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THEORY OF OPERATION

OF

DISPLAY SYSTEM

FOR

AN/FSQ-7 COMBAT DIRECTION CENTRAL
AND
AN/FSQ-8 COMBAT CONTROL CENTRAL

VOLUME II

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*The asterisk indicates pages revised, added or deleted by the current revision.

CONTENTS

VOLUME II

CONTENTS (cont'd)

CONTENTS (cont'd)

CONTENTS (cont'd)

CONTENTS (cont'd)

CONTENTS (cont'd)

CONTENTS (cont'd)

CONTENTS (cont'd)

CONTENTS (cont'd)

CONTENTS (cont'd)

CONTENTS (cont'd)

CONTENTS (cont'd)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (cont'd)

LIST OF ILLUSTRATIONS (cont'd)

LIST OF ILLUSTRATIONS (cont'd)

LIST OF ILLUSTRATIONS (cont'd)

LIST OF TABLES

LIST OF TABLES (cont'd)

PART 5
ASSOCIATED EQUIPMENT

CHAPTER 1
SCOPE

1.1 GENERAL

The equipment already described is of the major element grouping and components. While it is true that these elements, the SDGE, SDIS, and the DDGE and DDIS, generate and display the results of the computer, they would be of small consequence unless the operating personnel could act upon the information presented by them.

The associated equipment provides the controls and housing for the indicators, operating devices, and systems that contribute the necessary flexibility of operation for the Display System.

The chapters in this part treat each prime component of the associated equipment separately. Where the organization of a detailed breakdown is advantageous, the chapters are broken down to sections. This chapter in its scope presents a limited explanation of each equipment so treated.

1.2 PHOTOGRAPHIC RECORDER-REPRODUCER ELEMENT

The discussion of the PRRE is separated into five sections. There is a complete theory of operation for both the SDS and the PRR, an explanation of the console circuits applicable to both units, and a section on the operating controls and relays. Section 5 covers the photographic recorder-reproducer, including the underlying theory of the optics employed.

1.3 SITUATION DISPLAY CONSOLES

The two basic types of consoles are figuratively described, and the accessories that are mounted and affixed to the consoles are discussed separately. The differences between the SD and AUX consoles and the devices installed on or in them are referenced to their logical systems.

1.4 SITUATION DISPLAY CAMERA ELEMENT

The situation display camera element is described, and the circuits necessary for semiautomatic operation are included. Timing charts for sequence generation of signals are traced.

1.5 COMMAND POST CONSOLE

The Command Post console plays an important part in providing the operating positions for the command personnel and staff. The types of information available are listed according to installation of accessory devices in the various sections of the console.

1.6 DISTRIBUTION ELEMENTS

The distribution element is discussed from the output distribution viewpoint of the SDIS and DDIS. The routing of the cables to other associated elements and equipment is covered, as well as a description of the signal data patching panels.

1.7 SUPPORTING COMPONENTS

The supporting components are discussed separately in a section assigned to each component. Components discussed include the unit status switch, the audible alarms and warning lights, and the communication equipment. The communication equipment, for example, is discussed in those areas that are limited only to voice lines within the Display System.

1.8 DISPLAY TESTER ELEMENT

The display tester element has a mode of test procedure occurrence for the generator element by means of switch storage and light panels. Typical examples are given of both components used in the duplication of a message for test purposes.

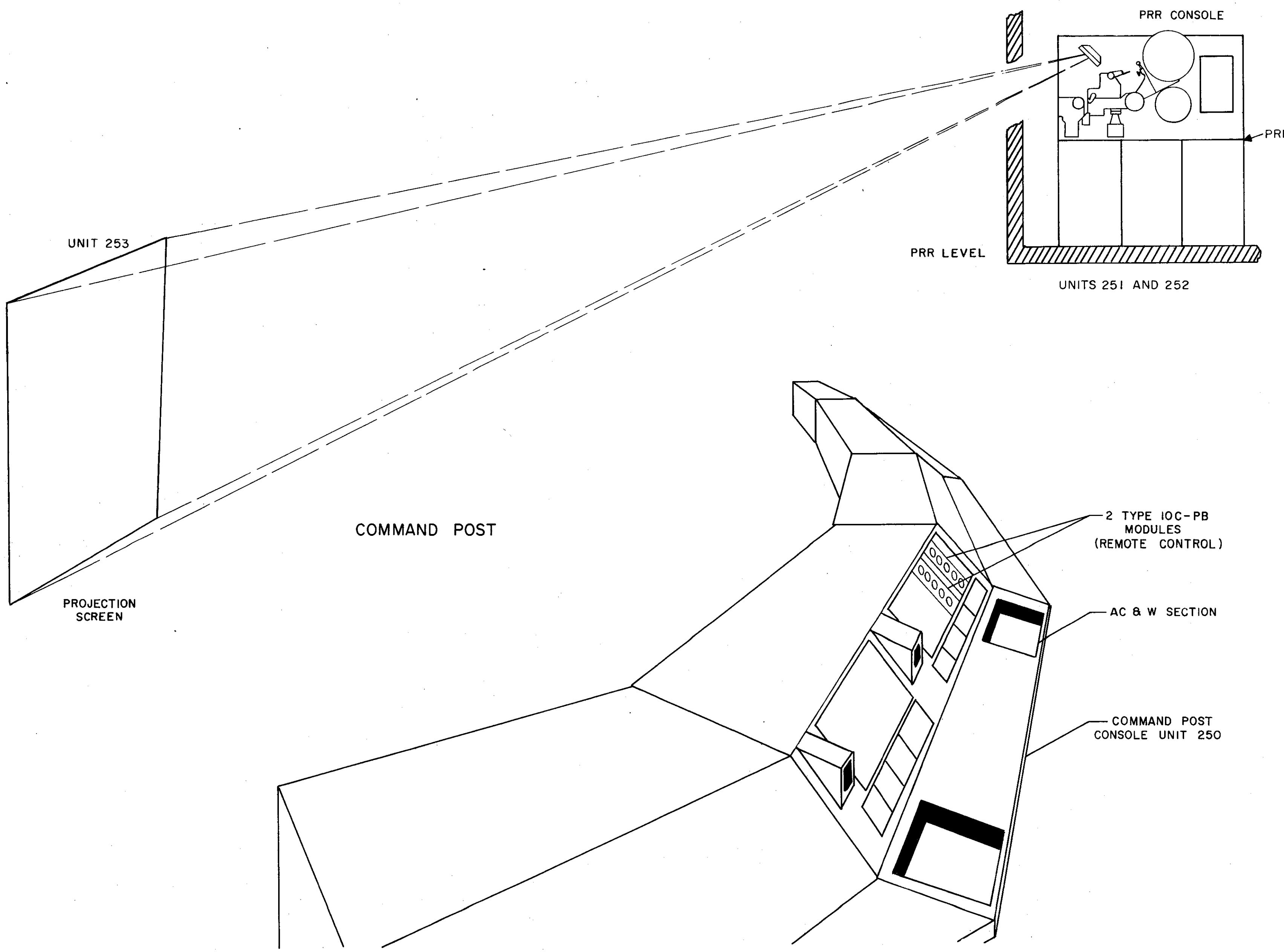


Figure 5–1. PRRE Components within Command Post Area

CHAPTER 2

PHOTOGRAPHIC RECORDER-REPRODUCER ELEMENT

SECTION 1

INTRODUCTION

1.1 SCOPE

Chapter 2 describes and explains the operation of the photographic recorder-reproducer element (PRRE). The PRRE as a unit consists fundamentally of two major sections. One section is designated the photographic recorder-reproducer (PRR); the other is called the situation display section (SDS). The SDS functions in very much the same manner as the SDIS, which has been described in previous chapters; therefore the subject matter will be limited to those functions peculiar to the PRRE. Wherever the previous descriptive text is called out, as an aid to PRRE explanation, it will be so noted and referenced.

1.2 PHYSICAL DESCRIPTION

The photographic recorder-reproducer (fig. 1—13) consists of the units and modules necessary to receive the signal output of the SDGE, to convert these signals to a visual situation display, and to photograph and project the image onto a large projection screen. The physical divisions of this element consist of units 251 and 252, which are the two PRR consoles, AN/KD-6 (1), unit 253, the projection screen, and the two 10-button remote control modules (type 10C-PB), located on the aircraft control and warning (ACW) control panel of the Command Post Console, OA-1013/FSQ.

1.3 LOCATION OF UNITS

The Command Post console (fig. 5—1), which contains the two remote control modules (type 10C-PB), is located on a balcony in the sector command area of the Combat Direction Central building. The projection screen, unit 253, is located on the wall in front of the Command Post console. The screen is 14 x 14 feet in area. Units 251 and 252 of the PRR element are located in the projection room above and to the rear of the Command Post console balcony. Each PRR element is approximately 51 inches long, 35 inches wide, and 89 inches high. Figure 5—1 indicates the approximate location of the various units.

1.4 SDS DIFFERENCES

The physical packaging of the SDS and the SDIS differs, since the SDIS is designed to have a seated operator view the SD CRT. The PRR console has the 7-inch SD CRT upright, with the recorder mounted above it. The upright design of the SDS required relocating many of the component parts contained in both sections. The exteriors of both sections are shown in figures 1—20 and 1—13, the operating controls in figures 4—14 and 5—2, pluggable units location in

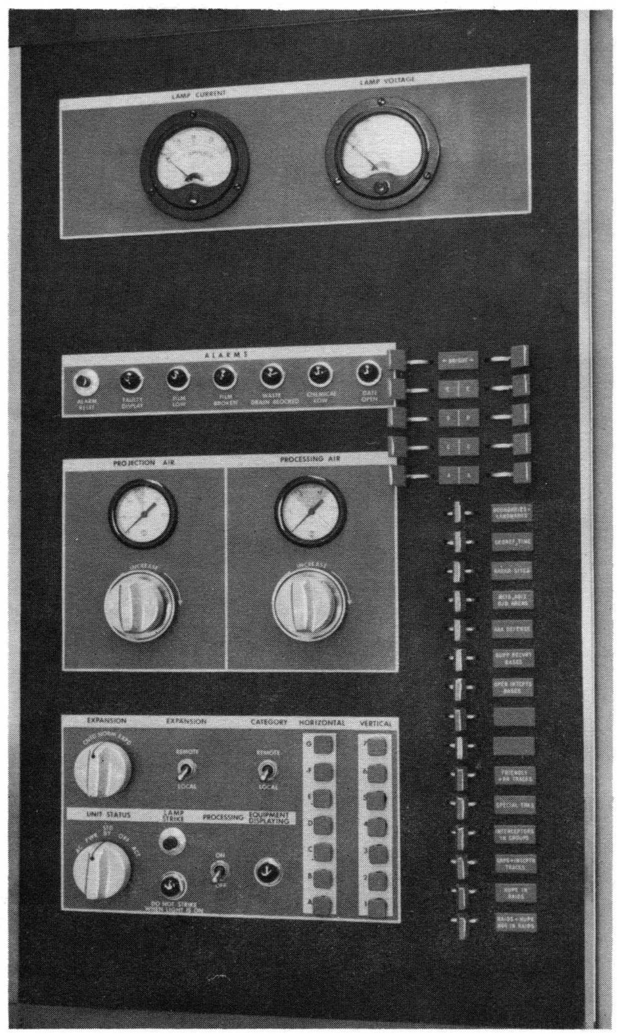


Figure 5—2. PRR Main Control Panel

figures 4–16 and 5–3, the signal relays in figure 5–4, the subpanels in figures 4–31 and 5–5, and the SD CRT's in figures 2–4 and 5–6. Figure 5–7 illustrates the placement of the test point panel, the category plugboard, and the expansion input panel. An approximation of the comparative physical differences and changes can be gained from the above illustrations.

1.4.1 Request Display Gate Generator

This circuit is added to insure that the film will not be blurred by the motion of the changing displays. There are about 11 different displays presented during the 30-second period that the recorder shutter is open. This generator allows only one SD cycle to be photographed during this period. By holding the intensity of the display down below that which is sufficient to register on the film, and by intensifying one SD cycle every 30-second period, a clear, unblurred display is recorded.

1.4.2 Display Assignment Bits

There are no display assignment bits (DAB's) currently programmed for the PRR. DAB's can be used with the present circuits of the PRR, if desired. A more complete discussion of DAB's can be found in Part 4.

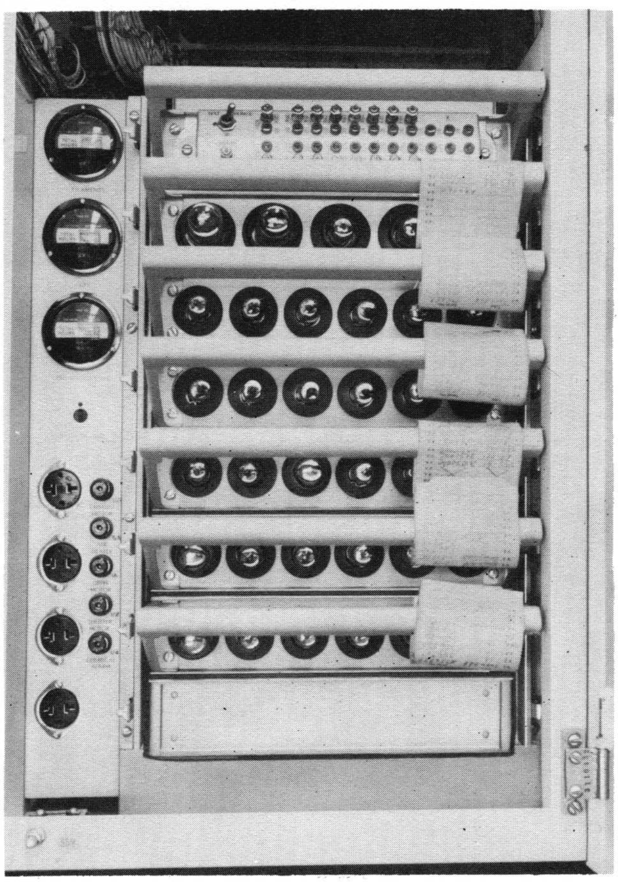


Figure 5–3. Pluggable Units in PRR

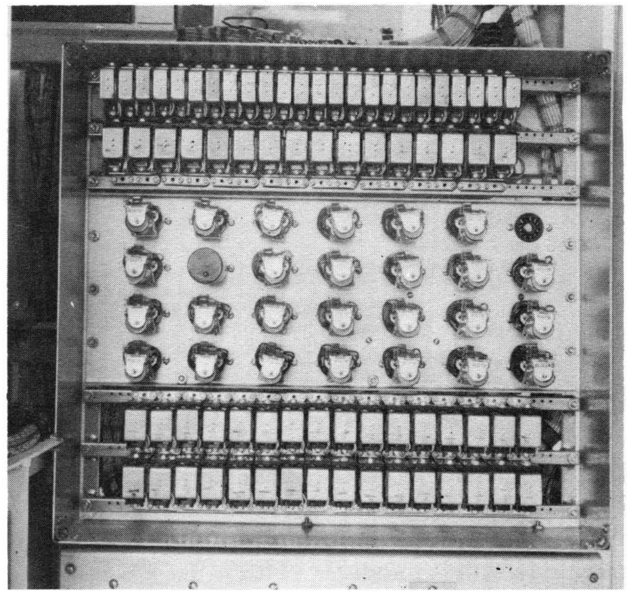


Figure 5–4. Relay Panel (K-60 removed)

1.4.3 B Feature

The B feature is not used by the PRR, but it is connected to the category plugboard. (See fig. 5–7.)

1.4.4 Radar Data Messages

Radar data messages are not brought into the PRR.

1.4.5 Remote Control

Since it is desirable for the Sector Commander's staff to be able to select the message categories to be displayed, 15 categories can be remotely selected from the ACW panel on the Command Post console. In order to provide this facility, circuit changes, mainly in the expansion and off-centering circuits, were required. These changes are detailed in Section 3.

1.4.6 Expansion Input Panel

The expansion input panel (fig. 5–7) and its related circuitry replace the expansion plugboard (fig. 4–26) of the SDIS. The expansion plugboard has more flexibility, but the expansion input panel has advantages that are more desirable than flexibility. The four rotary switches of the expansion input panel can be set to the correct expansion and off-centering positions quicker than the plugboard can be patched up for the same purpose. Thus, considerable time can be saved when it is necessary to change expansion levels and off-centering assignments for the PRRE.

1.5 LOGICAL RELATIONSHIP

The PRRE is essentially a combination of the SDS and PRR units. The SDS receives signals from the SDGE and displays selected data messages on the viewing screen of a 7-inch SD CRT (refer to Part 2). The SDS is similar to, but not identical with, the SDIS of the SDIE.

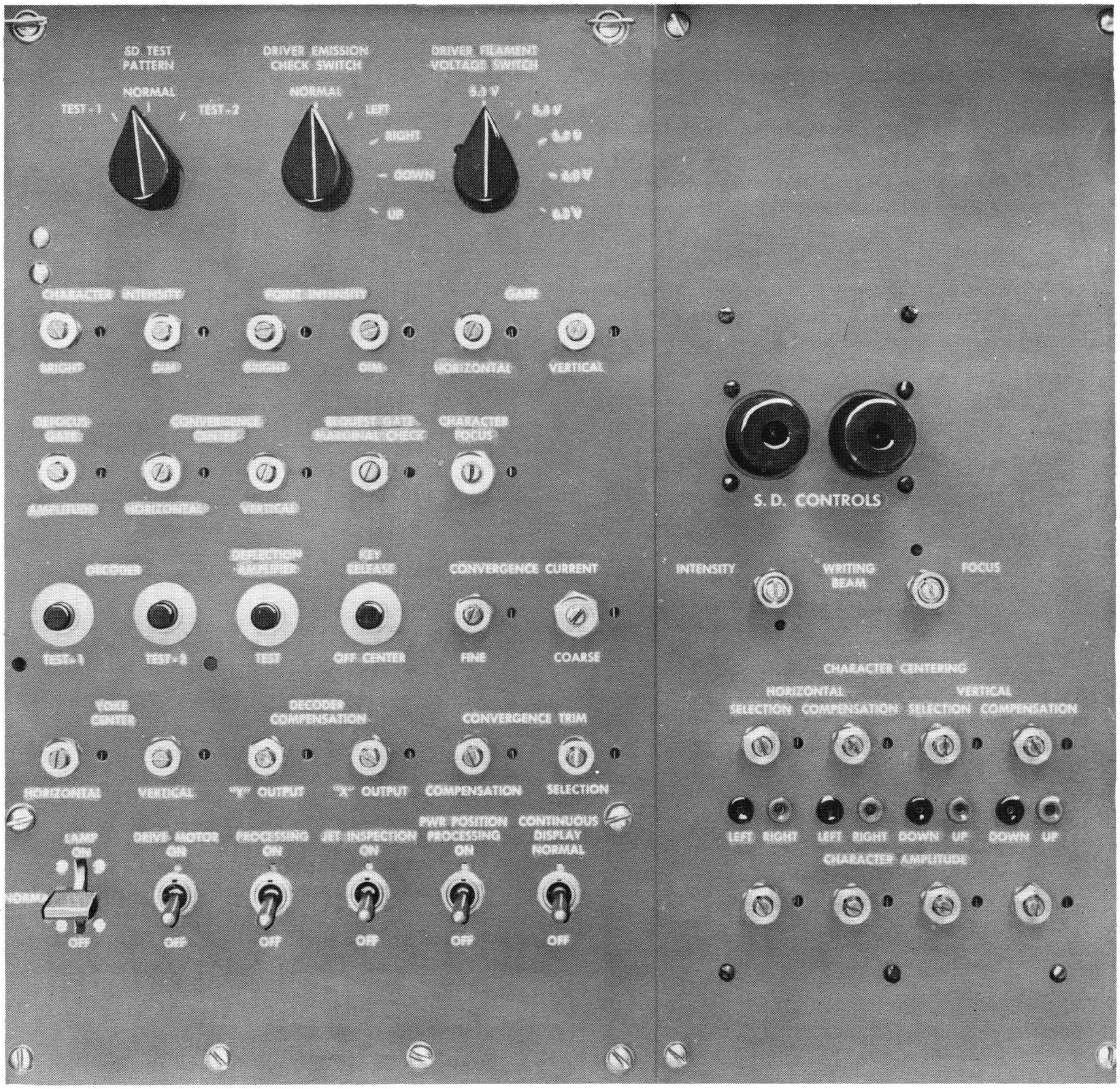


Figure 5—5. Subpanel (Left), High-Voltage Panel (Right)

The PRR consists of a recorder which automatically photographs the situation display onto 35-mm film, processes this film at high speed, and then projects the display image on a large screen. These operations take place in a film gate through which the film is moved from one process to another within a period of 30 seconds, the length of time the image is projected.

The PRRE is closely associated with the Command Post console in that it provides Command Post personnel with a large-screen tactical display. For this reason, limited remote-control facilities are located on the ACW panel of the Command Post console. The PRRE is a logical part of the Display System and receives its signal and control voltages from the SDGE (see fig. 5–8).

Each PRR is a simplex unit, but the two units (251 and 252) are interconnected so that it will be possible for only one unit to project a display at any one time. Both units may be energized at the same time so that

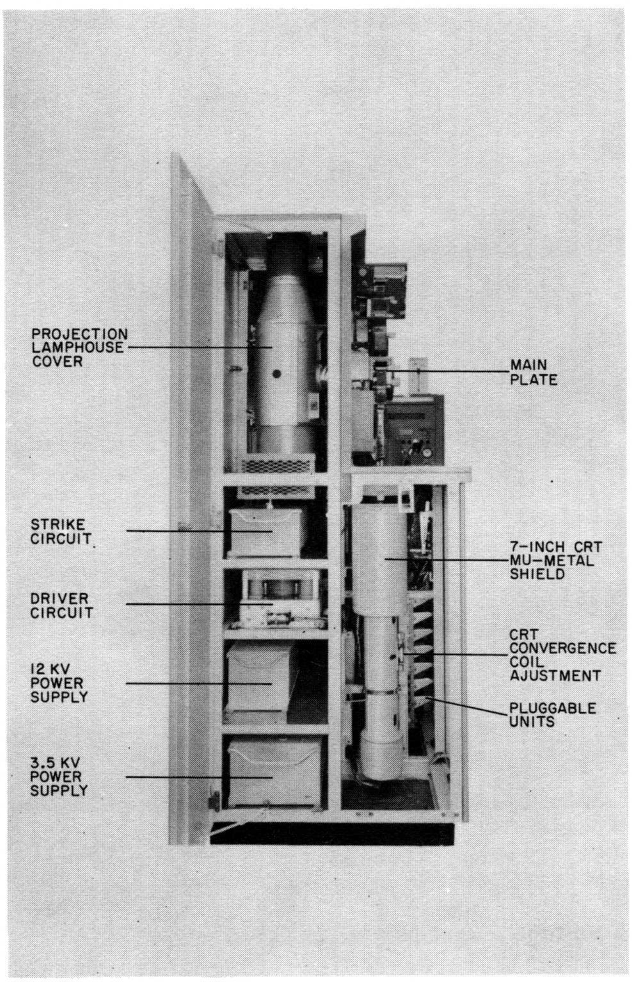


Figure 5–6. PRR, Side Doors Open

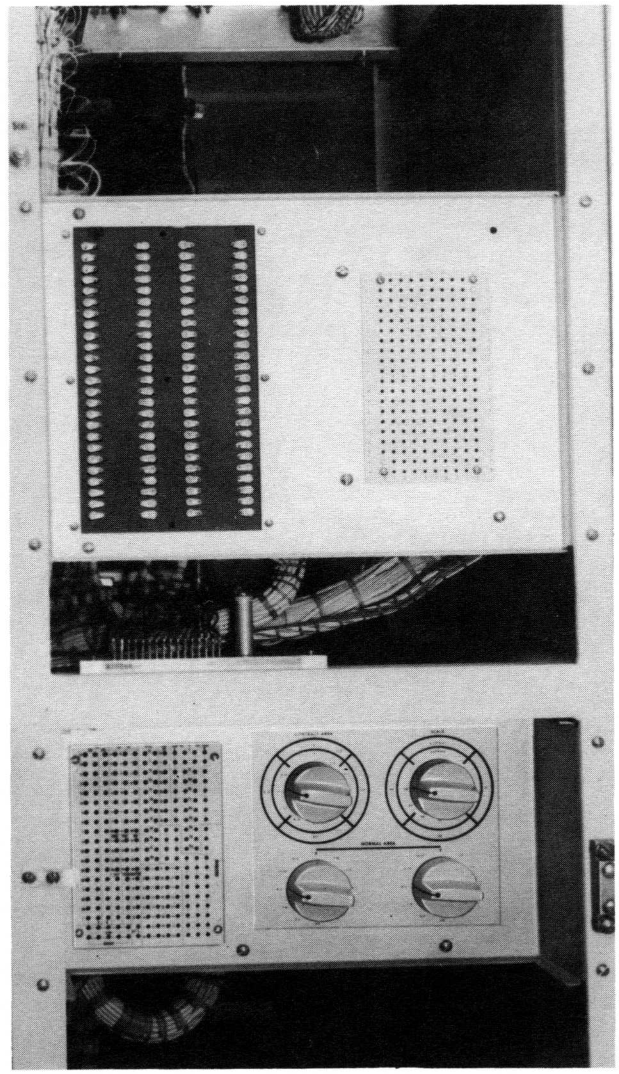


Figure 5–7. Test Point Panel (Upper Right), Category Plugboard (Lower Left), and Expansion Input Panel (Lower Right)

maintenance may be performed on one unit while the other is projecting. The interlocking circuits in use are covered in 5.5.3 of this chapter.

