

AN/FSQ7-8

MANUAL DATA INPUTS

MATERIALS REQUIRED

Manuals

1. Schematics Input System

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## Manual Data Input Element

## Introduction

## A. Purpose of Equipment

SAGE is by definition semiautomatic; at various times in its performance of the air defense function, human intervention is required. An operator may request a particular type of information from the machine, make known his decisions to it, or provide it with data which cannot be introduced automatically. The means of human interventions is the MDI element and its associated devices.

Refer to Fig. 1-1  
Overall MDI  
block diagram  
on Page 0050

## B. Function of MDI Element

The function of the MDI element is to accept information supplied by computer operating personnel, identify the information source, and provide the means by which the information can be transferred into the Central Computer, for processing. In order to perform its overall function, the MDI element accepts information from such input devices as keyboards, light guns and computer entry punches. The MDI element then transfers the information directly into the computer through its direct entry section or to the MI drum field through the drum entry section.

Figure 1-24 is a communication flow between operating personnel and automatic equipment. Figure 1-36 is a simplified flow diagram of manual data inputs.

Figs. 1-24,  
1-36,  
Page 0030

## C. Physical Description of Manual Data Inputs

1. To process the information supplied by operating personnel, the MDI element uses two units; namely, unit 23 (Manual Data Input Unit SN-169/FSO) and unit 28 (Manual Data Interconnection Unit J-726/FSO), and also various pieces of associated equipment, all described briefly below.
2. Unit 23
  - a. Unit 23, a duplex unit of standard modulator construction, houses the circuits of both the direct entry and drum entry sections. Modules A, B, and C contain the direct entry circuitry; modules D and E mount the pluggable units of the drum entry section; module Z provides standard power distribution and protection facilities.

## Manual Data Input Element

- b. The most conspicuous feature of the direct entry section is the core matrix located in module A. This is a 33 x 128 bit storage device capable of storing 128 32-bit words (the 33rd bit is used for error detection and test). Physically, the core matrix is made up of 16 core cans, each containing 33 cards. Each card contains eight core bits.

## 3. Unit 28

- a. Unit 28, the interconnection unit, is a patch-board associated with the MDI core matrix (module A of MDI unit 23). The unit is divided into top and bottom sections, each divided into four panels. The top section panels receive the cables from the side wing panels of SD consoles and front panels of auxiliary consoles. The bottom section panels contain jacks wired to the prime windings of the cores in the MDI core matrix. The top and bottom panels are connected by patch cords to set up the desired core assignments.

## 4. Keyboard Control Panels

- a. The keyboard control panels, or side wings have many variations and are described only generally in this chapter. Typically, each keyboard control panel is divided into an upper and lower panel and mounted in each panel are a number of 5-, 10-, or 15-pushbutton modules. The pushbuttons are depressed to express a message. Each keyboard control panel contains an activate pushbutton: a momentary action switch operated after the message or messages have been set up to indicate that they are complete and that the Central Computer may take action on them. The message pushbuttons remain depressed and therefore capable of repeating the message, until released by one or more pushbuttons provided for that purpose.

See Fig. 1-24

## 5. Light Gun

- a. The light gun is a hand-held photoelectric device for identifying a target on a display screen to the Central Computer. It contains:

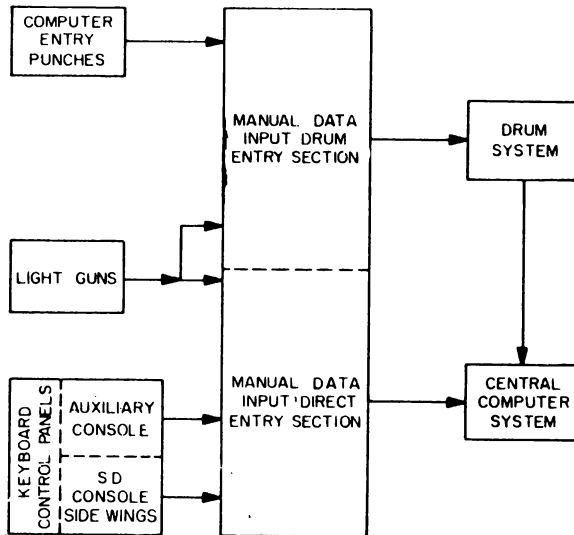


Figure 1-36. Manual Data Input Element, Simplified Flow Diagram

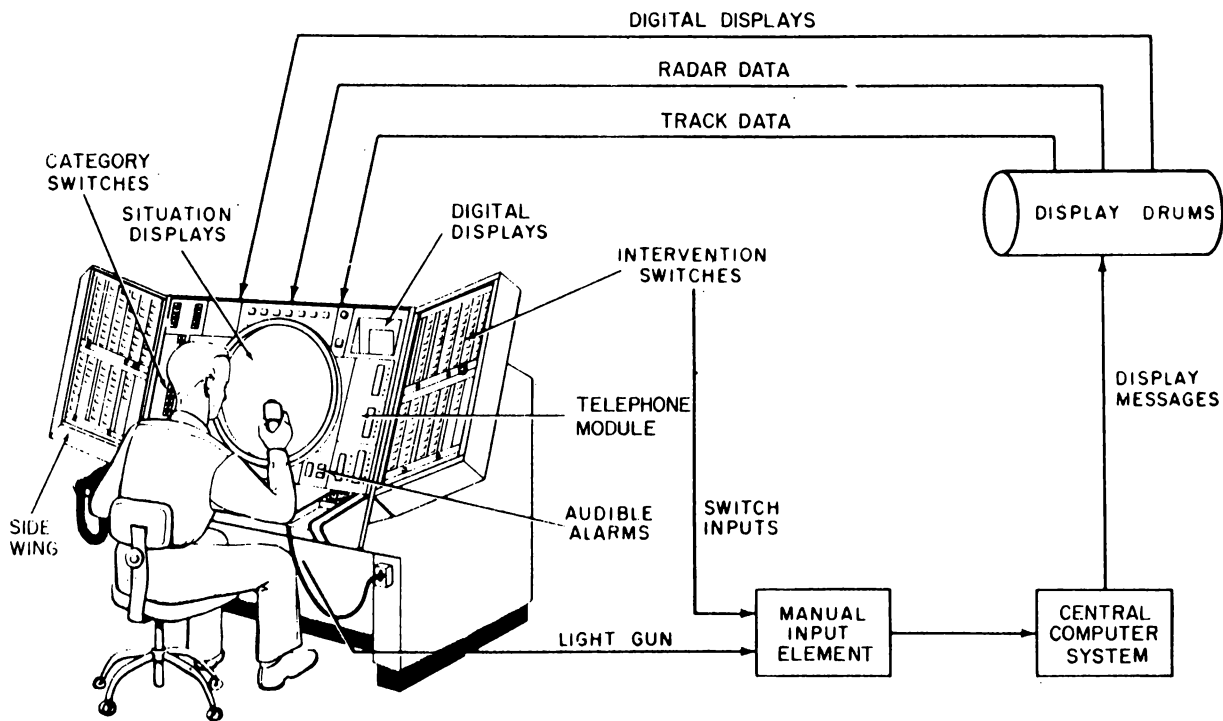


Figure 1-24. Communication Flow between Operating Personnel and Automatic Equipment

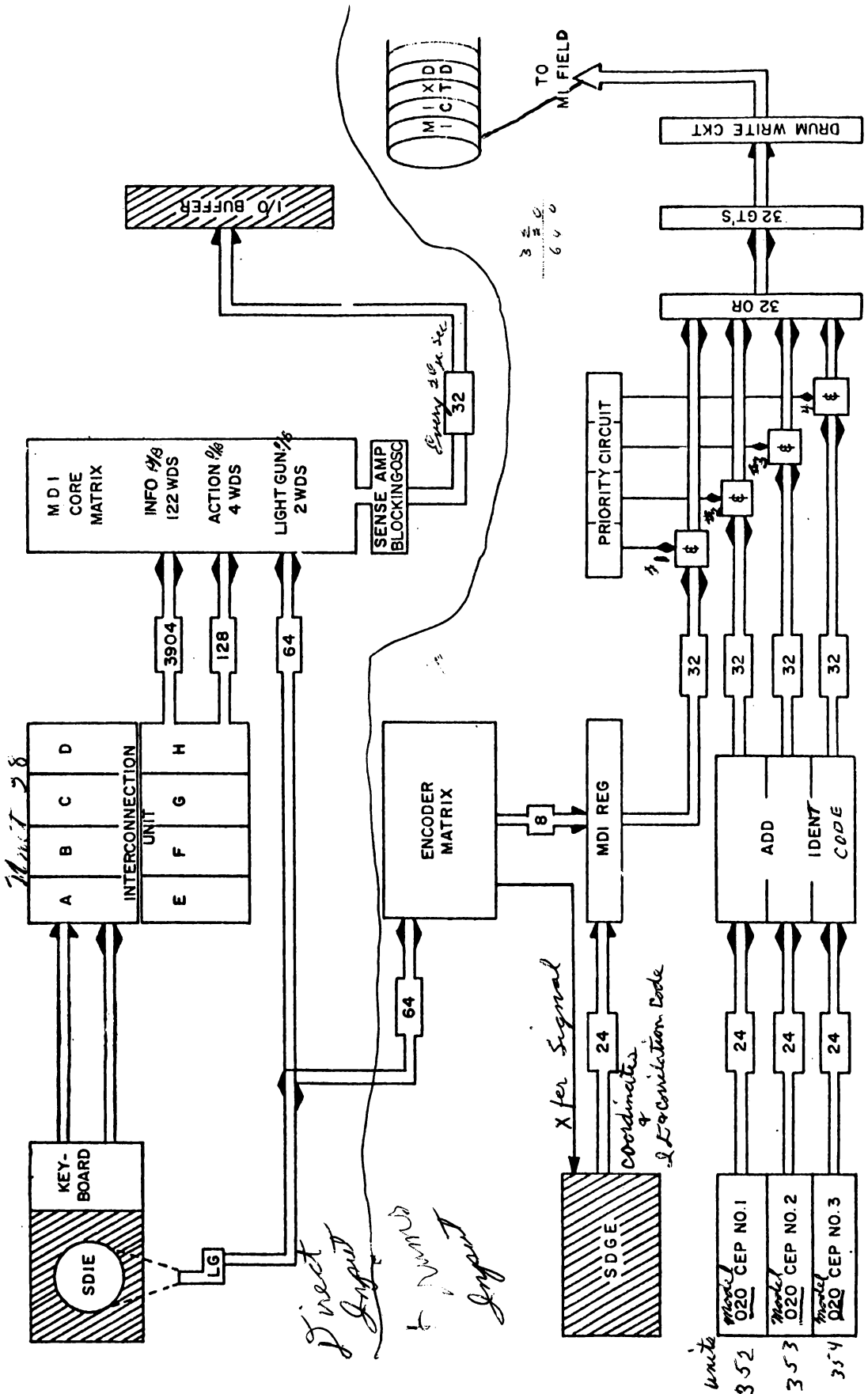
## Manual Data Input Element

- 1) An aiming light to assist the operator in pointing the light gun at the proper target.
  - 2) A trigger to activate the light gun.
  - 3) A photoelectric device to respond to the target indication.
  - 4) An indicator to show when the photoelectric cell has responded to a target.
- b. Various control and amplifying circuits associated with the light gun are housed in the console or the light gun itself.
6. Computer Entry Punch
- a. One other device employed to feed information to the MI element is the 020 computer entry punch. The CEP is used as a printing card punch and reader or as a pre-punched card reader. The information punched and/or read appears on standard IBM cards. This information is usually of static tactical significance such as weather data, flight plans, etc. Certain power status and alarm indications for the CEP's are remoted to the CEP control panel (simplex maintenance console) shown in figure 6-6.

Fig. 6-6,  
Page 0070

## D. Functional Description

1. The basic method of handling input data in the AN/FSQ-7 machine is to form it into drum words and deposit it on the drums. Data processing and drum operation are synchronized through the use of drum timing or its derivatives. The processing of CEP data falls into this pattern. The method has the advantage of getting data expeditiously into drum storage and thus keeping the data-processing circuits open for fresh data. However, certain types of MDI data are generated so slowly that this process can be simplified. In effect, data processing and storage are performed within the MDI element and readout is directly to the Central Computer. The storage device is a 33 x 128 core matrix in the direct entry section.



MDI Overall Block Diagram FIG. 1-1

## Manual Data Input Element

Thus, the path that data follows through the MDI element depends on its origin. One type of data flows through the drum entry section into the Drum System. Another type, which may be tactically associated with the first type, flows through the direct entry section directly to the computer. In certain types of data transfer, the two paths are functionally related; in other types, they are not. For these reasons, a theory of operation on the element diagram level (fig. 6-7) must take into consideration the type of data being processed; this is the basis of the following discussion.

Fig. 6-7  
Page 0070

2. Keyboard Control Panel Information
  - a. An operator sets up a keyboard control panel message by depressing appropriate keys in a keyboard. Each operated key produces a characteristic set of +10 and -30V levels. These levels set preassigned cores in the core matrix of the direct entry section. When a message has been set up, the operator depresses an activate pushbutton, which also sets a preassigned core in the core matrix. Messages may be set up concurrently at a number of keyboards, each producing a distinctive pattern of 1's in preassigned cores.
  - b. Periodically, a read-MDI-matrix command from the Central Computer causes the core matrix to read out word by word to the computer IO buffer register. This readout is accompanied by a break request, utilized in the transfer of the word to computer memory. The computer maintains a word count of the readout and, after a program-determined number of words, sends a disconnect-MDI-matrix command to the direct entry section.
  - c. An activate signal and the message or messages to which it applies are associated by the computer on the basis of their respective positions in the readout. The computer then takes action, in accordance with its program on message associated with an activate signal.



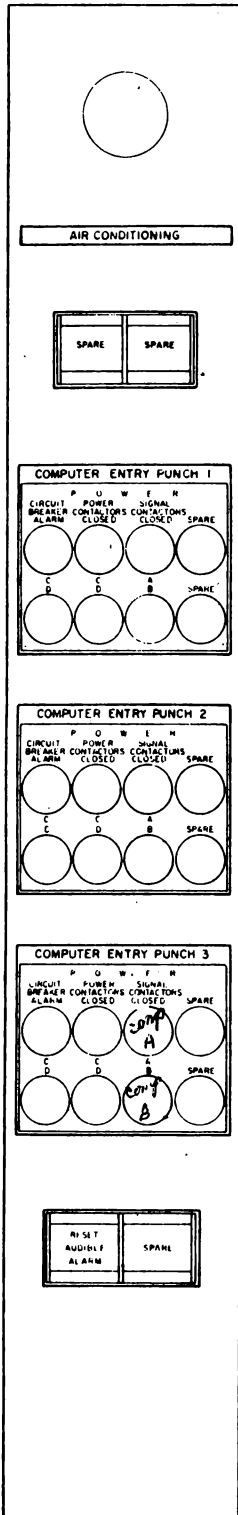


Figure 6-6. Computer Entry Punch Control Panel, Simplex Maintenance Console

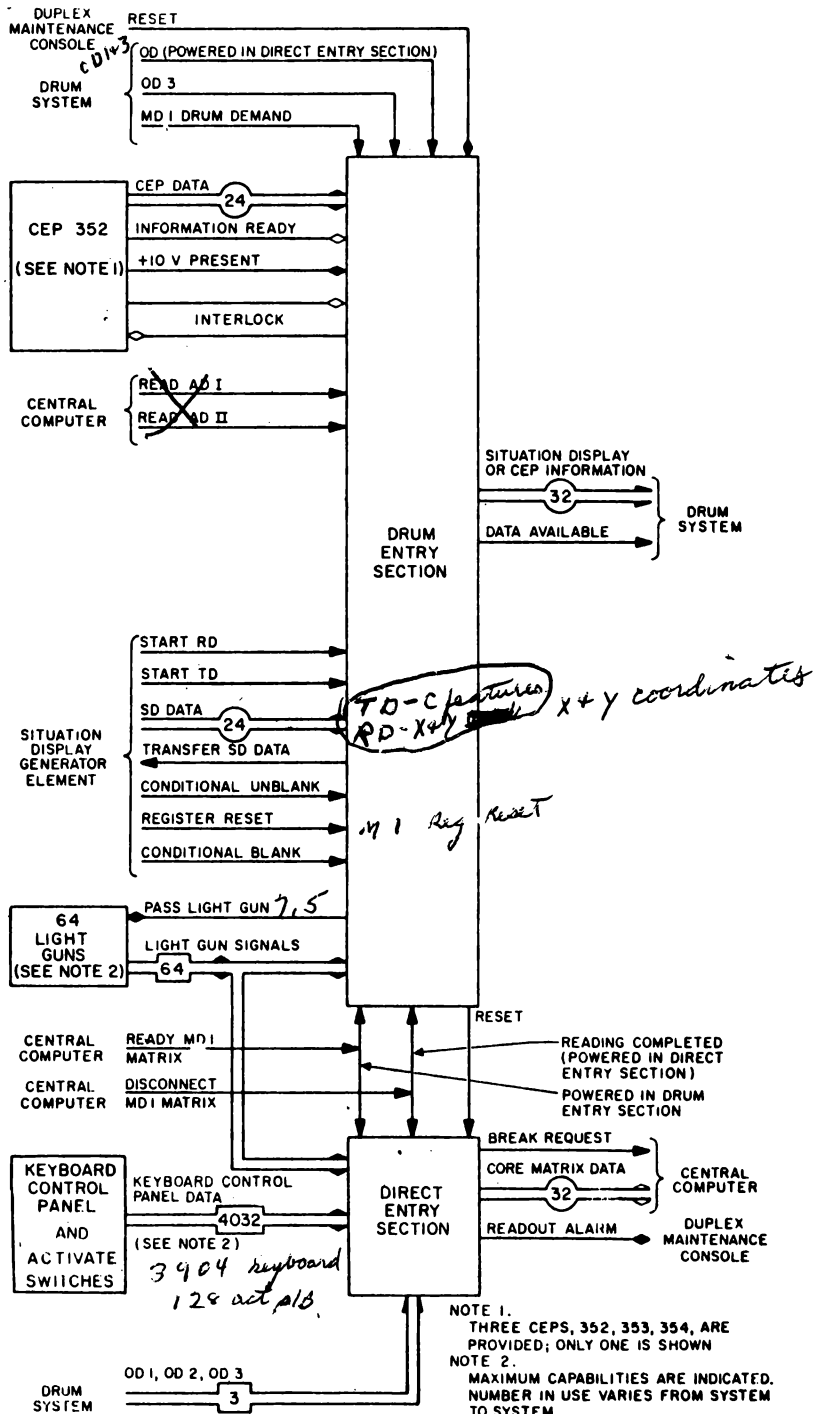


Figure 6-7. Manual Data Input Element, Block Diagram

## Manual Data Input Element

3. Keyboard Control Panel Information Plus  
Light Gun Reference Information

- a. At a light gun-equipped console, a message pertaining to a target may be set up on the keyboard control panel and the target then identified by the console light gun. The keyboard control panel message is stored in the usual manner in the core matrix. Activation of the light gun, under the proper conditions, produces a light gun signal which, like the operation of an activate pushbutton, sets a preassigned core in the core matrix. Simultaneously, the light gun signal is sent to the drum entry section. There it generates an 8-bit code identifying the light gun. The light gun code is added to the target description to form a 32-bit drum word. In response to a drum-demand pulse, the drum word is transferred to the Drum System and eventually to the computer.
- b. When the core matrix is read out, the computer receives the keyboard message and a light gun bit identifying the light gun used and, therefore, the console at which the target appeared. From the Drum System, the computer receives the 32-bit target-description-plus-light-gun identification. Using the light gun "tag", the computer, through its programmed operations, associates the target description with the particular keyboard control panel message.
- c. Various inputs to the drum entry section shown on figure 6-7, such as the conditional unblank, conditional blank, the read MDI-matrix-reading completed, pass-light gun signal, and conditional reset, can be explained to better advantage in the detailed theory found in later chapters. For the most part, they affect the operation of the light gun signal, determining when it can be accommodated, limiting its duration, etc.

## 4. Computer Entry Punch Information

- a. The three CEP's operate in the same way. A column of card information (12 bits) is read and stored in relays in the machine and an information-ready signal is sent to the drum entry section. Priority circuits discussed in section below, determine whether CEP information will be accepted and, if so, the CEP from which it will be transferred.

## Manual Data Input Element

- b. Upon receipt of a drum-demand pulse, 24 bits of information are transferred to the Drum System from the selected CEP; accompanying the transfer are two bits identifying the type (CEP) of data, and the ID of the originating CEP, 30 bits in all (two bit positions are spare). Until the transfer occurs, the CEP is interlocked; upon its completion, the CEP is permitted to read another column of information.
5. Priority Circuits
    - a. Circuits are provided to ensure an orderly flow of MDI information from the various sources and the desired priority of data transfer. Specifically, they perform the following functions. During read-out of the MDI matrix, pass-light gun signals are discontinued; consequently, no light gun signals can be generated nor can light gun cores in the core matrix be set. If more than one light gun simultaneously respond to the same target, the code identifying the light guns or the area discriminator will be invalid and will be recognized as such by the Central Computer which will take no action with respect to the target.
    - b. Priority circuits in the drum entry section give highest priority to SD data, then to data from CEP's 352, 353, and 354, in that order. Situation display data, whether originated by a light gun, is transferred to the Drum System upon receipt of the first drum-demand pulse after the drum word is found in the drum entry section. Data awaiting transfer in a CEP is simply held in the CEP relays until no SD data is available. Then data from CEP 352 is transferred. Data from CEP's 353 and 354 follows in that order when no data of higher priority awaits transfer.
  6. Manual Reset
    - a. All flip-flops in the drum entry and direct entry sections are reset when the MASTER RESET push-button on the duplex maintenance (module G) is operated. The reset pulse is developed in the drum entry section, distributed within that section, and furnished to the direct entry section. (Exception - Will not reset MDI Reg. FF's.)

**Manual Data Input Element****E. Summary Questions**

1. What is the purpose of unit 28?
2. How many different sources of manual inputs are there? Name each.
3. What is the difference between the function of the light gun and of the action button?
4. What is the priority of entering information into the drum entry section of the MDIE?

## Manual Data Input Element

## II. Manual Input Devices

## A. General

1. The transmission of information to the MDI is accomplished by one of the following: keyboard controls, light guns, and CEP's. This section provides an operational and functional discussion of these input devices whose relationship to the MDI is shown in figure 1-36.

Fig. 1-36,  
Page 0030

## B. Keyboard Control Panel

1. The keyboard control panel comprises a number of modules which contain neon warning lights, audible alarms and warning lights are used to attract the operator's attention to a particular situation. The MI information switches are employed to set up binary messages that are sent to the MI core matrix in element. After the message is formed, it is validated by a control signal which is generated by depressing an activate pushbutton.

These modules are mounted on the front panel of auxiliary consoles and on input data selection control panels of SD consoles. The input data selection control panels, commonly referred to as side wings, are attached to either the right or left side of the SD console or, in some cases, to both sides (fig. 1-24). A side wing that contains a telephone/radio module is designated a special input data selection control panel.

Fig. 1-24  
Page 0030

## 2. Manual Input Information Modules Description

- a. Several different types of MI information modules are used at the various operating positions. The number and type of modules employed is a function of the tactical requirements of the individual console. Each of the modules is available with or without labels; the label identifies the switch function. The following six pages give a description of various types of modular panels used.

Ref. Page  
0120 thru  
0170

The binary information (orders) selected by the MI information modules is sent to resistor cards. These cards modify the information and send it to the core matrix of the MI elements for computers A and B.

