SYNCHRONIZER</p> <p>TB. 1-2, 2-51, 3-10 BLACK SIP → TB. 1-90 3-6 GRAY</p> <p>ML → TB. 4-60 2-81 SPARE</p> <p>S1 CONNECTIONS</p> <p>NO REPRESENTATION OR WARRANTY, EXPRESSED OR IMPLIED, IS MADE THAT THE USE OF DISCLOSURE OF ANY INFORMATION, APPARATUS, METHOD OR PROCESS DISCLOSED IN THESE DRAWINGS MAY NOT INFRINGE PRIVATE RIGHTS OF OTHERS. NO LIABILITY IS ASSUMED WITH RESPECT TO THE USE OF OR FOR DAMAGES RESULTING FROM THE USE OF, ANY INFORMATION, APPARATUS, METHOD OR PROCESS DISCLOSED IN THESE DRAWINGS. THE DRAWINGS ARE BEING MADE AVAILABLE FOR INFORMATION TO BIDDER AND ARE NOT TO BE USED FOR OTHER PURPOSES, AND ARE TO BE RETURNED UPON REQUEST OF THE FORWARDING CONTRACTOR.</p>						
REVISION		BY	APP.	DATE	<p>ENGR. DIV. 1965</p>	<p>Y-12 PLANT OAK RIDGE, TENN.</p> <p>DATA LOGGING SYSTEM</p> <p>31 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66</p> <p>31 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66</p> <p>BLDG. B-I-25854</p>