1.6 SEVEN-INCH SD CRT

A 19-inch SD CRT could be used for the PRR instead of the specially dimensioned 7-inch tube. However, considering the extreme definition needed for the many-diametered enlargement projected on the screen, a 7-inch face plate with an additional electronic refinement such as the auxiliary focus coil would better answer specification needs. The placement of the focusing coil as well as a detailed explanation of the 7-inch CRT in its entirety is given in Part 2. A cutaway drawing of the 7-inch SD CRT is shown in figure 2–7.

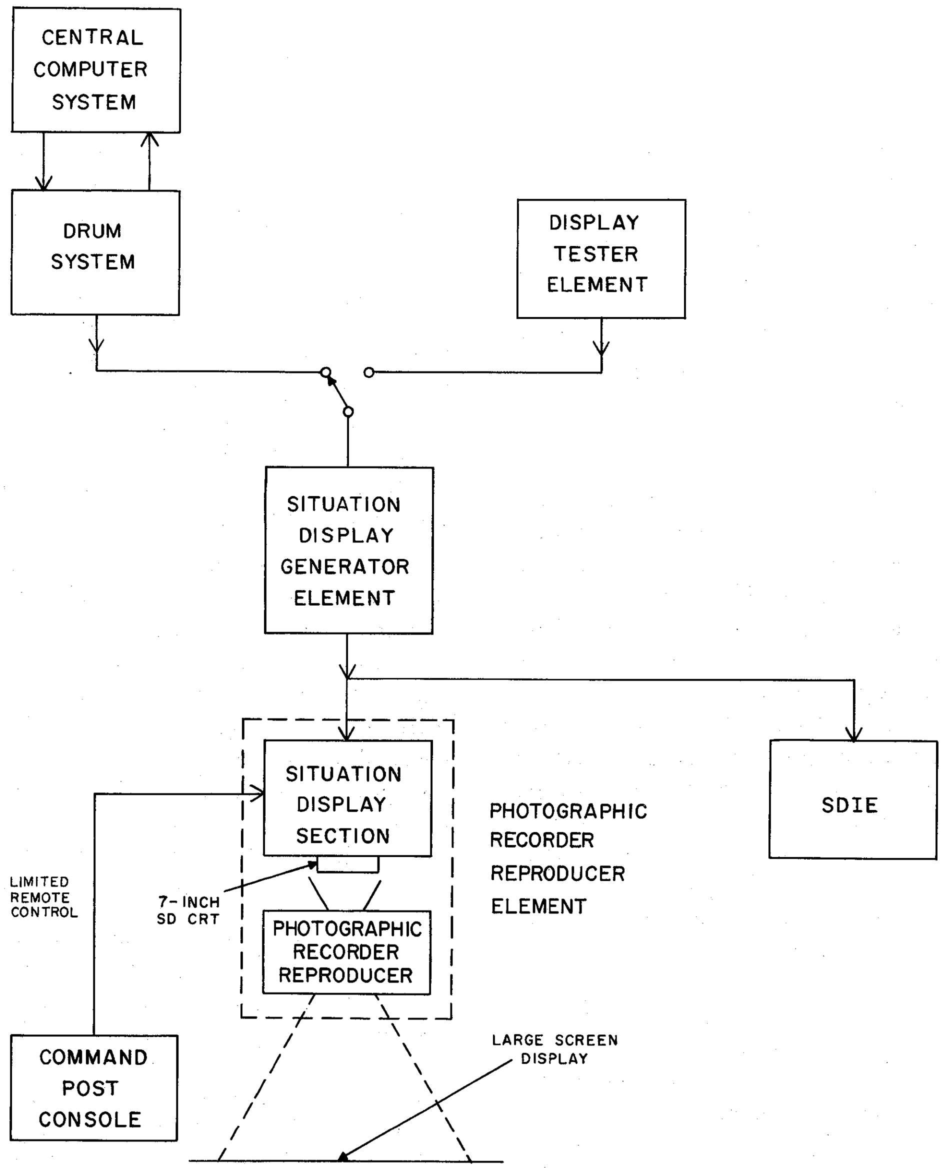


Figure 5–8. Information Flow to Photographic Recorder-Reproducer

SECTION 2
THEORY OF OPERATION

2.1 INTRODUCTION

This section discusses the logical functions of the SDS by explaining the functions of each block of the SDS block diagram, figure 5–9. Those blocks which are added to the SDS or modified from the corresponding circuits are discussed in Section 3 of this chapter. By comparing figure 4–13 (SDIS block diagram) with figure 5–9, it can be seen that the request gate generator is the only block added in figure 5–9. Therefore, Chapter 2 of Part 4 may be used as a reference for many of the SDS circuits.

2.2 GENERAL

The SDS of the PRR AN/KD-6 (1) receives each 8-word message from the Central Computer System after the messages are processed by the Drum System and the SDGE. The Drum System is used to slow down the transmission rate of the message from the Central Computer to the slower process rate of the Display System. In the SDGE, the message is converted into usable form to be presented to the SD CRT's. When the message arrives at the SDS, it is composed of analog and digital signals. Both of these signals are used for information purposes for the situation displays. The analog signals are used for character selection and positioning, whereas digital signals are used for message positioning. Only digital signals are used for control. Category and feature gates are examples of these.

2.3 EXPANSION AND OFF-CENTERING SELECTION

There are two steps involved in selecting the area to be displayed as determined by the setting of the EXPANSION switch. This switch has three positions: contracted, normal, and expanded. (The REMOTE-LOCAL switch transfers the selection of the expansion level from the PRR console to the Command Post console). The specific area to be seen for display is selected by depressing the off-centering pushbuttons. The seven horizontal selection pushbuttons are labeled A-G, while the seven vertical selection pushbuttons are labeled 1-7. These controls are located on the main control panel of the PRR console (fig. 5–2).

2.3.1 Expansion

The basic scale of expansion is designated as X1 (times 1). It is also called the frame of reference or unexpanded display. The X1 display can be expanded into X2 or X4 displays, and the X2 and X4 displays can be expanded into an X8 display.

Expansion and off-centering are closely interrelated in that, when expanding the display, the area to be displayed must be selected by using the off-centering pushbuttons.

The X1 display presents the complete area monitored by the AN/FSQ-7 Combat Direction Central. Switching to X2, X4, or X8 means that one segment, whose size depends on the level of the expansion selected, is enlarged and spread out over the entire face of the 7-inch SD CRT. This results in greater distances between adjacent messages and, therefore, increased clarity of the display.

The character size or spacing between characters is not affected because the digital voltages of word 1 (which are used to position the entire message on the face of the 7-inch SD CRT) are processed for expansion separately from the bits that are used for positioning each character within the message. The bits are actually decoded in the SDGE and arrive at the SDS as analog voltages. In the case of a TD vector message, the spacing between vectors will vary with the expansion, although the size of the vectors will not be altered by the particular expansion level.

An X2 expansion of the area covered by the X1 display contains only ¼ of the area displayed in the X1 expansion. In figure 5–10, an X2 expansion of the X1 display would cover an area the size of the shaded area KLOP. An X4 expansion would cover an area the size of one of the squares K, L, O, or P. Therefore, an X4 display contains 1/16 the area of an X1 display. Similarly, the X8 display shows 1/64 of the X1 area. In figure 5–11, an X8 display would be represented by an area the size of the shaded area, G7H7G8H8.

The three positions of the EXPANSION switch, labeled CNTD, NORM, and EXPD, stand for the contracted, normal, and expanded. To each of these positions is assigned a level of expansion. The PRR console expansion assignment might be, for instance, X1, X2, and X4. This means that when the EXPANSION switch is in the CNTD position, an X1 expansion will be displayed. Likewise, the NORM and EXPD positions of the switch will produce displays of the X2 and X4 expansions, respectively.

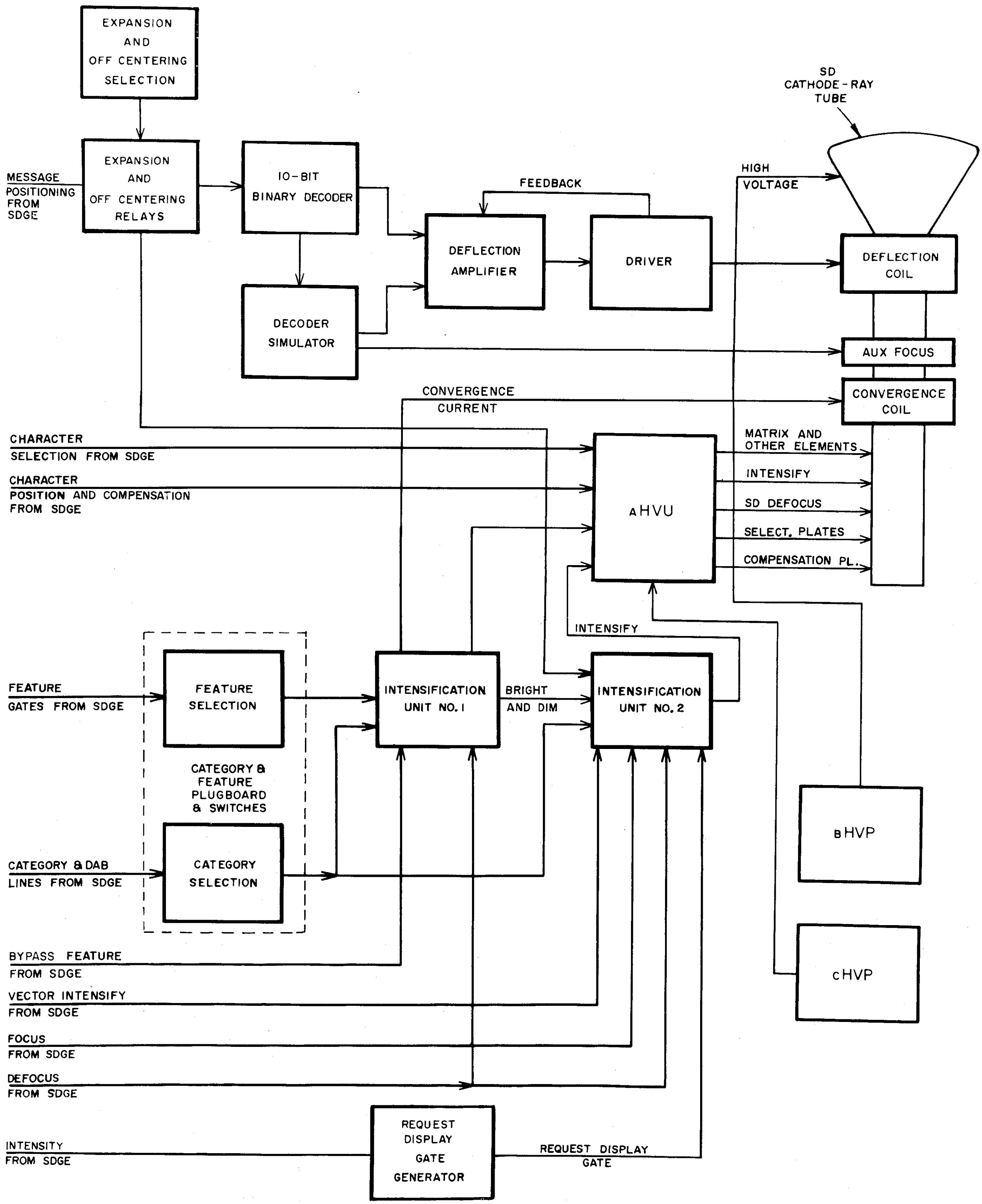


Figure 5-9. SDS Block Diagram

2.3.2 Off-Centering

Off-centering is the process by which a section of the total area monitored by the computer is selected for expanded viewing on a different expansion level. Whenever the EXPANSION switch is turned from CNTD to NORM or from NORM to EXPD, off-centering must take place. (An exception to this is where two positions of the switch are assigned the same expansion level. However, this situation will probably never arise in the PRR console.) The off-centering selection that occurs when going from CNTD to NORM is not under the control of the console operator. This selection has been assigned to the console by means of a set of rotary switches located in the rear of the console. These same switches are used for assigning the three expansion levels to the console. Their circuits are explained in Section 3 of this chapter.

Figure 5–10 illustrates the X1 display with the shaded area, KLOP, showing one possible X2 expansion and off-centering assignment. Figure 5–12 shows all the possible off-centering assignments with an X2 expansion. These are the shaded areas, ABEF, BCFG, CDGH, EFIJ, GHKL, IJMN, and KLOP. The rotary switches can be set automatically to select any one of the nine areas when switching to an X2 expansion. If the EXPANSION switch has been set up with an X1 expansion on the CNTD position, an X2 expansion on

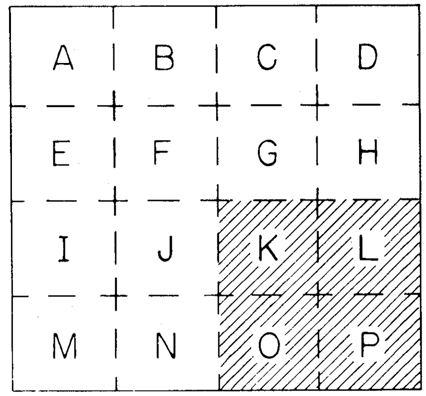


Figure 5–10. Division of X1 Display

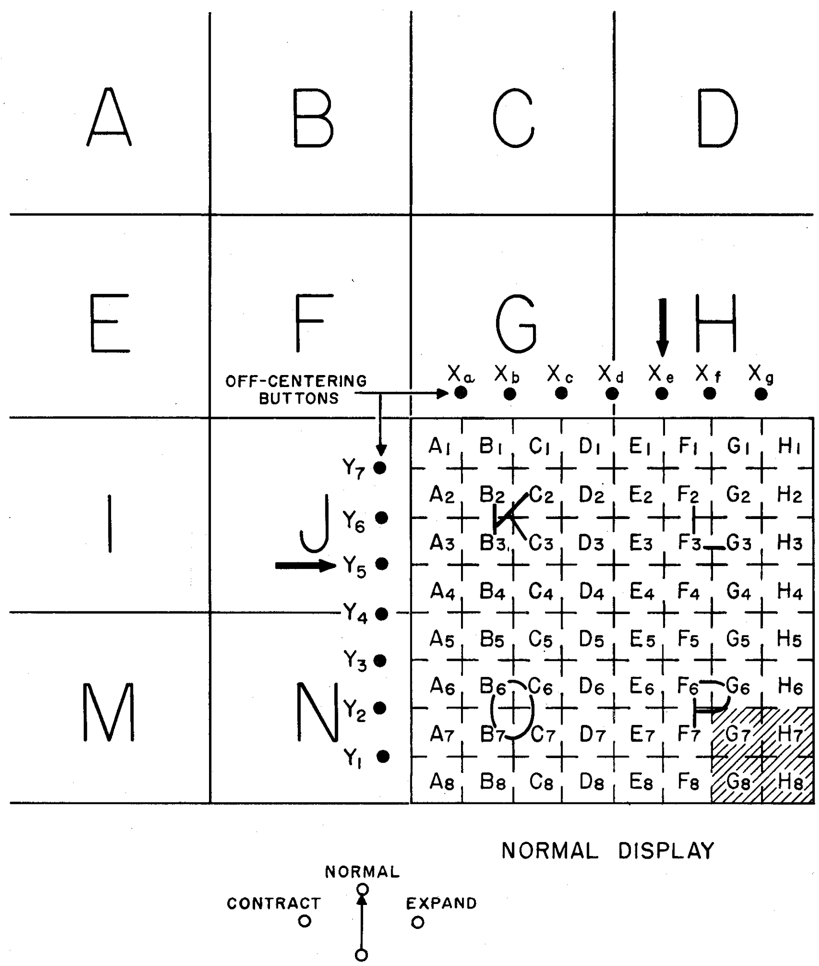


Figure 5–11. Division of X2 Display

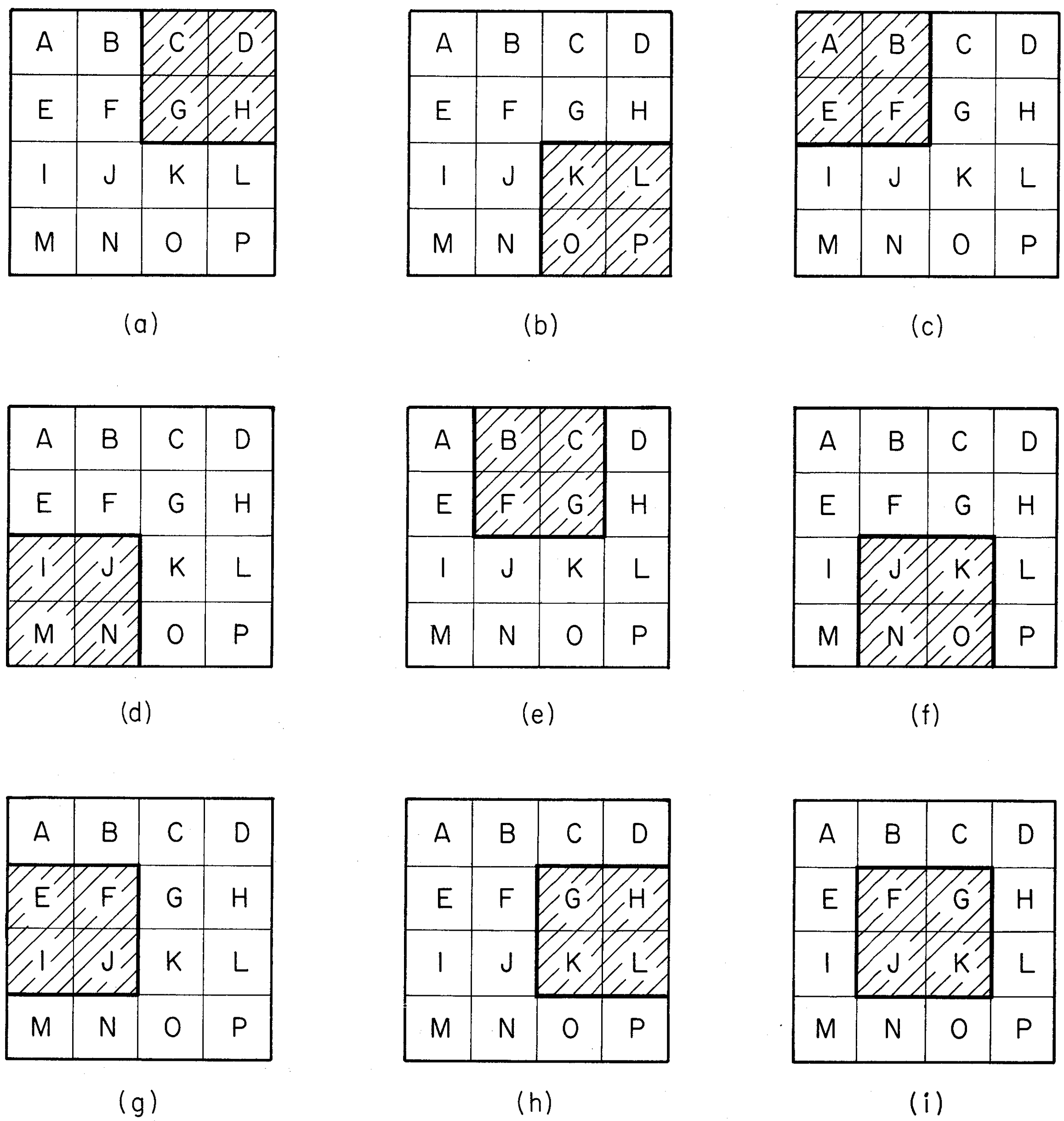


Figure 5–12. X2 Expansion of X1 Display Showing Possible Off-Centering Assignments

the NORM position, and an X4 expansion on the EXPD position, one of these nine areas will be selected on the NORM position depending on how the rotary switches have been set. If the rotary switches have been set to select area KLOP, the NORM display will show the area indicated in figure 5–13. (It will be well to remember that the letters shown in this figure and corresponding illustrations do not actually appear on any display but are used as an example to indicate the various off-centering areas.) With an X4 expansion assigned to the EXPD position, one of these areas, either K, L, or P, will be displayed on the EXPD position.

Now assume that an X8 expansion level were assigned to the EXPD position of the EXPANSION switch. The X2 display of the NORM position could

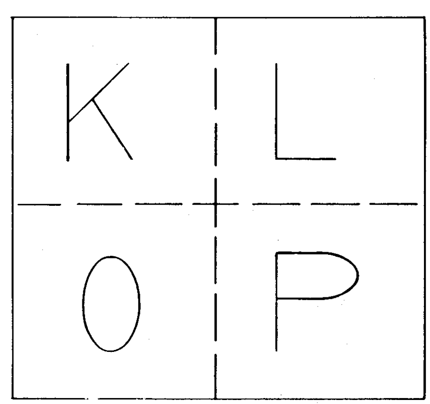


Figure 5–13. X2 Expansion with Off-Centering

then be divided up as shown in figure 5—11 into 49 individual areas. These areas would be A1B1A2B2, B1C1B2C2, etc. The selection of one of these areas for expanded viewing is done by the PRR operator on direction from Command Post personnel. The 14 off-centering pushbuttons are located on the main control panel of the PRR console (fig. 5—2). The HORIZONTAL pushbuttons are labeled A through G; the VERTICAL pushbuttons are labeled 1 through 7. One lettered and one numbered pushbutton are depressed to select an off-centered area. As shown in figure 5—11, depressing pushbuttons Xe and Y5 would be required for the selection of area E3F3E4F4. Figure 5—14 shows the expanded display as a result of making this area selection.

If the EXPANSION REMOTE-LOCAL switch on the main control panel is in the REMOTE position, the EXPANSION switch and the off-centering pushbuttons will be inoperative. The expansion level and the off-centered area displayed under this condition are determined by the patching arrangement of the category plugboard located on the expansion input panel of the SDS. If the operator of the ACW desk of the Command Post console now depresses his X1 pushbutton, an X1 expansion level will be displayed. This display is also patched through the category plugboard. (See fig. 5—7.) The use of the category plugboard is explained in detail in Section 3 of this chapter.

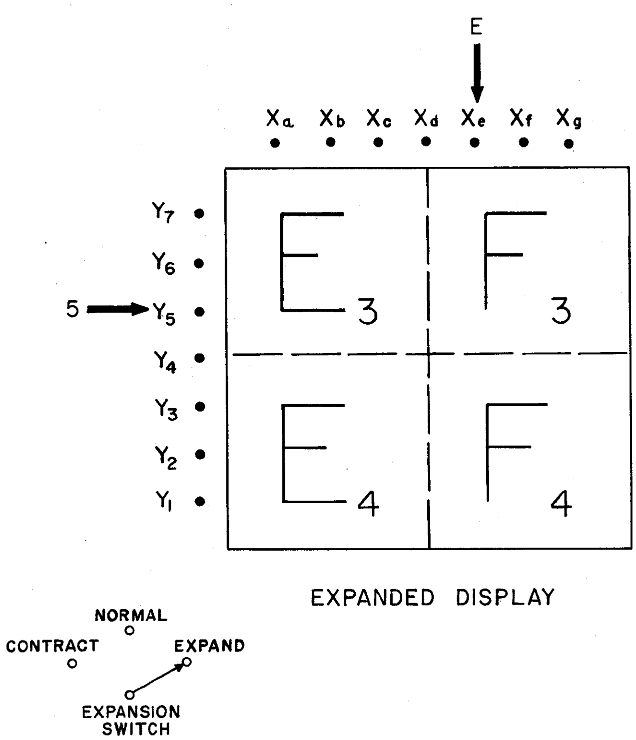


Figure 5—14. X8 Expansion with Off-Centering

2.4 EXPANSION AND OFF-CENTERING RELAYS

The message-positioning bits, as selected by the signal relays (figs. 5—4 and 5—15), go directly to the expansion and off-centering relay contacts. These contacts are selected by the settings of the EXPANSION switch, the rotary switches, and the off-centering pushbuttons. Some of these controls are transferred to the Command Post console when the EXPANSION LOCAL-REMOTE switch is on the REMOTE position.