(Continued on Page 0018)

## MODULAR PANELS

Type of Panel	Abbreviation
1. Modular audible alarm panel (see Fig. 1) (Page 4 of 6) <ul style="list-style-type: none"> <li>a. Special Audible Alarm Panel</li> <li>b. Contains two indicator lights, a reset push-button, a flasher and relay, and a bell or buzzer.</li> </ul>	AA
2. Blank standard width module <ul style="list-style-type: none"> <li>a. 1 and 1/2 inches wide</li> </ul>	1 - 1/2 B
3. Blank half-width module <ul style="list-style-type: none"> <li>a. 3/4 inch wide</li> </ul>	3/4 B
4. 10 - Light Indicator (see Fig. 2) (Page 4 of 6) <ul style="list-style-type: none"> <li>a. Contains 10 neons</li> <li>b. Each neon controlled by one bit from Warning Lights Element</li> </ul>	10 Ind
5. Heading and Speed Module (see Fig. 3) (Page 4 of 6) <ul style="list-style-type: none"> <li>a. Contains 5 push buttons               <ul style="list-style-type: none"> <li>1) Depressing any one push button will release any of the other four.</li> <li>2) Controls three bits to MDI Matrix</li> </ul> </li> <li>b. Contains an 8-position rotary switch indexed at 45 degree positions with no stops.               <ul style="list-style-type: none"> <li>1) Controls three bits to MDI Matrix</li> </ul> </li> </ul>	HS
6. Fifteen Push Button Module (see Fig. 4) (Page 4 of 6) <ul style="list-style-type: none"> <li>a. Contains 15 push buttons</li> <li>b. Depressing any one push button releases any of the other fourteen.</li> <li>c. Controls four bits to MDI Matrix</li> </ul>	15 PB

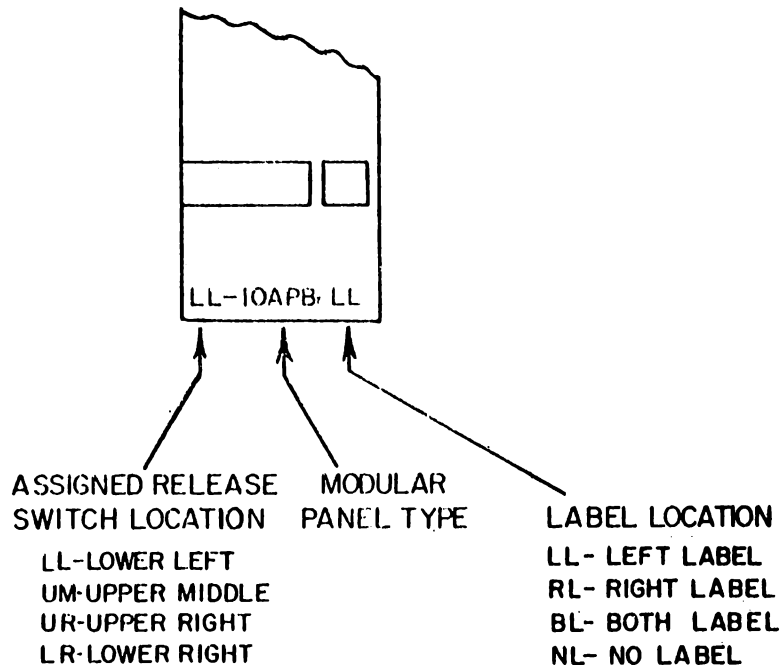
7. **Ten Push Button Type A Module (see Fig. 5) (Page 4 of 6) 10 APB**
- a. Contains 10 push buttons
  - b. Depressing any one push button releases any of the remaining nine.
  - c. Controls four bits to MDI Matrix
8. **Ten Push Button Type B Module (see Fig. 6) (Page 4 of 6) 10 BPB**
- a. Contains 10 push buttons
  - b. Any of nine pushbuttons can be depressed without releasing other eight. The tenth pushbutton is a common release of the other nine.
  - c. Controls nine bits to MDI Matrix
9. **Ten Push Button Type C Module (see Fig. 7)(Page 5 of 6) 10 CPB**
- a. Contains 10 push buttons
  - b. Each pushbutton has independent ON-OFF action
  - c. Release push button releases push button
  - d. Controls 10 bits to MDI Matrix
10. **Two 5-Push Button Module (see Fig. 8) ( Page 5 of 6) 2 x 5 PB**
- a. Contains two 5 push button sections
  - b. Depressing any push button in each section releases any of the other four.
  - c. Each Section controls 3 bits to MDI Matrix
11. **Five Push Button Module (see Fig. 9) (Page 5 of 6) 5 PB**
- a. Contains 5 push buttons
  - b. Depressing any one push button releases any of the other four.
  - c. Controls three bits to MDI Matrix
12. **Three Push Button Module (see Fig. 10)(Page 5 of 6) 3 PB**
- a. Contains three push buttons
  - b. Each push button has momentary contact action
  - c. Used to control monitor cameras
13. **Activate and Release Module (see Fig. 11) (Page 5 of 6) A & R**
- a. Contains two push buttons
  - b. Both push buttons momentary contact action
  - c. Activate push button sets one core in MDI Matrix
  - d. Release push button releases all push buttons

14. Modified Heading and Speed Module (see Fig. 12)(Page 5 of 6)MH & S

- a. Contains five push buttons and 8-position rotary switch
- b. Only two positions of rotary switch used
- c. Five push buttons not used
- d. Controls one Bit to MDI Matrix

15. Heading Module (see Fig. 13) (Page 6 of 6)

- a. Contains one pushbutton
  1. This enabling pushbutton supplies +10 Volts to the wiper arm of the rotary switch.
  2. It does not control any bits in the MDI matrix
- b. Contains a 32-position rotary switch indexed at 11.25 degree positions with no stops.
  1. Controls six bits to MDI matrix.



TITLE: KEYBOARD MODULE DISCRPTION

PAGE 3 OF 6



EXAMPLES OF MODULAR PANELS  
 TAKEN FROM VARIOUS CONSOLES IN  
 AN/FSQ - 7

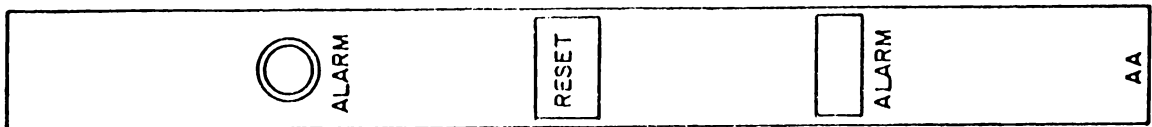


FIG. 1

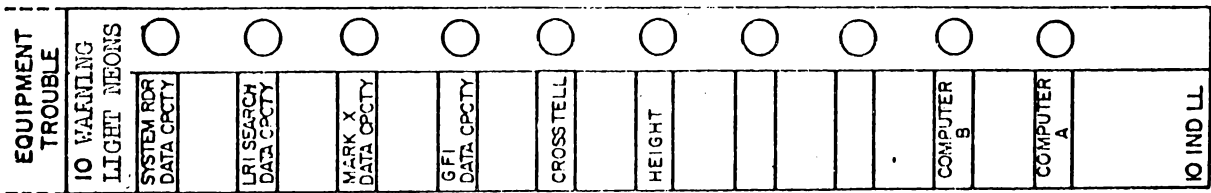


FIG. 2

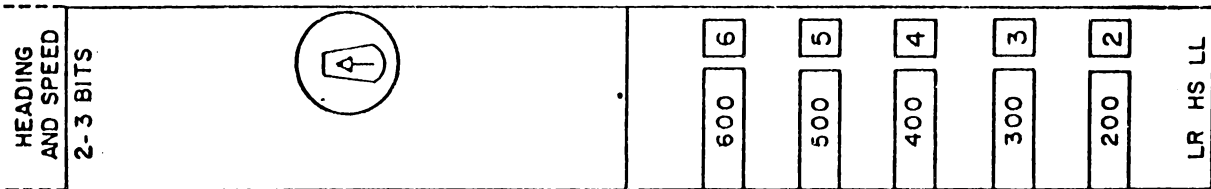


FIG. 3

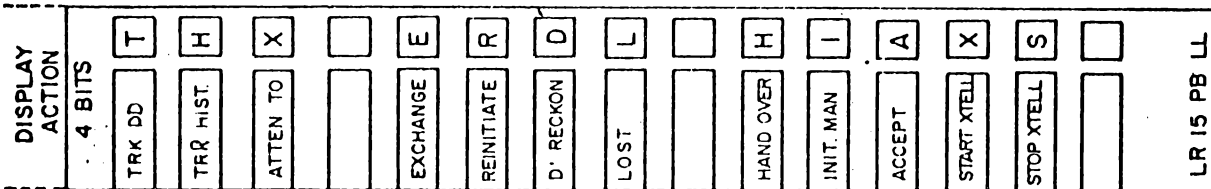


FIG. 4

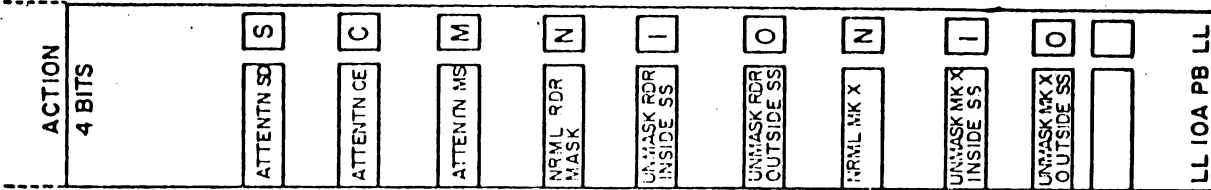


FIG. 5

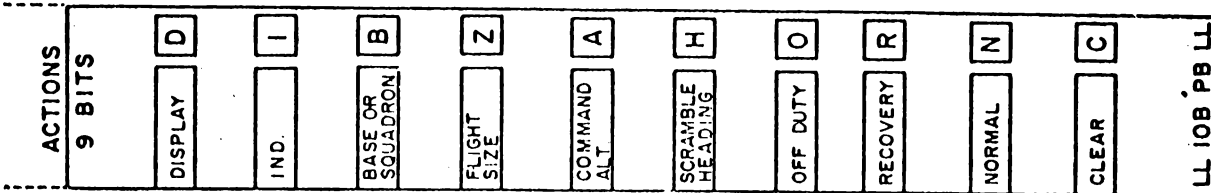


FIG. 6

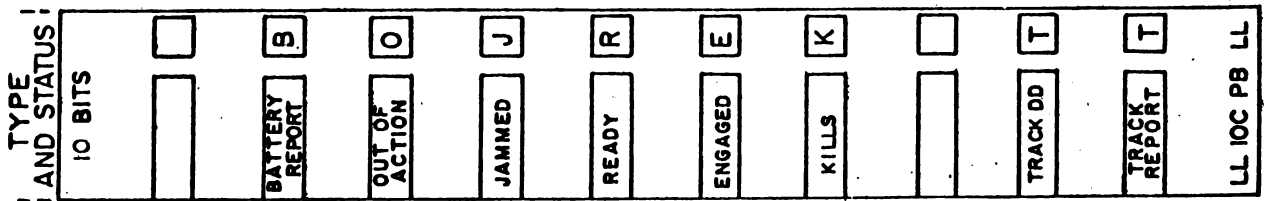


FIG. 7

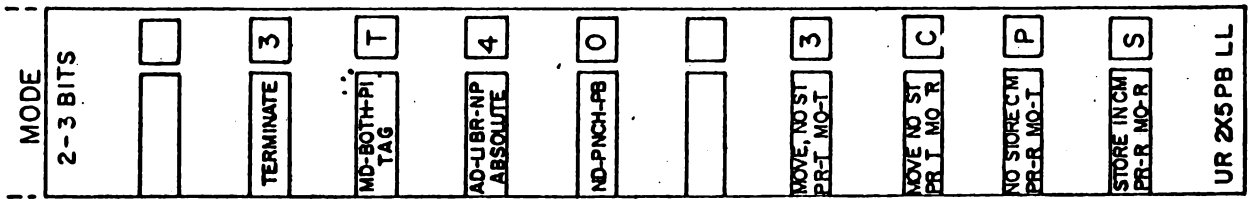


FIG. 8

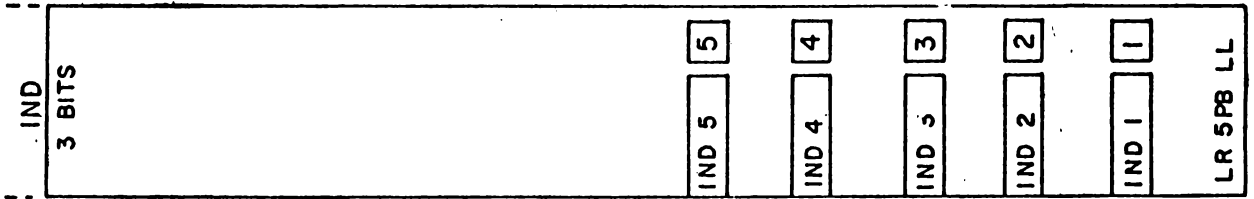


FIG. 9

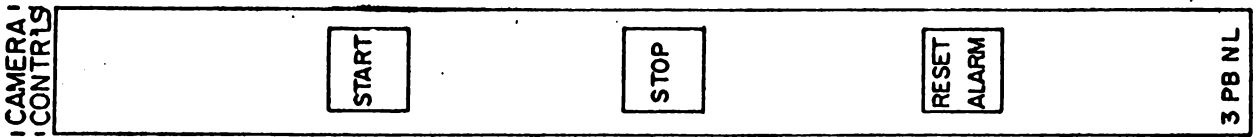


FIG. 10

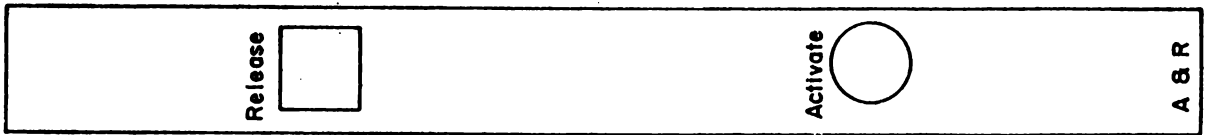


FIG. 11

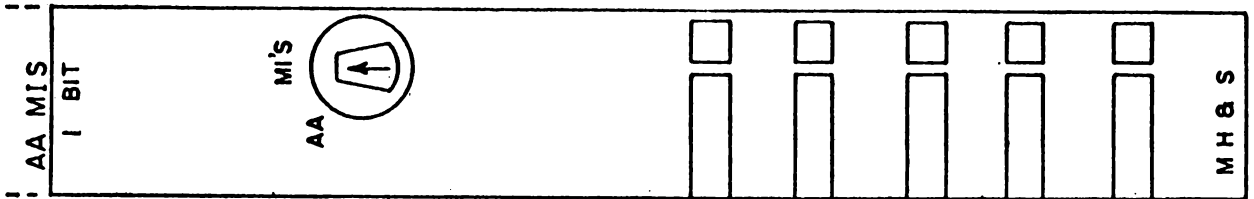


FIG. 12

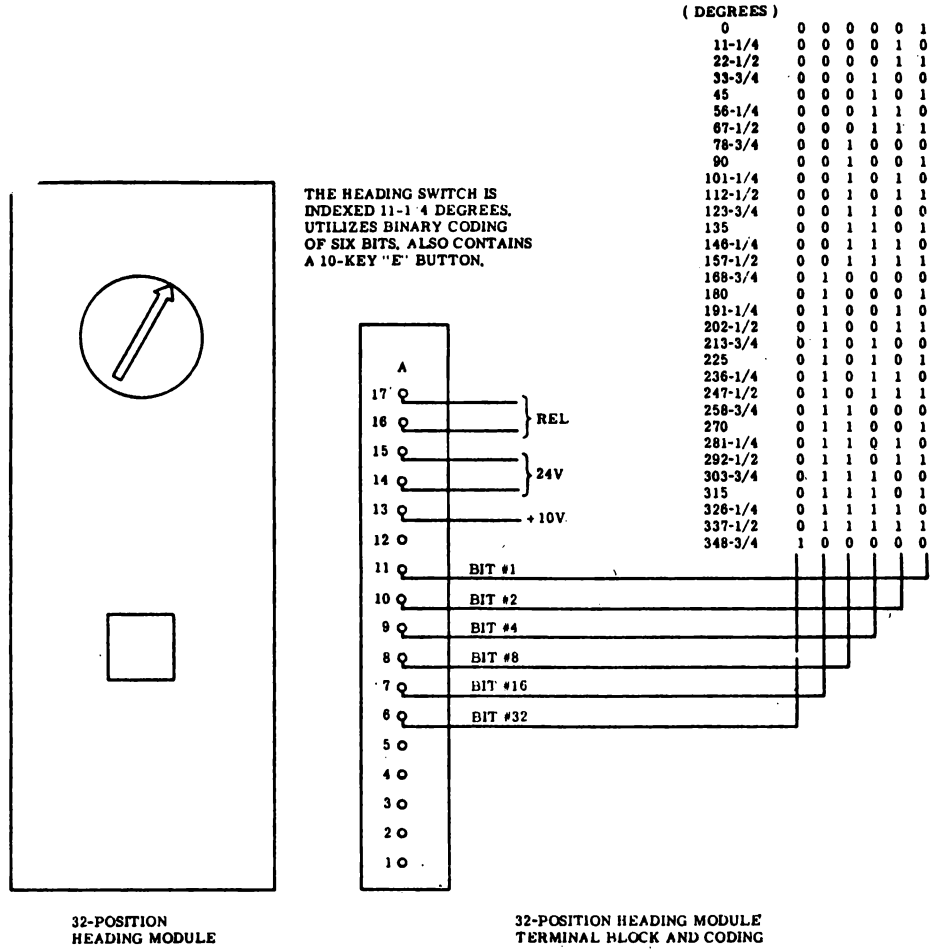


FIGURE 13. 32-POSITION HEADING MODULE

## Manual Data Input Element

## b. Bits Encoded by Modules

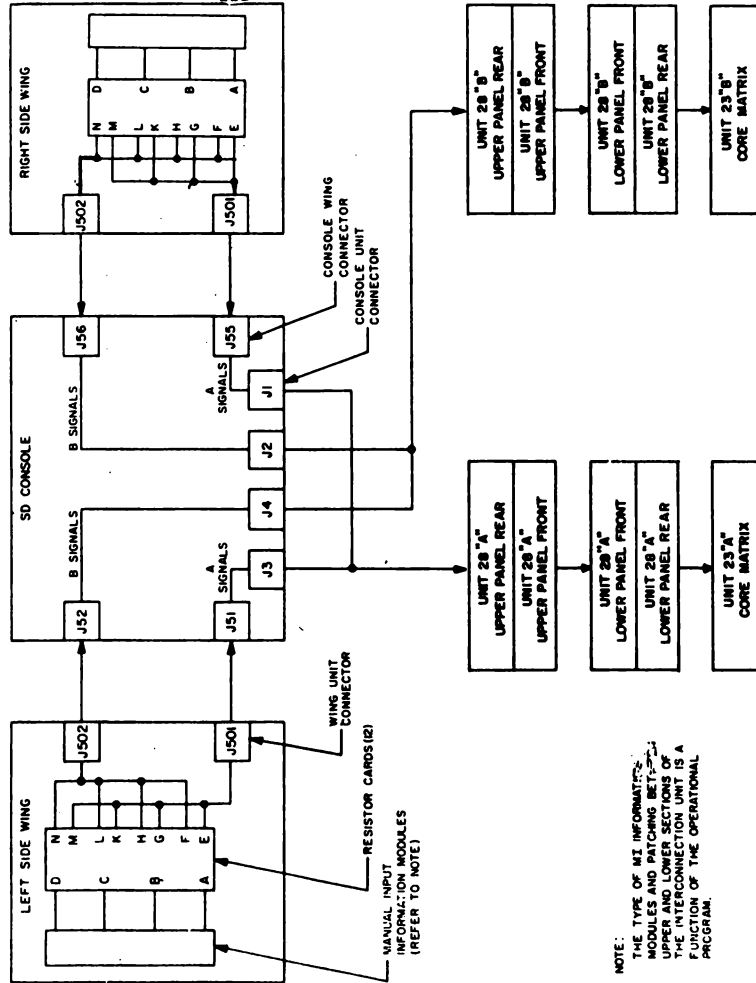
- 1) The pushbuttons of MI information modules are numbered consecutively, and when a pushbutton is depressed, a binary code is sent to a resistor card that represents the depressed pushbutton.
- 2) The modules that are equipped with interlocked-release pushbuttons use a binary code of either three or four bits. The code is a binary representation of the pushbutton depressed; the binary code set up with the rotary switch (HS module) represents the position of the switch. Figure 6-10 illustrates the pushbutton-code relationship for the 10A-PB module.
- 3) The modules that contain pushbuttons that operate independently of each other (10B-PB and 10C-PB) employ a binary code that differs from the code described above. The pushbuttons of these modules are each assigned one bit, providing a total of nine bits for the 10B-PB module (one button is a common release) and 10 bits for the 10C-PB module. This arrangement permits one or more pushbuttons to be depressed at any given time.
- 4) When a pushbutton is depressed, the associated bit is set to a 1 state; the unoperated pushbuttons represent the 0 state. The binary code resulting from the bits encoded by each module is stored in the MI core matrix of MI elements A and B. Each bit is assigned a specific core location in the core matrix and represents an instruction, or part of an instruction, to the Central Computer. The Central Computer System is programmed to read this information at regular intervals. Although the modules are simplex, the outputs are applied to both the active and standby sections of the MI element.

Fig. 6-10  
Page 0190

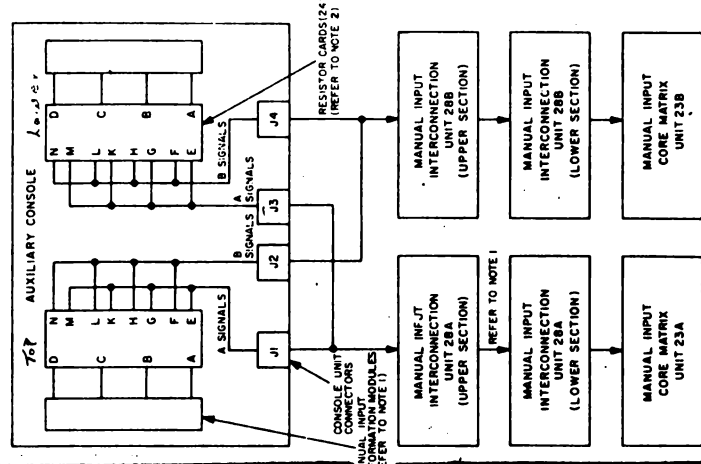
SHBITTON NUMBER	BINARY CODE	2 <sup>3</sup> BIT	2 <sup>2</sup> BIT	2 <sup>1</sup> BIT	2 <sup>0</sup> BIT
9	1 0 0 1				
8	1 0 0 0				
7	0 1 1 1				
6	0 1 1 0				
5	0 1 0 1				
4	0 1 0 0				
3	0 0 1 1				
2	0 0 1 0				
1	0 0 0 1				
C	0 0 0 0				

Figure 6-11.

Figure 6-10. Pushbutton-Binary Code Relationship for Module 10A-PB



NOTE:  
THE TYPE OF MI INFORMATION MODULES AND PATCHING BETWEEN THE UPPER AND LOWER SECTIONS OF THE INTERCONNECTION UNIT IS A FUNCTION OF THE OPERATIONAL PROGRAM.



NOTE 1:  
THE TYPE OF MI INFORMATION MODULES AND PATCHING BETWEEN THE UPPER AND LOWER SECTIONS OF THE INTERCONNECTION UNIT IS A FUNCTION OF THE OPERATIONAL PROGRAM.