BOTTOM VIEW OF CROSSBAR

CH 1, TAPE INPUT CKT., TB 3-1		CH 2, TB 3-5		CH 3, TB 3-9		CH 4, TB 3-13		CH 5, TB 3-17		CH 6, TB 3-21		CH 7, TB 3-25		CH 8, TB 3-29		INSPECT TB 2-45		INSPECT TB 4-67		INSPECT TB 4-68	
1	TAPE INPUT CKT., S REG., CABLE G9, TB 2-1	19	CROSSBAR DR., TB 2-19	37	PUNCH DR.	38	CROSSBAR DR., TB 2-20	39	CROSSBAR DR., TB 2-21	40	CROSSBAR DR., TB 2-22	41	CROSSBAR DR., TB 2-23	42	CROSSBAR DR., TB 2-24	43	CROSSBAR DR., TB 2-25	44	CROSSBAR DR., TB 2-26	45	CROSSBAR DR., TB 2-27
2	SYNCH CMT., TB 2-31, 3-10	20	CROSSBAR DR., TB 2-28	38	CROSSBAR DR.	39	CROSSBAR DR., TB 2-29	40	CROSSBAR DR., TB 2-30	41	CROSSBAR DR., TB 2-31	42	CROSSBAR DR., TB 2-32	43	CROSSBAR DR., TB 2-33	44	CROSSBAR DR., TB 2-34	45	CROSSBAR DR., TB 2-35	46	CROSSBAR DR., TB 2-36
3	TAPE INPUT CMT., S REG., CABLE G9, TB 2-3	21	CROSSBAR DR., TB 2-37	39	CROSSBAR DR.	40	CROSSBAR DR., TB 2-38	41	CROSSBAR DR., TB 2-39	42	CROSSBAR DR., TB 2-40	43	CROSSBAR DR., TB 2-41	44	CROSSBAR DR., TB 2-42	45	CROSSBAR DR., TB 2-43	46	CROSSBAR DR., TB 2-44	47	CROSSBAR DR., TB 2-45
4	CROSSBAR DR., TB 2-65	22	CROSSBAR DR., TB 2-46	40	CROSSBAR DR.	41	CROSSBAR DR., TB 2-47	42	CROSSBAR DR., TB 2-48	43	CROSSBAR DR., TB 2-49	44	CROSSBAR DR., TB 2-50	45	CROSSBAR DR., TB 2-51	46	CROSSBAR DR., TB 2-52	47	CROSSBAR DR., TB 2-53	48	CROSSBAR DR., TB 2-54
5	CROSSBAR DR., TB 2-73	23	CROSSBAR DR., TB 2-55	41	CROSSBAR DR.	42	CROSSBAR DR., TB 2-56	43	CROSSBAR DR., TB 2-57	44	CROSSBAR DR., TB 2-58	45	CROSSBAR DR., TB 2-59	46	CROSSBAR DR., TB 2-60	47	CROSSBAR DR., TB 2-61	48	CROSSBAR DR., TB 2-62	49	CROSSBAR DR., TB 2-63
6	TAPE INPUT CMT., S REG., CABLE G9, TB 2-6	24	CROSSBAR DR., TB 2-64	42	CROSSBAR DR.	43	CROSSBAR DR., TB 2-65	44	CROSSBAR DR., TB 2-66	45	CROSSBAR DR., TB 2-67	46	CROSSBAR DR., TB 2-68	47	CROSSBAR DR., TB 2-69	48	CROSSBAR DR., TB 2-70	49	CROSSBAR DR., TB 2-71	50	CROSSBAR DR., TB 2-72
7	PARTY, TB 2-11	25	CROSSBAR DR., TB 2-73	43	CROSSBAR DR.	44	CROSSBAR DR., TB 2-74	45	CROSSBAR DR., TB 2-75	46	CROSSBAR DR., TB 2-76	47	CROSSBAR DR., TB 2-77	48	CROSSBAR DR., TB 2-78	49	CROSSBAR DR., TB 2-79	50	CROSSBAR DR., TB 2-80	51	CROSSBAR DR., TB 2-81
8	PUNCH DR., ZERO DET., TB 2-8	26	CROSSBAR DR., TB 2-84	44	CROSSBAR DR.	45	CROSSBAR DR., TB 2-85	46	CROSSBAR DR., TB 2-86	47	CROSSBAR DR., TB 2-87	48	CROSSBAR DR., TB 2-88	49	CROSSBAR DR., TB 2-89	50	CROSSBAR DR., TB 2-90	51	CROSSBAR DR., TB 2-91	52	CROSSBAR DR., TB 2-92
9	TAPE INPUT CMT., S REG., CABLE G9, TB 2-9	27	CROSSBAR DR., TB 2-93	45	CROSSBAR DR.	46	CROSSBAR DR., TB 2-94	47	CROSSBAR DR., TB 2-95	48	CROSSBAR DR., TB 2-96	49	CROSSBAR DR., TB 2-97	50	CROSSBAR DR., TB 2-98	51	CROSSBAR DR., TB 2-99	52	CROSSBAR DR., TB 3-00	53	CROSSBAR DR., TB 3-01
10	TAPE INPUT CMT., CABLE G9, TB 2-10	28	CROSSBAR DR., TB 2-104	46	CROSSBAR DR.	47	CROSSBAR DR., TB 2-105	48	CROSSBAR DR., TB 2-106	49	CROSSBAR DR., TB 2-107	50	CROSSBAR DR., TB 2-108	51	CROSSBAR DR., TB 2-109	52	CROSSBAR DR., TB 2-110	53	CROSSBAR DR., TB 2-111	54	CROSSBAR DR., TB 2-112
11	CROSSBAR DR., INSPECT SEQ., TB 4-9	29	CROSSBAR DR., TB 2-113	47	CROSSBAR DR.	48	CROSSBAR DR., TB 2-114	49	CROSSBAR DR., TB 2-115	50	CROSSBAR DR., TB 2-116	51	CROSSBAR DR., TB 2-117	52	CROSSBAR DR., TB 2-118	53	CROSSBAR DR., TB 2-119	54	CROSSBAR DR., TB 2-120	55	CROSSBAR DR., TB 2-121
12	CROSSBAR DR.	30	CROSSBAR DR., TB 2-124	48	CROSSBAR DR.	49	CROSSBAR DR., TB 2-125	50	CROSSBAR DR., TB 2-126	51	CROSSBAR DR., TB 2-127	52	CROSSBAR DR., TB 2-128	53	CROSSBAR DR., TB 2-129	54	CROSSBAR DR., TB 2-130	55	CROSSBAR DR., TB 2-131	56	CROSSBAR DR., TB 2-132
13	CROSSBAR DR., TB 4-56	31	CROSSBAR DR., TB 2-135	49	CROSSBAR DR.	50	CROSSBAR DR., TB 2-136	51	CROSSBAR DR., TB 2-137	52	CROSSBAR DR., TB 2-138	53	CROSSBAR DR., TB 2-139	54	CROSSBAR DR., TB 2-140	55	CROSSBAR DR., TB 2-141	56	CROSSBAR DR., TB 2-142	57	CROSSBAR DR., TB 2-143
14	CROSSBAR DR.	32	CROSSBAR DR., TB 2-144	50	CROSSBAR DR.	51	CROSSBAR DR., TB 2-145	52	CROSSBAR DR., TB 2-146	53	CROSSBAR DR., TB 2-147	54	CROSSBAR DR., TB 2-148	55	CROSSBAR DR., TB 2-149	56	CROSSBAR DR., TB 2-150	57	CROSSBAR DR., TB 2-151	58	CROSSBAR DR., TB 2-152
15	CROSSBAR DR.	33	CROSSBAR DR., TB 2-155	51	CROSSBAR DR.	52	CROSSBAR DR., TB 2-156	53	CROSSBAR DR., TB 2-157	54	CROSSBAR DR., TB 2-158	55	CROSSBAR DR., TB 2-159	56	CROSSBAR DR., TB 2-160	57	CROSSBAR DR., TB 2-161	58	CROSSBAR DR., TB 2-162	59	CROSSBAR DR., TB 2-163
16	CROSSBAR DR.	34	CROSSBAR DR., TB 2-164	52	CROSSBAR DR.	53	CROSSBAR DR., TB 2-165	54	CROSSBAR DR., TB 2-166	55	CROSSBAR DR., TB 2-167	56	CROSSBAR DR., TB 2-168	57	CROSSBAR DR., TB 2-169	58	CROSSBAR DR., TB 2-170	59	CROSSBAR DR., TB 2-171	60	CROSSBAR DR., TB 2-172
17	CROSSBAR DR.	35	CROSSBAR DR., TB 2-175	53	CROSSBAR DR.	54	CROSSBAR DR., TB 2-176	55	CROSSBAR DR., TB 2-177	56	CROSSBAR DR., TB 2-178	57	CROSSBAR DR., TB 2-179	58	CROSSBAR DR., TB 2-180	59	CROSSBAR DR., TB 2-181	60	CROSSBAR DR., TB 2-182	61	CROSSBAR DR., TB 2-183
18	TAPE INPUT CMT.	36	CROSSBAR DR., TB 2-184	54	CROSSBAR DR.	55	CROSSBAR DR., TB 2-185	56	CROSSBAR DR., TB 2-186	57	CROSSBAR DR., TB 2-187	58	CROSSBAR DR., TB 2-188	59	CROSSBAR DR., TB 2-189	60	CROSSBAR DR., TB 2-190	61	CROSSBAR DR., TB 2-191	62	CROSSBAR DR., TB 2-192