Of the 26 positioning bits that come in, 13 are for X and 13 are for Y axis positioning. For any particular expansion, 10 of the X bits and 10 of the Y bits are selected. A different set of 20 bits is used for each individual expansion. The relays which select the 20 bits direct these bits to the 10-bit binary decoder (which accepts 10 bits for X and 10 bits for Y positioning), where the digital voltages are converted to analog voltages for use in the 7-inch SD CRT. In addition, 8 bits are routed to intensification unit 2, where they serve as the inputs to AND circuits and prevent the intensification of messages that are not in the selected expansion area.

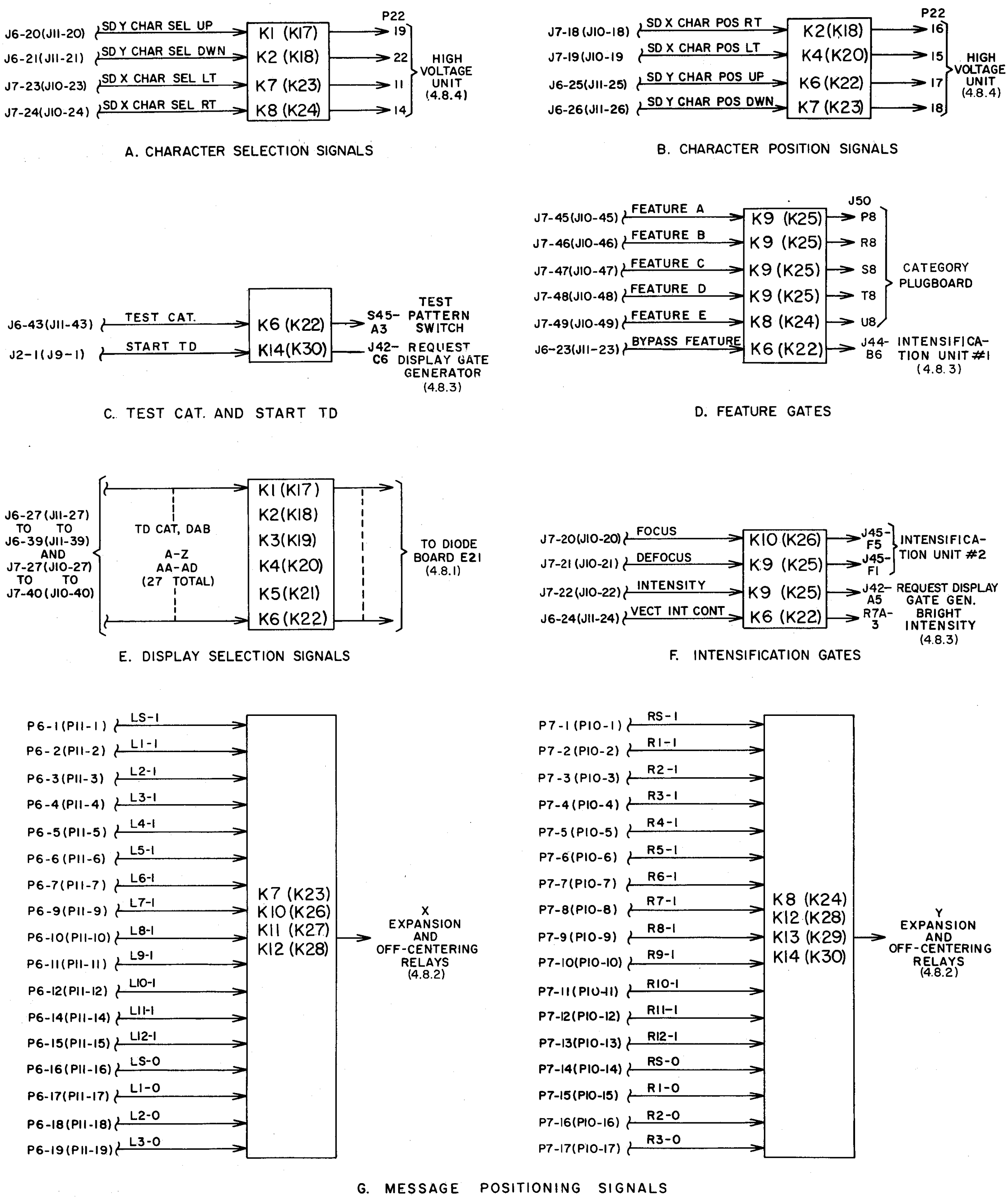
2.5 TEN-BIT BINARY DECODER

The 10-bit binary decoder converts the digital voltages of the positioning bits, which were routed from the SDGE through the expansion relay contacts, into analog form. These analog voltages are then amplified and fed to the deflection coil to position the message on the viewing screen of the 7-inch SD CRT. The decoder consists of two identical sections, one for positioning along the X axis and one for positioning along the Y axis. Each section receives 10 digital input voltages and combines them to form one X analog output voltage for the X section and one Y analog output voltage for the Y section.

2.6 DECODER SIMULATOR

The output of the 10-bit binary decoder is also fed to the decoder simulator, which is a constant current generator with a normal output of +125 volts. The decoder simulator uses the same voltages as those used for the binary decoder. This normal output of 125 volts and the output of the binary decoder are fed to the deflection amplifier.

The decoder simulator provides a compensated reference voltage for the differential input to the deflection amplifier. Any fluctuations in the reference voltages will have the same effect on both the decoder and decoder simulator. However, the compensated reference voltage output from the decoder simulator maintains a constant positioning potential difference of the decoder reference voltage variations.



NOTE: CONNECTOR PINS AND RELAYS SHOWN IN PARENTHESES APPLY TO "B" SIGNALS.

Figure 5–15. Relay Panel, Block Diagram

2.7 DEFLECTION AMPLIFIERS AND DEFLECTION DRIVERS

The deflection amplifier, a direct-coupled high-gain differential amplifier, amplifies the analog output of the 10-bit binary decoder. These amplified levels are then applied to the deflection driver as push-pull voltages. A large amount of degenerative feedback from the output of the deflection driver to the input of the deflection amplifier is a primary contributing factor in achieving linear operation in the deflection system.

2.8 HIGH-VOLTAGE UNIT

The model A high-voltage unit supplies the 7-inch SD CRT with most of the necessary voltages and currents. A majority of the signals and power needed for proper operation of the 7-inch SD CRT are routed through this unit. The model A high-voltage unit performs the following functions:

a. It provides the input network for the convergence current regulator, which generates a voltage proportional to the 7-inch SD CRT accelerating voltage. This voltage regulates the convergence coil current.

b. It contains the amplitude controls for horizontal and vertical character selection and compensation analog voltages.

c. It contains the potentiometers necessary for controlling the center of horizontal and vertical analog voltages.

2.8.1 Character Selection

The bits of a message that select a character are decoded (changed from digital to analog voltages) in the SDGE. The resulting analog voltages are applied to potentiometers in the high-voltage unit of the SDS. The voltages from the potentiometers, which are the amplitude controls, are applied to the selection plates of the 7-inch SD CRT. The voltages on the selection plates deflect the electron beam to the desired location on the character matrix. The portion of the beam passing through the matrix is shaped in the form of the desired character and displayed on the viewing screen of the 7-inch SD CRT. The portion of the beam which does not pass through the matrix is attracted by the potential on the matrix and passes off as matrix current.

2.8.2 Character-Positioning and Compensation

The character-positioning signals from the SDGE are applied to potentiometers in the high-voltage unit, which control the centering of the characters within the message. These signals are then fed to the character-positioning and compensation plates of the 7-inch SD CRT.

2.8.3 High-Voltage Power Supplies

There are two high-voltage power supplies in the PRR console: the model B and the model C high-voltage power supplies. The model B power supply produces high voltage for the second anode of the 7-inch SD CRT and for the helical accelerator. The model C power supply supplies the electrode voltages for the cathode and control grid of the 7-inch SD CRT. The filament voltage for the 7-inch SD CRT is obtained from the high-voltage unit.

2.9 FEATURE SELECTION

Feature selection (which applies only to TD tabular track messages) enables the operator to select portions of the messages selected at the category switches. Two banks of four feature switches are provided for this purpose. These switches are shown directly above the 15 category switches in figure 5–2. Each bank of four switches contains a fifth BRIGHT-DIM switch.

Four input lines to the PRR console carry features, A, C, D, and E to the feature switches. These switches determine which of the features (in messages selected by the category switches) will be intensified on the 7-inch SD CRT. When a feature is selected by a feature switch, the feature gate is sent to the intensification circuitry so that the 7-inch SD CRT is intensified during the generation of the feature. If the category switch is off, no messages in that particular category are displayed. In one on position of the category switch, the display of features of TD tabular track messages is controlled by one bank of feature switches. If the category switch is turned to its other on position, the display of features of TD tabular track messages is controlled by the other bank of feature switches. It is immaterial to the display of TD vector and TD tabular information messages which on position is being used by the category switch.

The BRIGHT-DIM switch, associated with each bank of feature switches, controls the intensity of illumination of messages assigned by the category switches to a particular bank of switches. For instance, one group of feature switches might be set for BRIGHT intensification while the other set is for DIM. The PRR operator is thus able to divide all messages into two tactical groups which will be distinguished from each other by their level of intensification.

2.10 DISPLAY SELECTION

The display selection is the method used to channel assigned messages to a specific SDS. Because every message produced by the Display System is present at every SDS, this method is necessary. The SDS of the PRRE has assigned definite tactical duties so that a need exists only for certain messages to be displayed. These messages are placed in separate categories and are assigned one or more DAB's, to permit the display of this message on the designated console CRT.

2.10.1 Categories

One method of selection is by categories. There are 32 TD categories in which messages are placed by the Central Computer. Twenty-two of these categories are currently assigned to the PRR console. (See table 5–1.) Fifteen categories can be selected at the front panel (see fig. 5–2) of the console. Only 13 categories (table 5–2) are assigned at present.

Bits LS through L4 of word 2 of a tabular or vector message are used to identify the category of the message. These five bits can be used to count up to 32 (2 to the 5th power), since there are 32 combinations of 1's and 0's possible with the five bits. Only 31 of these are actually used. The category corresponding to a 0 in all five bits is a null.

Although all the information signals (character selection, character position, etc.) of a particular TD message arrive at the projector console, the message will be displayed on the 7-inch SD CRT only if the category bits of that message form a combination that is assigned to the PRR console. In addition, the category switch must be turned to its on position. Each category switch has two on positions, to the left or to the right of the center position. The on position to the left allows the category switch to function in conjunction with one bank of feature selection switches; turning the category switch to its other on position allows it to function with the other bank of feature switches. (In the case of geography TD messages, the category switch position is immaterial.) The CATEGORY LOCAL-REMOTE switch on the main control panel allows the category switches on either the Command Post console or the PRR console to perform category selection for the SDS.

2.10.2 Display Assignment Bits

A message can be selected by means of a DAB as well as by category. At present, the PRR consoles have no assigned DAB's. More information on DAB's may be found in Part 4.

2.10.3 Supplemental Drivers

In addition to the 32 categories and the 90 DAB's, up to 45 supplemental drivers may be used by the SDGE to route messages to the various consoles. A supplemental driver consists of an OR circuit followed by a power cathode follower. The inputs to the OR circuit may consist of TD categories and DAB's in various combinations. The output of the supplemental driver, therefore, is a control signal similar to a category or DAB signal. A list of the supplemental drivers presently used with the PRR consoles is shown in table 5–1.

2.10.4 Selection Inputs

There are 27 input lines to each PRR console that are used to bring categories, supplemental drivers, or DAB's to the console. Figure 5–16 illustrates how the inputs may be connected in the PRR console. Not all the input lines are used in the patching shown in this figure.

2.11 INTENSIFICATION

Message selection by means of categories and DAB's, feature selection, and expansion of the display is implemented by the intensification circuits. Those messages (or features of messages) which are intended for display are sent to the category switches on the PRR console. When one or more of these switches is turned on, the particular message or messages will be intensified on the viewing screen of the 7-inch SD-CRT. Should there be reason to change the tactical requirements of the PRR, the category plugboard can be arranged to provide for those messages to be intensified.

In the case of expanded displays, the messages which fall in geographical areas outside the expanded area being viewed are still brought to the SDS. However, the geographical information produced in the expansion circuitry is sent to intensification unit 2 so that only those messages in the expanded area will be intensified.

2.11.1 Request Display Gate Generator

The request display gate generator is the only major functional change that distinguishes the SDS from the SDIS of the SD console. The messages from the SDGE are sent to the consoles in continuous SD cycles of approximately 2.6 seconds each. The SDIS is able to display all these messages. However, the SDS of the PRR is only concerned with each 30-second film cycle, when only one SD display cycle is photographed. All other SD cycles (approximately 11) must be left unintensified to prevent blurring of the photograph by message movement. The function of blanking all SD cycles but one in each 30-second period is performed by the request display gate generator. It allows the intensity gates accompanying each of the characters and vector of all messages to reach the intensification circuits during only one SD display cycle.

2.11.2 Intensification Unit 1

The functions of the unit are as follows:

a. The intensification of selected features (with intensification unit 2).

b. The intensification of bypass feature (with intensification unit 2).

c. The application of regulated current to the 7-inch SD CRT convergence coil.

d. The application of a defocus gate to the first

TABLE 5–1. CATEGORY ASSIGNMENTS TO THE PRR CONSOLES

CONSOLE STATION NO.	CONSOLE STATION NAME	UNIT NO.	CATEGORIES	TACTICAL SIGNAL NAMES	INPUTS TO SUPPL DRIVERS
C00	Projector A	251	TD CAT 2	A*	——
C00	Projector A	251	TD CAT 3	GS^1	——
C00	Projector A	251	TD CAT 7	GRS	——
C00	Projector A	251	TD CAT 9	GB^0	——
C00	Projector A	251	TD CAT 10	GB^S	——
C00	Projector A	251	TD CAT 12	GA^2	——
C00	Projector A	251	TD CAT 14	GI^1	——
C00	Projector A	251	TD CAT 17	HR	——
C00	Projector A	251	TD CAT 24	S	——
C00	Projector A	251	TD CAT 31	GG	——
C00	Projector A	251	SUP. DR. 27	GIN	TD CATS 19, 20, 23
C00	Projector A	251	SUP. DR. 28	RHN	TD CATS 16, 18
C00	Projector A	251	SUP. DR. 30	IG	TD CATS 21, 22
C00	Projector A	251	SUP. DR. 35	GS^3	TD CATS 3, 4, 5
C00	Projector A	251	SUP. DR. 41	GS^2	TD CATS 3, 4
C00	Projector A	251	SUP. DR. 42	GA^3	TD CATS 12, 13
C00	Projector A	251	TD CAT 25	F	——
C01	Projector B	252	SUP. DR. 45	A*	TD CAT 2
C01	Projector B	252	SUP. DR. 44	GS^1	TD CAT 3
C01	Projector B	252	TD CAT 7	GRS	——
C01	Projector B	252	TD CAT 9	GB^0	——
C01	Projector B	252	TD CAT 10	GB^S	——
C01	Projector B	252	TD CAT 12	GA^2	——
C01	Projector B	252	TD CAT 14	GI^1	——
C01	Projector B	252	TD CAT 17	HR	——
C01	Projector B	252	TD CAT 24	S	——
C01	Projector B	252	SUP. DR. 43	GG	TD CAT 31
C01	Projector B	252	SUP. DR. 27	GIN	TD CATS 19, 20, 23
C01	Projector B	252	SUP. DR. 28	RHN	TD CATS 16, 18
C01	Projector B	252	SUP. DR. 30	IG	TD CATS 21, 22
C01	Projector B	252	SUP. DR. 34	GS^3	TD CATS 3, 4, 5
C01	Projector B	252	SUP. DR. 40	GS^2	TD CATS 3, 4
C01	Projector B	252	SUP. DR. 42	GA^3	TD CATS 12, 13
C01	Projector B	252	TD CAT 25	F	——

**All category line*

TABLE 5-2. PRRE CATEGORY AND FEATURE SWITCH DESIGNATIONS AND ASSIGNMENTS

Station Number: C00, C01

Unit Number: 251, 252

Expansion Levels: X1*, X2*, X4

FEATURE BANK 1	FEATURE LABEL		FEATURE BANK 2
1	DIM	BRIGHT	1
2	E	E	2
3	D	D	3
4	C	C	4
5	A	A	5

CATEGORY*

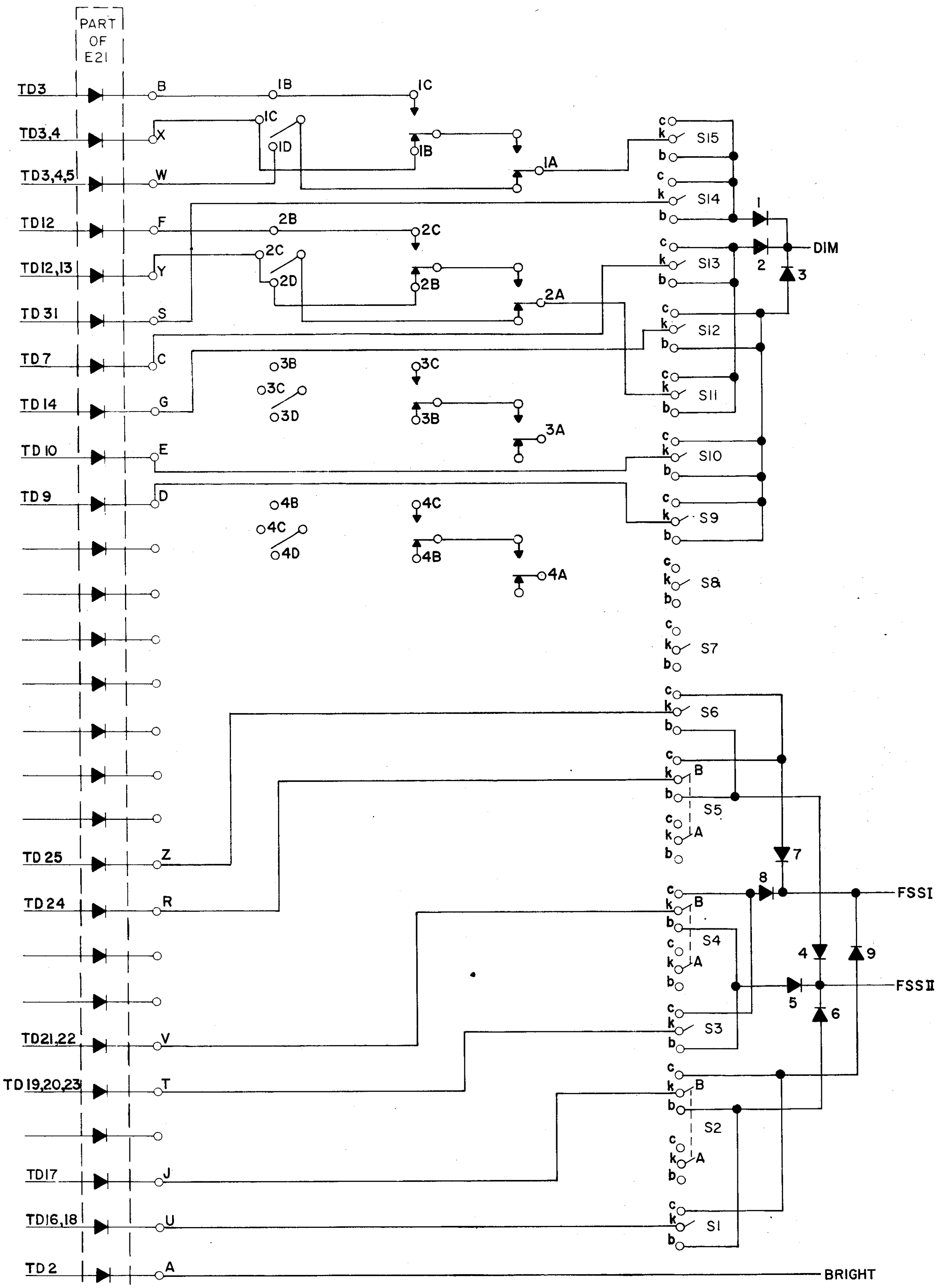
SWITCH	LABEL	INPUT LINES
15	BOUNDARIES + LANDMARKS	GS^1, GS^2, GS^3
14	GEOREF, TIME	GG
13	RADAR SITES	GRS
12	MCIS; ADIZ O/D AREAS	GI1, GI2
11	AAA DEFENSE	GA^2, GA^3
10	SUPP RECURY BASES	GB^S
9	OPER INTCPTR BASES	GB^0
8		
7		
6	FRIENDLY + RR TRACKS	F
5	SPECIAL TRKS	S
4	INTERCEPTORS IN GROUPS	IG
3	GRPS + INTCPTR TRACKS	GIN
2	HUKP IN RAIDS	HR
1	RAIDS + HUKP NOT IN RAIDS	RHN
Forced Display Name		Input Lines
All Categories		CAT 2

**Category switches and EXPANSION switch (X1–X2) are remotely controlled by AC & W. Expand selection and feature selection will be done manually at the console.*

anode of the 7-inch SD CRT in order to defocus the electron beam before it is applied to the character matrix (for all characters except the vector).

2.11.3 Intensification Unit 2

This unit functions with intensification unit 1 and the four input gates (defocus, focus, dim, and bright) to produce an intensification of all characters scheduled



NOTES:

1. FEAT SW WIRED A-16 & 21, C-17 & 22, D-18 & 23, E-19 & 24.
2. EXPANSION LEVELS X1, X2, X4.

Figure 5–16. PRRE Category Patching Diagram for display. The request display gate permits the intensification of the message to be photographed.

2.12 SEVEN-INCH SD CRT CIRCUITS

The 7-inch SD CRT requires the following input signals to display each message:

a. Character selection voltages

b. Character compensation and positioning and vector-generating voltages

c. Message-positioning coil current

d. Defocus gate (except generation of the vector)

e. Focus gate for generating a vector (also the beam is focused between characters)

f. Intensification gate for each character and vector

As has been previously stated, the 7-inch SD CRT differs from the 19-inch SD CRT solely in its photographic applications. In the same manner the characters are formed by passing the electron beam through the character matrix which contains 63 areas that have been cut out in the shapes of various characters and symbols. These apertures are cut out very much like a stencil; hence, when the electron beam is defocused and passed through one of these apertures, the shape of the cutout is projected onto the viewing screen of the 7-inch SD CRT. This in turn will activate the phosphors, displaying the character.

The vector is formed by passing the focused beam through the vector aperture in the character matrix to form a pinpoint spot. This spot is then swept across the viewing screen to display a vector. When no character or vector is desired during the display of a message, the beam is directed against a blank section of the matrix so that the beam is effectively blocked. The beam is deflected to the specific character on the matrix by varying the voltage on two sets of deflection plates, one set being for horizontal deflection and the other set for vertical deflection. These plates are called the character selection plates (fig. 2–7).

During the time that a character is being selected and displayed, the electron beam is defocused sufficiently to allow the beam to cover the character aperture. Whenever a vector is being generated, the beam remains focused. After the beam passes through the matrix it is no longer parallel with the axis of the tube. To deflect the beam back to the axis of the tube, there are two sets of deflection plates which compensate for beam deflection. These plates are called character compensation plates (fig. 2–7).

The compensation plates are also used to position the characters within a message to be displayed and to generate the vectors that may appear in the message. The vector is generated by selecting a point and sweeping this point by means of the voltage applied to the character positioning and compensation plates. A message positioning deflection coil positions the overall message in a particular location on the viewing screen of the 7-inch SD CRT. The convergence coil between the character selection plates and the character positioning and compensation plates focuses the beam which was deflected by the voltages on the selection plates. A trim coil, located at each end of the convergence coil and controlled by potentiometers located on the subpanel, insures that the total beam rotation through the convergence coil field is exactly 90 degrees.

An auxiliary focus coil is inserted between the character-positioning and compensation plates and the deflection coil to produce a definitive sharp display on the viewing screen. There is also a resistive coating around the bell of the tube in the form of a helix. Refer to Part 2 for a more detailed analysis of the 7-inch SD CRT.