NOTE 2:  
THE OUTPUTS OF 12 RESISTOR CARDS ARE FED TO J1 AND J2; THE OUTPUTS OF THE REMAINING 12 CARDS ARE FED TO J3 AND J4.

Figure 6-12. Manual Input Information Flow, Auxiliary Consoles

## Manual Data Input Element

## 3. Information Signal Flow

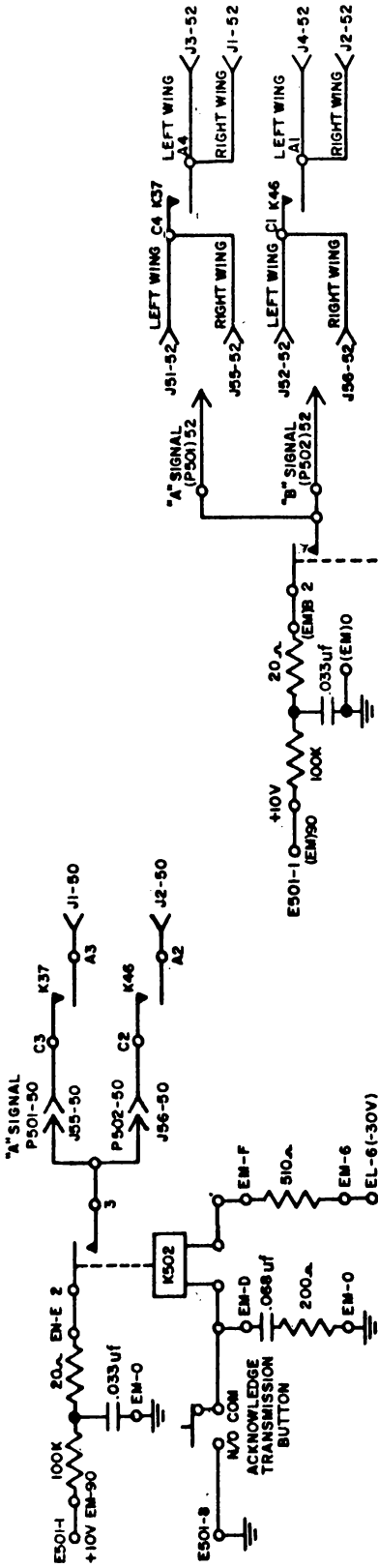
- a. The outputs of the MI information modules are wired to resistor cards. The number of outputs for each module depends upon the bits assigned to the module; i. e., the 10A-PB module has four outputs and the 10B-PB module has nine outputs. Each card is capable of receiving a maximum of only four inputs. There is a maximum of 12 resistor cards in each side wing and 24 cards in each auxiliary console.
- b. Each bit of the code associated with the respective modules is fed to the resistor cards as a 0 level or a +10V level. The 0 level represents a 0 bit and the +10V level represents the 1 bit. The resistive networks of the cards change the 0V levels to -30V levels. The +10V levels are reduced to approximately +0.5 volts at the output of the resistor cards due to the IR drop resulting from the prime current for the cores being set. Two identical sets of outputs are developed at the outputs of the resistor cards (see fig. 6-11 for side wings and fig. 6-12 for auxiliary consoles). Each set of outputs is connected to a separate output jack at the console. These outputs are fed to the upper section of MI interconnection unit 28. By means of patch-cords, the voltage levels are fed to the lower section of the interconnection unit. One set of outputs is fed to the MI core matrix of MI element A; the other set, to the core matrix of MI element B. The -30V and +10V levels continuously set the cores in each element to the code set up in the respective modules. Figure 6-13A represents a portion of logic 4.2.10 and provides a point to point wiring diagram from the keymodule pushbutton in the wing-panel to the console signal connectors going to the upper panel of unit A28. Another resistor (not shown) is also connected at point EA and its output at point EF feeds the same signal to the upperpanel of unit B28 through P502, J52 and J4.

Fig. 6-11,  
6-12,  
Page 0019

Fig. 6-13A  
Page 0210

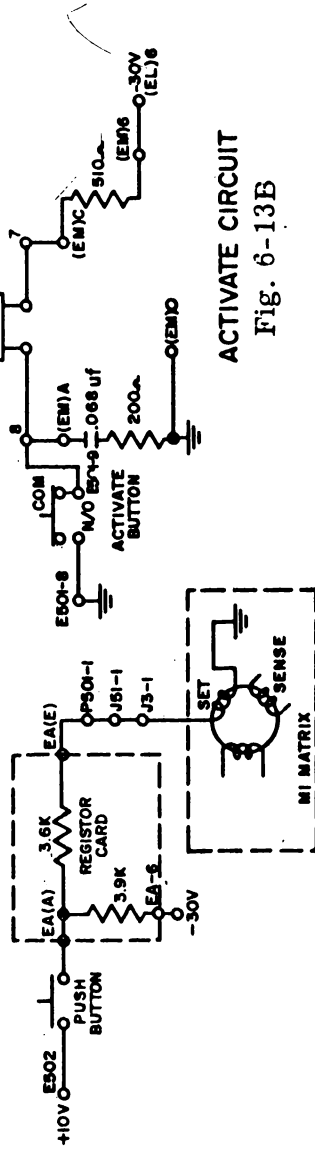
Table #1 is a portion of a chart on logic 4.2.10 which provides the point to point wiring from the resistor boards in the wing panel to the console MI signal connectors.

Table #1  
Page 0210



ACKNOWLEDGE TRANSMISSION CIRCUIT

Fig. 6-13C



ACTIVE CIRCUIT

Fig. 6-13B

Fig. 6-13A INFORMATION CORE SET CIRCUITRY

CONSOLE WIRING SEQUENCE FOR LEFT AND RIGHT WING UNIT.					
RESISTOR CARD	IN	OUT	CONSOLE WING UNIT CONN.		CONSOLE WING UNIT CONN.
			LEFT	RIGHT	
EA(A)	EA(E)	(P501) 1	(J3) 1	(J55) 1	(J1) 1
(A)	(F)	(P502) 1	(J4) 1	(J56) 1	(J2) 2
(B)	(G)	(P501) 2	(J3) 2	(J55) 2	(J1) 2
(B)	(H)	(P502) 2	(J4) 2	(J56) 2	(J2) 2
(C)	(K)	(P501) 3	(J3) 3	(J55) 3	(J1) 3
(C)	(L)	(P502) 3	(J4) 3	(J56) 3	(J2) 3
(D)	(M)	(P501) 4	(J3) 4	(J55) 4	(J1) 4
EA(D)	EA(M)	(P502) 4	(J4) 4	(J56) 4	(J2) 4
EB(A)	EB(E)	(P501) 5	(J3) 5	(J55) 5	(J1) 5
(A)	(F)	(P502) 5	(J4) 5	(J56) 5	(J2) 5

Table No. 1

## Manual Data Input Element

## 4. Activate, Acknowledge and Release Switches

- a. The activate (ACT) switch is a snap-action pushbutton used to signal the Central Computer System to accept the information set up on the MI information modules. This switch is located on a horizontal strip below the pushbutton modules. A guard is provided around the pushbutton to prevent accidental operation. Only one activate switch is provided for each side wing and auxiliary console.

Depressing the activate pushbutton applies +10V to a core in the MI core matrix. The activate signal, unlike the pushbutton outputs, does not go to both sections of the MI element. The routing of the activate signal is controlled by the unit status switch through signal relays on the associated console. The readout operation of the stored activate information is destructive, whereas the MI information cores are continuously set until the release switch is operated.

Referring to figure 6-13B, it should be noted that the signal which sets the activate core is generated by the momentary picking of relay k501. The resulting 35 usec signal sets the assigned activate core via the console signal relays and Interconnection Unit 28.

Fig. 6-13B  
Page 0210

- b. The Acknowledge switch causes a core in the MI matrix to be set through the momentary picking of relay K502. In this respect its electrical operation is very similar to that of the activate switch.

Fig. 6-13C  
Page 0210

Functionally however, it is used to acknowledge that a particular voice transmission has been completed by the console operator to an interceptor. As a result, the computer will update the Voice Digital Display at this console. Usually two Acknowledge switches, one on an Interceptor Director's console and one on the associated Interceptor Director Technicians console, will set the same core.



## Manual Data Input Element

- c. The release (REL) switch, like the activate switch, is a snap-action pushbutton; however, it is shaped differently and is physically separated from the activate switch to avoid confusion. This switch is wired to various combinations of pushbutton switch solenoids to permit the operator to release keys following the entry of data to the Central Computer. A maximum of four release switches may be provided on each side wing or auxiliary console.

## 5. Display Maintenance Specifications

Complete Manual Inputs core matrix assignment information is part of the information contained in the Display Maintenance Specifications for the DC or the CC sites (DMSD or DMSC respectively). The DMS is found in the Maintenance Handbook for Displays Volume 3 (M1-07-08). It indicates the resistor card(s) and the terminals to which a particular keymodule is wired and also the bits in the MI matrix which the module controls.

## C. Light Gun

1. It is possible for an operator to set up a complete message by means of the side wing pushbuttons, but he would encounter difficulty in identifying a RD target on the SD CRT solely by the information he entered by means of pushbuttons. The Central Computer requires additional information (not available on the side wings) to identify this target. The light gun overcomes this difficulty by initiating both the request and the information response to the Central Computer. In addition to performing the same function as the action pushbutton (which merely informs the computer that the message is complete), the light gun also allows the transfer of identity information to the MI element.

The operator can use the light gun to identify the target to which a message set up on the side wing pushbutton keyboard should apply and, in so doing, can indicate that the message is complete. The operator first sets up his message on the keyboard but does not press the action pushbutton. He then aims the red-aiming beam of the light gun at the target (an RD-bright symbol or the point in a TD tabular track message) and presses the trigger. Depressing the light gun trigger is functionally equivalent to pressing the action pushbutton.

## Manual Data Input Element

## 2. Functional Description of Light Gun

a. The light gun is a system that extends beyond the pistol-shaped pickup head. The system, as shown in figure 6-14, consists of the light gun proper, a light gun amplifier (LGA), and associated control circuits. The LGA contains an amplifier, a 3-way AND circuit, and a pulse generator.

Fig. 6-14  
Page 0250

b. The system is employed in making a query for additional SD intelligence from the Central Computer. It does this by figuratively pointing at the part of the display in question, demanding more information.

## c. Pickup Head

1) The photoelectric pickup head converts impulses of light appearing on the viewing screen of the SD CRT into electrical pulses for amplification by the light gun amplifier. This is accomplished by aiming the hand-held pickup head at an intensified-light target on the display and pressing a trigger switch. See figure 6-15 for the optical geometry of the light gun.

Fig. 6-15  
Page 0270

## d. Light Gun Amplifier

1) The light gun amplifier is used to amplify the output pulse of the light gun photomultiplier. The amplifier proper consists of a 3-stage amplifier, a 3-way AND circuit, and a pulse generator.

2) The 3-stage amplifier receives a negative pulse from the gun, amplifies this pulse, and inverts it to a positive-going output pulse. This, in turn, is coupled to an AND circuit and pulse generator that, in turn, develops a 10-usec level.

## 3. Functional Operation of Light Gun

a. Functionally and logically, the photoelectric pickup head is part of the manual inputs. It functions to transfer target data from the display console to the manual inputs for Central Computer use.

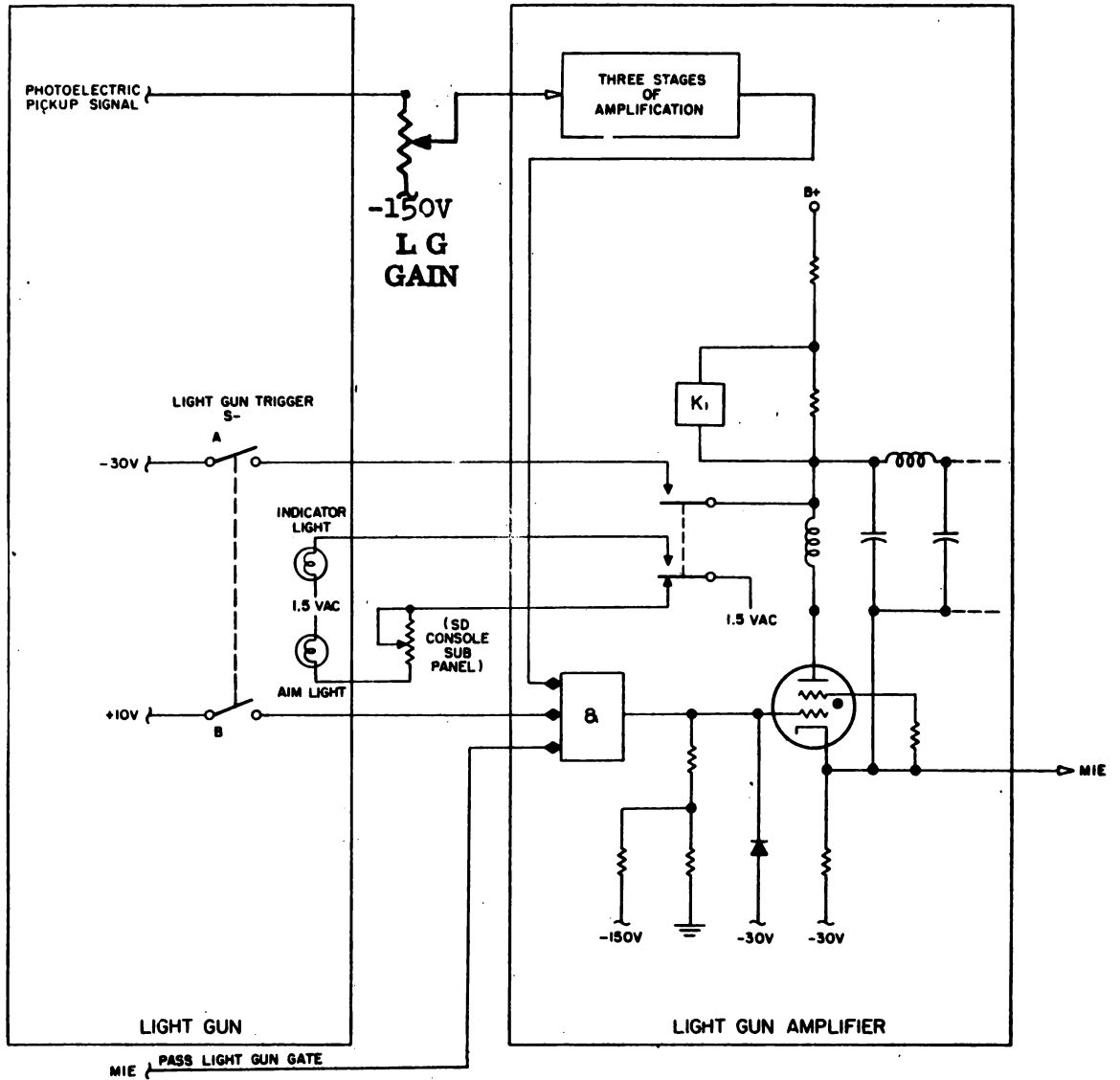


Figure 6-14. Light Gun Logic

## Manual Data Input Element

- b. The target data must either be a point appearing at the same position as the E character of a track message or a bright radar character. Figure 6-16 is a timing chart indicating the pulse sequence and timing required to effect the data transfer.

Fig. 6-16,  
Page 0270

c. **Pulse Sequence**

- 1) Depressing the trigger of the photoelectric pickup head applies +10V level on one of the inputs to an AND circuit. This allows a point feature signal to intensify the CRT. The intensified point on the viewing screen of the CRT is picked up by the photoelectric pickup head which sends a negative pulse to the light gun amplifier.
- 2) A red aim light (fig. 6-15) in the pickup head is incorporated in the optical system to enable the operator to determine when the unit is properly focused on the target. When the pulse generator sends a pulse to the MDI, a relay closes, extinguishing the aim light and lighting an indicator lamp to signify the completion of a light gun operating cycle. Firing of the thyratron in the pulse generator will cause the indicator lamp to light.
- 3) Releasing the trigger extinguishes the indicator lamp and lights the aiming light, denoting that the light gun is ready for a new operation. The aiming beam must be held on the character until the Central Computer accepts the information. There will be occasions when the Central Computer will not accept a light gun message. This will be indicated to the operator by the red indicator light, which will not light under these circumstances.

d. **Pickup Head Optics**

Figure 6-15 shows the operational geometry of the pickup head light system. The light pulse emanating from the CRT phosphors enters the barrel of the unit, goes through each element of the lens cell, and is thus focused on the dichroic mirror. The mirror reflects primarily blue light to the photomultiplier tube through an interposing aperture. The aim light

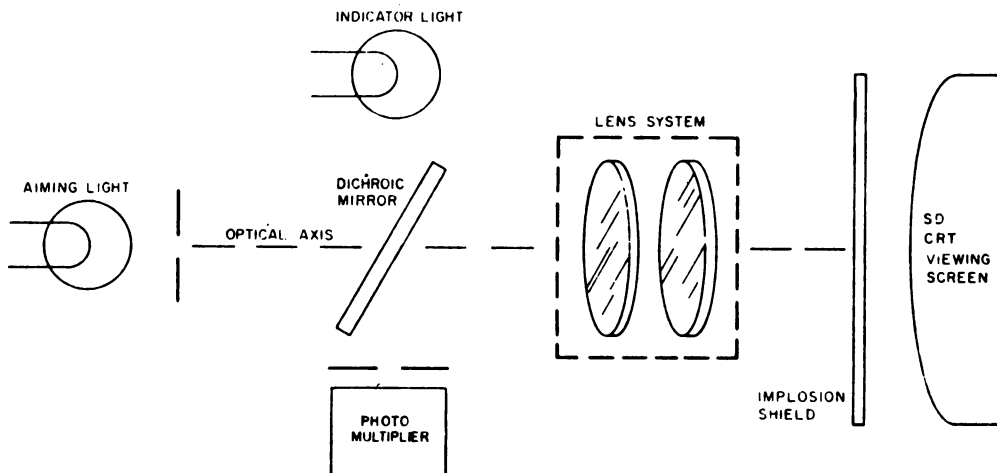


Figure 6-15. Light Gun Optical Geometry

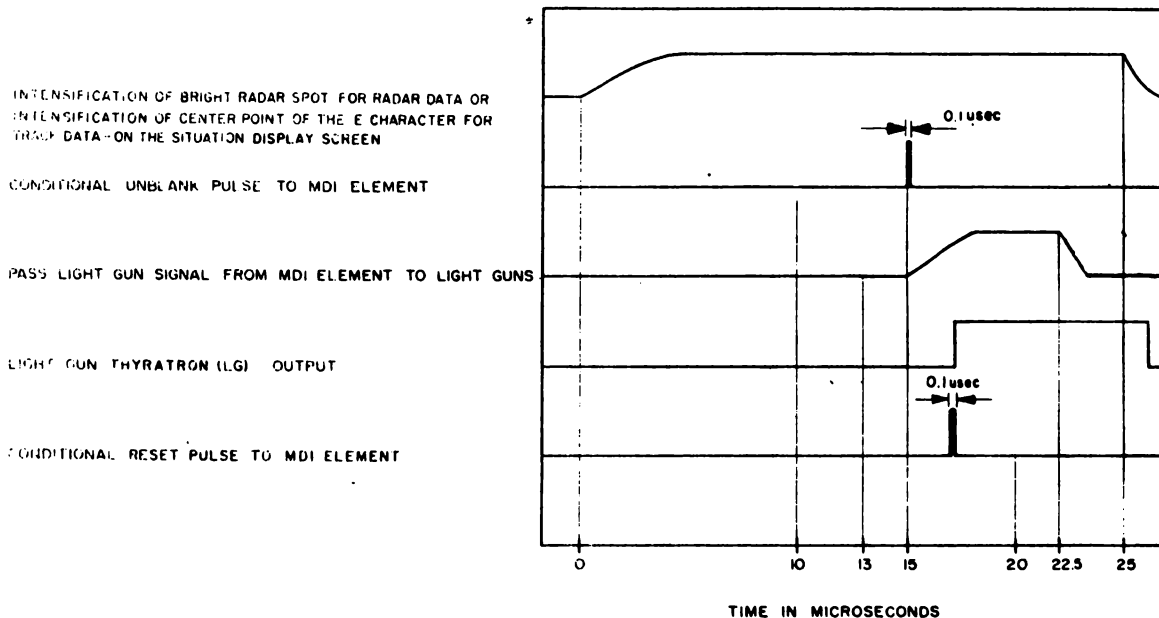


Figure 6-16. Timing Sequence Relationship of MDI Element and Display System in Light Gun Output

## Manual Data Input Element

is mounted directly to the rear of the aperture on the axis of the lens. Red light is filtered through the other side of the mirror, through the lens system, and forms the aim light seen by the operator. The indicator lamp is mounted above the mirror and is easily observed by the operator.

### 4. Logic Operation of Light Gun

- a. The light gun output voltage serves to condition one leg of a 3-legged AND circuit. (See fig. 6-14). The remaining two legs are conditioned by the appearance of a pass-light gun signal from the MDI drum entry section and a +10V level when the trigger switch is actuated. At this point, it should be noted that the presence of extraneous or ambient light, of sufficient intensity and spectral frequency, will naturally produce a light gun output. However, the conditions necessary for AND circuit conduction, and, therefore, output are possible only when the trigger switch is actuated simultaneously with the output of the light source.
- b. If the above conditions are satisfied, depressing the trigger will close a switch. (See fig. 6-14). Section A contacts will close first, then section B contacts. When the A section closes, -30V is applied to one of the normally open contacts of relay K1. Relay K1 is not energized at this time, however, and the -30V does not affect the circuits. When section B of the switch closes, a +10V conditioning voltage is applied to one leg of the AND circuit. The output from the LGA and a pass light gun gate sets up the AND circuit for complete conditioning. The pass light gun gate is of a 7.5 usec interval and is sent out by the MI element to indicate that the particular message that has been activated will be accepted by the Central Computer for necessary requests or instructions.
- c. When the AND circuit requirements are met with resulting condition, the control grid of the thyatron rises to above cut off, and the thyatron fires. The pulsed time of the thyatron is governed by a 10-usec delay line in the plate circuit, and a 10-usec gate appears at the thyatron cathode. It is this output gate that is sent to the MI element.

## Manual Data Input Element

- d. The thyatron plate current flowing through the coil of relay K1 causes the relay to operate some milli-seconds after the output gate has occurred. When this happens, the energizing path for K1 is obtained through the normally open contacts of the relay and the A section of the switch. Current is thus diverted around the thyatron, making it possible to de-energize. In addition, by means of the other relay contacts, the aiming light has been extinguished and its voltage is now applied to the lamp indicator, signifying that the light gun operation is completed.
- e. Releasing the trigger switch opens section B first and, in this manner, eliminates the possibility of the AND circuit being conditioned by an undesired message. The grid of the thyatron is now definitely cut off. Section A now opens, removing the return path of K1, and it de-energizes (the thyatron now is no longer conducting). At this point, the indicator light is extinguished and the aiming beam is turned on again, indicating that the light gun cycle is completed and ready for a new operating cycle.
- f. The SD CRT is coated with phosphors which produce a bluish fluorescence of short persistence during the intensification period. After excitation during the fadeout period, the screen exhibits a greenish-yellow phosphorescence that persists for several minutes. The photomultiplier cathode and the implosion shield response are in the green light spectrum, falling off rapidly in the yellow light region. The dichroic mirror characteristics reflect practically all the light within the spectral frequency response of the photomultiplier and still allow the red light to filter through from the aim light.
- g. Maximum light input to the photosensitive cathode is obtained when the lens is focused to cover the entire light source. The importance of this cannot be overemphasized in obtaining maximum gain and signal-to-noise ratio of the photomultiplier tube.