THE REPRESENTATION OF PARTIALITY, EXPRESSED OR IMPLIED, IS MADE THAT THE USE OR DISCLOSURE OF ANY INFORMATION, APPARATUS, METHOD OR PROCESS DISCLOSED IN THESE DRAWINGS DOES NOT CONSTITUTE A WARRANTY OF THE USE OF OR FOR THE INFORMATION, METHOD OR PROCESS DISCLOSED IN THESE DRAWINGS. THE DRAWINGS ARE MADE AVAILABLE FOR INFORMATION TO OTHERS AND ARE NOT TO BE USED FOR OTHER PURPOSES, AND ARE TO BE RETURNED UPON REQUEST OF THE DRAWING CONTRACTOR.

TERMINAL BOARD #1

Y-12 PLANT		OAK RIDGE, TENN.	
DATA LOGGING SYSTEM			
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"NO REPRESENTATION OR WARRANTY, EXPRESSED OR IMPLIED, IS MADE THAT THE USE OR DISCLOSURE OF ANY INFORMATION, APPARATUS, METHOD OR PROCESS DISCLOSED IN THESE DRAWINGS MAY NOT INFRINGE PRIVATE RIGHTS OF OTHERS. NO LIABILITY IS ASSUMED WITH RESPECT TO THE USE OF OR FOR DAMAGES RESULTING FROM THE USE OF, ANY INFORMATION, APPARATUS, METHOD OR PROCESS DISCLOSED IN THESE DRAWINGS. THE DRAWINGS ARE BEING MADE AVAILABLE FOR INFORMATION TO BIDDER AND ARE NOT TO BE USED FOR OTHER PURPOSES, AND ARE TO BE RETURNED UPON REQUEST OF THE FORWARDING CONTRACTOR."