SECTION 3
DETAILED EXPLANATION OF CONSOLE CIRCUITS

3.1 INTRODUCTION

Some of the PRR console circuits operate the same as circuits explained in preceding sections of this book. The character selection and character compensation in the PRR console are identical to those sections in the SDIE. Therefore, for the explanation of this operation, see Chapter 2 of Part 4.

The PRR circuits are similar in operation to circuits previously described; however, some differences exist. In the event of similarities, the previous explanation is referred to; where differences exist, the operation is explained in this section. The UNIT STATUS switch, intensification circuits, and message-positioning circuits are explained in this section. Since the PRR console remote-control circuits and location of the units in the PRR console are entirely new, they are explained in detail.

3.2 UNIT STATUS SWITCH

The UNIT STATUS switch is located in the lower left corner of the main control panel of the PRR console (fig. 5–2). Just as in the other simplex units, the UNIT STATUS switch, with its power and signal relays, is used to select the proper power and signals for use by the PRR console. Figure 5–17 is a simplified schematic of the UNIT STATUS switch with the coils of the power and signal relays.

The PRR console signals are switched by the UNIT STATUS switch energizing either the A or B signal relays. Table 5–16 gives the voltage inputs to the UNIT STATUS switch that are used to operate these signal relays. Table 5–3 indicates which of the relays are energized for each of the five positions of the UNIT STATUS switch with computer A or B active.

The power for the PRR console is switched by the UNIT STATUS switch energizing either the C or D power relays. Table 5–17 gives the voltage inputs to the UNIT STATUS switch that are used to operate these power relays. Table 5–4 indicates which relays are energized to activate the C or D power supply.

One portion of the UNIT STATUS switch supplies —48 volts to the request display gate generator.

The power source to the recorder-reproducer section is controlled by relay K59, K60, K102, and K103. With either set as these relays (as shown in figure 5–17) energized, the desired a-c and d-c voltages are fed to the recorder-reproducer section so that it may operate.

3.3 INTENSIFICATION CIRCUITS

Most of the SDIS's in the SDIE have the intensity gate signal from the SDGE going directly to intensification unit 2 (see fig. 4–21). This signal, after it has been modified by intensification unit 2, is used to intensify the CRT to give the desired tactical display.

TABLE 5–3. SIGNAL RELAY OPERATION

UNIT STATUS SWITCH POSITION	ACTIVE COMPUTER	A SIGNAL RELAYS	KA	B SIGNAL RELAYS	KB
ACT	A	Eng*	Eng	D**	D
	B	D	D	Eng	Eng
STDBY	A	D	D	Eng	Eng
	B	Eng	Eng	D	D
OFF, POWER, and AC	A or B	D	D	D	D

**Eng = Energized*

***D = De-energized*

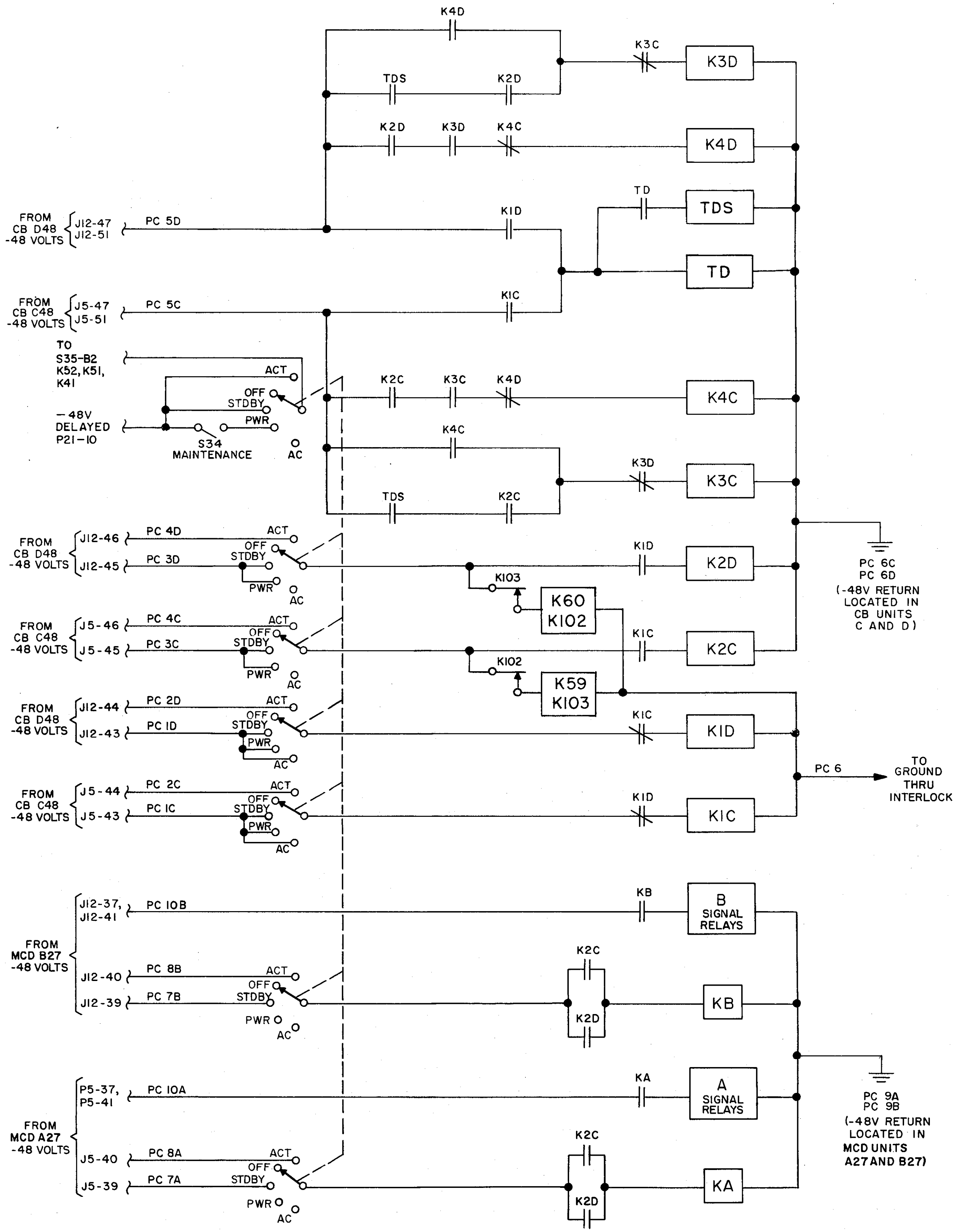


Figure 5-17. Unit Status Switch, Diagram

Each time the information for the display is available (about every 2.6 seconds) the intensity signal is sent from the SDGE. However, in the PRRE, the tactical display is not intensified each time the information is available because each frame of film used is exposed to the face of the 7-inch SD CRT for about 30 seconds. During these 30 seconds, about 11 tactical displays would be intensified if all were used. Each frame of film being exposed to 11 displays would be undesirable because the resulting photographs would be blurred. To eliminate the blurring, only one display is intensified for each frame of film.

Only one intensity gate signal from the SDGE goes to intensification unit 2 to intensify each frame of film. Limiting the intensity signal is done by inserting a request display gate generator in the intensity signal line that goes to intensification unit 2 from the SDGE. (See fig. 5–18.) In normal operation, this generator uses an input from the film mechanism to gate only one intensity gate signal to intensification unit 2 for each frame of film. This gated signal from the generator is called the request display gate signal, and it is used by intensification unit 2 in the same way as an intensity signal from the SDGE.

In normal operation, the display gate generator goes through a cycle of operation for each new frame of film that is exposed to the CRT. The cycle is controlled by the same cam timing circuit that controls the movement of the film. During each cycle, the generator produces a request display gate signal. This signal lasts as long as the intensify gate signal received from the SDGE. Besides normal operation, the request gate display generator can be set to one of two types of maintenance operations. During one maintenance operation, no tactical displays are intensified, and during the other maintenance operation all tactical displays are intensified. Figure 5–19 is a logic diagram of the request display gate generator. The type of generator operation, normal or maintenance, is determined by the four relay contacts shown in the figure.

For normal operation, K51 and K80 are energized, and K53 is periodically energized and de-energized by a switch in the cam circuit. Initially, during normal operation, K51 and K80 are energized about a minute after the UNIT STATUS switch is set to STDBY, ACT, or PWR. Relay K51 grounds the input of PG-1, which sends a signal to reset FF 1 and FF 2. Relay K80 connects one AND input to the 1 output of FF 2, and the cam switch energized K53, thus removing the input of PG-2 from ground.

When it is time to expose a frame of film to a tactical display (about seven seconds before the frame is changed), the generator cycles starts with the cam switch de-energizing K53. This action grounds the input of PG-2. PG-2 then sends a signal to set FF 1. The output of FF 1 conditions the gate tube, and the next start-TD input pulse goes through the gate tube to CDG-1 and CDG-2, where it is stopped because these two gates are not conditioned by FF 2. The start-TD pulse also goes to set FF 2. The output of FF 2 now conditions CDG-1 and CDG-2, and is also fed to the AND circuit. The intensity input signal that follows the start-TD pulse goes through the AND and out to intensification unit 2 as the request-display gate signal. This signal is used to

TABLE 5–4. POWER RELAY OPERATION

UNIT STATUS SWITCH POSITION	ACTIVE SYSTEM	K1C	K1D	K2C	K2D	K3C	K3D	K4C	K4D	TD	K60 K102	K59 K103
ACT	C	Eng*	D**	Eng	D	Eng	D	Eng	D	Eng	D	Eng
	D	D	Eng	D	Eng	D	Eng	D	Eng	Eng	Eng	D
OFF	C	D	D	D	D	D	D	D	D	D	D	D
	D	D	D	D	D	D	D	D	D	D	D	D
STDBY and PWR	C	D	Eng	D	Eng	D	Eng	D	Eng	Eng	Eng	D
	D	Eng	D	Eng	D	Eng	D	Eng	D	Eng	D	Eng
AC	C	D	Eng	D	D	D	D	D	D	Eng	D	D
	D	Eng	D	D	D	D	D	D	D	Eng	D	D

**Eng = Energized*

***D = De-energized*

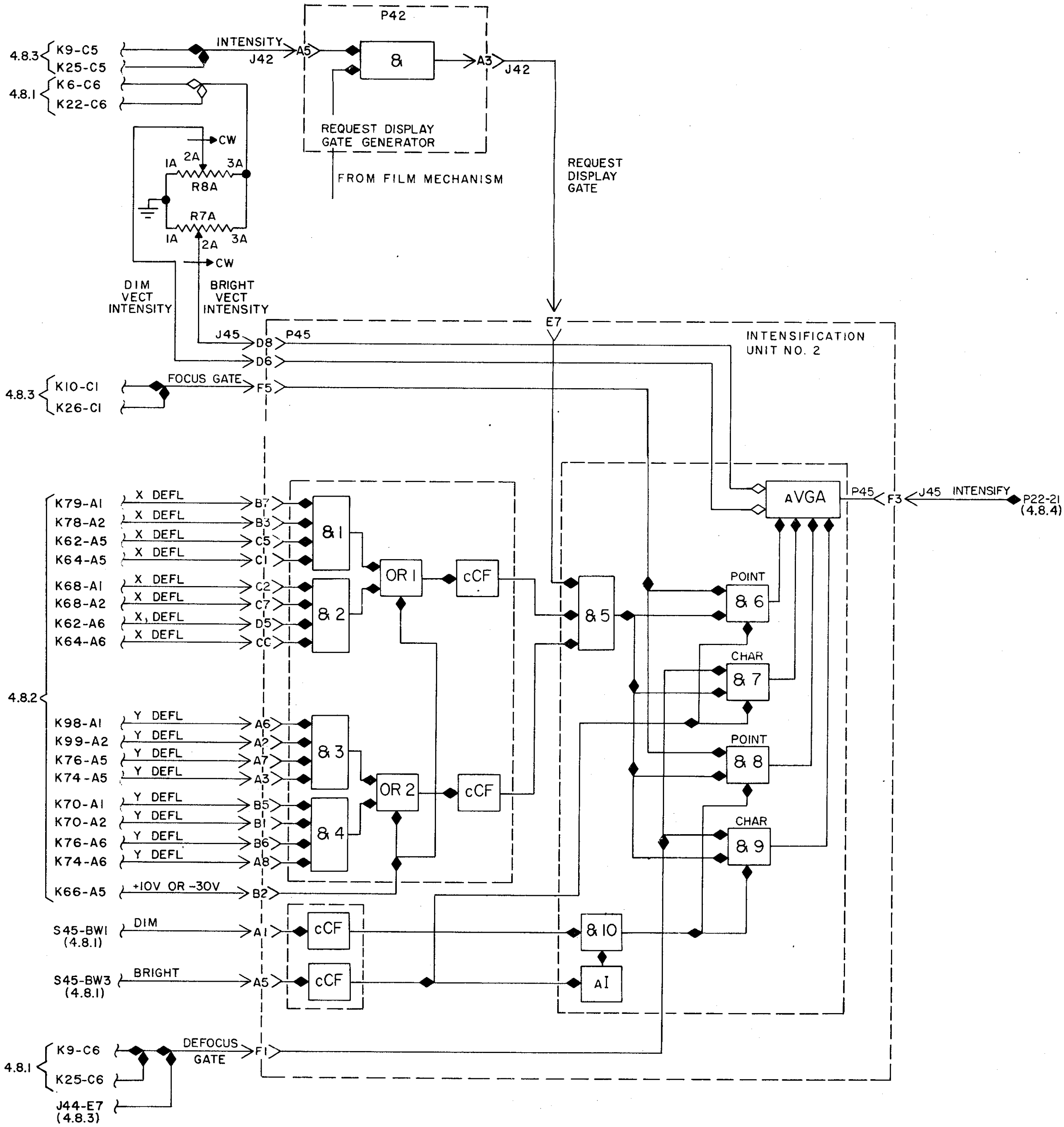


Figure 5—18. PRRE Intensification Unit 2

intensify the SD CRT for the one tactical display that is used to expose the frame of film.

When the next start-TD signal comes in (start-TD signals and intensity signals follow one another) it goes through the conditioned gate tube to FF 2 where it does nothing because FF 2 is already set. This signal from the gate tube also goes through conditioned CDG-1 and CDG-2 to reset FF 1 and FF 2. The intensity signals that now occur do not go through the AND because it is not conditioned by FF 2 and, therefore, no SD messages are intensified until the next generator operation cycle. When the next frame of film is moved into position for exposure to one SD message, K53 is energized by the cam switch. The next generator operation cycle starts when K53 is de-energized.

For one type of maintenance operation, K51 and

K80 are energized, but K53 remains de-energized. Without K53 opening and closing, the generator operation cycle will not start; therefore, no SD messages will be intensified because no request-display gate signals are generated.

For the other type of maintenance operation, K50 is energized and K80 is de-energized. The contacts of the relays connect +10 volts to the AND to condition it. Thus, whenever the intensity signal enters the AND it will be sent out as a request-display gate signal. The continuous generation of this signal will intensify the 7-inch SD CRT for every SD message.

The setting of the relays in the generator is controlled by the setting of the UNIT STATUS switch, the PROCESSING switch (S36) located on the main control panel, and the CONTINUOUS DISPLAY switch (S35) located on the subpanel.

Figure 5–20 shows the relay circuits with both S35 and S36. With the UNIT STATUS switch set to ACT, STDBY, or PWR, this circuit receives the —48-volt delayed power. When this occurs, time delay relay K52 is energized, and after 15 seconds the contacts of K52 close to energize K51. The closed contacts of K51 keep K51 energized and, at the same time, de-energize K52. K51 remains energized until the power to the circuit is turned off.

The operation of the other relays is not determined by setting switches S35 and S36. Table 5–5 lists the request-display gate generator outputs for all three types of generator operation. Behind each type of output is listed the relay operation needed to get the desired output (operation of some relays for the outputs is not important). The switch and its setting to get the proper relay operation are listed behind each relay. For example, to get a normal output from the generator, the operation of K50 is not important because its contacts do not enter into the generator operation at this time. (See fig. 5–19.) Relay K51 is energized by the UNIT STATUS switch at ACT, STDBY, or PWR. Relay K53 is energized and de-energized because S36 is set to ON to feed power to the cam circuit. Relay K80 is energized regardless of the position in which S35 is set.

3.4 MESSAGE-POSITIONING CIRCUITS

The method used for message positioning is the same in the SDS as in the SDIS. This method is described in Chapter 2 of Part 4. To prepare the SDS console for display of certain areas within the air defense sector, rotary switches are used.

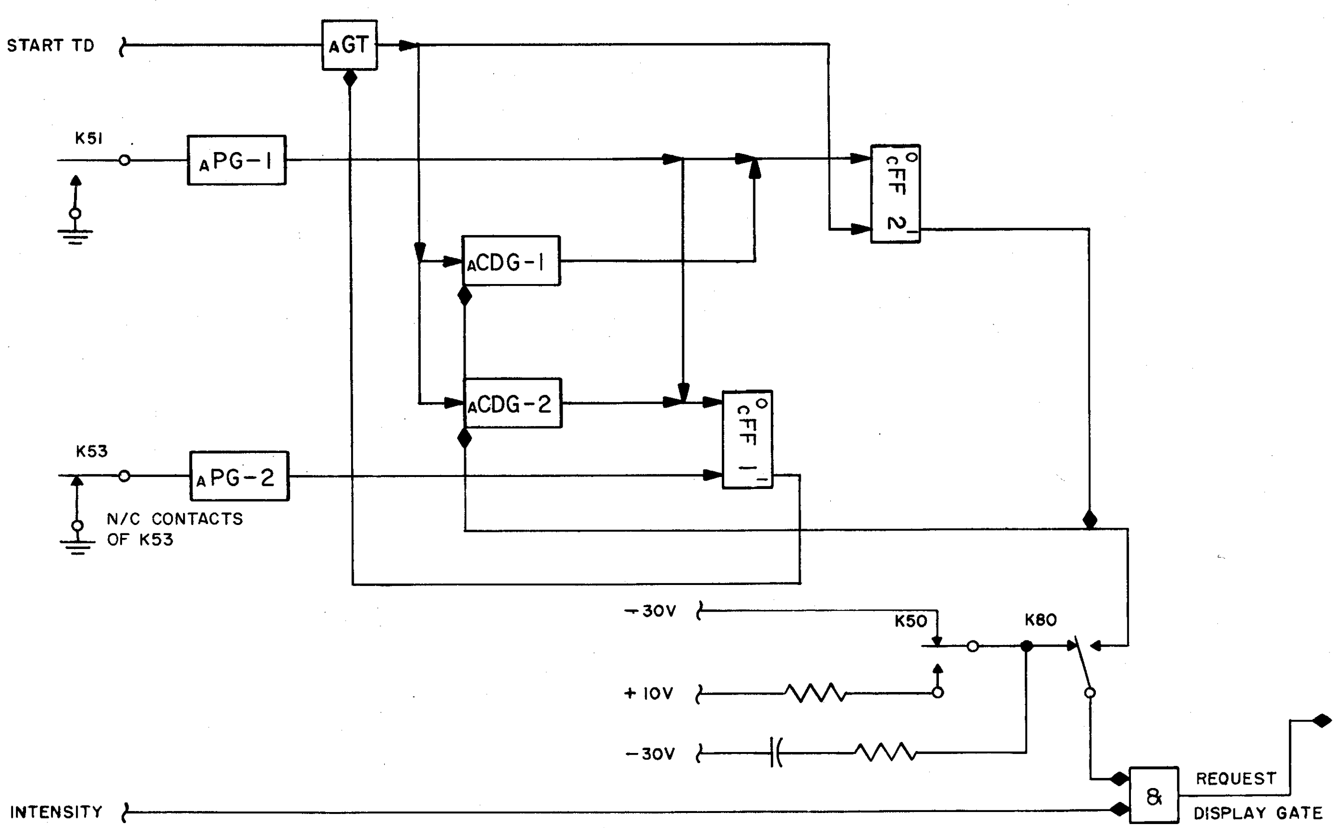


Figure 5–19. Request Display Gate Generator

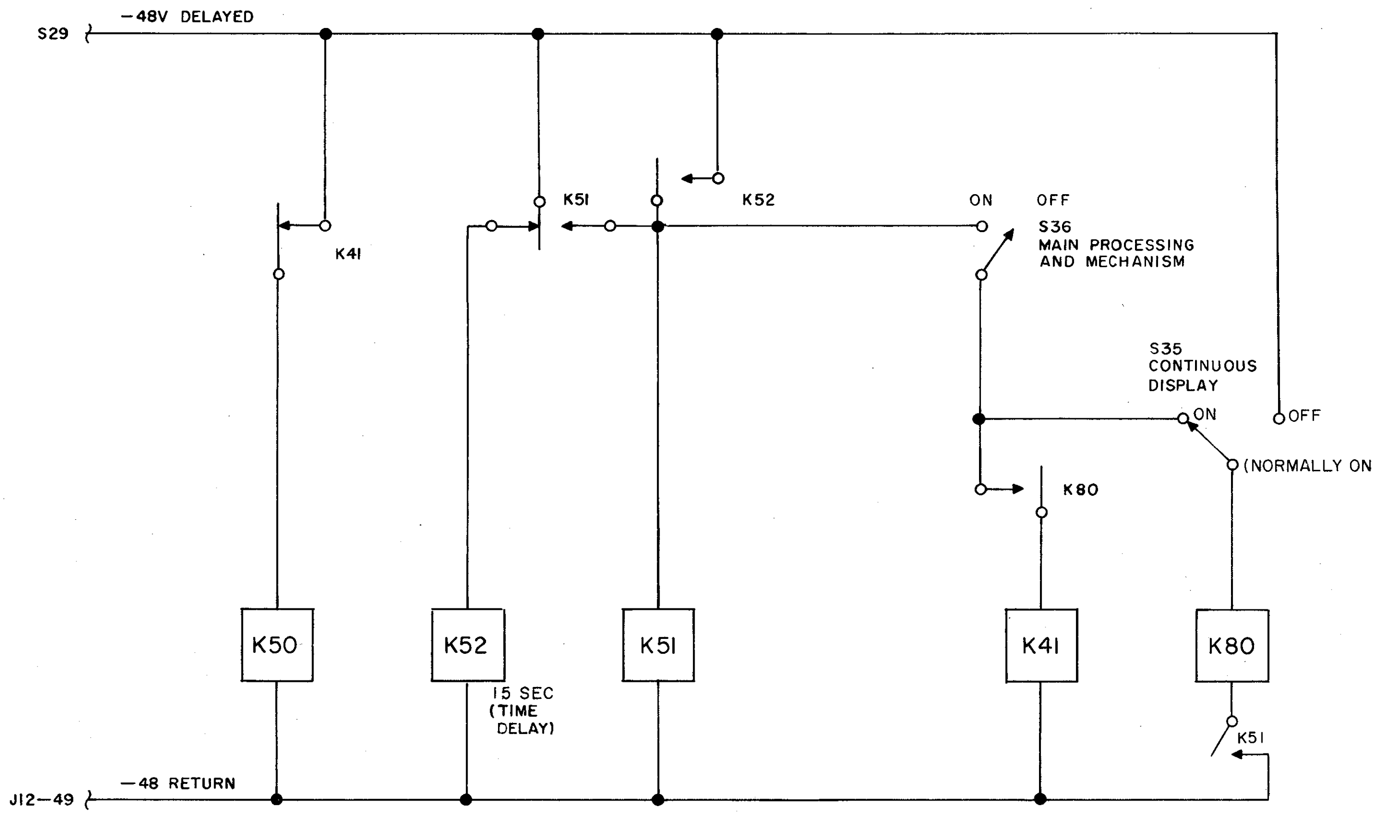


Figure 5-20. Request Display Gate Generator Relay Operation

TABLE 5-5. OPERATION OF RELAYS IN REQUEST DISPLAY GATE GENERATOR

GENERATOR OUTPUT	RELAY OPERATION	SWITCH SETTINGS
Normal	K50 not important	
(One SD message intensified for each frame of film)	K51 energized	Unit status ACT, STDBY, or PWR, S36 on*
	K53 energized and de-energized	
	K80 energized	S35 normal or off
No output	K50 not important	
	K51 energized	Unit status ACT, STDBY, or PWR
	K53 de-energized	S36 off
	K80 energized	S35 off
Continuous output	K50 energized	S36 off
(All SD messages intensified)	K51 energized	Unit status ACT, STDBY, or PWR
	K53 not important	
	K80 de-energized	S35 normal

**S36 is in the circuit that turns power on and off for the cam circuit in the PRRS that is used to energize and de-energize K53.*

3.4.1 Rotary Switches

The settings of the rotary switches (fig. 5—21, foldout) control both expansion levels and the selection of off-centering. These rotary switches enable the PRR operating personnel to quickly select areas pertinent to the site defense sector.