## Manual Data Input Element

- h. The surface of the display tube is convex and, for practical purposes, can be considered to offer an equal intensification light output at all points. The distance from the implosion shield (upon which the plunger of the pickup unit rests) to the display tube is a minimum at the center and increases radically to a maximum at the edges of the display area. With the plunger fully extended, the aim light is prefocused for the center of the display tube. In the center area, the diameter of the aim light is approximately 1/8 inch. For targets outside the center area, the focusing rod should be depressed until the diameter of the aim light is approximately 1/8 inch. (The aim light should always completely cover the intensified area.)
- i. If the MI message has been composed in the input data selection control panel switches, the generation of the light gun output gate accomplishes the same function as the ACTIVATE pushbutton on the control panel; therefore, it need not be depressed when the light gun is used.
- j. The operation of the pulse generator and amplifier circuits is discussed in the Special Circuits Manual, 3-3-0. Nevertheless, at this point, the pulse generator output can be logically traced. The generated 10-usec non-standard pulse is fed to the MI drum entry section, to enter light gun identity bits into the message, prior to its transfer to the Central Computer System. The 10-usec pulse also goes to the direct entry section, where it will set a light gun core in the core matrix, thus informing the computer of the light gun operation.

## D. Computer Entry Punches

- 1. Three model 020 computer entry punches are associated with the MDI element. These machines may be used to punch information into standard IBM cards, read prepunched cards, or both. An optional printing feature permits information to be printed as it is punched. Cards can be punched by hand (keyboard) or automatically duplicated. Card machine operations can be controlled automatically by means of a program card. A unit status switch selects the computer machine, active or standby, with which the CEP is to be associated.



## Manual Data Input Element

Complete details on the CEP's will be found in the student text.

2. Certain power status and alarm indications for the CEP's are remoted to the CEP control panel (fig. 6-6) of the simplex maintenance console (module H, upper section). This panel is divided into three identical sections, one for each CEP. Each section mounts the following indicators:
  - a. A-B SIGNAL CONTACTORS CLOSED: indicates the duplex machine, A or B, to which the CEP data is being fed.
  - b. C-D POWER CONTACTORS CLOSED: indicates the simplex power supply, C or D, which is powering the CEP.
  - c. C-D CIRCUIT BREAKER ALARM: indicates an open circuit breaker in the C or D power supply circuits, whichever is operative, powering the CEP. An audible alarm is also operated by an open circuit-breaker condition.

Fig. 6-6  
Page 0070

A RESET AUDIBLE ALARM pushbutton on the bottom of the CEP control panel permits the audible alarm to be discontinued; the visual alarm indication remains lit until the condition causing the indication is corrected.

### E. Summary Questions

#### (1-4) True or False

1. Depressing a keyboard button may result in priming cores in both matrixes.
2. Depressing a keyboard button may result in priming more than one core in both matrixes.
3. Each SD console will have only one reset button.
4. Consoles with keyboard must also have light guns.
5. What three things are necessary to an output from the light gun amplifier pulse generator?
6. Why is it not possible to get more than one output pulse from the light gun pulse generator by keeping the light gun trigger depressed.



## Manual Data Input Element

## III. Direct Entry Logic Operation

## A. General

The direct entry section processes data for direct transfer to the Central Computer; a storage facility in the form of a core matrix is included in this section, and the Drum System is entirely bypassed.

## B. Functional Theory of Operation

Fig. 6-19  
Page 0350

1. The direct entry section performs three main functions; it receives, stores, and reads out data in a form suitable for acceptance by the Central Computer.
2. Data Input
  - a. The direct entry section receives three types of data: light gun signals (also sent to the drum entry section), activate signals, and keyboard control panel data.
  - b. A properly conditioned light gun responds to a target indication by generating a 10-usec light gun signal. This level is sent to the core matrix.
  - c. Keyboard control panel data is developed by push-buttons and rotary switches on display console or auxiliary console keyboard control panels. Each operated message pushbutton produces a characteristic 1-to-4 bit code in the form of +10 and -30V levels sent over four lines to the interconnection panel. Each rotary switch represents a 45-degree sector by a 3-bit binary code sent in the form of +10 and -30V levels to the interconnection panel. (Each operated activate push button generates a +10V, 35-usec pulse, sent to the interconnection panel.)
  - d. The interconnection panel performs no logic function. It simply routes the lines from the activate and keyboard control panel circuits to the proper cores in the core matrix.

## Manual Data Input Element

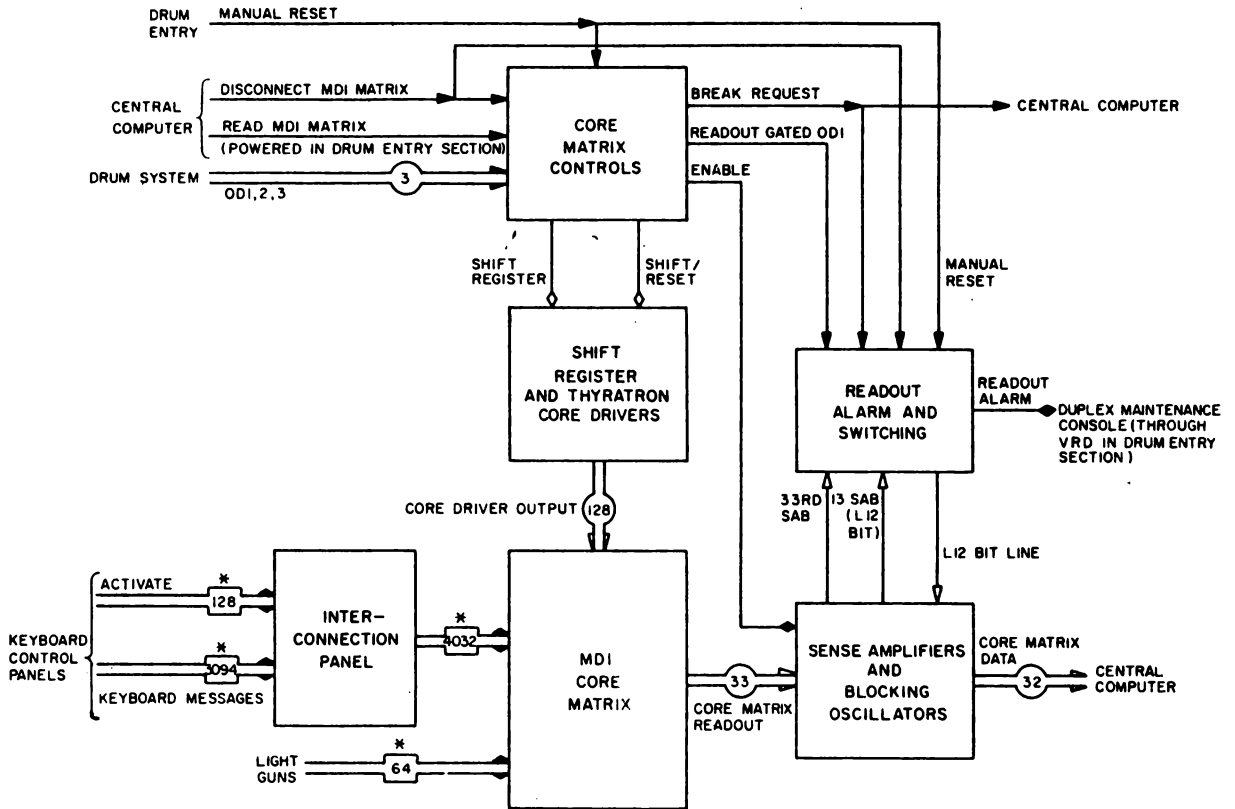
### 3. Data Storage

- a. The core matrix contains 128 rows of 33 cores each. The 33rd core of each row is used for test purposes and a 1 is permanently set in it. Each light gun output line is connected through a distribution box and a special connection panel to a specific core in rows 1 and 2 of that matrix; a light gun signal sets a 1 in the core. Each activate switch is connected through the inter-connection panel to a core in rows 3 through 6; operating the switch sets a 1 in that core. Keyboard control panel message lines and unit status indication lines are patched through the inter-connection panel to cores in rows 7 through 128. Depressing a message pushbutton sends one to four levels to as many cores; a +10V level sets a 1 in the core; a -30V level sets a 0. Rotary switches generally set a 3-bit code, determined by the switch position, into the three cores assigned to the switch (a few rotary switches utilize only two switch positions and one core). Thus, it can be seen that the core matrix will accommodate a maximum of 64 light gun inputs, 128 activate pushbutton inputs, and 3,904 message bits. The actual number of cores employed varies with the equipment and its operational requirements.
- b. Following readout of the core matrix (described below), the bits supplied by message pushbuttons and rotary switches are reinserted into the core matrix, since the pushbuttons remain depressed until manually released and the rotary switches remain in the positions until manually repositioned. Light gun and activate switch cores are not reset after readout.

### 4. Data Readout

- a. Readout of the core matrix is initiated by a Read-MDI-Matrix computer command (powered in the drum entry section) to the core matrix control. This sub-section drives the shift register and thyatron core driver sub-section. The outputs of the shift register and thyatron core drivers pulse the 128 rows

Basic Readout  
Program  
SEL 06  
LDC any address  
RDS 200



NOTE:  
 \* MAXIMUM: ACTUAL NUMBER IN USE VARIES WITH SYSTEM AND OPERATIONAL REQUIREMENTS

Figure 6-19. MDI Direct Entry Section, Block Diagram

32/4032

128  
 32  
 256  
 384  
 4096

## Manual Data Input Element

of the core matrix, driving out the contents of one row, as a parallel 33-bit word, every 20 usec. The readout is processed by the sense amplifiers and blocking oscillators which transfer 32 bits of each word to the Central Computer. The 33rd bit is sent to the readout alarm circuit which senses for a 1 permanently set into the 33rd core of each row. The absence of a 1 strongly indicates a readout failure and is presented as an alarm condition at the duplex maintenance console.

- b. The core matrix control also furnishes an enabling level during readout to the sense amplifiers and blocking oscillators and a break request with the readout of each word to the Central Computer. A disconnect-MDI-matrix command from the Central Computer to the core matrix control ends the readout process.

## C. Circuits Used in Direct Entry

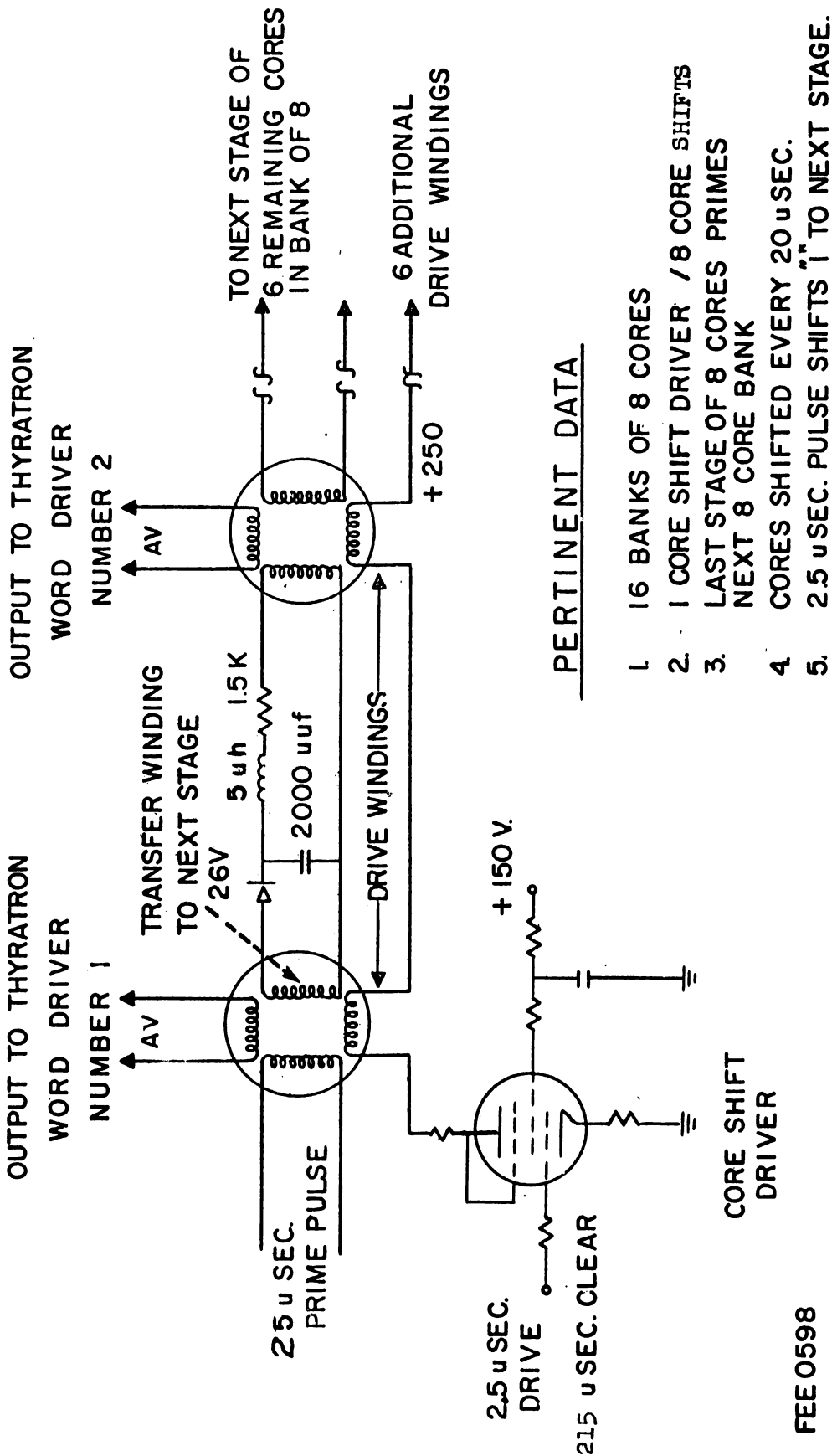
## 1. Shift Register

Page 0370  
Fig. 0598

## a. Core Shift

## 1) Four Windings on Tape Core

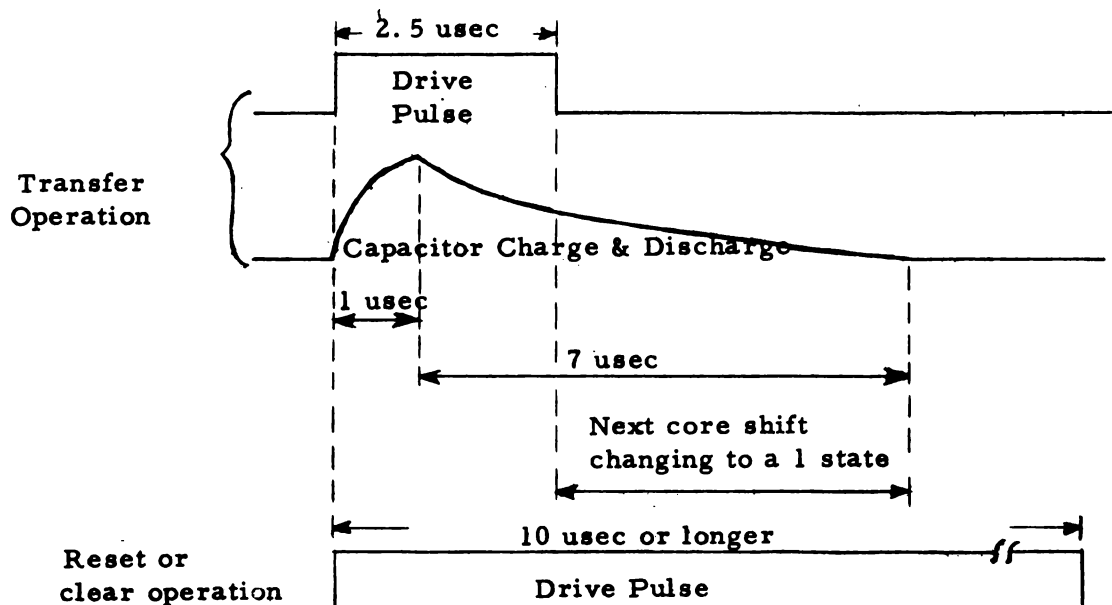
- a) Read in or prime winding sets core to a "1" state. Prime pulse is 25 usec.
- b) Drive winding drives core to a "0" state regardless of previous condition. A 2.5 usec pulse to drive core out and shift core to next stage. 215 usec drive pulse will clear all cores to a "0" state and nullify any shift.
- c) Transfer winding will charge capacitor through the Diode when core is changing from a "1" state to "0" state. The high impedance of coil prevents current from immediately flowing through lead in coil of next core shift. When capacitor reaches peak charge it will start to discharge but through the read in winding of next core shift, thus transferring the state of one core to the next.



FEE0598

MANUAL INPUT MATRIX SHIFT REGISTER

## Manual Data Input Element



If a drive pulse of 10 μsec or longer is applied to all drive winding, this will cancel out the current through the prime winding and all cores will result a "0" state.

- d) Read out winding will apply the change in state of the core to the input of the thyatron core driver.

b. Core Shift Driver

The cCSD, shown in schematic form on page 0410 consists of a pentode amplifier and associated components. The plate load of the stage consists of the series-connected CS drive windings or the add-in windings.



## Manual Data Input Element

In its quiescent state, the voltage at the grid of V1 is -30V which is the effective bias on the tube, and the cathode is at ground potential. The input signal to the stage is a pulse +10V in amplitude and approximately 2.5 usec (bias-width) in duration. As this input voltage rises to +10V, the bias on the tube is overcome, and the stage conducts. When the stage conducts, plate current flows through the core lead in the shift register. When the stage is being employed to amplify drive pulses, the plate current magnetizes the cores in a direction opposite that caused by setting a 1 into the cores. (Clears them to a zero.)

### 2. Thyatron Core Drivers

- a. A thyatron core driver (TCD) is a logic circuit which produces a peaked current waveform utilized to drive out the contents of a core register. There are three models of the TCD utilized in AN/FSQ-7 and -8 equipments. The basic difference between models A and B is in the number of cores driven by each. Model C is essentially the same as A and B, except that it is gated.

Since all models of the TCD operate basically the same, only the aTCD is discussed in detail.

#### b. Principles of Operation

- 1) Figure 3-203 is the schematic diagram for the aTCD. Table 3-94 lists associated detail parts and their functions. The circuit consists of a tetrode thyatron and its associated circuits.
- 2) The grid of the thyatron is biased at approximately -12V established by voltage divider R2 and R4 between -15V and ground. This bias is sufficient to cut off the tube. The input signal, which is 40V to 60V positive, overcomes this bias, triggering

Fig. 3-203  
Page 0410  
Table 3-94  
Page 0410

## Manual Data Input Element

the tube. Since the internal resistance of an ionized thyatron is negligible, plate voltage drops from +250V to almost zero. Capacitor C3, originally charged to the +250V supply, now discharges through the driver load consisting of 33 core windings, setting all cores to the 0 state and producing a sense output from those cores that were in the 1 state. The low plate voltage now present at the thyatron is insufficient to maintain current flow through the tube and, as a result, the thyatron deionizes and returns to cutoff. Capacitor C3 again begins to charge through R5 toward the +250V supply, terminating the current flow through the core drive windings.

### 3. Isolation Circuit, Model A

- a. The model A isolation circuit (aIC) is a nonlogic circuit which allows the 25-usec positive Load-Shift-Register pulse to set a core but prevents the subsequent -30V level from clearing the same core. The logic block symbol for the aIC is shown in figure 3-103.

Fig. 3-103  
Page 0410

- b. Principles of Operation

- 1) Figure 3-104 is the schematic diagram for the aIC. The circuit consists of a type Y crystal diode and a 1,500-ohm resistor in series. The aIC performs the above mentioned function by allowing current to flow only when its anode is more positive than the cathode. This action is made possible by the crystal diode utilized in the circuit. R1 is a current-limiting resistor.

Fig. 3-104  
Page 0410

### 4. Reset Circuit, Model A

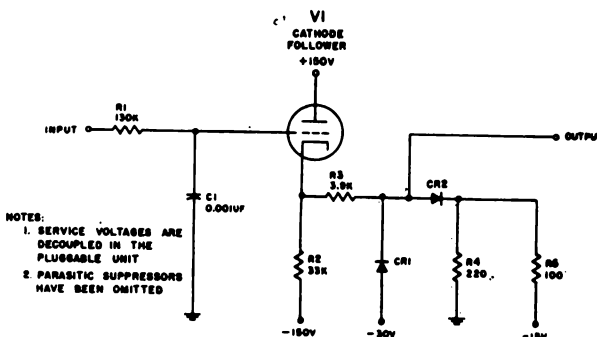
- a. Definition and Description

**TABLE 3-86. RESET CIRCUIT, MODEL A, FUNCTION OF DETAIL PARTS**

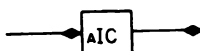
REFERENCE SYMBOL	FUNCTION
C1	Part of input integration network (with R1)
R1	Part of input integration network (with C1)
R2	Cathode load resistor
R3	Output current-limiting resistor
R4, R5	Voltage divider network between -15V and ground
CR1, CR2	Crystal diodes which serve to clamp output voltage



**Figure 3-177. Reset Circuit, Model A, Logic Block Symbol**



**Figure 3-178. Reset Circuit, Model A, Schematic Diagram**



**Figure 3-103. Isolation Circuit, Model A, Logic Block Symbol**

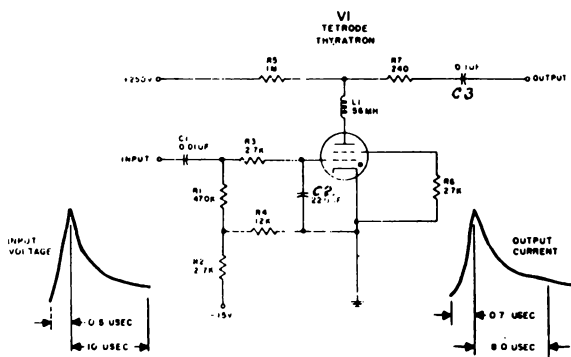


**Figure 3-104. Isolation Circuit, Model A, Schematic Diagram**



**TABLE 3-94. THYRATRON CORE DRIVER, MODEL A, FUNCTION OF DETAILED PARTS**

REFERENCE SYMBOL	FUNCTION
R1	Forms part of input pulse-shaping network (with C2).
R2	Forms part of voltage divider network (with R4)
R3	Grid current-limiting resistor
R4	Part of voltage divider (with R2)
R5	Serves as high resistance source which produces voltage drop necessary to cut off V1.
R6	Screen grid return
C1	Input coupling capacitor
C2	Forms part of input pulse-shaping network (with R1)
C3	Provides output current when discharged
L1	Limits surge voltages when V1 fires or deionizes.



**Figure 3-203. Thyatron Core Driver, Model A, Schematic Diagram**

## Manual Data Input Element

- 1) The model A reset circuit ( $A_{RS}$ ) is a nonlogic circuit which produces a pulse of adequate power and having the characteristics required to return the cores to some predetermined configuration. The logic block symbol for the  $A_{RS}$  is shown in figure 3-177.

Fig. 3-177  
Page 0410

## b. Basic Operation

- 1) Figure 3-178 is the schematic diagram for the  $A_{RS}$ . Table 3-86 lists associated detail parts and their functions. The circuit consists of a cathode follower which incorporates an integrating circuit in its input and clamping circuits in its output. The cathode follower provides the power required by a low-impedance load. The integration circuit rounds off the steep slopes of the input waveform, avoiding the abrupt transitions that might cause shifting action in the register. The clamping circuits hold the output waveform within the voltage limits required for proper clearing action in the register.