				ENGR. SUPT. <i>22</i>		1966 <i>4-20</i>		ENGINEER <i>W.W. LEE</i>		1965		BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED. TOLERANCE UNLESS OTHERWISE SPECIFIED: FRACTIONS ± DECIMALS ±		Y-12 PLANT OAK RIDGE, TENN.									
				DEPT. SUPT. <i>B.B. Bell</i>		<i>4/2</i>		DESIGN ENGINEER <i>W.A. GROPPE</i>		<i>4/66</i>				<div> <div> <div>30-41</div> <div>30-42</div> <div>30-43</div> <div>30-44</div> </div> <div> <div>30-45</div> <div>30-46</div> <div>30-47</div> <div>30-48</div> </div> <div> <div>30-49</div> <div>30-50</div> <div>30-51</div> <div>30-52</div> </div> <div> <div>30-53</div> <div>30-54</div> <div>30-55</div> <div>30-56</div> </div> </div> <div> <div>30-57</div> <div>30-58</div> <div>30-59</div> <div>30-60</div> </div> <div> <div>30-61</div> <div>30-62</div> <div>30-63</div> <div>30-64</div> </div> <div> <div>30-65</div> <div>30-66</div> <div>30-67</div> <div>30-68</div> </div> <div> <div>30-69</div> <div>30-70</div> <div>30-71</div> <div>30-72</div> </div> <div> <div>30-73</div> <div>30-74</div> <div>30-75</div> <div>30-76</div> </div> <div> <div>30-77</div> <div>30-78</div> <div>30-79</div> <div>30-80</div> </div> <div> <div>30-81</div> <div>30-82</div> <div>30-83</div> <div>30-84</div> </div> <div> <div>30-85</div> <div>30-86</div> <div>30-87</div> <div>30-88</div> </div> <div> <div>30-89</div> <div>30-90</div> <div>30-91</div> <div>30-92</div> </div> <div> <div>30-93</div> <div>30-94</div> <div>30-95</div> <div>30-96</div> </div> <div> <div>30-97</div> <div>30-98</div> <div>30-99</div> <div>30-100</div> </div>									
				PROJECT ENGR.				DRAWN <i>W.A. GROPPE</i>						<div> <div>30-101</div> <div>30-102</div> <div>30-103</div> <div>30-104</div> </div> <div> <div>30-105</div> <div>30-106</div> <div>30-107</div> <div>30-108</div> </div> <div> <div>30-109</div> <div>30-110</div> <div>30-111</div> <div>30-112</div> </div> <div> <div>30-113</div> <div>30-114</div> <div>30-115</div> <div>30-116</div> </div> <div> <div>30-117</div> <div>30-118</div> <div>30-119</div> <div>30-120</div> </div> <div> <div>30-121</div> <div>30-122</div> <div>30-123</div> <div>30-124</div> </div> <div> <div>30-125</div> <div>30-126</div> <div>30-127</div> <div>30-128</div> </div> <div> <div>30-129</div> <div>30-130</div> <div>30-131</div> <div>30-132</div> </div> <div> <div>30-133</div> <div>30-134</div> <div>30-135</div> <div>30-136</div> </div> <div> <div>30-137</div> <div>30-138</div> <div>30-139</div> <div>30-140</div> </div> <div> <div>30-141</div> <div>30-142</div> <div>30-143</div> <div>30-144</div> </div> <div> <div>30-145</div> <div>30-146</div> <div>30-147</div> <div>30-148</div> </div> <div> <div>30-149</div> <div>30-150</div> <div>30-151</div> <div>30-152</div> </div> <div> <div>30-153</div> <div>30-154</div> <div>30-155</div> <div>30-156</div> </div> <div> <div>30-157</div> <div>30-158</div> <div>30-159</div> <div>30-160</div> </div> <div> <div>30-161</div> <div>30-162</div> <div>30-163</div> <div>30-164</div> </div> <div> <div>30-165</div> <div>30-166</div> <div>30-167</div> <div>30-168</div> </div> <div> <div>30-169</div> <div>30-170</div> <div>30-171</div> <div>30-172</div> </div> <div> <div>30-173</div> <div>30-174</div> <div>30-175</div> <div>30-176</div> </div> <div> <div>30-177</div> <div>30-178</div> <div>30-179</div> <div>30-180</div> </div> <div> <div>30-181</div> <div>30-182</div> <div>30-183</div> <div>30-184</div> </div> <div> <div>30-185</div> <div>30-186</div> <div>30-187</div> <div>30-188</div> </div> <div> <div>30-189</div> <div>30-190</div> <div>30-191</div> <div>30-192</div> </div> <div> <div>30-193</div> <div>30-194</div> <div>30-195</div> <div>30-196</div> </div> <div> <div>30-197</div> <div>30-198</div> <div>30-199</div> <div>30-200</div> </div>									
REVISION				BY		APP.		DATE		<i>SCB</i>		<i>4/20/66</i>		CHECKED		SCALE <i>~</i>		W.O.		BLDG.		C-I-30846

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REVISION		BY	APP.	DATE	8/22	1/14/4
ENGR. SUP.		1966	ENGR.	1965	BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED.	
DEPT. SUP.		4/27	W.H. LEE	4/66	SPECIFIED: FRACTIONS ± DECIMALS ±	
PROJECT ENGR.			W.A. GROPE		SCALE ~	
			W.A. GROPE		W.O.	
			CHECKED		BLDG.	
					C-I-30847	

Y-12 PLANT OAK RIDGE, TENN.

DATA LOGGING SYSTEM

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				DES. SUPT. <i>JH</i>	1966 4-28	ENGINEER W.W. LEE	1965 4/6	BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED. TOLERANCE UNLESS OTHERWISE SPECIFIED: FRACTIONS $\frac{1}{8}$ DECIMALS 2	Y-12 PLANT OAK RIDGE, TENN.
				DEPT. SUPT. B.B. BELL	4/7	DESIGN ENGINEER W.A. GROPPE	4/6	DATA LOGGING SYSTEM 3 20 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 2 1 50K S PUNCH DRIVER CKT	
				PROJECT ENGR.		DRAWER W.A. GROPPE			
						CHECKED		SCALE	W.O. BLDG. C-I-30850
REVISION				BY	APP.	DATE	8/22/66