3.4.1.1 Expansion Levels

The rotary switches provide the following levels for the various settings of the EXPANSION switch, S28:

CNTD	X1, X2
NORM	X1, X2, X4
EXP	X2, X4, X8

All the necessary levels and combinations needed for the PRR console can be formed with the above. From these a selection of three is made. At present, the PRR console is assigned the following levels:

CNTD	X1
NORM	X2
EXP	X4

Control of the expansion level is effected by the proper selection of relay groups. The selection is made by grounding the coils of the selected relays through a rotary switch contact. This allows the —48-volt relay control voltage to complete its circuit through the relay coil to ground. Switch S71 supplies the ground to the relays when switch S28 is set to the CNTD position. Switch S72 controls both the NORM and EXP positions of switch S28. The normally closed contacts of relays K55 to K58 are open only during remote operation and are discussed under remote operation circuits.

3.4.1.2 Expansion on CNTD Position

With switch S28 on the CNTD position and S71 in position 12, the E relay is energized, producing an X1 expansion. None of the other positions of S71 energize an expansion. When no expansion relays are energized, an X2 expansion is produced.

TABLE 5—6. NORMAL EXPANSION

S72 POSITION	EXPANSION
12	X1
11	X1
10	X2
9	X2
8	X2
7	X4
6	X4

TABLE 5—7. EXPANDED EXPANSION

S72 POSITION	EXPANSION
12	X2
11	X4
10	X2
9	X4
8	X8
7	X4
6	X8

3.4.1.3 Expansion on NORM Position

Switch S72 controls the expansion when S28 is in the NORM position. The arms (movable contacts) of sections S72A and S72C are connected to the NORM position of S28, and with the switch set in this position, the possible expansion levels are as shown in table 5—6.

3.4.1.4 Expansion of EXP Position

Wafers B and D of S72 control the expansion level when EXPANSION switch S28 is on the EXP position. The expansion level for each switch position is shown in table 5—7.

3.4.1.5 Off-Centering

The off-centering relays are coded to simplify the discussion of their functions. The codes are shown on figure 5—21, foldout. The various off-centering selections are obtained by operating the A-D relays in various combinations. Figure 4—25 shows how the X1 display is divided up into 15 overlapping segments in each axis. These basic segments are numbered 1-15. For an X2 expansion, each axis is divided into three sections, as shown. The first section includes segments 1-7; the second section includes segments 5-11; the third section includes segments 9-15. The Y axis is divided the same way. The result of this division is to provide nine overlapping areas, any one of which will fill the entire usable portion of the 7-inch SD CRT face when an X4 expansion is displayed. The remaining level of expansion is the X8 display. In this expansion, one of the basic segments of the X1 display is expanded to fill the 7-inch SD CRT. There are 225 possible X8 expansions.

3.4.1.6 Off-Centering Relays

Various combinations of the off-centering relays are needed to select the different segments and groups of segments of the X1 display. Table 5—8 shows which relays are energized for various segments of the X1 display.

3.4.1.7 Actuation of Off-Centering Relays on CNTD Position

Switch S71 is used to select the off-centering segments for the CNTD position of EXPANSION switch S28. The selection of segments is made by energizing various off-centering relays, as shown in table 5—9, for different settings of switch S71.

3.4.1.8 Actuation of Off-Centering Relays on NORM Position

Wafers E and F of S73 and S74 perform the function of area selection for the NORM position. S73 selects the X relays while S74 selects the Y relays. The appropriate switch to be used for either the X or the Y area is listed in table 5—10.

3.4.1.9 Actuation of Off-Centering Relays on EXP Position

The off-centering relays on the EXP position are actuated by means of the off-centering pushbuttons. Seven pushbuttons are required for a complete selection when NORM is X2 and EXP is X8. The X8 display contains seven segments, and there must be a choice provided for any one of the seven. If NORM is set for X4, only three segments are displayed, and, therefore, only three pushbuttons are allowed for full selection. In this situation, four of the pushbuttons should be masked off.

When the NORM position is X2, the off-centering switches will select any of four sections. Assuming that the selection was 9-15 in both axes, this would be the area contained by KLOP in figure 5—11. Therefore, with an X8 expansion on EXPD, pushbutton A would select the X axis between A and B. Pushbutton 1 would select the Y axis between rows 1 and 2. Refer to figure 5—21, foldout, to trace this action. Switches S73 and S74 would have to be on position 9, since this was their position for the X2 expansion on NORM. S72 would be on position 8, since this is the only position that would furnish an X2 expansion on NORM and X8 expansion on EXPD. When you switch from NORM to EXPD on switch S28, without depressing any off-centering pushbuttons, relay Ax and Ay will be energized. Therefore, pushbuttons 1 and A will have no effect, and segment 9 in both axes will be displayed. Operating pushbuttons 2 and B will add Dv and Dy and change the display to segment 10 according to table 5—8. By continuing to trace each pushbutton, the complete operation can be checked.

3.4.1.10 SD Test Pattern Switch

The —48-volt return for the expansion and off-centering relays in the CNTD, NORM, and EXPD positions of the EXPANSION switch is obtained through one section of the SD TEST PATTERN switch. When this switch is in either of the TEST positions, only the E expansion relays are operated, so that an X1 display is assured for the test pattern.

3.4.2 Magnitude Bit Selection

These circuits operate in the same manner as those explained in Chapter 2 of Part 4.

TABLE 5—8.
OFF-CENTERING RELAY SEGMENT SELECTION

EXPANSION	RELAYS	SEGMENTS
X2	CD	1—7
X2	BCD	5—11
X2	ACD	9—15
X4	D	1—3
X4	CD	3—5
X4	BD	5—7
X4	BCD	7—9
X4	AD	9—11
X4	ACD	11—13
X4	ABD	13—15
X8	—	1
X8	D	2
X8	C	3
X8	CD	4
X8	B	5
X8	BD	6
X8	BC	7
X8	BCD	8
X8	A	9
X8	AD	10
X8	AC	11
X8	ACD	12
X8	AB	13
X8	ABD	14
X8	ABC	15

TABLE 5–9. CONTRACTED SEGMENT SELECTION

S71 POSITION	EXPANSION LEVEL	X RELAYS	(X) (AREA)	Y RELAYS	(Y) (AREA)
12	X1	None	1–15	None	1–15
11	X2	CxDx	1–7	CyDy	1–7
10	X2	CxDx	1–7	ByCyDy	5–11
9	X2	CxDx	1–7	AyCyDy	9–15
8	X2	BxCxDx	5–11	CyDy	1–7
7	X2	BxCxDx	5–11	ByCyDy	5–11
6	X2	BxCxDx	5–11	AyCyDy	9–15
5	X2	AxCxDx	9–15	CyDy	1–7

3.4.3 Digit 0 Selection, X2, X4, and X8 Expansion

The digit 0 selection circuitry operates in the same manner as in the SDIS. The SDIS circuitry is described in Chapter 2 of Part 4.

3.4.4 Intensification Selection

These circuits are similar to those in the SDIS which are covered in Chapter 2 of Part 4.

3.5 REMOTE CONTROL CIRCUITS

The PRR can be operated locally at the PRR or remotely (to a limited degree) at the Command Post console. The PRR operator has complete control when CATEGORY switch S26 and EXPANSION switch S27, located at the PRR console, are set to LOCAL. Switching both of these switches to REMOTE, therefore, allows the Aircraft and Warning Officer at the Command Post console to assume limited control of the PRR.

There are 20 pushbuttons located at one desk section of the Command Post console that are used for remote control of the photographic recorder-reproducer element (PRRE). These pushbuttons give the command staff some control over the display projected on the screen. Of the 20 pushbuttons, a maximum of 15 are labeled and used to select various combinations of display categories. One is labeled X1 and is used for contracted display. Another, labeled OPERATOR, is used to signal the operator in the projection room when there is trouble or faulty display. Three pushbuttons are spares.

When the X1 pushbutton is depressed, the remote contracted display relays, K36, K37, K38, and K81, are energized. These energized relays switch the —48-volt return line from the A column of the remote expansion and off-centering section of the plugboard to the corresponding terminals in the B column (fig. 5—7). The B column terminals are connected to relays Ex (K66 and K67) and EY (K71 and K72), which form the X1 expansion of the display.

Each of the 15 remote category switches energizes the 15 category relays, K83 through K97. These relays are located in the PRR proper. The normally closed contacts of these relays allow the category gate signals to go to the category switches (S1-S15) that are located on the PRR (see fig. 5—16). When one of the remote pushbuttons is depressed, its associated relay is energized. Energizing the relay causes the category gate to be disconnected from the category switch. This action prevents the message of that category from being intensified.

TABLE 5–10. NORMAL SEGMENT SELECTION

(S73 OR S74) POSITION	EXPANSION LEVEL	(X OR Y) AREA	(X OR Y) RELAYS
12	X1	1–15	None
11	X2	1–7	CD
10	X2	5–11	BCD
9	X2	9–15	ACD
8	X4	1–3	D
7	X4	3–5	CD
6	X4	5–7	BD
5	X4	7–9	BCD
4	X4	9–11	AD
3	X4	11–13	ACD
2	X4	13–15	ABD

3.5.1 10C-PB (Pushbutton) Module

The 20 pushbuttons are located in two 10C-PB modules (fig. 5—22). This type of module contains 10 pushbuttons, with each button having independent push-to-make and push-to-break action. When the button is depressed to the ON position and the finger is removed, the button will not release. To release the button, the button must be pushed beyond the ON position. Since there is no release solenoid, the REL button is inactive. Furthermore, since these buttons are independently released, more than one button in a module may be depressed at any one time.

3.5.2 Operation

All of the pushbuttons except the spares are connected to coils of relays in the PRRE. The contacts of these relays are connected in the circuits of the projection element. Figure 5—23 shows a simplified diagram of the pushbuttons and the relays they operate.

Before any action can be taken by the pushbuttons on the Command Post console, K39 has to be energized by the UNIT STATUS switch at the desk section that has the PRR remote controls. The UNIT STATUS switch must be set to ACT, STDBY, or PWR to energize the relay. The 15 category pushbuttons will not operate any relays unless K39 is energized and the category LOCAL-REMOTE switch S26 at the PRR is set to REMOTE. The contracted X1 display pushbuttons will operate its remote contact display relays only when the expansion LOCAL-REMOTE switch S27 located at the PRR is set to REMOTE and relay K39 is energized. The button labeled OPERATOR, at the desk section, will energize the faulty display alarm relay K49 any time K39 is energized.

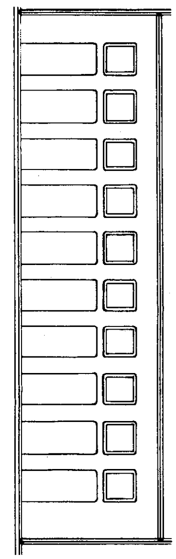


Figure 5—22. 10C-PB Module with Labels

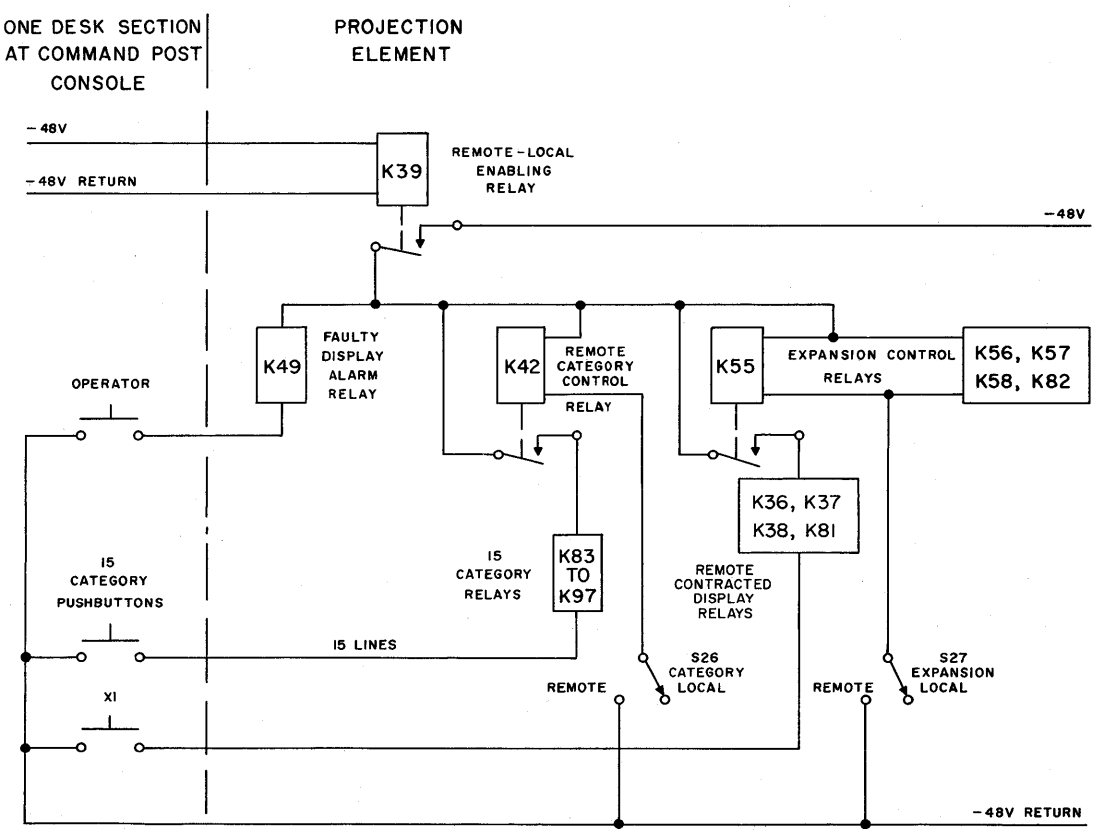


Figure 5—23. Remote Control of Projection Element, Simplified Diagram

SECTION 4
OPERATING CONTROLS AND RELAYS

4.1 SUBPANEL CONTROLS

The PRR console subpanel, shown in figure 5–5, contains the necessary controls to adjust both the SDS and the PRR. The following list describes briefly the controls used for the SDS:

a. SD TEST PATTERN: A 3-position switch which allows normal console operation only in NORMAL position. When in either of the TEST positions, only the test category is displayed, while all other categories are disconnected. In addition, the X1 expansion is selected for display. In TEST 1 position, the feature selection switches in FSS 1 are operative: when in TEST 2 position, the feature selection switches in group 2 are operative.

b. DRIVER EMISSION CHECK SWITCH: A 5-position rotary switch which allows checking of the operation of the driver unit. In NORMAL position, the driver unit operates normally. In any of the other four positions (LEFT, RIGHT, DOWN, UP), only one of the four driver tubes is operating.

c. DRIVER FILAMENT VOLTAGE SWITCH: Reduces the filament voltage applied to all four driver unit tubes, testing the tubes for low emission.

d. BRIGHT and DIM CHARACTER INTENSITY: Vary the intensity of the bright characters and the dim characters, respectively.

e. BRIGHT and DIM POINT INTENSITY: Adjust the intensification levels for bright and dim points, respectively.

f. HORIZONTAL and VERTICAL GAIN: Vary the width and height of the display area on the 7-inch SD CRT. By varying the gain of the deflection amplifier, the display is made to fit within the inscribed square on the face of the 7-inch SD CRT.

g. DEFOCUS GATE AMPLITUDE: Adjusts the evenness of illumination of bright characters. This adjustment is made by observing a test pattern and adjusting by eye.

h. HORIZONTAL and VERTICAL CONVERGENCE CENTER: Adjusted for electronic center rather than mechanical center of the convergence field.

i. REQUEST GATE MARGINAL CHECK: Marginally checks three voltage lines to the request display gate generator.

j. CHARACTER FOCUS: Adjusts character size and clarity.

k. DECODER TEST 1 and TEST 2: Used for marginal checking the 10-bit binary decoder.

l. DEFLECTION AMPLIFIER TEST: Provides a means for marginal checking the deflection amplifier.

TABLE 5–11. RELAY FUNCTIONS

FUNCTION	RELAY NUMBER
Remote category control	42
Category	K83 to K97
Remote contracted display	K36, K37, K38, K81
Expansion control	K55, K56, K57, K58, K82
Faulty display alarm	K49
Remote-local enabling	K39
A signal relays	K1 to K14
B signal relays	K17 to K30
X off-centering	K68, K77, K78, K79
X off-centering	K70, K98, K99, K100
Expansion	K62, K63, K64, K65, K66, K67, K71, K72, K73, K74, K75, K76
PRRS	K33, K34, K40, K41, K43, K44, K46, K47, K48, K49, K50, K51, K52, K53, K59, K60, K80
Spares	K15, K16, K31, K32, K35, K45, K54, K61, K69

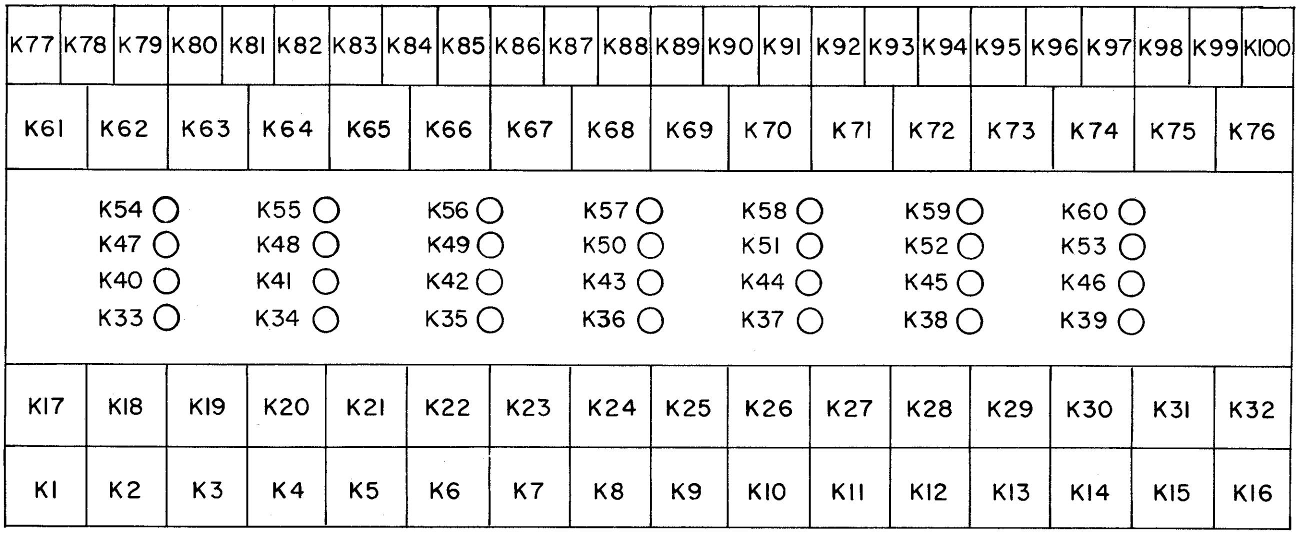


Figure 5—24. Relay Panel, Location Diagram

m. OFF-CENTER KEY RELEASE: Energizes a solenoid that releases the off-centering keys on the front panel in case they are depressed.

n. FINE and COARSE CONVERGENCE CURRENT: Adjusted for the sharpest character register as viewed on the screen of the 7-inch SD CRT.

o. HORIZONTAL and VERTICAL COIL CENTER: Used to secure centering of the electron beam.

p. "Y" OUTPUT and "X" OUTPUT – DECODER COMPENSATION: Used for balancing the decoder output.

q. COMPENSATION and SELECTION-CONVERGENCE TRIM: Provide fine adjustment of character register and format.

The remaining controls on this panel are used in the PRR section and will be discussed in Section 5 of this chapter.

4.2 HIGH-VOLTAGE PANEL

This panel (fig. 5—5) contains the controls that are part of the SD high-voltage unit. They are all part of the SDS and are described briefly below:

a. WRITING BEAM INTENSITY: Adjusts the overall brightness of the SD display.

b. WRITING BEAM FOCUS: Adjusts the size of the point displays. Reduces a bright point to its optimum size.

c. CHARACTER CENTERING – HORIZONTAL and VERTICAL SELECTION: Adjust for proper selection of columns and rows of characters on the character matrix. Set so that the defocused writing beam is centered on the selected character aperture.

d. CHARACTER CENTERING – HORIZONTAL and VERTICAL COMPENSATION: Adjust horizontal and vertical character registration. Adjusted while viewing a test pattern to reduce the variation in position of different characters displayed sequentially in the same location.

e. CHARACTER AMPLITUDE – LEFT, RIGHT, UP, and DOWN: Adjust both the compensation and selection amplitude.

4.3 RELAY OPERATION

The relay panel in figure 5—4 is also illustrated by a block diagram in figure 5—24. This block diagram shows the numbers of the relays and their positions on the panel. Table 5—11 groups the relays by function.

SECTION 5
PHOTOGRAPHIC RECORDER-REPRODUCER SECTION

5.1 INTRODUCTION

The photographic recorder-reproducer section (PRRS) of the photographic recorder-reproducer element (PRRE) is described in this chapter. This section of the PRRE consists of a recorder which automatically photographs the sequential information on the face of a 7-inch SD CRT, a rapid film processor, and a reproducer which automatically projects the processed picture onto a large screen in front of the Command Post. The PRRS is physically a part of and located within the PRR AN/KD-6(1) (fig. 1–13).

The recorder automatically photographs a 6-inch display area of the 7-inch SD CRT as a 0.800-inch circle on the 35-mm film frame. The film is then processed automatically by the time-and-temperature method, without manual intervention. In the proper sequence, chemicals are mixed with hot air and jet-sprayed onto the emulsion side of the film. Separate venturi-type jets are used for each chemical and for air-drying the film. Flow control is achieved by a solenoid air valve in each line.

When processing has been completed, the film is transported to the reproducer area of the film gate for projection.

5.2 THEORY OF OPERATION

The PRRS of the photographic recorder-reproducer console (PRRC) provides the projected situation display on the large screen in front of the Command Post (see frontispiece).

Film loaded on a film magazine travels to a film gate, where it is exposed at a recording section of the gate. The film then moves to the processor section of the gate, where it is developed and fixed. Next, the film moves to the reproducer section of the gate, where it is projected onto the screen. Once projected, the film travels to the takeup reel. The film drive components transport the film from the film magazine through the various sections of the film gate to the takeup reel, as shown in the basic flow diagram of figure 5–25. The film gate is operated electromechanically.

The film gate assembly is the heart of the PRR. In that small area the end function of the three basic photographic processes takes place: taking the picture, developing the picture, and enlarging the picture by projection.

The film is advanced through the film gate by a film drive assembly, which also positions the cams that control the timing of the recording, processing, and reproducing operations. Figures 5–26 and 5–27 show these three operations from right to left. The mechanical linkages move the film from one gate aperture to the next (a distance of 10 film perforations) and also move the timing control cams and the visual timing cycle indicator. The electrical lines control the film mechanism and the timing.

The operation up to this time can be considered that of normal photographic equipment, but any device that will expose, process, and project a film display every 30 seconds must have a special, ultra-rapid processing method. The PRR makes use of heated air mixed with the proper chemicals to jet-spray the exposed emulsion. In less than 30 seconds the film frame has been developed, bleached, reversed, washed, and dried, in precisely timed cycles.

Reproducing the now fully processed 35-mm frame by projecting the display image onto a 14-by-14-foot screen is accomplished by a unique projection system. The projector employs a high light-output mercury vapor lamp and a complex beam-directing optical system to project the initial 0.800-inch image 35 feet to the large screen area.

5.3 RECORDER

The recorder is, in effect, a camera. Light from the SD CRT passes through the recorder lens, which is about 17 inches above the CRT screen and some 2 inches below the film plane. The light in passing through the lens is focused to a sharp image on the film when the shutter is in the open position.

The film is held flat in the film gate by a clamping device. The shutter is interposed between the lens and the film to prevent blurring of the image when the film is transported from one gate operation-aperture to the next. The lens is mounted to the film gate at one end and slipped into the viewing shroud on the other. The lens adjustments are the conventional external iris diaphragm ring and focusing ring. The ring markings are in standard units and f/stops. See figure 5–28.