Fig. 3-178  
Page 0410

Table 3-86  
Page 0410

## c. Detailed Operation

- 1) The input signal is integrated by RC network R1 and C1 and applied to the grid of V1. In normal condition, V1 conducts because of the negative voltage on its cathode which is derived from the -150V source. As the input voltage rises, the voltage across the cathode load follows the signal. This voltage change is clamped at its upper and lower limits by two diode-limiting circuits which act in the following manner: Assume that the input voltage, and therefore the voltage at the cathode of V1, is rising. This voltage is applied to the cathode of CR1 and the anode of CR2. Consider the action of CR2 first. The cathode of this diode is at -10V established by the voltage divider between the -15V source and ground.

## Manual Data Input Element

Therefore, CR2 conducts when the rising output voltage reaches -10V, clamping the upper level of the output at this voltage. When the voltage falls below -10V, CR2 ceases to conduct, and the output is unaffected by either diode. However, when the voltage falls below -30V, CR1 conducts and the output is clamped at -30V.

## 5. Sense-Amplifier Blocking Oscillator, Model B

## a. Definition and Description

- 1) The model B sense-amplifier blocking oscillator ( $\text{B}_{\text{SAB}}$ ) is a logic circuit which amplifies the readout pulses developed in the sense windings of the core matrix cores and utilizes these pulses to provide output pulses properly shaped for use in the Central Computer System. The logic block symbol for the  $\text{B}_{\text{SAB}}$  is shown in Figure 3-189.

Note: Fig.  
3-189  
Page 0450

## b. Principles of Operation

- 1) Figure 3-190 is the schematic diagram for the  $\text{B}_{\text{SAB}}$ . The circuit consists of a 2-stage pulse amplifier (V1A, V1B) followed by a conventional blocking oscillator (V2).
- 2) As the contents of the core matrix are driven out register by register, the readout pulse from a particular core is applied to its associated sense amplifier, amplified in two stages, and then used to excite a blocking oscillator.
- 3) The  $\text{B}_{\text{SAB}}$  has specified accept and reject levels. An input to the circuit of a 300-mv positive pulse will produce a 0.17-usec output pulse; an input of 200 mv will yield no output.

Note: Fig.  
3-190  
Page 0450

## Manual Data Input Element

- 4) Assume that a 300-mv positive pulse is applied to the primary of T1. This pulse is stepped up by a ratio of 1:15 and appears as a negative pulse of 4.5V across the T1 secondary. This negative pulse, in turn, is applied to the grid of V1A. Normally, V1A is conducting. The negative signal produces a positive pulse at the plate of V1A. This pulse is coupled through C1 to the grid of V1B, causing a negative pulse at the plate of this stage and at the plate end of T2 primary (terminal 2). Since the primary of T2 is in the plate circuit of both V1B and V2, the voltage across the primary reflects the action of both these tubes.
  
- 5) A control input voltage stepped at -30V and -67V respectively is applied to the grid of V2 through the secondary of T2. Assume that a negative-going voltage has been applied to terminal 2 of T2. Polarity inversion by the transformer produces a positive-going pulse at terminal 3 which is applied to the grid of V2. This pulse has a peak amplitude of +60V, insufficient to override a bias of -67V; consequently, when the control voltage is down (-67V) the tube remains cut off. However, when the control voltage is up (-30V), the positive 60V pulse causes conduction through the tube. The ensuing current surge through the T2 primary re-enforces the negative-going voltage at terminal 2, which is reflected regeneratively as an increase in the positive voltage applied to the V2 grid. V2 quickly saturates, and current flow through the T2 primary levels off at maximum. Since a transformer can couple only ac, the magnetic field around the secondary of T2 is unsupported. Consequently this magnetic field collapses, producing a voltage approximately equal but opposite in direction to the voltage previously applied to V2 grid. The

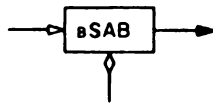


Figure 3-189. Sense Amplifier Blocking Oscillator, Model B, Logic Block Symbol

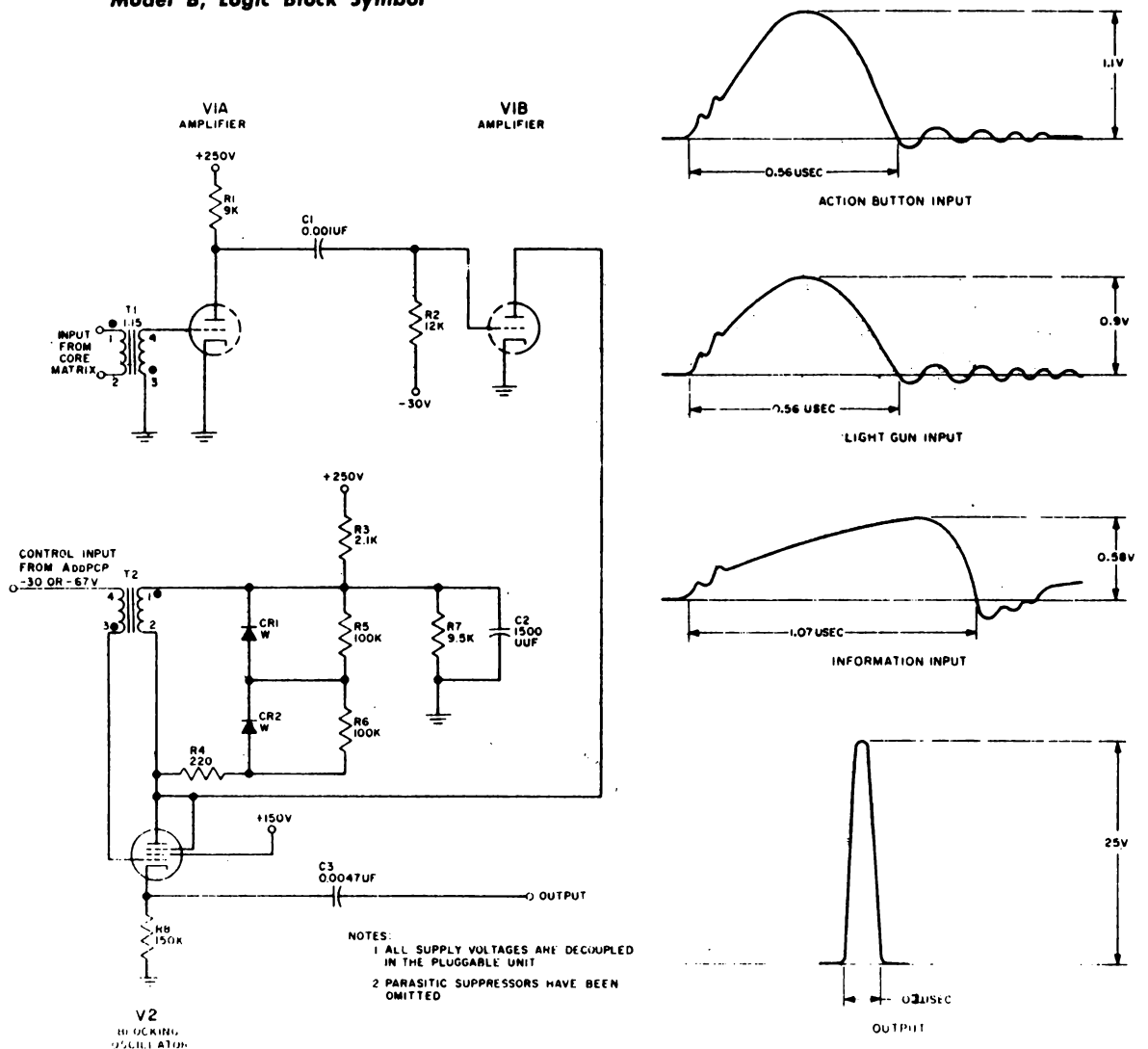


Figure 3-190. Sense Amplifier Blocking Oscillator, Model B, Schematic Diagram

## Manual Data Input Element

re-generative action of the blocking oscillator is now in the negative direction, rapidly cutting off V2. This completes the cycle, which is repeated when another negative pulse is supplied by V1B. Meanwhile, the current pulse through V2 has appeared as a corresponding positive voltage pulse across the cathode load of this tube. This pulse, 0.2 usec wide as determined by the circuit constants, is utilized as the output of the circuit.

## 6. Power Cathode Followers

## a. Definition and Description

- 1) The power cathode follower (PCF) is a nonlogic circuit that amplifies power. It is essentially a modified cathode follower circuit designed to satisfy the comparatively large power requirements of specific types of loads. Its high-input and low-output impedance makes the circuit particularly useful as an isolating device, driving low-impedance loads from a high impedance source. Circuit features are incorporated into the PCF to regulate the output levels and to maintain or shape the output waveform. The logic block symbol for the PCF is shown in figure 3-158.

Note: fig.  
3-158  
Page 0490

## b. Principles of Operation

## 1) General Analysis

- a) All PCF's, both standard and special, consist of an input differential amplifier and an output cathode follower section (fig. 3-159). Specific models employ de-generative feedback to stabilize the output voltage and output clamping to protect subsequent circuits. The feedback is applied to the differential amplifier, and in effect, adjusts the

Note: fig.  
3-159  
Page 0490



## Manual Data Input Element

voltage applied to the cathode follower section, maintaining the PCF output at a constant level for a given input level.

- b) Figure 3-160 is a simplified schematic diagram of a differential amplifier; the circuit consists of a cathode follower (V1) and an amplifier (V2). The inputs (input 1) to the cathode follower section of the differential amplifier are usually 10V and -30V levels. The output of V1 is direct-coupled to the cathode of V2 (common cathode resistor R2 is used). The other input (input 2) to amplifier V2 is a portion of the output voltage of the PCF. Amplifier V2 amplifies the difference in potential between its grid and cathode. Note: fig. 3-160  
Page 0490
- c) If the PCF output voltage should rise for a given input, the feedback to the grid of V2 becomes more positive and the plate voltage drops. This decrease in plate voltage is applied to the cathode follower section of the PCF and is sufficient to return the PCF output to its established level. Should the output voltage decrease, the reverse action occurs, again restoring the circuit to balance. It is in this manner that the differential amplifier functions as a regulating device, maintaining the output constant within specified limits for a given input voltage.

## 2) Standard Power Cathode Followers

- a) Since all the standard PCF's are basically the same, only the model A (A<sub>PCF</sub>) will be discussed in detail. Note: Fig.  
3-161  
Page 0490

## Manual Data Input Element

- b) Figure 3-161 is the schematic diagram for the  $A_{PCF}$ ; table 3-77 lists the detail parts and their function. The nominal inputs to the PCF are +10V and -30V levels. With the input at +10V, the common cathodes of V1 and V2 are approximately +11V. Assuming that there is an output voltage of +13.5V at the cathode of V3, the grid of V2 is set at a voltage (+7V) determined by the attenuating network composed of resistors R6 and R7. The resultant voltage at the grid of V2 drives the tube close to cutoff, raising the plate potential to +194V. A proportionate voltage is applied to the grid of the output circuit through voltage divider network R3 and R4 (+10V), causing V3 to conduct heavily and maintaining the output voltage at +13.5V.
- c) If the output voltage drifts below +13.5V, the voltage at the grid of V2 falls. This causes a reduction in plate current of V2 and a resultant increase in the plate potential of V2 and the grid of V3. With a more positive grid, the plate current through V3 increases, causing the output voltage drifts positive, the grid of V2 becomes more positive, increasing conduction and lowering the plate potential of V2 and the grid potential of V3. This reduces the plate current of V3 and causes the output voltage to fall to +13.5V.
- d) Assume that the input level is now -30V; the common cathode potential of V1 and V2 is approximately -26V. With an output of -32V (balanced condition), the voltage fed back to the grid of V2 is -28V. The resultant bias on the grid of V2 causes the plate voltage of V2 to fall to +100V. As a result of voltage divider R3 and R4, the grid voltage of V3 equals

Note: table  
3-77  
Page 0500

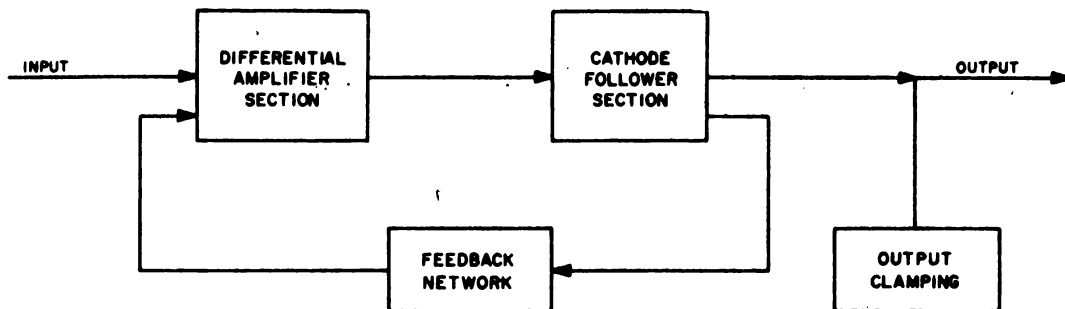


Figure 3-159. Power Cathode Follower, Block Diagram

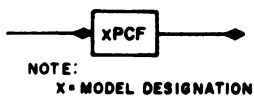


Figure 3-158. Power Cathode Followers, Logic Block Symbol

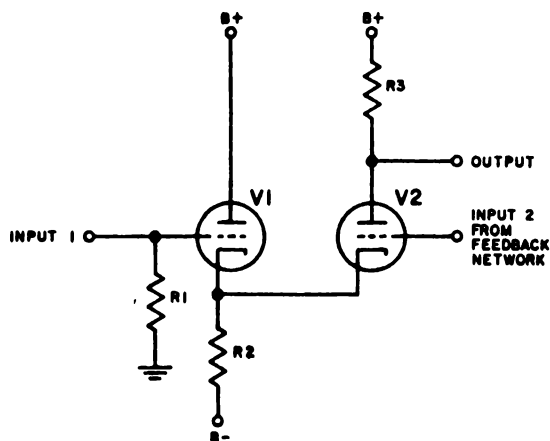


Figure 3-160. Differential Amplifier, Simplified Schematic Diagram

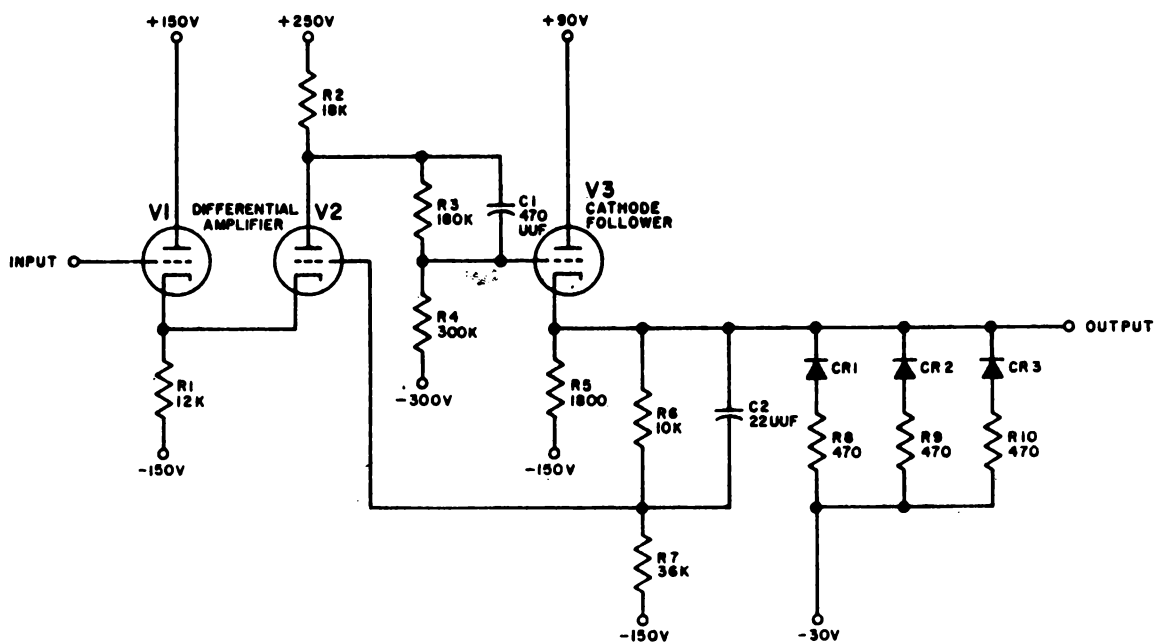


Figure 3-161. Power Cathode Follower, Model A, Schematic Diagram

## Manual Data Input Element

-50V and an output voltage of -32V is developed at the cathode of V3. Changes in this output level are fed back to the grid of V2, causing the output to be restored to its normal level in the same manner as described above.

- e) Capacitor C1 compensates for the transition time loss caused by voltage divider R3 and R4. Capacitor C2 is a speedup capacitor in the feedback network which reduces positive and negative overshoot in the circuit. Clamping diodes CR1, CR2, and CR3 protect subsequent circuits should the +90V supply fail and also clamp the lower output level at approximately -32V. Refer to table 3-77 for the function of detail parts not discussed.

## 3) Special Power Cathode Followers

- a) The special PCF's are modified standard PCF's. Therefore, since the fundamental building block of these PCF's is a standard PCF, the special PCF's will only be discussed in terms of their modifications with respect to the aPCF discussed earlier.

TABLE 3-77. POWER CATHODE FOLLOWER  
MODEL A, FUNCTION OF DETAIL PARTS

REFERENCE SYMBOL	FUNCTION
C1	Speedup capacitor
C2	Feedback capacitor (speedup) reducing positive and negative overshoot.
CR1, CR2, CR3	Output clamping diodes
R1	Common cathode resistor for V1 and V2
R2	Plate load resistor for V2
R3, R4	Voltage divider

## Manual Data Input Element

R5	Cathode resistor for V3
R6, R7	Feedback voltage divider network
R8, R9, R10	Current limiting and equalizing resistors for CR1, CR2, and CR3, respectively

---

- b) Special qPCF employs an input isolation cathode follower whose output is capacitively coupled to a differential amplifier. The differential amplifier section employed in the qPCF differs from that used in the aPCF; the amplifier portion consists of two amplifiers instead of one. Feedback from the output is applied to both of these amplifiers. One amplifier has a regulative effect upon the output when the signal is at an up level and cut off when the signal is at a down level. Conversely, when the output is at a down level, the other amplifier provides regulation and is cut off on the up level. As a result of this dual feedback, clamping diodes are not employed in the output circuit. It has four cathode followers connected in parallel in the output to provide sufficient driving power. The output of a qPCF is +12.5 volts or -30 volts for a +10 volts or -30 volts input respectively.
- c) The ddPCF is similar to the qPCF in that a dual feedback loop is employed. Differences between the two models extends to different output levels and circuit complement. The dd<sup>dd</sup>PCF does not use an input isolation cathode follower. Its outputs of -27 volts and -67 volts are obtained from an input of +10 volts and -30 volts respectively by utilizing appropriate reference voltages for the feedback circuit.
- d) Table 3-76 on page 135 of the Special Circuits T. O. provides the model distinguishing characteristics for all models of power cathode followers.

## Manual Data Input Element

## D. Core Matrix Control

1. The core matrix control (fig. 6-20) initiates, controls, and terminates readout of the core matrix. The read-MDI-matrix signal from the Central Computer triggers SS 1. The output of SS 1 is sent as a load shift register pulse to the shift register. The fall of SS 1 sets FF1 which remains set during the entire readout, conditioning GT 1 and furnishing an enabling level to the sense amplifiers and blocking oscillators. Gate 1, FF2, and GT 2 form a frequency divider, passing alternate OD 1 pulses to set FF's 3 and 4. Flip-flop is reset by OD 2 pulses. The output of FF 4 is therefore an OD 1-to-OD 2 level, every 20 usec; sent as a shift level to the shift register.
2. The output of FF3 (set by alternate OD 1 pulses) conditions GT 3 which passes OD 3 pulses as MDI break requests to the Central Computer. The output of GT 3 also resets FF's 2 and 3.
3. The disconnect-MDI-matrix command from the Central Computer is passed as a reading-completed signal to the drum entry section, resets FF1 and FF2, and triggers SS 2 through OR 5. The resetting of FF1 discontinues the enabling level to the sense amplifiers and blocking oscillators. The output of SS2, a 215-usec level, is processed by a reset circuit into a reset level for the shift register.
4. A manual reset pulse (developed in the drum entry section when the MASTER RESET pushbutton on the duplex maintenance console is operated) resets all flip-flops in the core matrix control circuit and triggers SS 2 as well.

Note: fig.  
6-20

Page 0530

Note: for over-  
all simplified  
logic diagram  
see fig. 6-6

Page 0550

## E. Shift Register and Thyatron Core Driver (Block Form)

1. The shift register and thyatron core driver circuit reads out the core matrix. It consists of a register of 128-core shifts (CS), 128 thyatron core drivers (TCD), and 16 core shift drivers (CSD). Each CSD drives eight CS's. The output of each CS is connected to a TCD.