5.3.1 Lens Assembly

The lens assembly is physically mounted to the bottom of the film gate. The assembly resembles the standard f/2, 2-inch focal length objective used in miniature

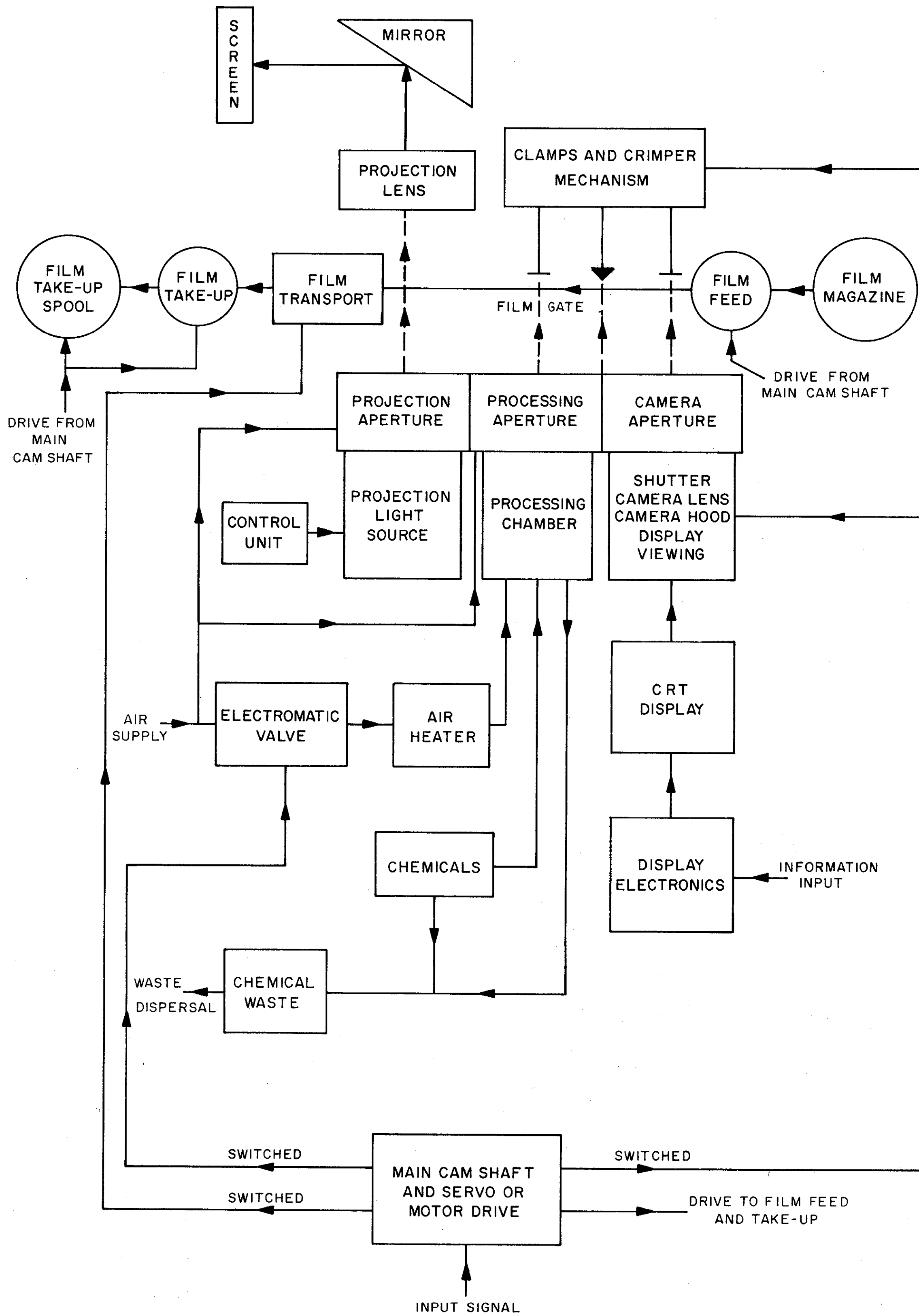


Figure 5–25. Block Schematic of the PRR

cameras. Lenses of this type consist of several lumenized or coated-glass elements spaced and contained, according to optical formulas, within a metal tube or barrel. Within the barrel, and between the elements, is a variable aperture (iris diaphragm) with an external control ring. A method for moving the lens forward or toward the film plane (focusing) is controlled by another external ring on the barrel.

Since the function of the lens is to focus the rays of light emanating from the CRT, the lens opening should be large enough to obtain exposures in the desired range. The variation in this range is obtained by the iris diaphragm.

5.3.1.1 Lens and Mirror Elements

Lens elements are used in both the recorder and reproducer section of the PRR. How they function can be explained by fundamental optic laws.

When a light ray enters glass from the air, its speed is reduced; when it returns to the air, it resumes its original speed. If the ray enters or leaves the glass at any angle other than 90 degrees, it is bent, or "refracted," in a predictable manner, the extent of refraction being controlled by the nature of the glass and the angle at which the ray strikes the surfaces.

If the entering and emerging surfaces of glass are parallel, light rays passing through will continue in the original line of travel. If the entering and exiting surfaces are not parallel, as in a prism, the rays will emerge in a different direction from the original path.

All the rays of light reflected, or emanating, from any one point on the face of the CRT being photographed and passing through the lens will be focused as a virtual point at the film plane of the recorder. In both theory and practice this "point" is never a true point, but instead, a circle small enough to appear as a point to the eye. The film emulsion is thus exposed by varying intensities of these point sources of light.

5.3.1.2 Lens Barrel Assembly

The lens barrel assembly consists of several coated elements mounted in a metal sleeve (barrel). A single element or convergent lens can be used to form an image. The image will, however, be found to suffer from defects due to lens aberrations, especially when the lens is used at large apertures. Therefore, where speed and good definition are required, several additional elements are added, each one correcting a particular fault or aberration. These elements are so mounted in the barrel that the centers of their spherical surfaces lie on the same principal axis.

5.3.1.3 Focal Length, Focal Plane, and Focus

A fundamental characteristic of any lens is the focal length. The focal length is the property which deter-

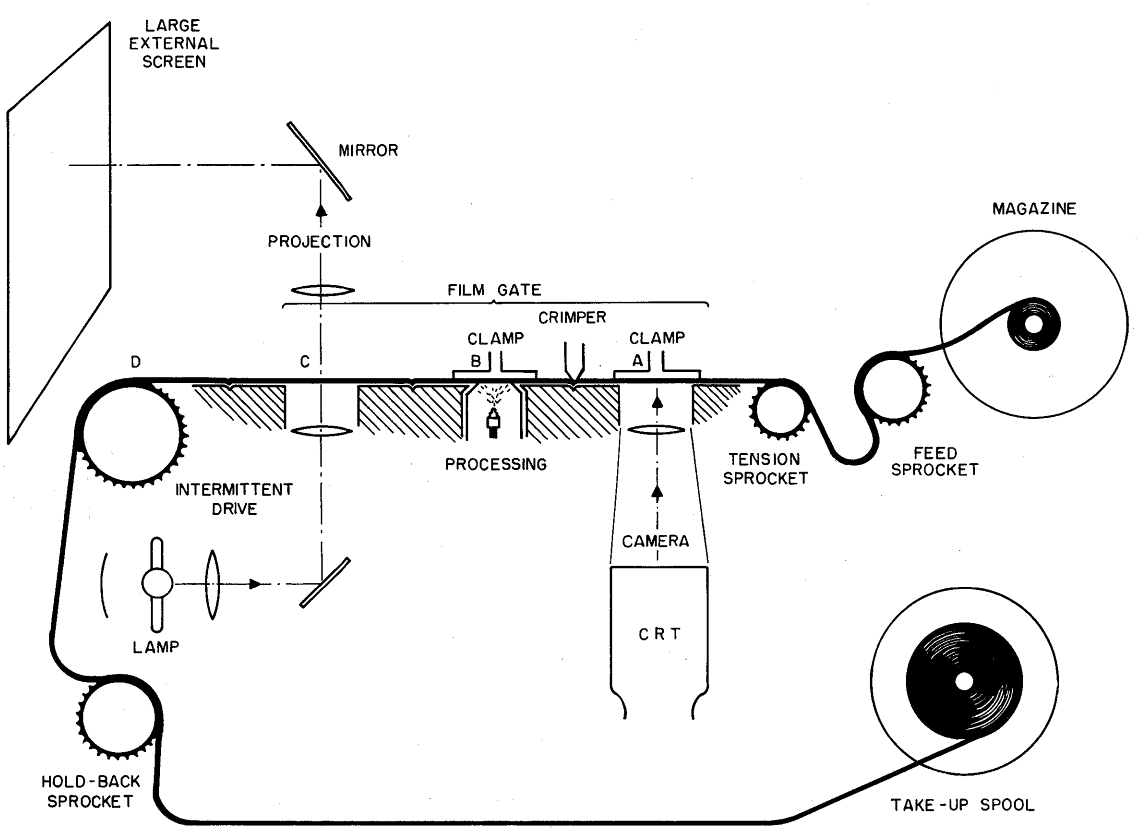


Figure 5–26. Basic Principles of the PRR

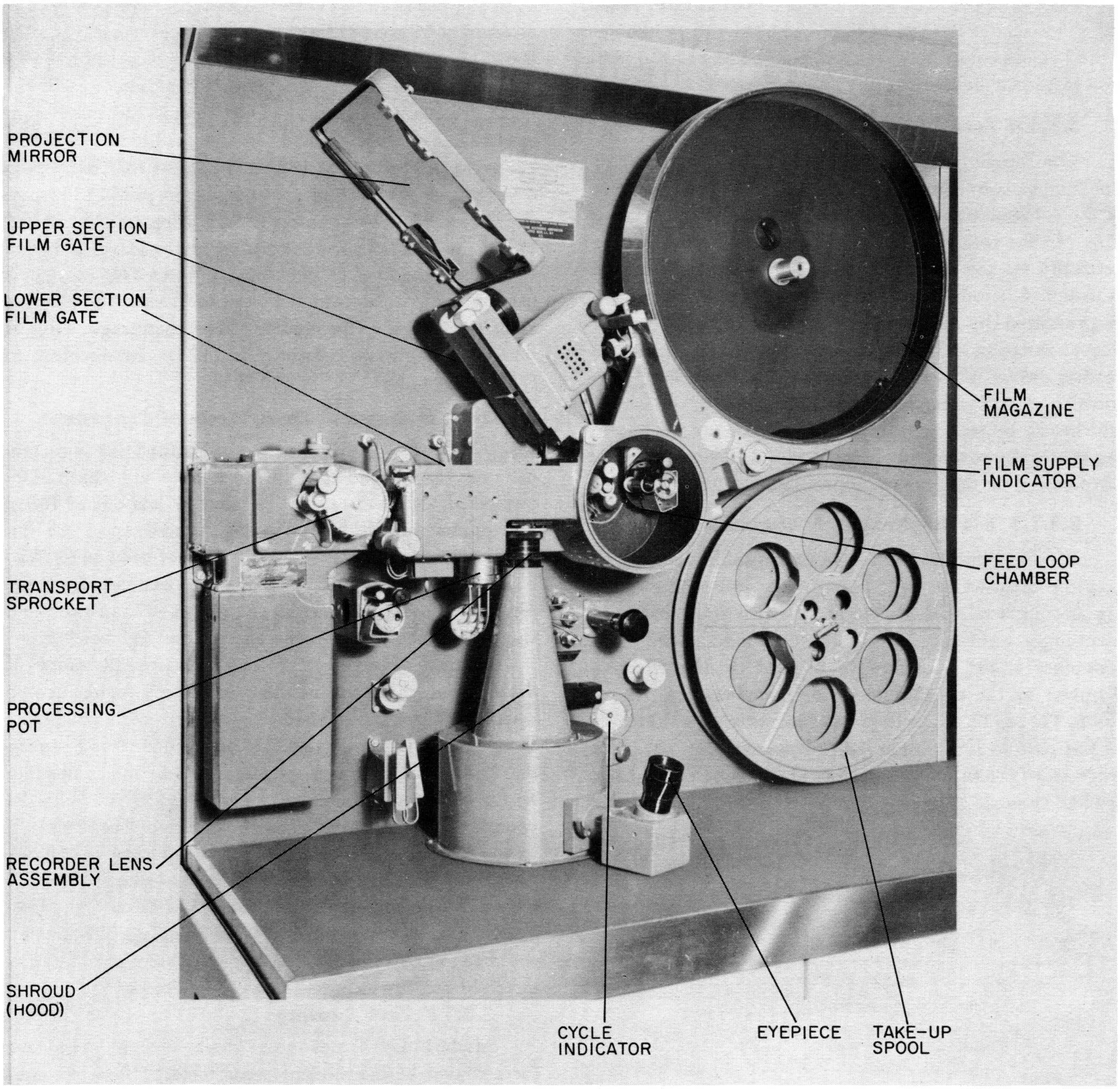


Figure 5—27. Photographic Recorder-Reproducer Main Plate Mechanism

mines the size of the image of an object placed at a given distance from the lens. For all practical purposes, the light from a point in an infinitely distant scene may be said to enter the lens as parallel rays. The lens bends these rays so that they converge behind the lens to form an image of the point from which they originate. The distance from this image to the rear nodal point in the lens is the focal length. The longer the focal length the larger the image of an object at a given distance.

As parallel rays of light from the SD CRT pass through the lens elements, they are refracted and intersect on a plane which is at right angles to the principal axis. This is known as the focal plane. The point at which the principal axis intersects the focal plane is known as the focal point of the lens.

When a lens is placed at a suitable distance from a luminous object (CRT display), it forms an inverted image which may be received sharply on a plane at a determined distance from the lens. This distance can never be nearer to the lens than the focal plane which represents the nearest plane on which real images can be received. Since a sharp image is required at the fixed plane (i.e., the plane of the film), it is necessary to move the lens relative to the film in order to satisfy the required relationship between image and film. This operation is known as focusing.

5.3.1.4 Focusing Assembly

The focusing assembly is held to the lower part of the film gate by four screws which pass through holes at the corners of a square retaining plate. The focusing ring can be rotated, but it is prevented from moving vertically by the retaining plate. The force transmitted (through friction) from the rotating ring to the sleeve is prevented by the retaining pin from rotating the sleeve. Rotation of the focusing ring, therefore, causes vertical travel of the sleeve and the camera lens. The focusing ring carries a scale of 24 engraved divisions, which may be read against an index mark on the retaining plate. A movement of one division alters the vertical position of the lens by approximately 0.001 inch.

5.3.1.5 Iris Diaphragm, f/Numbers

Photographic lenses have an adjustable opening to vary the quantity of light passed. The size of the opening as compared with the focal length is indicated by a diaphragm scale, generally marked in f/numbers. Each f/number is the focal length divided by the effective diameter of the diaphragm. The f/numbers 1.4, 2.8, 4, 5.6, 8, 11, 16, 22, 32, and 45 indicate successive decreases of one-half in light intensity (an aperture of f/4 gives twice as bright an image as f/5.6, f/2.8 twice as bright as f/4 and so on.)

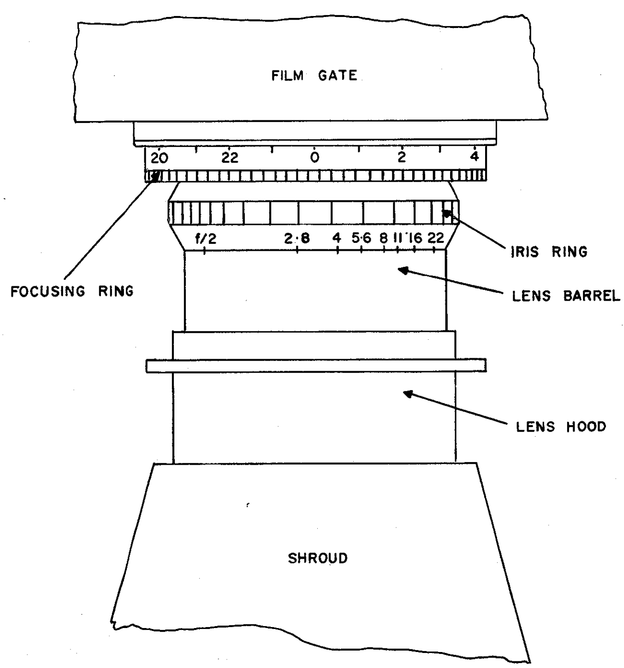


Figure 5–28. Recorder Lens Assembly

The variable aperture (iris diaphragm) is a mechanical device consisting of a set of curved leaves. The leaves, depending on how much they are caused to overlap, cover a circular area with a central, and nearly circular, hole left uncovered. This hole is the diaphragm aperture. The diaphragm is situated within the lens barrel between two of the lens elements so that it restricts the effective diameter of the light beam passing through the second lens. By rotating the iris ring, on the periphery of the lens barrel, the position of the leaves is varied to change the size of the central hole. The change is usually made in calibrated f steps or "stops," as they are generally called. The recorder lens diaphragm ring is marked in eight stops from f/2, the largest opening, to f/22, the smallest.

5.3.1.6 Depth of Field, Circle of Confusion

Theoretically, when a lens is focused for a certain distance, objects at that distance only are sharp. Objects at all other distances are more or less out of focus, and points outside of the plane focused upon are imaged as blurred circles which can be referred to as "circles of confusion." The farther the points are from the plane focused on, the larger the circles of confusion and the greater the out-of-focus effect. (See fig. 5–29.)

"Depth of field" of a lens refers to the range of distances on the near and far sides of the plane focused upon, within which details are imaged with acceptable sharpness when received. Other things being equal, depth of field increases with increasing object distance and with decreasing focal length; depth of field decreases with increasing relative aperture. For example, in the PRR at maximum diaphragm opening (f/2), the image on the film in the film gate is sharply defined over the area and tends to become blurred at the edges. As the lens is stepped down (increasing the f/number), the area of sharp definition spreads out until at f/4 it covers the entire exposed area of the frame.

5.3.1.7 Lens Coating

Modern-day lenses have their various glass surfaces coated with a film of some metallic fluoride, usually magnesium. This is applied by vacuum evaporation to produce a normally hard coating that will withstand careful handling and cleaning by the proper techniques.

Coated lenses can be identified by the slight tint seen by reflected light. The lens will appear to be uncolored by transmitted light. These coated, lumenized, or bloomed lenses reduce surface reflections and thus reduce flare light and spots. This would also increase the speed of a taking lens slightly. In a projection system, when all glass surfaces are coated, the screen brightness will be increased as much as 50 percent.

5.3.1.8 Care of Lenses

To perform satisfactorily, a lens must be properly aligned with the film in the film gate. Rough handling

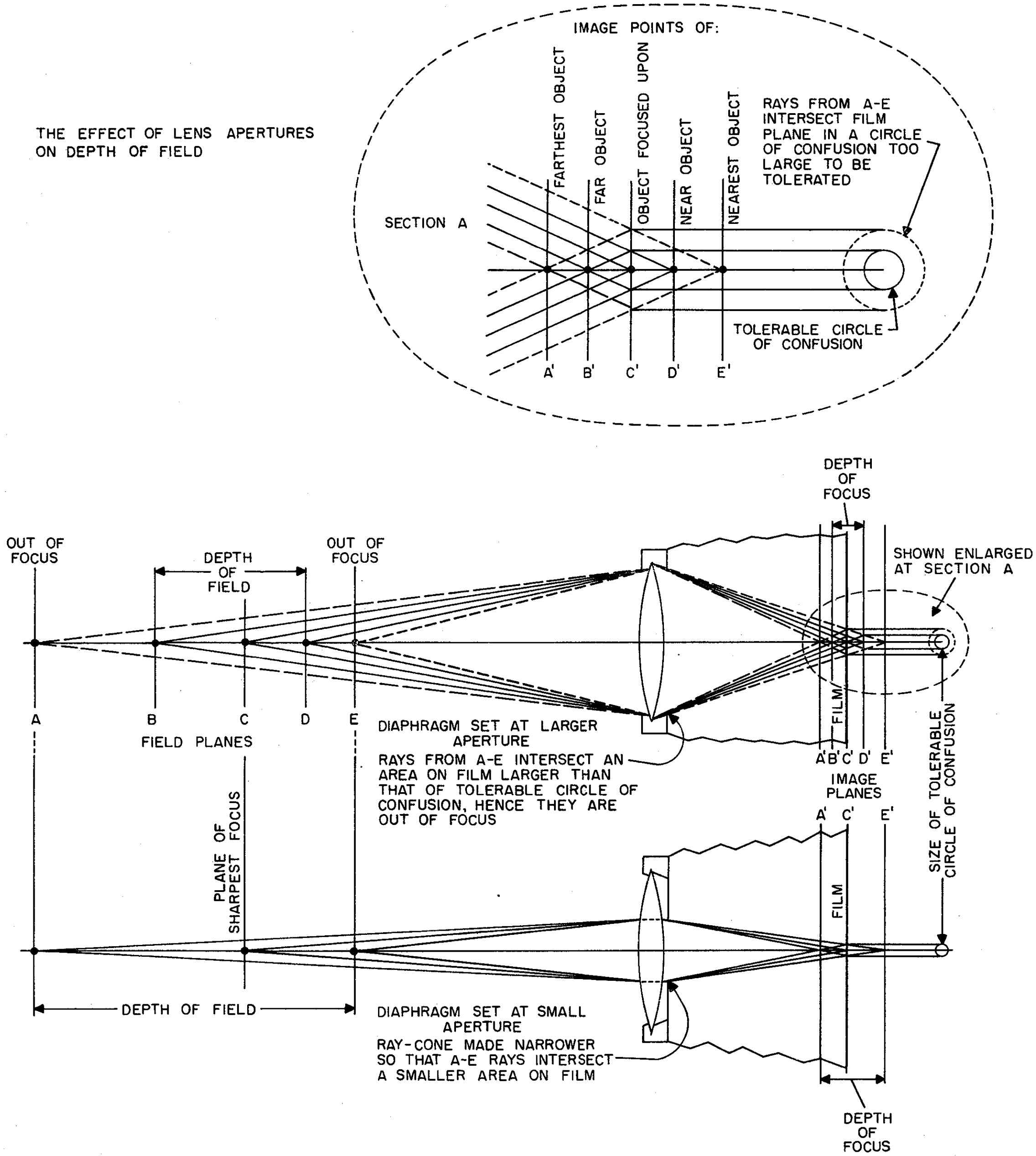


Figure 5–29. Lens Aperture, Depth of Field Effect

or the application of undue force may upset such alignment.

All optical-glass surfaces should be protected as much as possible from dust, dirt, and fingerprints. Lenses should also be protected from jars and jolts, and from extreme and sudden changes in temperature. They should not be stored in hot or humid places.

An occasional cleaning of both rear and front lens surfaces is necessary in the camera lens assembly and the individually mounted lenses in the reproducer. Care should be taken not to scratch these lens surfaces while cleaning. Any dust or grit should be removed first by gently brushing the surface with a fine-hair brush. A clean, soft, lint-free cloth, such as well-washed linen or the Selvyt Cloth, may be used when brushing is inadequate. In the case of fingerprints or scum formation, breathing on the lens is suggested or the sparing use of a recommended lens cleaner.

CAUTION

Do not use acid, alcohol, or other solvents. Avoid excessive cleaning and excessive pressure, as this may do more harm than good. Do not remove elements from a barrel or otherwise take a lens apart. The use of silicone-treated tissues for cleaning coated lenses should be avoided. The effectiveness of a lens coating is due, in part, to its critically controlled thickness (millionths of an inch). The silicone deposited by this type of tissue (sight savers, etc.) adds to the coating thickness, changes its apparent color, and impairs its anti-reflection function.

5.3.2 Recorder Shutter

A shutter is a device designed to shut off or block the exposure of light in its path. Generally, the familiar type of camera shutter consists of several spring-loaded blades that open and close in an iris fashion, when the spring release is tripped. This type of delicate mechanism is replaced in the recorder by a comparatively trouble-free, rotating drum type of shutter.

The film drive unit moves the film once every 30 seconds. The SD CRT unblanking or intensification occurs within this quiescent interval for a period of 2.6 seconds for the full frame exposure. This SD cycle is the only one illuminated; the other displays (about 11) are effectively blanked during the 30 seconds that the shutter is open. Thus, it would appear that there would be no need for a shutter device.

Although seemingly unnecessary at the current speed of operation, the shutter would be essential at increased speeds to prevent blurring of the image when the film is transported.

5.3.2.1 Recorder Shutter Mechanism

The recorder shutter is a hollow drum with a diametrical hole. See figure 5–30. The rays of light passing through the recorder lens have a free path to the film when the axis of the hole is vertical. The light is cut off if the drum is turned 90 degrees. Energy for the shutter operation is derived from a coil spring which is wound by a small induction motor. This shutter motor drives a shaft by means of a pinion and gear wheel. The shaft, however, cannot rotate, since the release arm is engaged by the leading tooth of the pallet and energy becomes stored in the spring. When the spring is fully wound, the motor stalls; a series resistor in the motor circuit prevents overheating of the motor in the stalled condition. The shutter is closed just before the film clamps lift, and it is opened just after the film is reclamped.

5.3.2.2 Shutter Solenoid

The drive spring is attached to a release arm that is held in place by the first tooth of the double pivoting pallet. The motion of the pallet is controlled by a solenoid, in this manner:

a. In the open-shutter position, the solenoid is not energized. The armature of the solenoid is controlled by its spring, and the pallet is engaged at one end. This prevents the action of the drive spring from moving the release arm.

b. When the solenoid is energized, the end of the armature is drawn down; this has the effect of rotating the armature and pallet. The leading tooth of the pallet falls, releasing the end of the release arm. The release arm is caught by the second tooth of the pallet; this action closes the shutter by having it turn 90 degrees. Each time the shutter drum rotates, the resulting decrease in tension of the drive spring is made up again

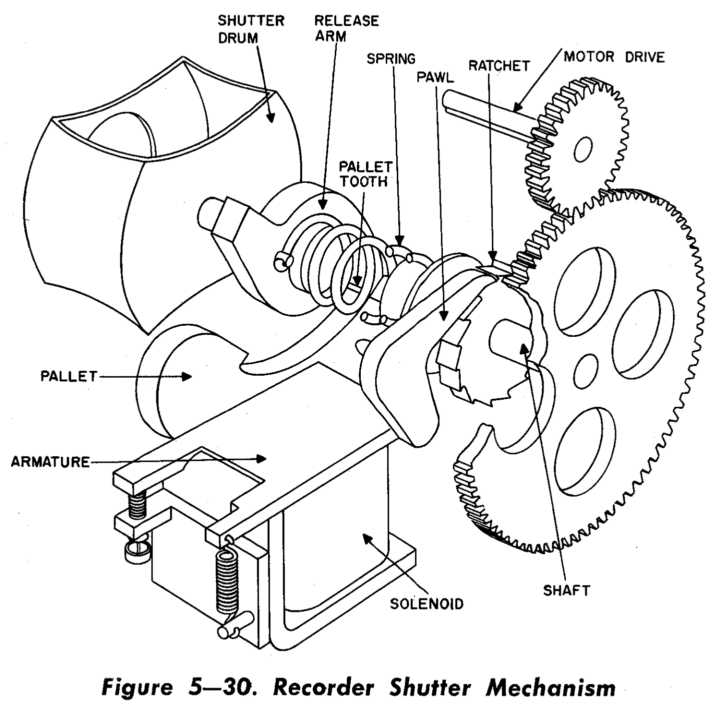


Figure 5—30. Recorder Shutter Mechanism

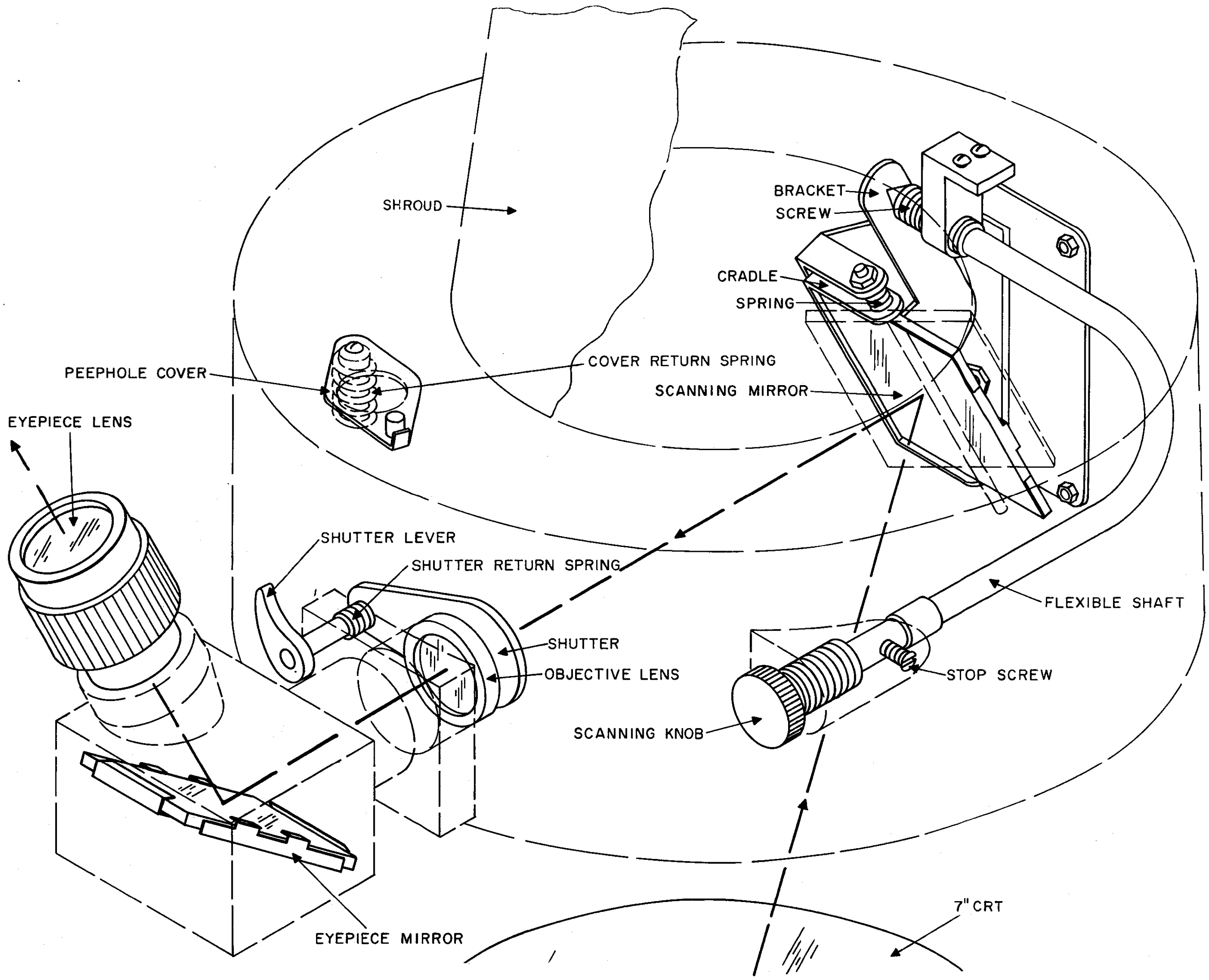


Figure 5—31. Viewing Assembly Mechanism

by rotation of the shutter motor, which stalls again immediately after the spring is fully wound.

5.3.3 Viewing Assembly

The viewing assembly is essentially a light-tight shroud, extending from the recorder lens to the SD CRT. Its purpose is to prevent extraneous light from entering the recorder lens and fogging the film. It also serves as a light-tight enclosure to prohibit ambient light from washing out the image contrast on the face of the tube.

To enable monitoring of the CRT for proper display, the face of the CRT would have to be observed. Therefore, provision for viewing the CRT is made by means of a peephole device and an optical assembly affixed to the shroud.

5.3.3.1 Shroud

The shroud consists of two fabricated parts, one conical and the other cylindrical, forming an integral unit. See figure 5—31. The conical portion has a movable lens hood attached to its apex by a tension screw. The lens hood slides in a felt sleeve attached to the shroud. The sleeve acts as a friction shim permitting the shroud extension (lens hood) to be moved up to and over the lens barrel, yet maintaining the upper part of the receiving assembly light-tight.

The cylindrical portion of the shroud is its base, extending to and covering the face of the CRT. The spring-loaded peephole cover and the optical viewing system are mounted to this lower part of the shroud.

5.3.3.2 Optical Viewing Mechanism

The optical viewing mechanism incorporates an optical system employing a magnifying lens and a scanning mirror. By this means, an element of the CRT face may be viewed with a magnification of about six times. The use of the scanning mirror enables this element to be moved along a diameter of the tube face. Breaking down the optical system further, to its component parts as shown in figure 5—31, it will be seen that this indirect viewing method is necessary if magnified portions of the display are to be observed. Light from a small section of the tube face strikes the scanning mirror and is reflected from it to the eyepiece. After passing through the objective lens, it is further reflected at the eyepiece mirror and passes through the eyepiece lens to the eye of the observer.

The scanning mirror consists of a section of aluminized plate glass which can be turned at an inclined axis to the vertical. The mirror is turned by a flexible shaft affixed to the mirror mount on one end and protruding through the shroud, with a control knob affixed to the other end. Rotation of the scanning knob determines the position of the mirror and thus that portion of the viewed display desired.

The objective lens (fig. 5—31) causes an image of the viewed elements of the CRT face to be formed at the focal plane of the eyepiece lens. It consists of two cemented elements of differing types of glass. The purpose of this combination is to apply color correction to the eyepiece assembly and so prevent the appearance of multicolored blurring at the edges of the image seen by the observer. Such blurring occurs when the amount of refraction or bending of a ray of light upon entering or leaving a polished glass surface varies with the color of the light. Every property of a lens depends on color. Thus, the position of the image itself changes slightly with the color, or wavelength, of light; this effect is known as axial, or longitudinal, chromatic aberration. This deficiency can be reduced by using the proper combination of two or more different kinds of glass.

The eyepiece assembly (fig. 5—31) is positioned so that the observer can view the display on the CRT without interference. The housing for the various components of the eyepiece assembly consists of a mirror box which extends into a short tube attached to the cylindrical part of the shroud. The end of the tube adjacent to the mirror box contains the objective lens. The inner end of the mounting tube is normally closed by a spring-loaded cover operated by a trigger control accessible to the observer. The purpose of this cover is to prevent extraneous light from passing through the eyepiece system and being reflected by the scanning mirror on to the tube face.

The eyepiece mirror (fig. 5—31) is a section of surface-aluminized plate glass on a brass mount. Two mounting screws make possible final assembly adjustments. The mirror box has a removable cover plate giving access to the mirror.

The eyepiece lens has a screw-mount attachment at the top of the mirror box. The focal length of this lens can be altered slightly by rotation of the milled ring encircling the lens mount. For an observer with normal eyesight, the focus is arranged so that the image formed by the objective lens lies exactly in the focal plane of the eyepiece lens; the observer then sees a sharp, magnified version of this image.

5.4 PROCESSOR

The film frame now having been exposed in the recorder aperture of the film gate, it is pulled to the next aperture for rapid processing. It is this rapid chemical processing that makes possible a new display every 30 seconds on the large projection screen. The exposed area of film over the processing aperture is sprayed with the proper chemicals by means of air jets, in timed sequence. The film remains in the same position for the full processing time, from the initial developer spray to the final drying of the film. This can be done because the aperture is the top of the processing pot which contains the jet-spray nozzles (jet unit). See figure 5—32,B.

The jet unit contains three jets (fig. 5—32,A) for applying the develop, fix, and wash solutions to the film in the form of a fine spray; a fourth jet directs warm dry air on to the processed film, substantially drying it. The various jets are operated by compressed air, which is controlled and heated electrically. The jets are supported on their supply tubes in a central cluster within the processing pot. The air drying tube passes axially through the bottom plug of the pot, and the three chemical jets are equally spaced around it. The chemical jets converge slightly so that each is directed toward the center of the processing aperture. See figure 5—32,A.

5.4.1 Chemical Supply

The chemicals for developing and fixing the film are prepared in 50-oz. glass bottles for use in the PRR. The developer solution is contained in an amber bottle, to prevent deterioration, while the fixer and wash solutions are contained in clear glass bottles. For ease of identification, the fixer solution contains a blue dye and the wash solution, a pink dye.

Each solution is fed through a manually controlled on-off valve, (pinch cock) to the processing pot, where they are mixed with heated, pressured air and jet-sprayed against the film emulsion. The air pressure determines the quantity of chemical solution admitted to the processor. The pressure of the air supply (from an external air compressor) is regulated manually at the PRR unit.

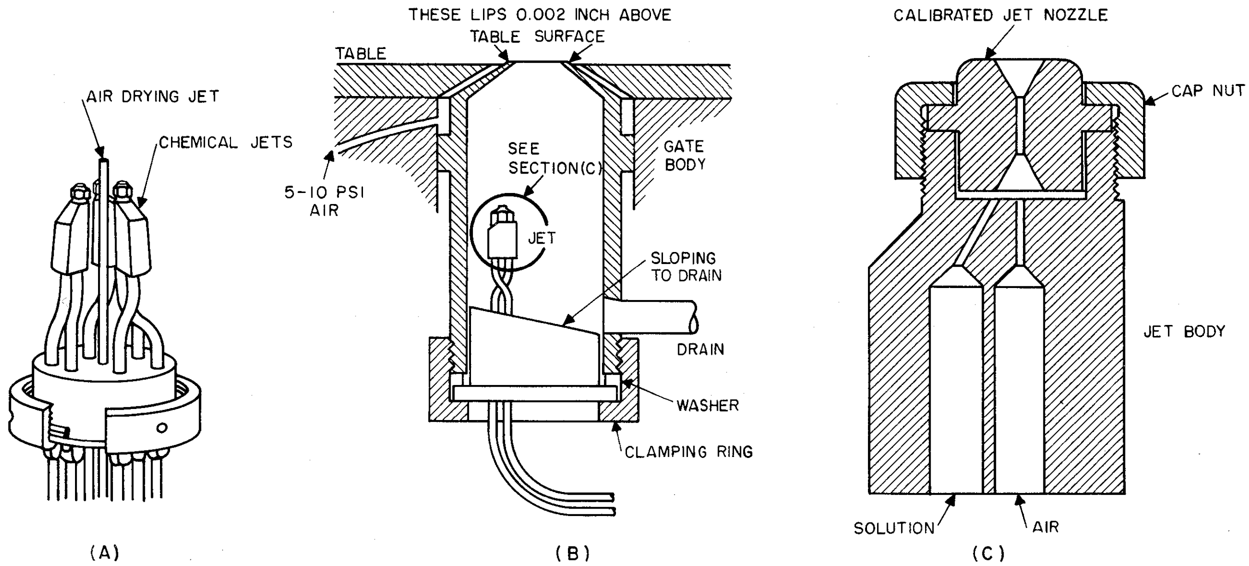


Figure 5—32. Processing Aperture, Functional Diagram

When in their correct positions in the PRR console, the three chemical bottles are inverted over constant-level chambers. (See fig. 5—33.) Liquids flow out of the bottles until the levels in the chambers just reach the ends of the bottle nozzles. Atmospheric pressure on the surface of the liquids in the chambers prevents accidental gravity flow.

Each level chamber has an outlet at the bottom and an overflow outlet near the top. Overflowing liquid passes through a drain pipe into a tray formed by the chemical shelf on which the level chambers stand. These chambers contain contact probes which become uncovered when the liquid falls 1/4 inch below normal. These probes are associated with the chemical-flow warning circuit.

5.4.2 Air Supplies

Each PRR unit requires two separate air supplies:

a. A high-pressure air supply with a flow corresponding to 4 cubic feet of free air per minute.
b. A large volume of low-pressure air (normally derived from the site equipment cooling air supply) to provide cooling of the electronic equipment and the projection lamp.

5.4.2.1 High-Pressure Air Supply

The high-pressure air is normally delivered from a compressor in the site installation at between 40 and 80 psi. This air is fed to the manual PROJECTION AIR shutoff valve on the main control panel. The pressure is regulated to 30 psi for use at the reproducer aperture. From the PROJECTION AIR valve, air is directed through the PROCESSING AIR valve, where it is further reduced to 10-psi gauge pressure for use at the recorder aperture. The air at 30 psi also passes through a pressure switch to the solenoid air-control valve that distributes the air among four output pipes for processing in a timed sequential cycle determined by the control cams. The pressure switch is part of the interlock circuit. (See fig. 5—34.)

The solenoid air control valve (fig. 5—33) is actually four solenoid actuator plunger-type valves. Three of the valves are normally closed; the fourth, normally open. Compressed air at cycled intervals from the solenoid control valve passes through an electric element that heats the air. This heater air passes through the union board and into the processing pot. Figure 5—34 is a diagram of the compressed air system.

Overflow liquids escape through a drain in one corner of the chemical shelf and pass through a glass splash trap to the fume pipe, which carries waste liquids to the waste tank. The waste tank is hermetically sealed and is emptied by the admission of compressed air. The waste outlet pipe extends nearly to the bottom of the tank. When compressed air is admitted at the top, it displaces the liquid in the tank and forces it up a plastic waste pipe to a suitable drain. See figures 5—33 and 5—34.

5.4.2.2 Low-Pressure Air Supply

Air for cooling the electronic chassis and projector lamphouse is derived from the site equipment cooling air supply and is connected to an inlet pipe at the top of the PRR unit.

The air passes into compartments, panels, and vertical cavities inside the housing. Baffle plates, in the floor compartment, deflect the air into two streams. One of these passes up through the electronic units and then combines with the other stream to pass via ducting into the lamphouse. Exhaust air from the lamphouse returns to the site cooling air system via a short length of 6-inch pipe, fixed to the PRR unit roof. The pipe contains an automatic damper and above it an air flow indicator. See figure 5—35.

The damper consists of a metal disc which is pivoted in the tube on a diametrical spindle. The controlling element is a spiral spring, formed of a bimetallic strip. When the air emerging from the lamphouse is cold, this spring loads the damper against a stop, closing the pipe and restricting the air flow. This enables the projector lamp to reach its operating temperature as quickly as possible after the equipment is switched on.

As the lamp warms up, the air temperature in the outlet pipe rises. This causes the bimetallic spring to unwind, opening the damper and allowing an increase in the flow of cooling air.

The air-flow indicator consists of a 3-cup anemometer rotor mounted on the inner end of a radial shaft in a short pipe section interposed between the outlet pipe from the unit and the return. The outer end of the radial shaft is mounted on a ball bearing and carries an indicator dial. The dial is marked in red and white quadrants and is visible through a window in the surface of the pipe section. The rotor speed depends on the rate of air flow through the pipe. The indicator dial permits the operator to ascertain speed of air flow.

5.4.3 Processing Pot

The processing pot is a corrosion-resistant chamber mounted with its upper edge flush with the processing aperture in the lower section of the film gate. At the bottom of the pot are three chemical and four com-

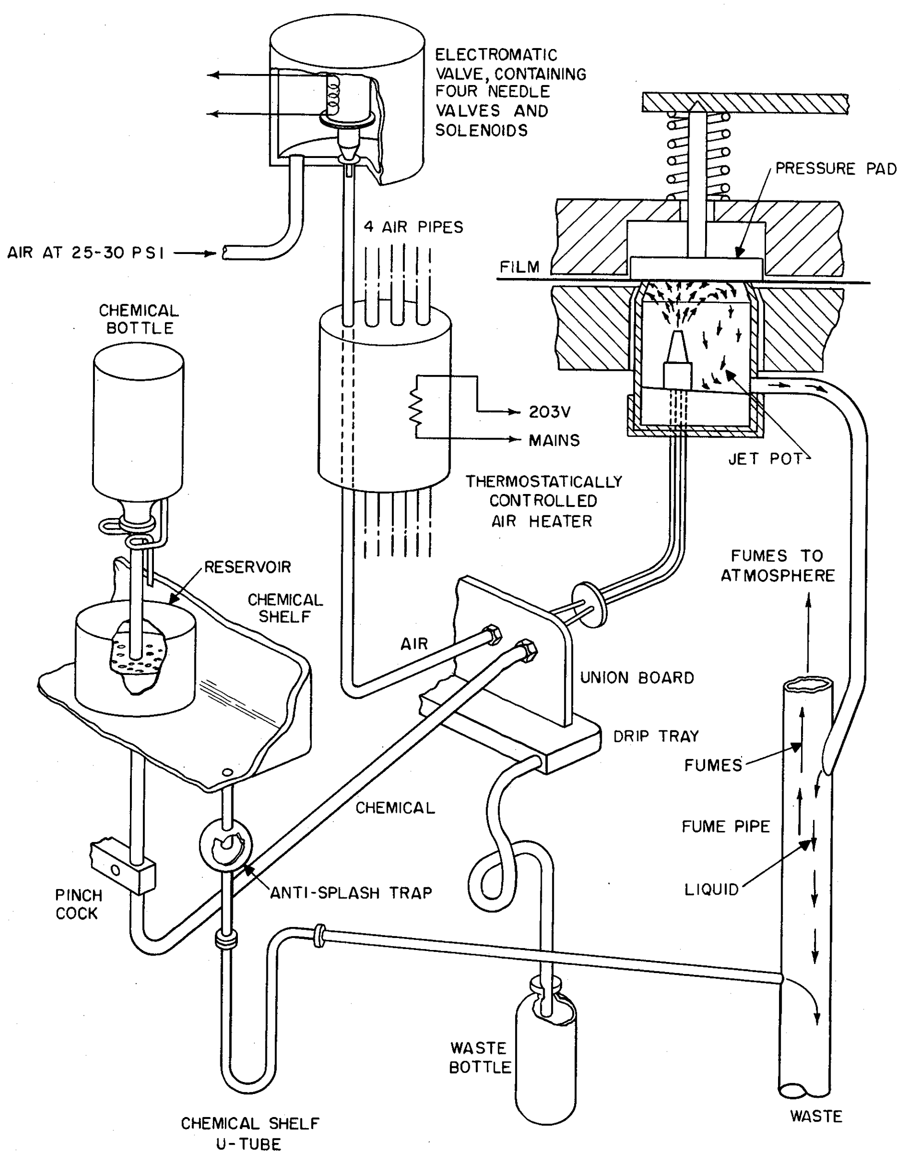
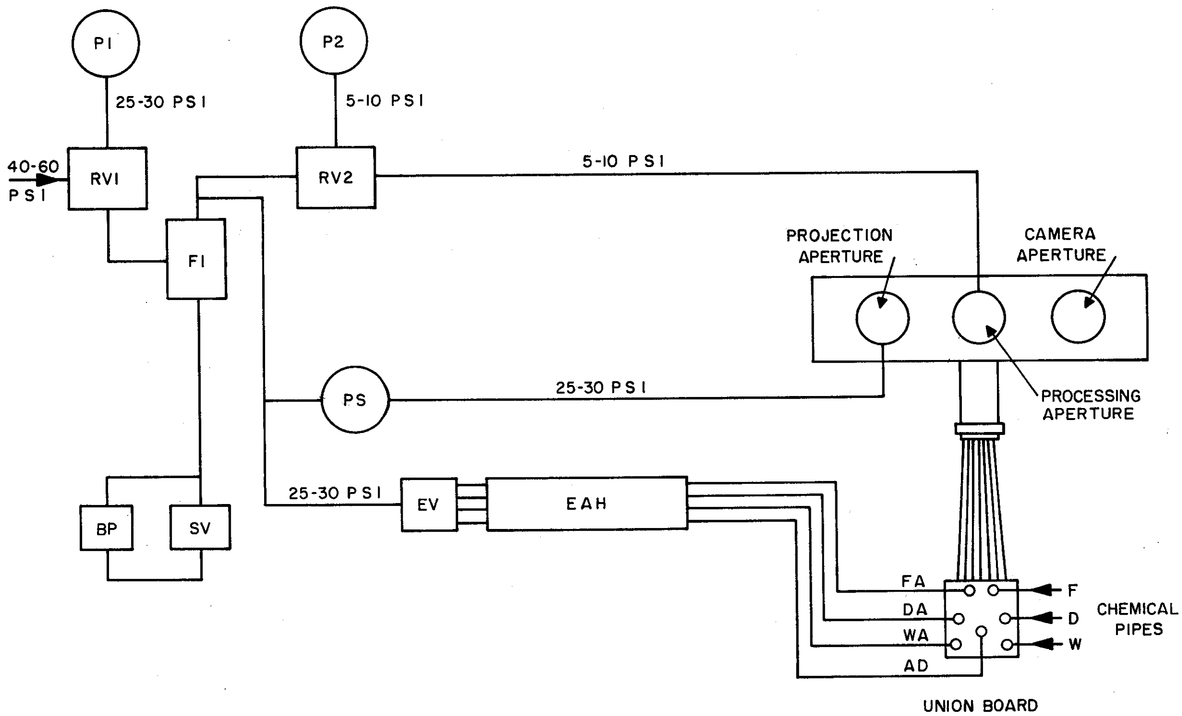


Figure 5—33. Chemical System



PI, P2, P3 PRESSURE GAUGES
RVI, RV2 REDUCING VALVES
FI FILTER
BP BY-PASS
SV SAUNDERS VALVE
PS PRESSURE SWITCH
SV SOLENOID AIR CONTROL
EAH ELECTRICAL AIR HEATER

Figure 5—34. Compressed Air System Diagram

pressed air input lines. One air input is for drying purposes. The remaining three air lines and the three chemical lines meet in three jet units (fig. 5—34) within the pot.