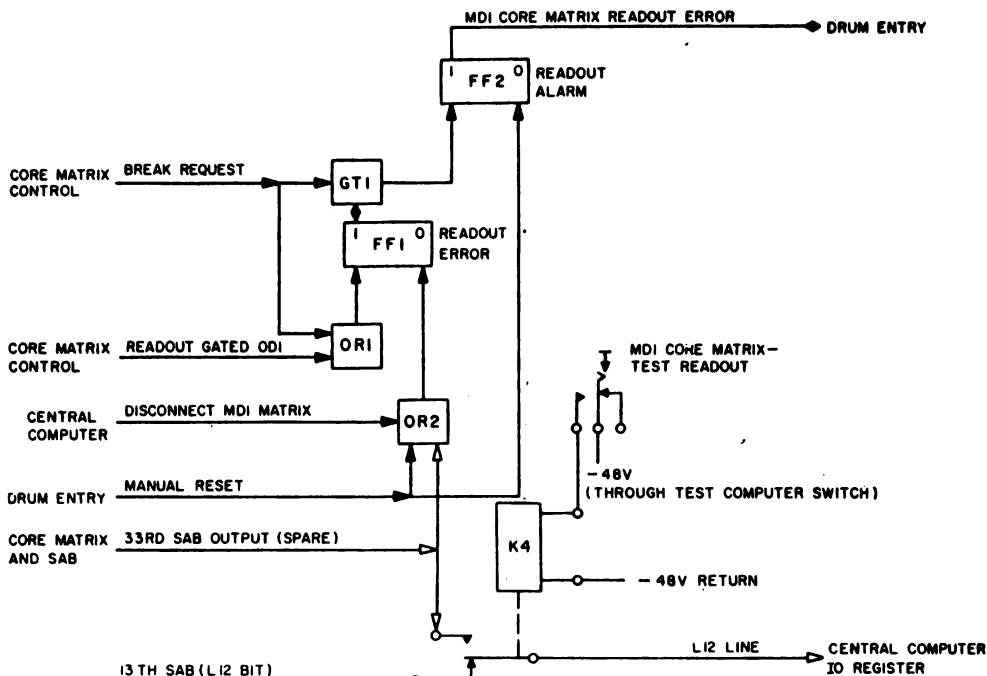


Figure 6-23. Readout Alarm and Switching Circuit, Simplified Logic Diagram

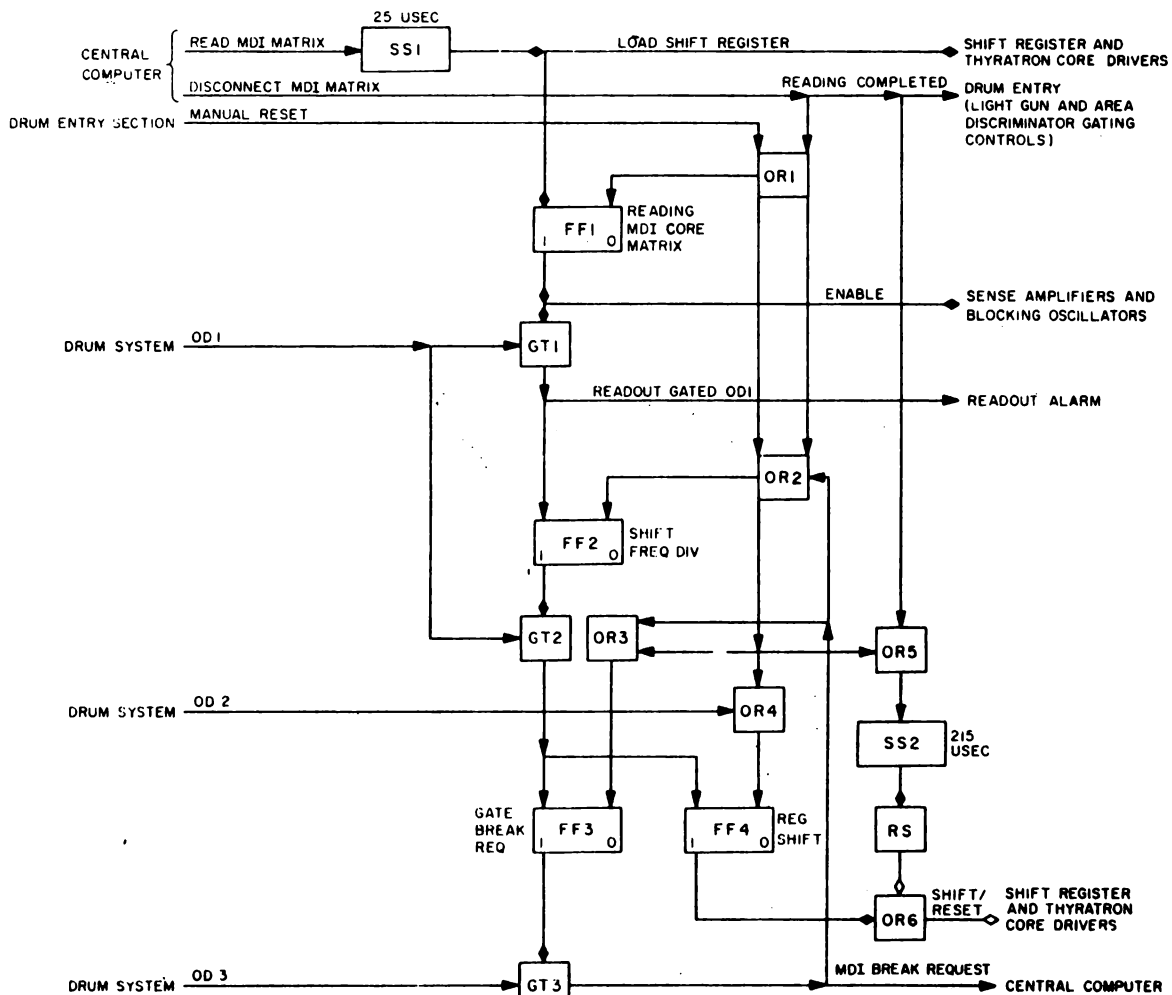


Figure 6-20. Core Matrix Controls, Simplified Logic Block Diagram

## Manual Data Input Element

2. A load shift register pulse from the core matrix controls sets a 1 into CS 1 of the register. The CSD's, driven by shift pulses from the core matrix controls, drive the 1 through the register, transferring this 1 from one CS to the next every 20 usec. As the 1 leaves a CS, it triggers the TCD associated with it. Each TCD is connected to one row of cores in the core matrix. When the TCD fires, it drives out the contents of one row of cores, i. e., one word, from the core matrix. Thus, passing through the register, the 1 fires 128 TCD's, one every 20 usec, reading out 128 rows, or the complete core matrix. The 215-usec reset pulse (generated by the disconnect-MDI-matrix command or by a manual reset pulse), then clears the register completely by reason of its duration. (The effect of this reset process on the core matrix, if any, is immaterial since the enabling level to the sense amplifiers and blocking oscillator is discontinued at the beginning of the reset period.)

## F. Core Matrix and SAB Circuits

1. The core matrix is composed of 128 rows of cores, 33 cores to the row, read out sequentially one row every 20 usec. Thirty-three buses carry the readout to as many sense amplifiers and blocking oscillators (SAB). The outputs of SAB 1 through SAB 32 are conducted to the IO registers of the Central Computer. The 33rd core of each row is a spare, and the output of the 33rd SAB is transferred to the readout alarm and switching circuit.

## G. Readout Alarm and Switching Circuit

1. The readout alarm and switching circuit (fig. 6-23) is provided to detect and analyze readout failure in the core matrix. OD 1 pulses during readout set FF 1. Normally, the output of the 33rd core, processed by SAB 33, clears FF 1 at OD 1-OD2 time, and no alarm is registered. Should there be no output from the SAB at this time, FF 1 remains set, and GT 1 passes the break-request pulse (OD 3 following readout), setting FF 2. The output of FF 2 is sent as an MDI-core-matrix-readout error to a VRD physically located at the drum entry section, which generates both an audible and visual alarm indication at the duplex maintenance console. The manual reset pulse clears both flip-flops.

Fig. 6-23  
Page 0530



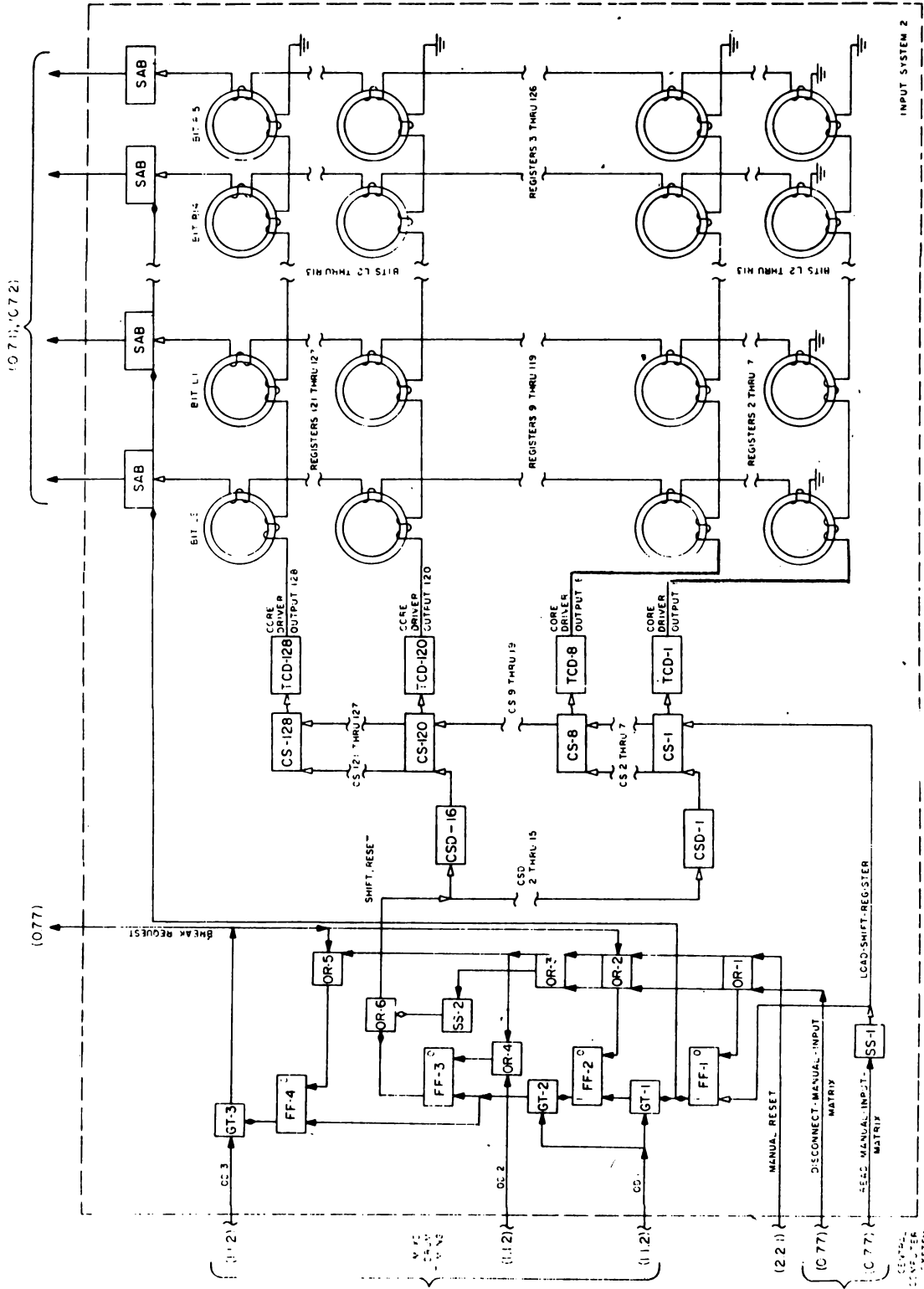


Figure 6-6. Manual Input Matrix, Simplified Logic Diagram

## Manual Data Input Element

2. Since a 1 is permanently installed in the spare core, failure to obtain an output from this core suggests readout failure of the entire row, and a readout alarm therefore indicates a readout failure in one or more rows of the core matrix. A switching circuit is provided to use the facilities of the Central Computer in locating the failing rows. Operation of the MDI CORE MATRIX TEST READOUT switch energizes relay K4 and substitutes the output of the 33rd SAB for the output of the SAB that serves the L12 bit of the readout words. The Central Computer may be programmed to sense for a 1 in the L12 position of each word and make note of the word in which the 1 is not obtained. The failing row is thus located.

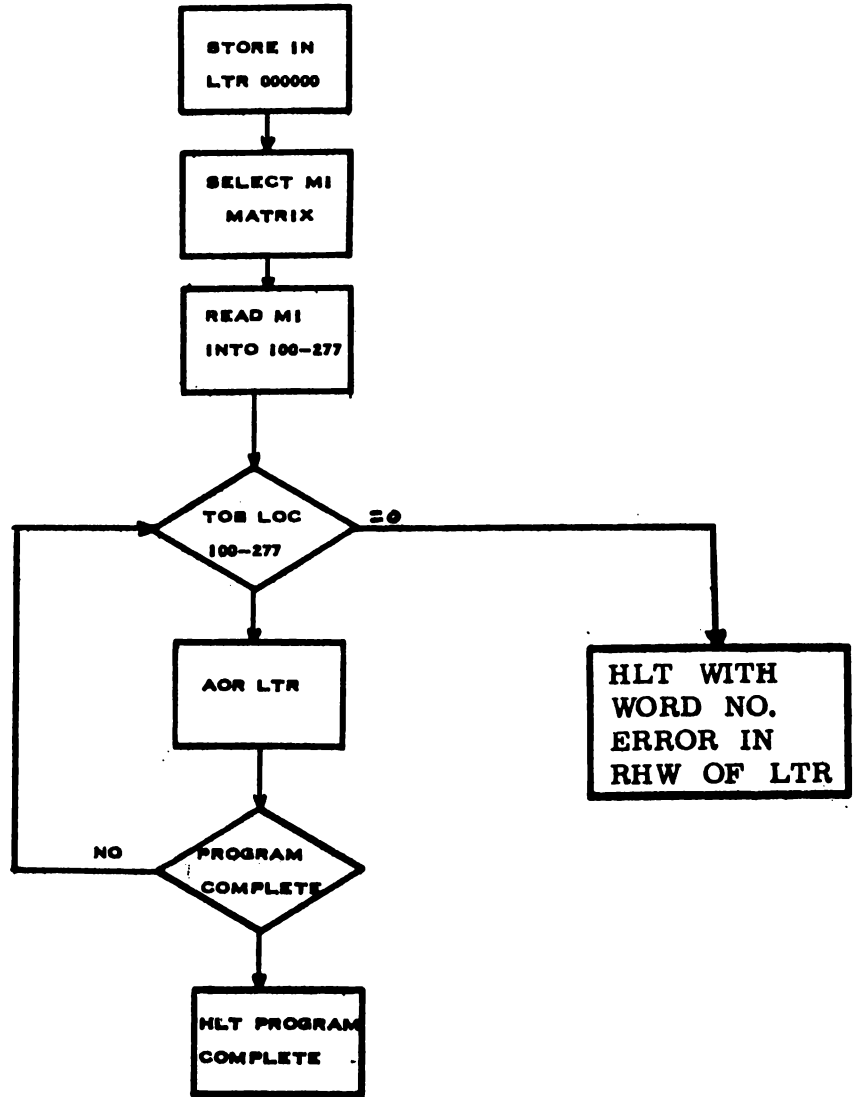
```

000 CAD      014
001 FST      3.77777
002 SEL(06)
003 LDC      100
004 RDS      200
005 BSN 14   005
006 1XIN     177
007 TOB(14) 100
010 BPX      015 - to error HLT
011 AOR      3.77777
012 AOR      007
013 IBPX(01)007
014 HLT      0.00000 correct HLT
015 HLT      0.00000 error HLT
016 BPX      012 Depress continue P. B.

```

## H. Summary Questions

1. Match the following:
1. Intervention Switch
  2. Action Button
  3. Core Shift Driver
  4. Isolation Circuit
  5. Thyatron Core Driver
  6. Sense Amplifier Blocking Osc.
  7. Core Shift
  8. Reset Circuit
  9. Tape Core
  10. Power Cathode Follower Model DD



## Manual Data Input Element

- a. Allow setting but not clearing of tape core
  - b. Generate a near-std. pulse with sine wave input from tape core
  - c. Provide +10 or -30 volts to set or clear tape core
  - d. Tape core used in shift register
  - e. Store Binary Bit
  - f. Provide current to readout 33 cores
  - g. Provide +10 to set tape core
  - h. Condition SAB's
  - i. Clear 128 core shifts
  - j. Shift "1" Bit from one core to next
  - k. Provide current to prime 32 cores
  - l. Condition T. C. D's
  - m. Provide -30 volts to set core
2. At what rate are words read out of MDI MATRIX?
  3. Give basic program for reading out MDI MATRIX.
  4. An open pin at H8 of P. U. 23 B. ~~5~~ (logic 2.2.2, 5A) will:
    - A. Prevent any words from being read from the manual input matrix.
    - B. Prevent 200<sub>8</sub> words from being read from the manual input matrix.
    - C. ~~Prevent shift drive pulses from~~ being applied to cores of the core shift register for words 10 through 177.
    - D. Have no effect.
    - E. Prevent TCD's for words zero thru seven from firing.
  5. Word 110<sub>8</sub>L4 cannot be read out to SAB, this may be due to:
    - A. 23 AS 46 b open (2.2.2, 16B)
    - B. 28 F 30 hh open. (2.2.2-2, 16E)
    - C. 23 AS 11 b open. (2.2.2-2, 17D)
    - D. 23 AS 10 b open. (2.2.2-2, 16D)
    - E. 23 AS 47 b open. (2.2.2, 17D)
  6. Which of the following hubs on 28H is connected to the core used for word #33<sub>8</sub> L7 bit.
    - A. 27m
    - B. 10m
    - C. 9m
    - D. 10Z
    - E. 26m

## Manual Data Input Element

7. Which one of the following would prevent the transfer of the fifty-ninth word to the I/O buffer from the MI matrix? (2. 2. 2) Other words OK.
- A. 23 BGA6 open (4A)
  - B. 23 BNH8 open (13A)
  - C. 23 AP73d open (14A)
  - D. 23 BPJ7 open (14A)
  - E. 23 AP73e open (14A)
8. Logic 2. 2. 2, (2C) 23 BD GT5, fails to pass pulses. This will cause:
- A. Failure to read out MI matrix to I/O buffer register.
  - B. A reset pulse to be generated.
  - C. Reading out of first MI matrix word only.
  - D. Matrix to be read at a 100 KC rate.
  - E. FF 3 23 BC to clear.

## Manual Data Input Element

### IV. Drum Entry Logic Operation

#### A. General

1. The drum entry section processes SD data and CEP data for transfer to the Drum System and thus to the Central Computer. The SD data pertains to targets appearing at display consoles equipped with a light gun. Computer entry punch data is generated in three model 020 computer entry punches. Data is formed into drum words and released to the Drum System in the order of priority assigned on the basis of the data's origin.

#### B. MDI Drum Word Format

1. The MDI drum word format is shown in figure 6-24. Situation display data may be either track data or radar data, and radar data may be either correlated or uncorrelated, depending on the type of target to which the light gun has responded. In all types, 24 bits of the 32-bit drum word, LS through R5, are allotted to target information; eight bits, R6 through R13, to identification of the console at which the message originated; and two bits, R14 and R15, to a code for the type of information. Computer entry punch information is read into the drum entry section one column at a time, and the drum word transferring this type of information is organized as follows:

LS-L11:	One column of card information
L12-L15:	Identification of CEP machine
RS-R1:	Not used
R2-R6:	Card count
R7-R13:	Column count
R14-R15:	Type of information (CEP)

#### C. Functional Description

1. Data flows into the drum entry section through four channels; one SD channel and three CEP channels. The drum entry section performs the following functions with respect to this data:

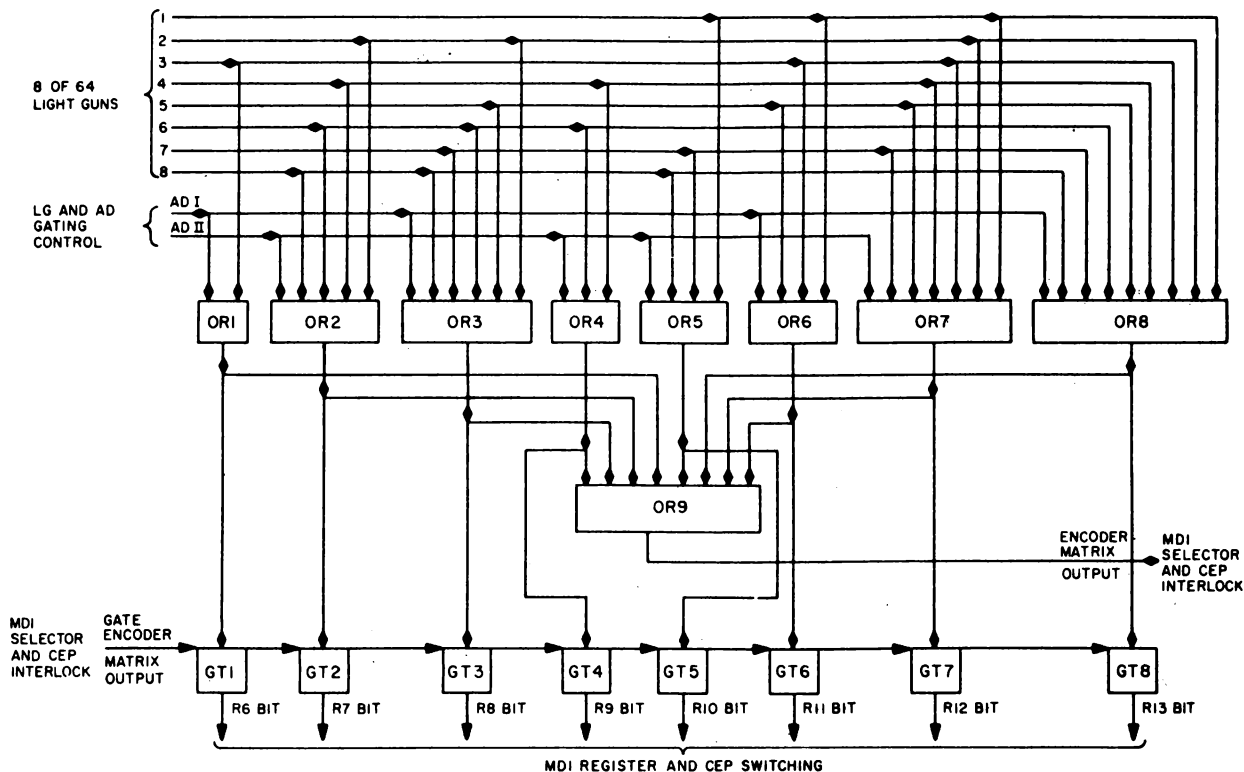


Figure 6-27. Encoder Matrix Subsection, Simplified Logic Diagram

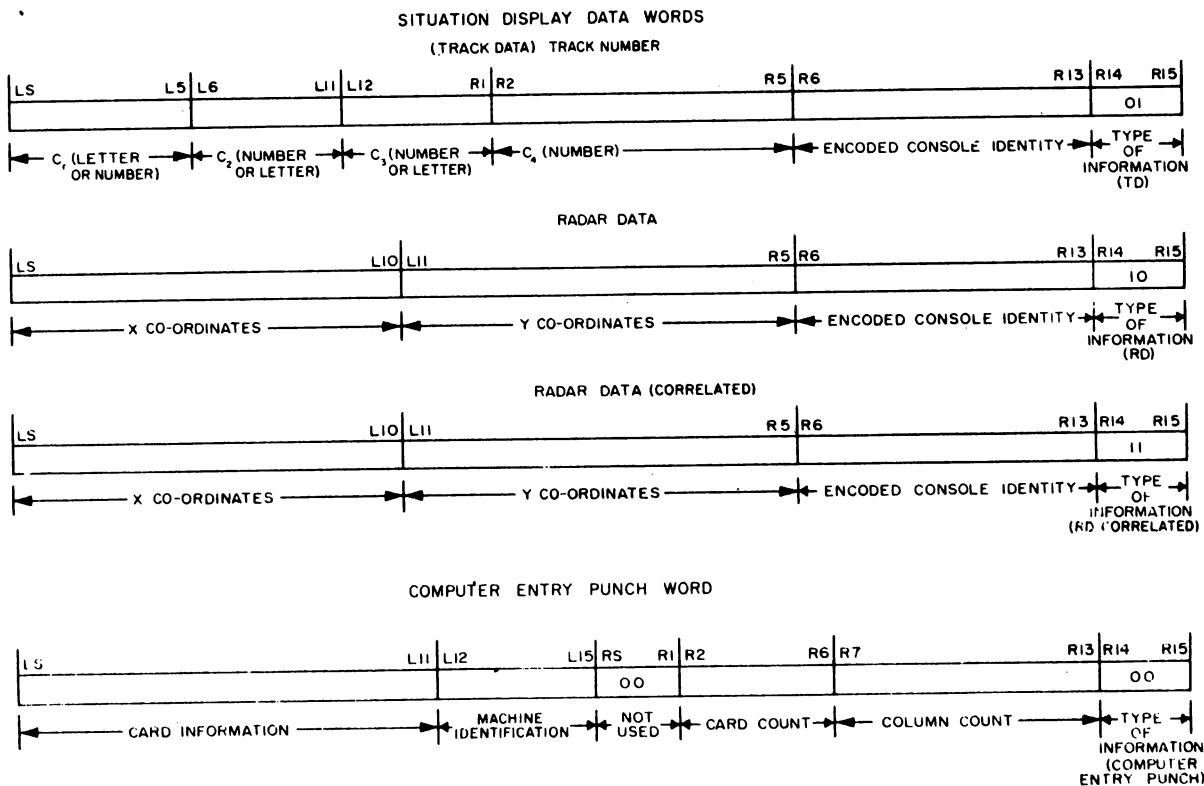
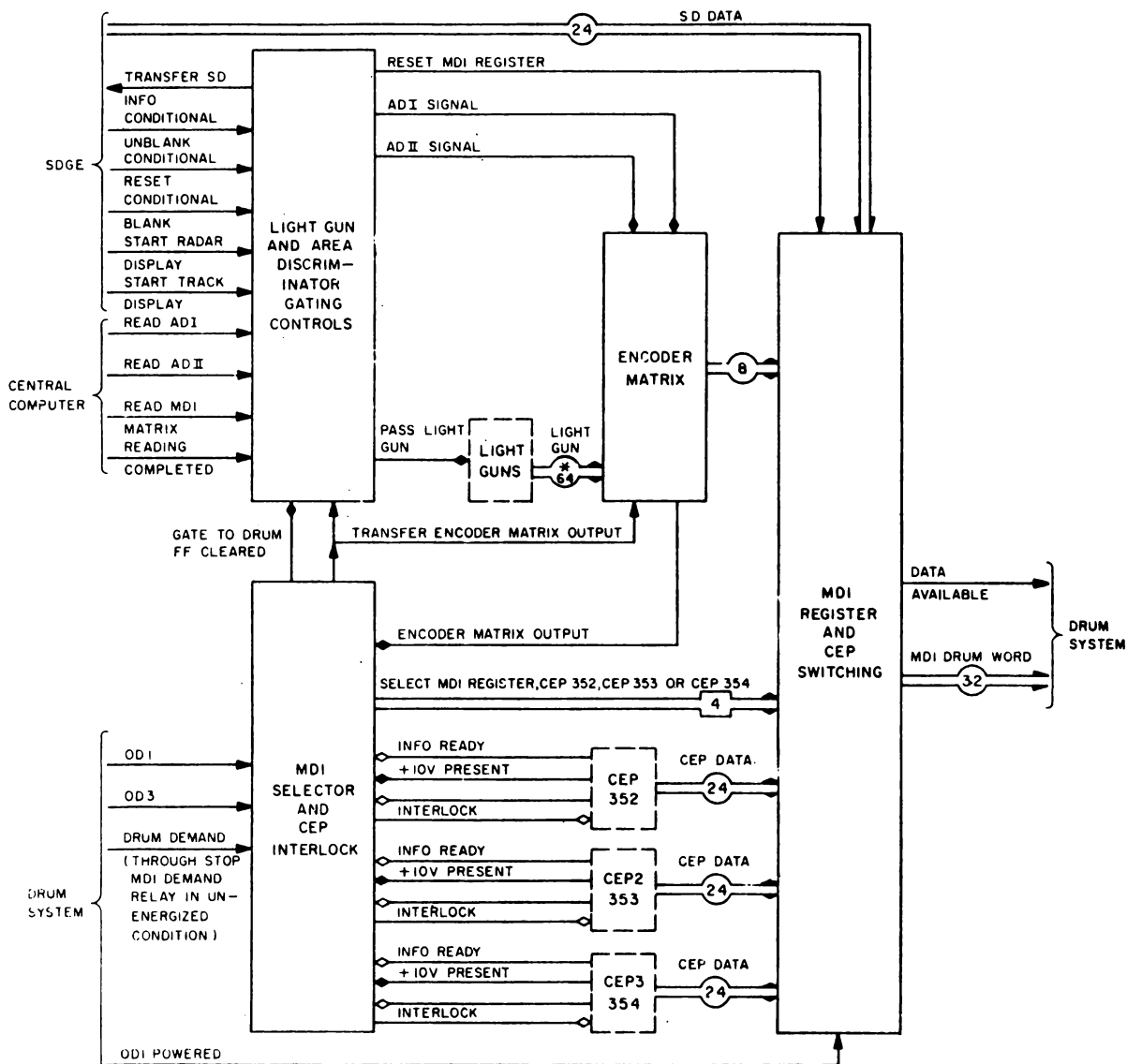


Figure 6-24. Manual Data Input Drum Word Format

## Manual Data Input Element

- a. Senses each channel for the presence of data and reads out the data in the order of pre-established priority: SD, CEP 352, CEP 353, CEP 354.
  - b. Adds a 4-out-of-8-bit code to SD data identifying the console at which a light gun responded to a target.
  - c. Inhibits light gun operation during readout of the core matrix in the direct entry section.
  - d. Provides circuits to test the processing of light gun signals.
2. The drum entry section is organized into six subsections (fig. 6-25) listed and briefly described below:
- a. Light gun and area discriminator gating control (LG and AD gating control): controls the flow of SD data into and through the drum entry section. (Note: The Area Discriminator (AD) gating and control circuitry is now used for Encoder Matrix test purposes only.) Fig. 6-25  
Page 0630
  - b. Encoder matrix: adds the 4-out-of-8-bit console identification to the SD message.
  - c. MDI selector and CEP interlock: exercises priority control in the selection of data and controls readout of data.
  - d. MDI register and CEP switching: receives, stores, and reads out data to the Drum System.
  - e. Manual reset: resets all flip-flops in both the direct entry and drum entry section, with the exception of the MDI register, upon operation of the MASTER RESET pushbutton on the duplex maintenance console.
  - f. Test circuit: Permits a test of the processing of light gun and area discriminator signals.





NOTE:  
 MANUAL RESET CIRCUIT OMITTED FOR SIMPLICITY; SUPPLIES  
 RESET PULSE TO ALL FLIP-FLOPS EXCEPT THOSE IN MDI REGISTER  
 \* MAXIMUM CAPABILITY

Figure 6-25. Drum Entry Section, Block Diagram

## Manual Data Input Element

The operation of these subsections depends to an important extent on the type of data being processed. Situation display and CEP data are processed differently. Therefore, the theory of operation on the subsection diagram level discusses the processing of each type of data separately: light gun and computer entry punch.

### 3. Light Gun Data

- a. Light gun data is introduced into the drum entry section by the response of a light gun to a target indication. The action begins with the intensification of a target on the display screens. Fifteen usec after intensification begins (regarded as 0 time), the SDGE sends a conditional-unblank signal to the LG and AD gating control subsection. This subsection generates a pass-light-gun signal if the following conditions are met.
  - 1) The MDI core matrix is not being read out. (In effect, this means that no pass-light-gun signal can be generated in the interval between the read-MDI-matrix signal and the reading-completed signal.)
  - 2) The SD message previously installed in the MDI register has been transferred to the Drum System (signified by the gate-to-drum FF-cleared signal from the MDI selector and CEP interlock).
- b. The pass-light-gun signal is distributed to all light guns, permitting them to respond to the intensified target. At 17.5 usec, the LG and AD gating control passes a conditional-reset signal from the SDGE, as a reset-MDI-register pulse, to the MDI register and CEP switching circuit. This pulse resets the MDI register in preparation for receipt of an SD message. At 22.5 usec, the LG and AD gating control converts the conditional-blank pulse from the SDGE to a transfer-SD-information signal; this signal causes the transfer of 24 bits of target description from the SDGE to the MDI register. If, meanwhile, a light gun has

Fig. 6-16  
Page 0270

## Manual Data Input Element

responded to the intensified target, it sends a light gun signal to the encoder matrix. The encoder matrix generates a distinctive configuration of four 1's out of 8 bits, identifying the console at which the light gun signal originated, and signalizes this action with an output pulse to the MDI selector and CEP interlock. This subsection then utilizes OD timing to cause transfer of the 4-out-of-8-bit console identification from the encoder matrix to the MDI register. The MDI register now contains a 32-bit drum word: 24 bits of SD information plus 8 bits of console identification. Upon receipt of an MDI-drum-demand signal the MDI selector and CEP interlock send an MDI register select level to the MDI register, causing readout of the register to the Drum System.

- c. It is possible for more than one light gun to respond simultaneously to the same target. In that case, two light gun signals are sent to the encoder matrix which responds with a more-than-4-out-of-8-bit output. Such a code will not interfere with the operation of the drum entry section, but will be recognized as improper by the Central Computer which will ignore the SD message associated with the target.
- d. One feature in the processing of light gun data warrants additional explanation. The sole function of the pass-light-gun signal is to permit interlock of the light gun function and thus prevent the setting of light gun cores in the MDI core matrix during core matrix readout. (The light gun output must be directed to the core matrix since this is the means by which a keyboard message is associated with the target to which it pertains.)
- e. It should also be noted that the 24-bit SD portion of the drum entry message is moved into the MDI register by SDGE timing, whereas the 8-bit console identification portion is moved into the register by drum timing. The distinction is made necessary by the fact that the time of arrival of the light gun output in the encoder

## Manual Data Input Element

matrix is variable; it depends on the length of the lines from the display consoles to the encoder matrix, the responsiveness of the photoelectric element in the light gun, etc. Consequently, a 1-time signal such as the conditional-blank pulse will not furnish reliable timing in this application whereas OD timing, being repetitive, does.

### 4. Computer Entry Punch Data

- a. Computer entry punch data originates in punched cards fed into one of the three CEP's. Data is introduced one card-column at a time and held in the relays of the CEP machine until accepted for transfer by the drum entry section. The data is made accessible to the MDI register and CEP switching subsection. The presence of data is indicated by an information-ready signal to the MDI selector and CEP interlock subsection, which interlocks the CEP machine; i. e., prevents it from introducing additional data until the data in its relays is processed. A drum-demand pulse from the Drum System passes through the MDI selector and CEP interlock subsection, sensing for the presence of data. If no SD data is available (held in the MDI register), the drum-demand pulse senses the CEP 352 circuit in the MDI selector and CEP interlock subsection, initiating readout, from the MDI register and CEP switching subsection, of data offered by the CEP 352 machine. If this machine holds no data in its relays, the drum-demand pulse passes to the circuit serving CEP 353, initiating readout of data, if any, offered by that machine, and if no such data is available, passing to the circuit for CEP 354.

### 5. Significance of Priority Control

- a. Drum-demand pulses are sent to the drum entry section at a maximum rate of once every 10 usec; this rate is maintained as long as the MDI drum field offers empty slots. The maximum rate at which SD data is made available is once every 60 usec in the case of radar data and once every 1,040 usec in the case of track data. On the

## Manual Data Input Element

order of 1 ms is required to set up a column of punched card data in the CEP relays. It is evident that priority control has no significance as long as ample drum storage is available; even if all the data sources offer information at the maximum rate, it will be processed considerably faster than it is made available. However, any time the MDI drum field cannot accommodate all available data, the priority control circuits in the MDI selector and CEP interlock operate to reserve storage space for the data of highest priority.

## D. Light Gun and Area Discriminator Gating Control

1. The light gun and area discriminator (LG and AD) gating control subsection (fig. 6-26) controls the flow of SD data through the drum entry section, synchronizing the action of this section with timing and control pulses from the SDGE. Following readout of a word from the MDI register, a gate-to-drum-FF cleared level is furnished GT1. A conditional-unblank pulse, occurring 15 usec after the start of target intensification, passes GT 1 to set FF 3, the MDI-register-ready flip-flop. The 1 side of the flip-flop provides a conditioning level to AND's 1, 2, and 3 and gates 9 and 10.
2. Light gun data processing: Flip-flop 2 is clear at all times, except during readout of the MDI core matrix, conditioning GT 2. The conditional-unblank pulse passes GT 2 to set FF 4. The set side of FF 4 supplies the second input to AND 1 required to produce the pass light gun level. This level, supplied to all light guns, permits a light gun to respond to the target indication. (During readout of the MDI core matrix, FF 2 is set, GT 2 is deconditioned, and the pass-light-gun signal is not produced; this interlock prevents a light gun core in the MDI core matrix from being set during readout.) At 17.5 usec in the intensification period, a reset-MDI-register pulse from the SDGE passes GT 10, clearing the MDI register in preparation for receipt of the new drum word. At 22.5 usec, the conditional blank pulse from the SDGE passes GT 9, as a transfer-SD-information pulse, causing the SDGE to release its 24 bits of target information. The conditional blank pulse also resets FF 4, and the output of GT 9 also resets FF 3. The action of the circuit with respect to a single target presentation is complete.

Fig. 6-26  
Page 0690

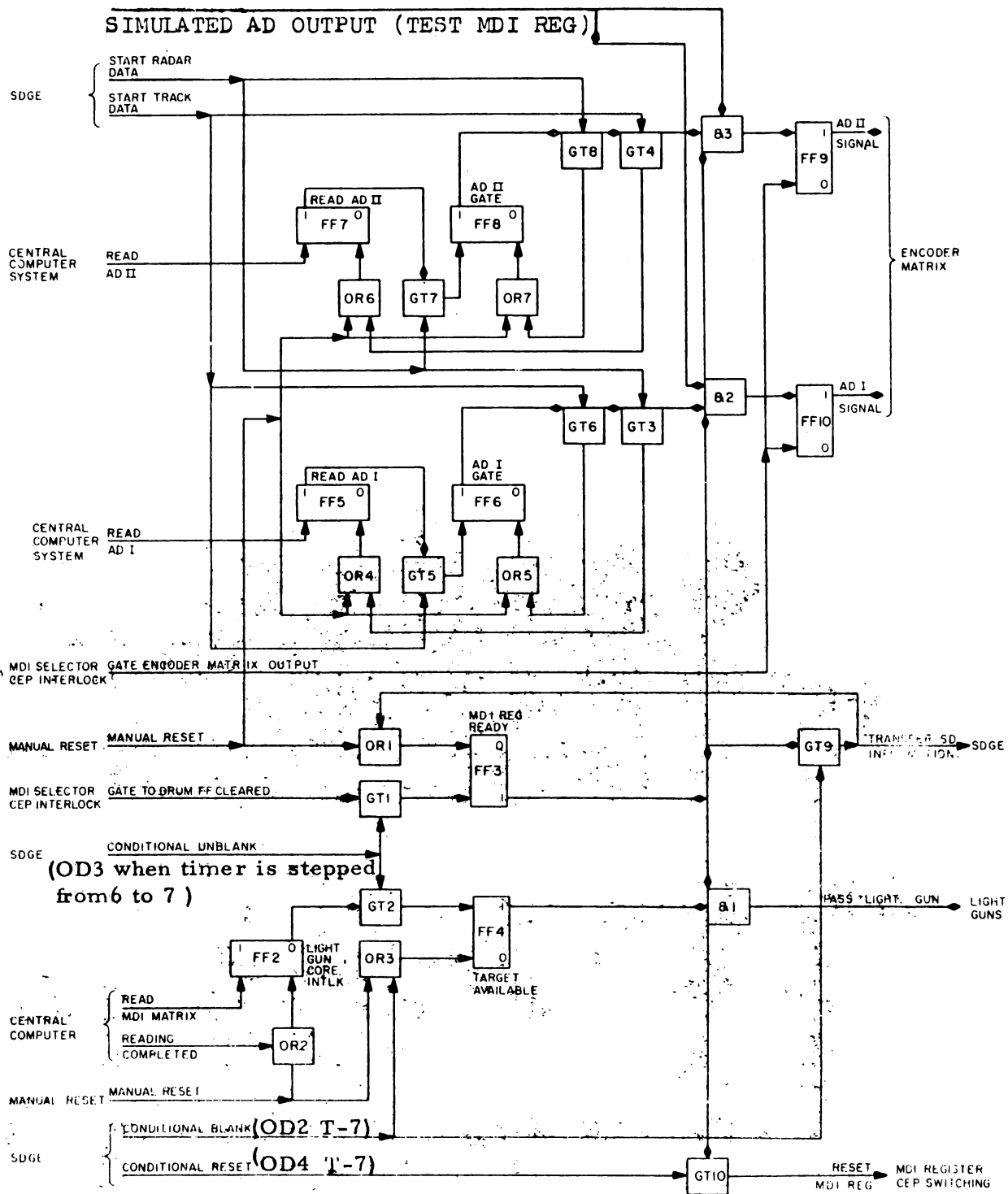
## Manual Data Input Element

## E. Encoder Matrix

1. On receipt of a light gun signal, the encoder matrix (fig. 6-27) generates a 4-out-of-8 bit code (four 1's out of 8 bits); the code identifies the console at which the light gun responded to a target. Fig. 6-27  
Page 0610
2. The encoder matrix incorporates a great number of diode OR's organized in such a way that each input to the matrix will apply conditioning levels, in a distinctive pattern, to four out of eight gates. In figure 6-27, 8 out of a theoretical maximum of 64 inputs from light guns are shown.
3. Any input to the encoder matrix will produce an output from OR 9. This level (encoder-matrix-output) is sent to the MDI selector and CEP interlock circuit where it is synchronized with OD timing, delayed, and returned as a gate-encoder-matrix-output pulse to the encoder matrix. This pulse strobes the eight gates in the encoder matrix, four of which are conditioned, sending a 4-out-of-8 bit code to the MDI register and CEP switching subsection. Should more than one light gun signal arrive simultaneously at the encoder matrix, more than four gates will be conditioned, and a more-than-4-out-of-8 bit code will be transferred to the MDI register and CEP switching subsection; the operation of the encoder matrix is not otherwise affected.

## F. MDI Selector and CEP Interlock

1. The MDI selector and CEP interlock subsection controls the flow of data to the MDI register and CEP switching subsection, ensuring precedence to data of the highest priority. The subsection consists of four groups of circuits, governing the flow, in the order of priority, of SD data and CEP 352, CEP 353, and CEP 354 data, respectively. Two groups of circuits, those relating to SD and CEP 352 data, are shown in figure 6-28; the CEP 353 and CEP 354 circuits duplicate the CEP 352 circuit.
2. Review Drum Theory Status Operation Fig. 6-35  
Page 0710
  - a. Two Status Channels (Fig. 6-35)
    - 1) OD Status Channel written by CD, read by OD



**Manual Data Input Element**

- a) Indicates to OD side whether or not registers read by CD side. Generates Drum Demand Pulse (OD3) whenever it reads a zero.
  - 2) Status channel written by OD read by CD1. Indicates to computer whether or not registers contain information.
- b. Writing information on OD Side of MI Drum
- 1) Drum Write Register (32 F. F. 's)
    - a) Receives information from MDI Drum Entry Section.
    - b) "Data available pulse" accompanies information to Write Register.
      - (1) Allows information in Drum Write Register to be written on Drum.
      - (2) Allows a "1" to be written in CD Status channel.
- c. Reading information CD Side of MI Drum
- 1) Mode of Reading - Status Identity
    - a) Computer Selects MI Drum for reading
    - b) CD Status channel controls reading of information.
      - (1) Detecting a "1" allows information from that register to be transferred to computer.
      - (2) Computer checks R14 and R15 of Drum word for identity.
      - (3) If identity compares computer writes a "0" in OD Status channel.
      - (4) If identity does not compare, computer writes a "1" in OD Status channel.



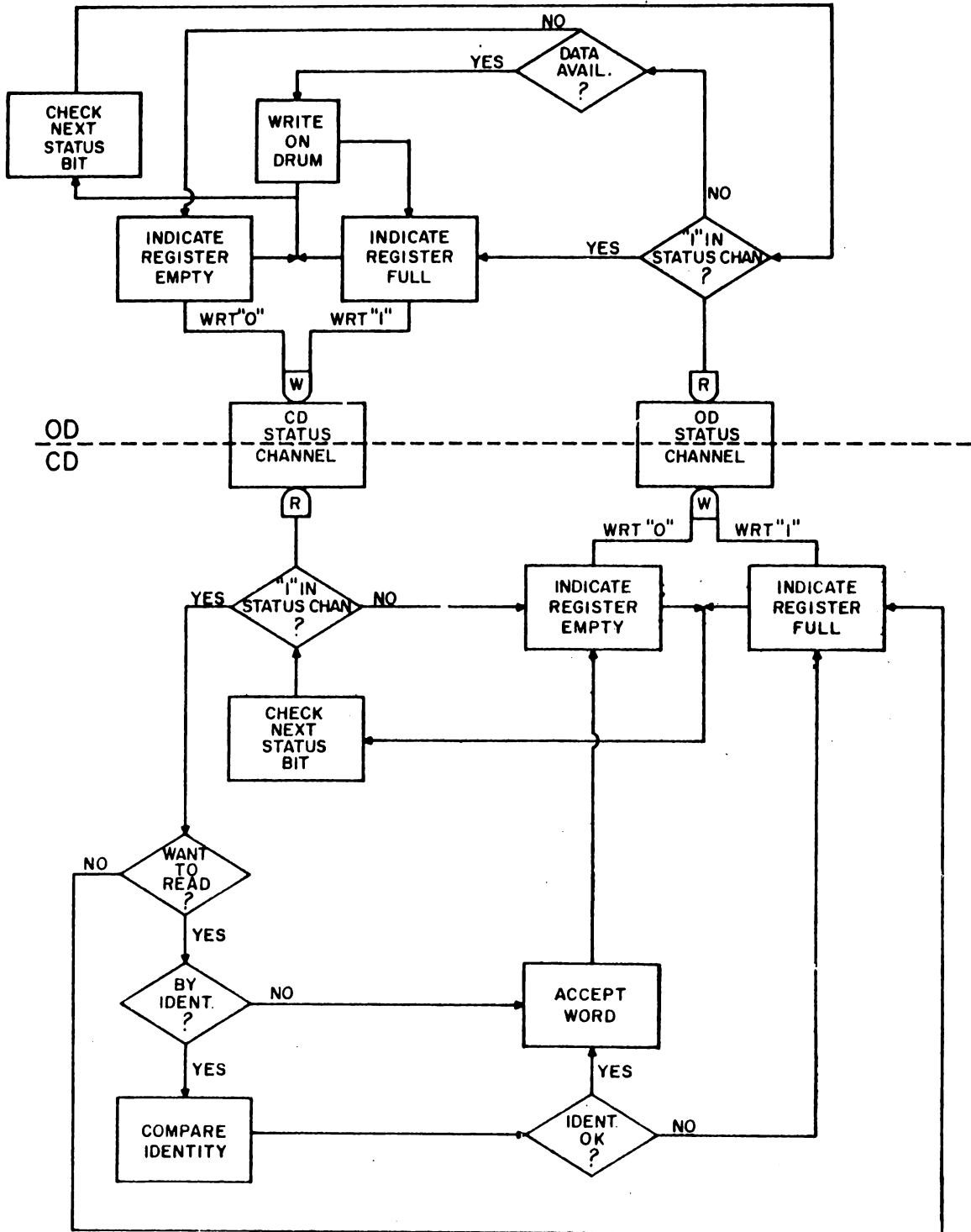


Figure 6-35 STATUS-IDENTITY READING

## Manual Data Input Element

## 3. Situation Display Data Selection

- a. The priority of SD data processing is provided in the following manner. Assume that a light gun has responded to a target. This response sends an encoder matrix output level to the MDI selector and CEP interlock subsection. This level, produced 15-plus usec after the start of target intensification, signifies that the message relating to the target is to be processed; it is applied to AND 1. The other input to AND 1 is available, except when a previously processed SD message is awaiting transfer to the Drum System (i.e., awaiting a drum-demand signal). Assume that this input to AND 1 is available. The output of AND 1 is up, conditioning GT 1. Five to 10 usec later (variable because the relationship between the encoder matrix output level and OD timing is variable), the following effects occur:

Fig. 6-28  
Page 0730

- 1) The output of GT 2 is sent to the encoder matrix (where it transfers the 4-out-of-8-bit console identification to the MDI register).
- 2) FF 2 is set; the gate-to-drum-FF-cleared level to the LG and AD gating control circuit is discontinued; the output of AND 1 is down.
- 3) GT 3 is conditioned.

The overall effect of the above operation is to complete the drum word in the MDI register and to inhibit light gun signals until the contents of the register are transferred to the Drum System.

- b. Transfer is accomplished by a drum-demand pulse. This pulse passes GT 3 to set FF 3, which conditions GT 5 and sends an MDI register-selected-level to the MDI register and CEP switching circuit. The level permits the transfer of the word in the MDI register at the following OD 1 time. The same OD 1 pulse resets FF 3, and passes GT 5 to reset FF 2,

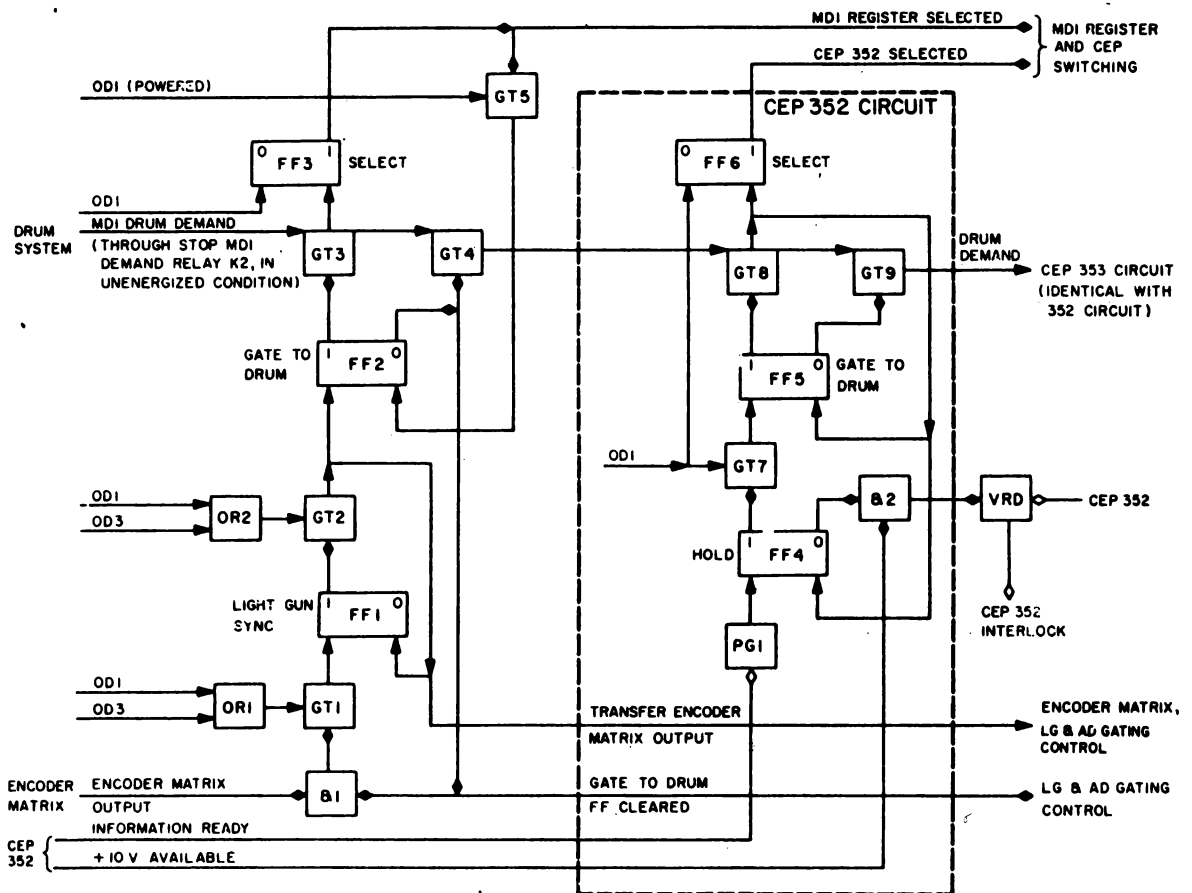


Figure 6-28. MDI Selector and CEP Interlock Circuit

## Manual Data Input Element

restoring the gate-to-drum-FF-cleared level to the LG and AD gating control subsection. Light gun signals may now be generated again, and should such a signal be generated, the action described above will be repeated. The output of AND 1 is brought up and, in 5 to 10 usec, GT 3 is conditioned. Thus, each light gun signal prepares an SD message for transfer to the Drum System, and the first drum-demand signal, after the message has been installed in the MDI register, accomplishes the transfer.

## 4. CEP Data Selection

- a. Assume now that no light gun has responded to a target in the interval between drum-demand signals; therefore, no SD data need be processed. The MDI selector and CEP interlock then operate to sense for and transfer available data of the next highest priority; that is, from CEP 352.
- b. Since no light gun signal has been produced, no encoder matrix output level is sent to AND 1; FF 2 remains clear, and GT 4, conditioned. The drum-demand signal is passed by GT 4 to the CEP 352 selection circuit. Assume next that data is held in the relays of CEP 352. This condition is indicated by an information-ready signal, triggering PG 1. Gate 8 is therefore conditioned. The drum-demand pulse passes this gate to set FF 6, sending a CEP 352 selected level to the MDI register and CEP switching subsection. This level accomplishes transfer of the data held in the CEP 352 relays.
- c. The output of GT 8 also resets FF 4, supplying one input to AND 2. The other input to AND 2, +10V present, is available whenever the CEP is associated by its unit status switch with the duplex half of unit 23 assumed under discussion. The output of AND 2 triggers the VRD, closing the interlock circuit to CEP 352. This permits the machine to advance the punched card to the next column. The pulse generator is then triggered again,

## Manual Data Input Element

setting FF 4 which opens the interlock to CEP 352. The punched card cannot now be advanced until the next drum-demand pulse accomplishes readout of the data held in the relays and closes the interlock. The machine continues to read out data as long as two conditions are met:

- 1) Card information is available.
  - 2) Drum-demand pulses are admitted to the CEP 352 selector circuit.
- d. Should there be no SD or CEP 352 information available for transfer, both FF 2 and FF 5 will be clear, and the drum-demand pulse will then be passed by both GT 4 and GT 9 to the gate equivalent to GT 8 in the CEP 353 selector circuit. In this circuit, identical to that for CEP 352, the drum-demand pulse senses for the availability of data, accomplishes its readout if it is present, and closes the interlock to the CEP 353 machine, permitting another column of punched card information to be set into the CEP relays. If CEP 353 offers no data, the drum-demand pulse is passed by the equivalent of GT 9 to the CEP 354 selector circuit to perform its sensing and readout function there.

### MDI Register and CEP Switching

1. The MDI register and CEP switching (fig. 6-29) receives all drum entry data, stores SD data in a 32-FF register, accepts CEP data from the CEP relays in the form of sets of conditioning levels, and reads out data to the Drum System under the priority control of the MDI selector and CEP interlock subsection.
2. Situation Display Data Storage and Readout
  - a. The MDI register (FF's 1 through 32) is cleared 17.5 usec after the start of each target intensification by the reset-MDI-register pulse from the LG and AD gating control subsection. At 22.5 usec of each intensification period, 24 bits of SD data are transferred from the SDGE to FF's 1 through 24.

Fig. 6-29  
Page 0770

## Manual Data Input Element

- b. If a light gun responds to the target, the encoder matrix stores a 4-out-of-8-bit console identification code in FF's 25 through 32. Each set flip-flop supplies an input to a corresponding AND in the SD bank of AND's. The MDI-register-selected level, furnished by the MDI selector and CEP interlock subsection, in response to a drum-demand signal, supplies another input to this bank of AND's, conditioning the readout gates, through the 32 4-way OR's, in a reflection of the SD word in the MDI register. The MDI-register-selected level also conditions GT 1 through OR 1. The next OD 1 pulse passes GT 1 to strobe the readout gates, reading out the SD word into the Drum System. The output of GT 1 is also supplied to the Drum System as a data-available signal.

## 3. CEP Readout

- a. Information held in the relays of a CEP machine is expressed as a pattern of +10V levels to a bank of AND's associated with that machine. Twenty-four AND's are included for each machine, for this purpose: equivalent to the LS through L11 and R2 through R13 bits in the drum word. Inputs to four other AND's, equivalent to bits L12 through L15, are permanently wired to identify the CEP machine, in accordance with the following code:

	L12	L13	L14	L15
CEP 352	0	0	0	1
CEP 353	0	0	1	0
CEP 354	0	0	1	1

Inputs to the AND's equivalent to the RS, R1, R14, and R15 bits of the drum word are wired to -30V, making them bits permanently zero. The 0-0 in the R14-R15 bit positions signify CEP information; the RS-R1 bit positions are blank.

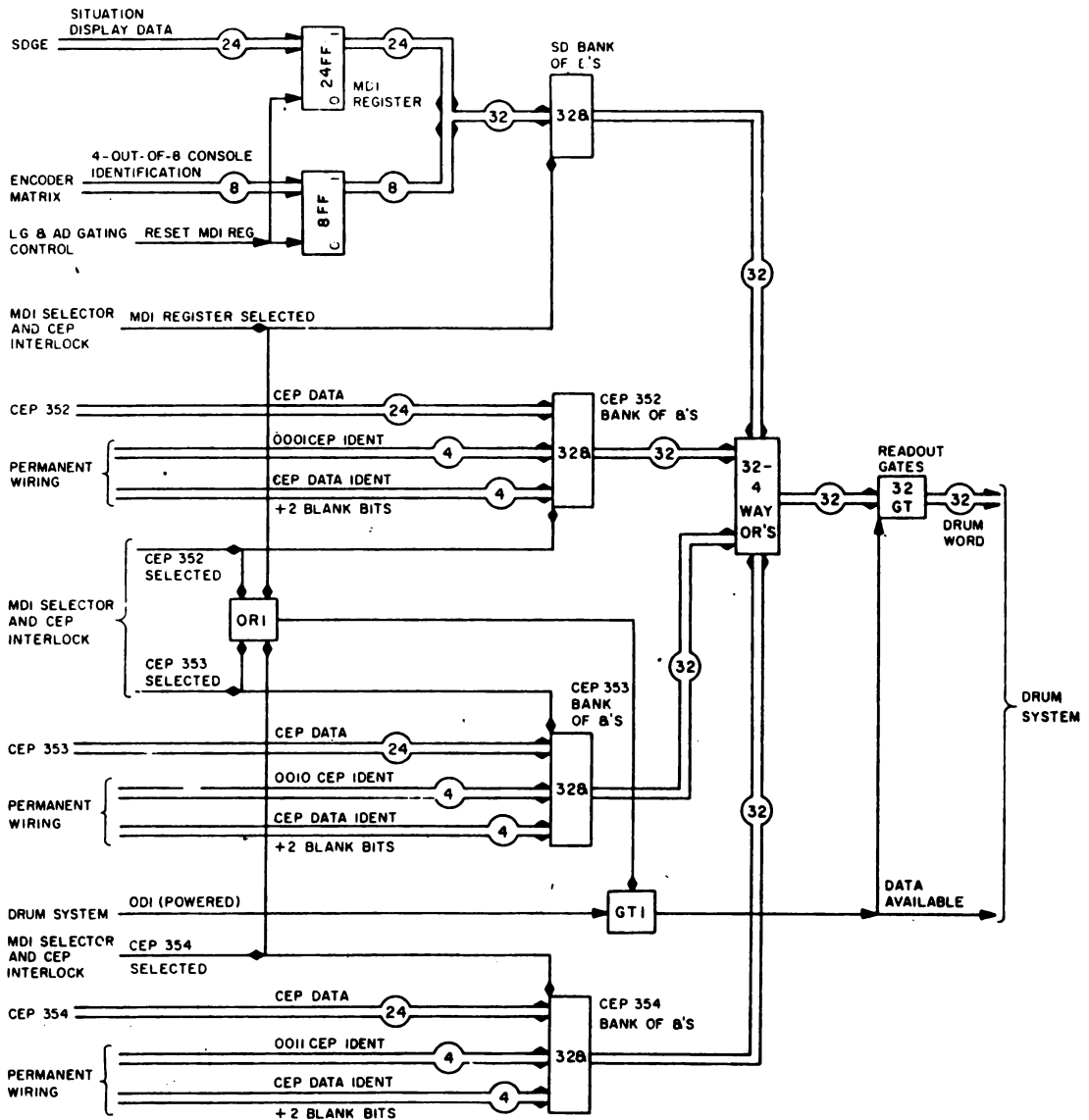


Figure 6-29. MDI Register and CEP Switching, Simplified Logic Diagram

## Manual Data Input Element

Assume that the MDI selector and CEP interlock subsection has selected CEP 352 data for readout. A CEP 352 selected level supplies the second input to the AND's for CEP 352, conditioning the readout gates through the 32 4-way OR's in a pattern reflecting the CEP drum word. This level also conditions GT 1 through OR 1. The next OD 1 pulse passes GT 1 to strobe the readout gates, reading out the CEP 352 word to the Drum System. The output of GT 1 also serves as a data-available pulse.

Readout of data from all CEP machines is accomplished in the same manner. A CEP 353 selected level is applied to the bank of AND's provided for the CEP 353 machine and to GT 1, accomplishing readout if this machine holds data in its relays. A CEP 354 selected level performs the same function for the CEP 354 machine.

### H. MANUAL RESET CIRCUIT

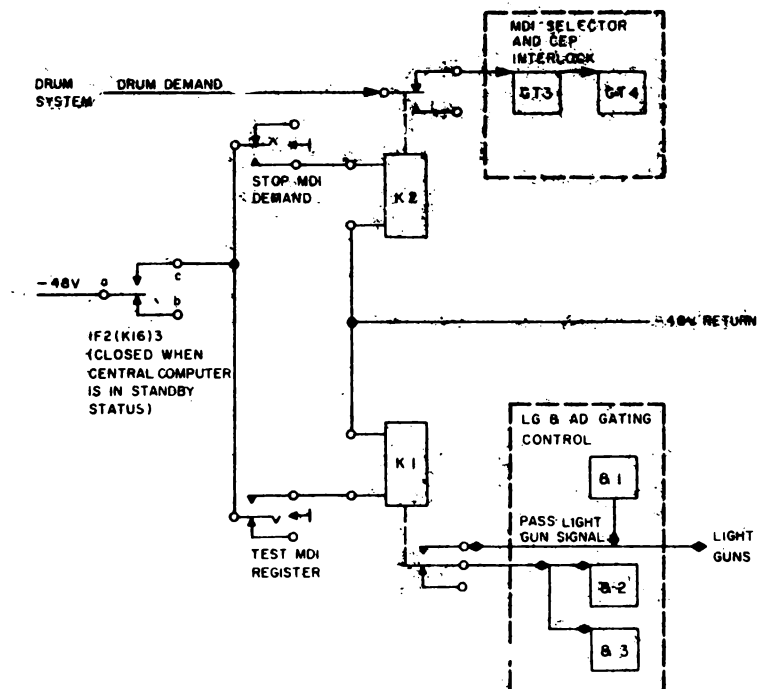
1. The manual reset circuit consists of a pulse generator and power amplifiers. The pulse generator is triggered by depression of the MASTER RESET push-button on the duplex maintenance console. The standard pulse output of the PG is power-amplified and distributed to all flip-flops in both the drum entry section and the direct entry section, except for the MDI register flip-flops; these are reset by the conditional-reset pulse from the SDGE, occurring at 17.5 usec in every target-intensification period.

### I. LIGHT GUN AND CONSOLE IDENTIFICATION TEST CIRCUIT

1. A circuit is provided (fig. 6-30), to test the operation of the light guns and console identification circuitry. THE STOP MDI DEMAND and TEST MDI REGISTER switches in the MI portion of module C, duplex maintenance console, are used to set up the test circuit; the "console identification" section of the MDI register neons, in the same portion of the duplex maintenance console, provides convenient success-failure indications. Operating the STOP MDI DEMAND switch energizes relay K2, disconnecting the drum-demand input from the Drum System and preventing readout of the MDI register. Operation of the TEST MDI REGISTER

Note:  
Fig. 6-30  
Page 0790





**Figure 6-30. Light Gun and Console Intensification Test Circuit**

## Manual Data Input Element

switch energizes relay K1. The pass-light gun signal is thereby routed to AND 2 and to AND 3 of the LG and AD gating control, providing simulated AD output signals. (See paragraph 4 below for a detailed description of the operation of the AD gating control circuitry.) Activated by a read-AD11 command and a start-RD signal, this subsection operates to transform the pass-light-gun signal into a simulated AD 11 signal. This signal, in the encoder matrix, generates a 01011010 output pattern which, transferred to the MDI register, sets the R12, R10, R9 and R7 flip-flops, lighting the corresponding neons. A read-AD 1 command and a start-TD signal will prepare a simulated AD 1 signal which, in the encoder matrix, will generate the complement of the AD II code, 10100101. Together, these outputs thoroughly exercise the encoder matrix and provide a general, though incomplete, check of the operation of the drum entry section.

2. To check the operation of the light gun and the processing of light gun signals, only the STOP MDI DEMAND switch is operated. A light gun responding to a target generates a 4-out-of-8-bit code which appears in the MDI register neons, thus permitting a rapid visual check of the operation of the light gun. All light guns may thus be checked in succession.
3. The STOP MDI DEMAND switch must be restored to the off position between each of the tests described above. This allows the drum-demand signal access to the MDI selector and CEP interlock subsection, restores the gate-to-drum-FF-cleared level to the LG and AD gating control subsection, and permits the pass-light-gun signal to be generated and the MDI register to be reset during the next intensification period.
4. Referring to figure 6-26 on page 0690, the following is a description of the operation of the AD gating and control circuitry. Assume that area discriminator II test pattern is desired. A read-AD II signal from Central Computer sets FF 7, conditioning GT 7. The start-radar-data pulse from the SDGE passes GT 7 to set FF 8. The set side of this flip-flop conditions GT 8 and GT 4 and supplies an input to AND 3. The simulated AD output from the TEST MDI REGISTER supplies a second input to AND 3. Fifteen usec after the start of intensification, the set side of FF 3 supplies the third input to AND 3, causing it to produce a +10 volt output.

## Manual Data Input Element

At 22.5 usec, FF 3 is cleared and FF 9 is set as the output of AND 3 drops to -30 volts. FF 9 being set sends an AD II signal level to the encoder matrix. The gate-encoder-matrix-output pulse, which transfers the 8-bit console identification from the encoder matrix into the MDI register, also clears FF 9. The next start-track-data pulse from the SDGE resets FF 7 and the following start-radar-data pulse resets FF 8. The action of the circuit is now complete for one test pattern.

If an area discriminator I test pattern is desired, a read-AD I signal from Central Computer would be required and flip-flops 5, 6 and 10 would now perform the control function instead of flip-flops 7, 8 and 9.

## J. Summary Questions

1. Briefly describe the following:
  - a. Light gun and area discriminator gating control.
  - b. Encoder matrix
  - c. MDI selector and CEP interlock
  - d. MDI register and CEP switching
  - e. Manual reset
  - f. Test circuit
  
2. True or False
  - a. Information can be written on consecutive registers on the MI drum field.
  - b. The MI drum field is written on by status and read by address.
  - c. Writing information on the MI drum field is not programmed during normal operation.
  - d. The 020s are duplexed equipment.
  - e. The MI field can be read on the OD side.
  
3. Assume information available in MDI Register and all three CEP's simultaneously. Assume an empty MI Drum. Assume all gate to drum ffs set at same time, OD 1.
  - a. How long will the Gate to Drum FF's be set in each selection circuit?
  - b. How long will the Select FF's be set in each selection circuit?

## Manual Data Input Element

4. Assuming that only letters and figures will be entered via the 020's, what would be the maximum number of "1's" in an MI drum word from the CEP?
  - a. 8
  - b. 9
  - c. 10
  - d. 11
  - e. 12
  
5. The filament of CF-4A, 23DC (2. 2. 1, 14C) is open. The result is:
  - a. No ADI or ADII test patterns possible.
  - b. ADII test pattern will function intermittantly.
  - c. AD I test pattern will function intermittantly.
  - d. No AD I test pattern possible.
  
6. What is the maximum time that FF 5 - 23DK (2. 2. 1, 15C) might remain set?
  - a. 7.5 usec
  - b. 10 usec
  - c. 25 usec
  - d. 1041 usec
  - e. None of the above
  
7. The following word is written on the MI field 0.04001 0.01054. Which one of the following statements describe this word?
  - a. C. E. P. #352, card 1, column 11
  - b. C. E. P. #352, card 1 column 13
  - c. C. E. P. #352, card 2, column 13
  - d. C. E. P. #353, card 1, column 11
  - e. C. E. P. #353, card 2, column 13
  
8. Information can be transferred from the MI register to the MI OD write register normally. CEP information sometimes is transferred incorrectly. This could be due to:
  - a. 23 DG E 5 (2. 2. 1, 22B)
  - b. 23 EG FF-3 has an open filament (2. 2. 1, 20B)
  - c. 23 ES H7 open (2. 2. 1, 6E)
  - d. 23 ET H4 open (2. 2. 1, 4E)

## Manual Data Input Element

9. Light gun actions is taken on an RD MKX message.  
The resulting drum word could be:
- a. 1. 04002 0. 02004
  - b. 0. 25172 0. 00075
  - c. 0. 00021 1. 34076
  - d. 0. 010021 1. 34077
  - e. None of the above

## SAVE A LIFE

If you observe an accident involving electrical shock,  
**DON'T JUST STAND THERE - DO SOMETHING!**

### RESCUE OF SHOCK VICTIM

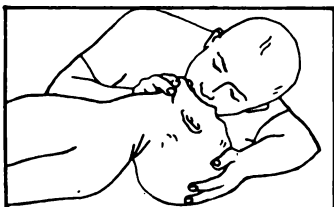
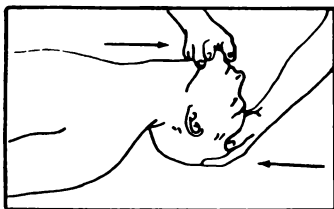
The victim of electrical shock is dependent upon you to give him prompt first aid. Observe these precautions:

1. Shut off the high voltage.
2. If the high voltage cannot be turned off without delay, free the victim from the live conductor. REMEMBER:
  - a. Protect yourself with dry insulating material.
  - b. Use a dry board, your belt, dry clothing, or other non-conducting material to free the victim. When possible PUSH - DO NOT PULL the victim free of the high voltage source.
  - c. DO NOT touch the victim with your bare hands until the high voltage circuit is broken.

### FIRST AID

The two most likely results of electrical shock are: bodily injury from falling, and cessation of breathing. While doctors and pulmotors are being sent for, DO THESE THINGS:

1. Control bleeding by use of pressure or a tourniquet.
2. Begin IMMEDIATELY to use artificial respiration if the victim is not breathing or is breathing poorly:
  - a. Turn the victim on his back.
  - b. Clean the mouth, nose, and throat. (If they appear clean, start artificial respiration immediately. If foreign matter is present, wipe it away quickly with a cloth or your fingers).



- c. Place the victim's head in the "sword-swallowing" position. (Place the head as far back as possible so that the front of the neck is stretched).
- d. Hold the lower jaw up. (Insert your thumb between the victim's teeth at the midline - pull the lower jaw forcefully outward so that the lower teeth are further forward than the upper teeth. Hold the jaw in this position as long as the victim is unconscious).
- e. Close the victim's nose. (Compress the nose between your thumb and forefinger).
- f. Blow air into the victim's lungs. (Take a deep breath and cover the victim's open mouth with your open mouth, making the contact air-tight. Blow until the chest rises. If the chest does not rise when you blow, improve the position of the victim's air passageway, and blow more forcefully. Blow forcefully into adults, and gently into children).
- g. Let air out of the victim's lungs. (After the chest rises, quickly separate lip contact with the victim allowing him to exhale).
- h. Repeat steps f. and g. at the rate of 12 to 20 times per minute. Continue rhythmically without interruption until the victim starts breathing or is pronounced dead. (A smooth rhythm is desirable, but split-second timing is not essential).

**DON'T JUST STAND THERE - DO SOMETHING!**