The upper end of the pot is of slightly less external diameter than the aperture in the lower part of the gate. Air at 10 psi is admitted to the annular space so formed. This is done for two reasons:

a. To prevent processing liquids from seeping out between the upper edge of the pot and the film, which would give a ragged edge to the processing area.

b. To ensure that the film is lifted from the edge of the pot at the instant the pad rises in order to prevent the slightly swollen emulsion from being torn off the film during transport.

5.4.4 Chemical Jets

A simple cross-sectional diagram illustrating the principles of the jet is shown in figure 5—32,C. Compressed air enters the chamber via the compressed air inlet. In the chamber, the air loses pressure energy, causing a partial vacuum around the sides of the chamber. Consequently, liquid is drawn in from the chemical orifice, and it combines with the air to form a fine high-velocity spray.

A very small alteration in the bore of the nozzle has a significant effect on delivery. It has been determined that increasing the bore of either the liquid nozzle or the air nozzle increases the flow of liquid through the jet, and also increases the size of the droplets of liquid in the spray.

CAUTION

The three nozzles are not interchangeable. The chemicals differ in specific gravity and the nozzles have been bored for a particular rate of flow for each chemical.

5.4.5 Air Drying Jet

The air drying jet (fig. 5—32,A) consists of a simple nozzle driven into the end of the air drying tube. The bore of the nozzle determines the rate of flow of drying air.

5.5 REPRODUCER

Upon completion of the processing cycle, the film is automatically transported to the reproducer aperture of the film gate for projection to the Command Post screen. A high-intensity mercury vapor arc lamp is used for image projection. Light from the lamp is reflected by a parabolic reflector to a group of four condenser lenses. These condensers concentrate the light and, with the aid of a lens behind the condensers, either disperse the beam or condense it further, as needed.

The adjusted light beam then passes through a manually operated sliding-shutter device to a mirror which redirects the light 90 degrees upward. The shutter is used to block the projector light path when there is need to have the lamp on and light projection is unwanted. Reflected light from the mirror passes through two additional condenser lenses, an aperture in the film gate, and through the film and projection lens to the screen. Illumination for the reproducer elements is provided by a 1,000-watt mercury vapor lamp. A reproducer switchover circuit is used to prevent two reproducers from projecting images on the Command Post screen simultaneously and also to prevent the projected light from one washing out the image of the other.

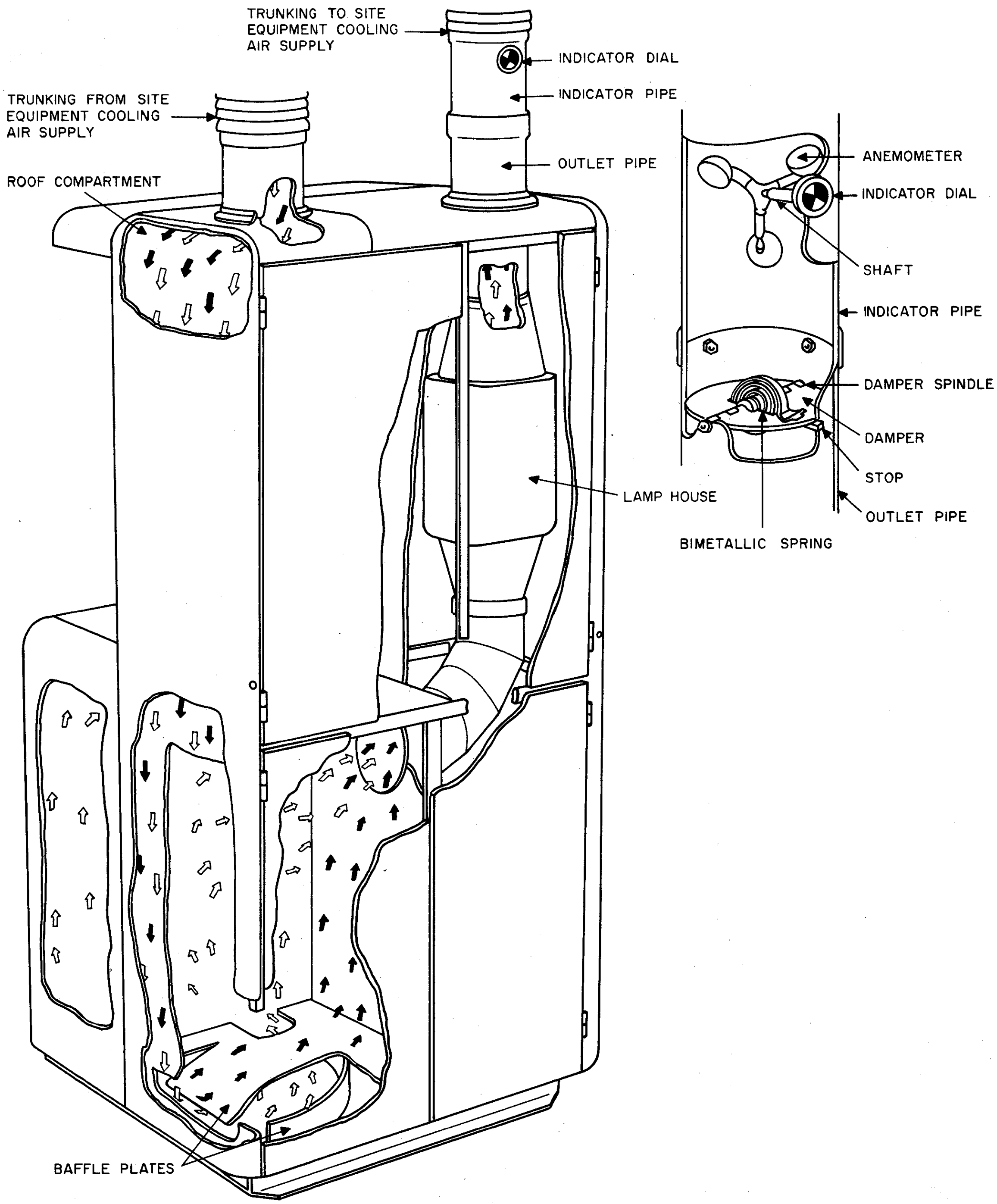


Figure 5–35. Low-Pressure Cooling System

5.5.1 Mercury Vapor Lamp

High-intensity illumination necessary for projection of an image to the large screen is provided by a mercury vapor lamp. The lamp consists of a glass envelope containing xenon gas and a droplet of mercury. Brass ferrules, one on each end of the envelope, are connected internally to carbon electrodes within the lamp. The electrodes are so spaced that an arc can be formed between them. High voltage must be applied across the lamp electrodes to start the arc, which in turn vaporizes the mercury. After the arc has once been initiated, it can be maintained with a much lower voltage. The lamp is enclosed in a housing, and provision is made for regulating the temperature of the air surrounding the envelope.

5.5.2 Reproducer Optical System

The reproducer optical system is employed to direct all available light from the projector lamp to the screen image. It does this by means of mirror, condensers, and lens elements, to gather the light into a narrow beam and control its intensity.

Figure 5–36 shows the relative placement of parts of the optical system. The cylindrical shield within the lamp housing encloses the mercury vapor lamp. Two holes diametrically opposite permit reflected and directed light to pass through the shield. Light from the projector lamp passes through the rear hole and is reflected by the mirror toward the front hole. The light passes through the forward hole directly to the first four condenser lenses. When the light leaves these lenses, it has been concentrated to a narrow beam. The beam is sent down a conical sleeve, extending from the lamp housing to the fifth condenser lens. This fifth lens, a focusing lens, is mounted at the end of a tube which slides in and out of the sleeve. The movement of the lens spreads or narrows the light beam to the film and thereby changes the intensity of the light. An adjusting pin moving along a helical slot in the tube varies the lens.

The light leaving the fifth condenser lens is directed upward 90 degrees by an interlens mirror. The light, now traveling in a vertical direction, passes through the sixth and seventh condenser lenses and through the film.

5.5.2.1 Projection Lens

The light leaving the film passes through a projection lens having a focal length that will project the film image 35 feet to the 14-by-14-foot screen. The projection (reproducer) lens closely resembles the recorder lens both in appearance and construction. The several lens elements are mounted in a specially designed antireflection barrel and are fully corrected to obtain high definition and flatness of field. As in the recorder lens, focusing is achieved by varying the distance of the lens to the film plane. (See figs. 5–36 and 5–37.)

5.5.2.2 Reproducer Mirror

The reproducer mirror is a rectangular section of surface-aluminized plate glass that reflects the light from the projection lens to the screen. The interlens mirror reflected the light, from the mercury vapor lamp, 90 degrees to a vertical beam. The reproducer mirror reflects the light back again to a horizontal beam. (See fig. 5–36.)

The reproducer mirror is mounted in a cast metal frame just above the projection lens. Three screws entering the rear of the frame bear against the back of the mirror opposite the springs. The mirror can therefore be adjusted both horizontally and vertically by individually rotating the spring-loaded screws. By loosening the frame central mounting bolt, the entire frame can be rotated considerably in the vertical direction.

5.5.3 Manual Shutter and Switchover

Two operational PRR units are provided for each site to enable the standby warmup, for minimum downtime, during changeover. The manual shutter and switchover circuit is provided to prevent the possibility of both units projecting to the screen at the same time. To have either unit in standby operation, with the projector lamp alight but not projecting, a manually controlled sliding shutter is interposed between the fifth condenser lens and the interlens mirror of the optical system.

When a shutter is pushed to the up position, light from the lamp is barred from the film. This action also closes a set of contacts in a microswitch mounted adjacent to the shutter. These contacts control the switchover circuit. To understand the operation of the switchover circuit (see fig. 5–38), assume that reproducers A and B are on, both shutters are down, and S/A and S/B are open. (Because the PRR units are identical and have the same symbol designations, the letters A and B are arbitrarily assigned in figure 5–38 to avoid confusion in analyzing the switchover circuit.)

To strike the lamp in reproducer A, push its shutter to the up position. This action closes microswitch S/A. As S/A closes, relay K34A is energized. The contacts of K34A close, energizing K117. Relay K117 provides power to the lamp circuit, which may now be struck; i.e., high voltage for starting can be applied. (See 5.5.1 of this section.) Although lamp A is lighted, light is not projected to the screen because the shutter is still in the up position. When the shutter is pulled down, S/A is opened and K34A is de-energized. Relay K117A, however, remains energized through its own contacts and the normally closed contacts of K33B. Under these conditions, the lamp is lighted and the beam projects to the screen.

To strike the lamp in reproducer B, push up the shutter. This action permits striking the lamp through

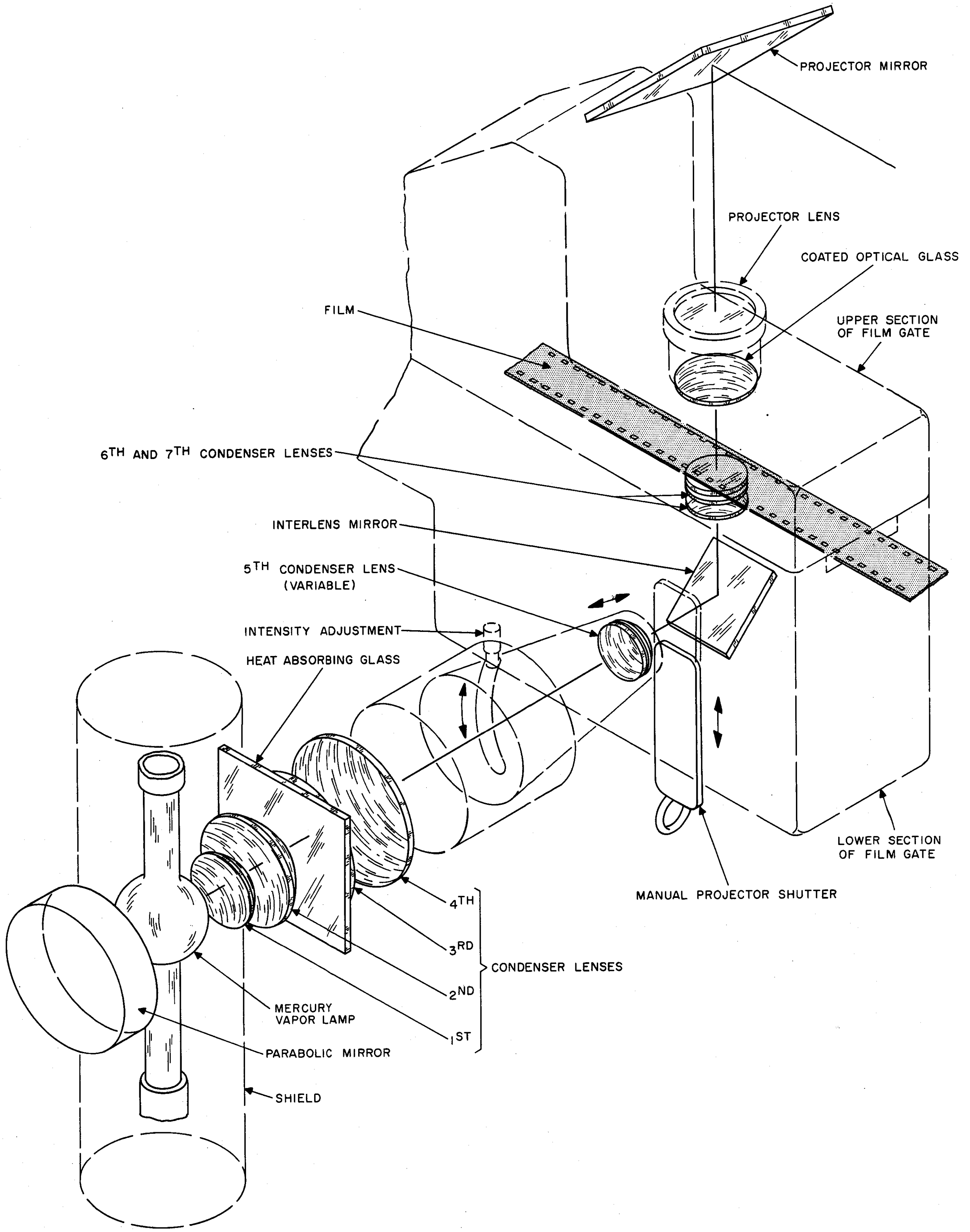


Figure 5–36. Projection Optical System

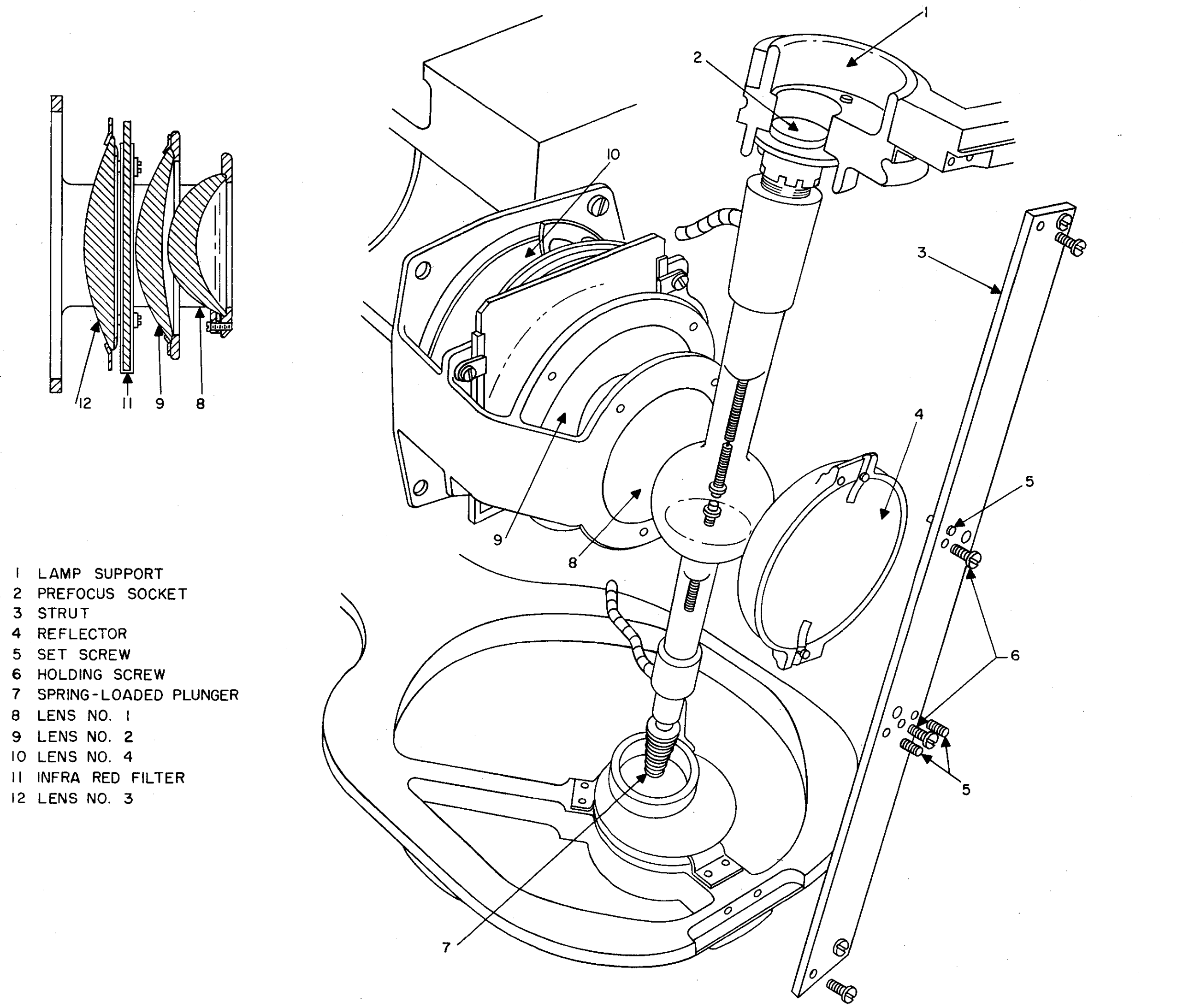


Figure 5–37. Projection Lamp and Lenses

relay K117. Assume now that light from reproducer A is on the screen and that the lamp in reproducer B is set with the shutter in the up position. In order to switch the operation from reproducer A to reproducer B (switchover), pull down the shutter of reproducer B. This physical action permits the light beam of reproducer B to reach the screen. The electrical action (opening S/B) de-energizes K34B. The resultant opening of K33B contacts de-energizes K117, cutting off the lamp in reproducer A.

The mercury vapor lamp striking circuit (fig. 5–39) operates in the following manner. As K117A closes, 12Vac is applied across the lamp via the three paralleled chokes, the ammeter, and the secondary of T2. This voltage will keep the lamp running, but it is not high enough for starting purposes. To provide the high-voltage RF necessary for starting, a stepup transformer, capacitor, and spark gap are employed. When the strike button is depressed, 120Vac is fed across the primary of T1, The resultant high voltage across the secondary charges capacitor C1 until enough voltage builds up to jump the spark gap. When this happens, the spark gap (which now offers zero impedance), the capacitor, and the primary of T2 form an LC network, producing a high-voltage RF. This high voltage is induced across the secondary of T2 and thus across RF bypass capacitor C2 and the lamp. As the high voltage jumps the gap in the lamp, it vaporizes the pool of mercury. The vaporized mercury offers a low-impedance path across the lamp electrodes, and the 120Vac is now sufficient to keep the lamp running. Three adjustable chokes inserted in the 120V line limit start current to 28 amperes and running current to a maximum of 19 amperes. This difference in current reading determines the length of time the start button is depressed.

5.6 SUPPORTING COMPONENTS

Component parts of the PRR, such as the film gate, magazine, reels, sprockets, and clamps, etc., are common to the three major assemblies that have been previously described. The functional diagram (fig. 5–40) and the block schematic (fig. 5–25) label, and show the employment of, the components that follow the recorder, processor, and reproducer groups.

5.6.1 Film Gate

The film gate consists of two main castings hinged together at one end; these are known as the gate and gate cover. The upper surface of the gate (fig. 5–41) and the lower surface of the gate cover are faced with a special plastic which withstands the action of the processing chemicals, while its black finish prevents light reflection. The film passes between these surfaces in a clearance space provided by a shallow depression in the upper surface. A switch consisting of a contact in the upper section and a similar contact in the lower section opens when the gate cover is raised and breaks the processing interlock circuit.

At the right end of the gate is a light-tight chamber which contains the film's feed and tension sprockets as well as the mounting for the film magazine. The front of the chamber is closed by a light-tight lid which is secured by a central bolt.

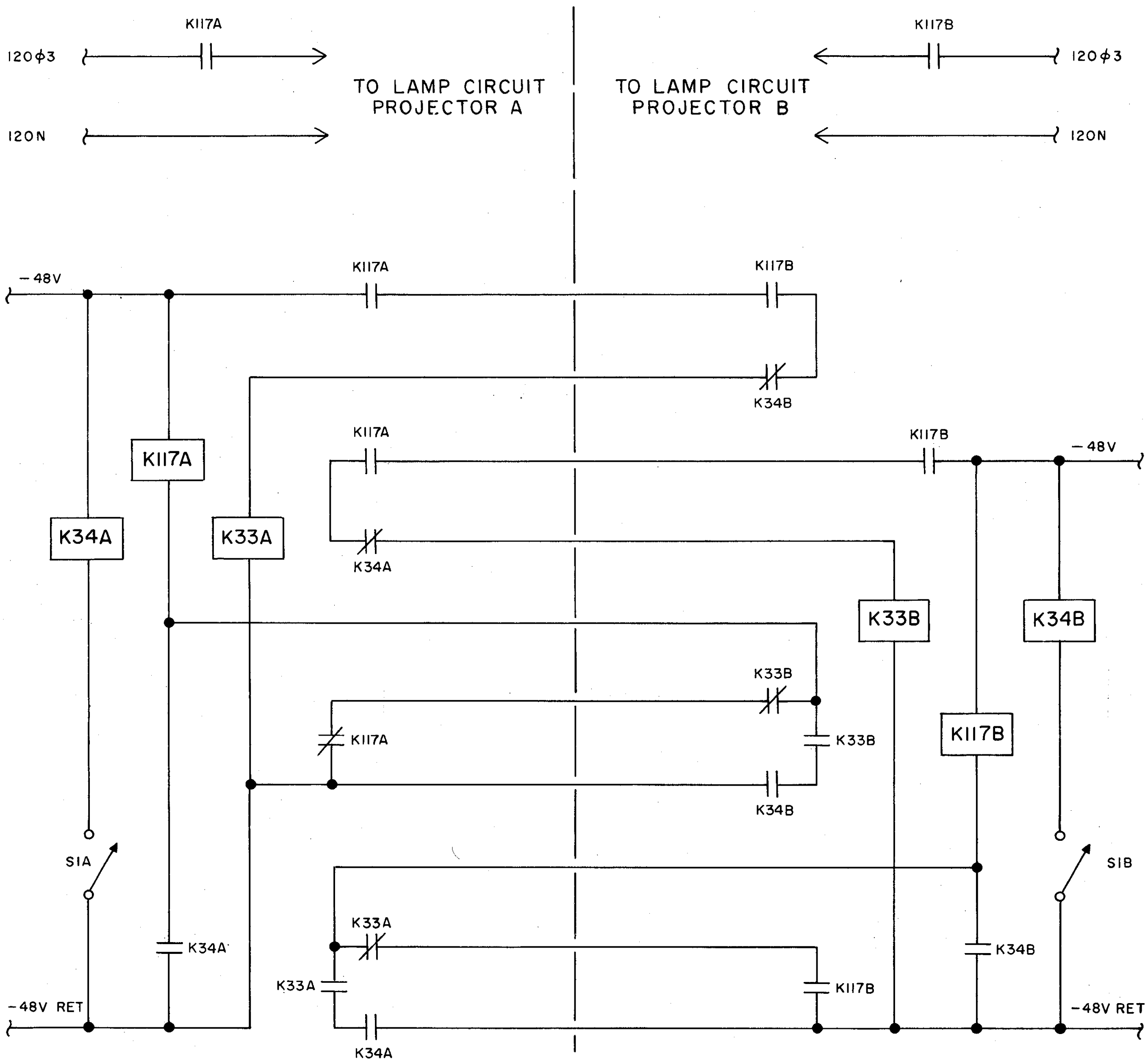


Figure 5–38. Projection Lamp Switchover Circuit

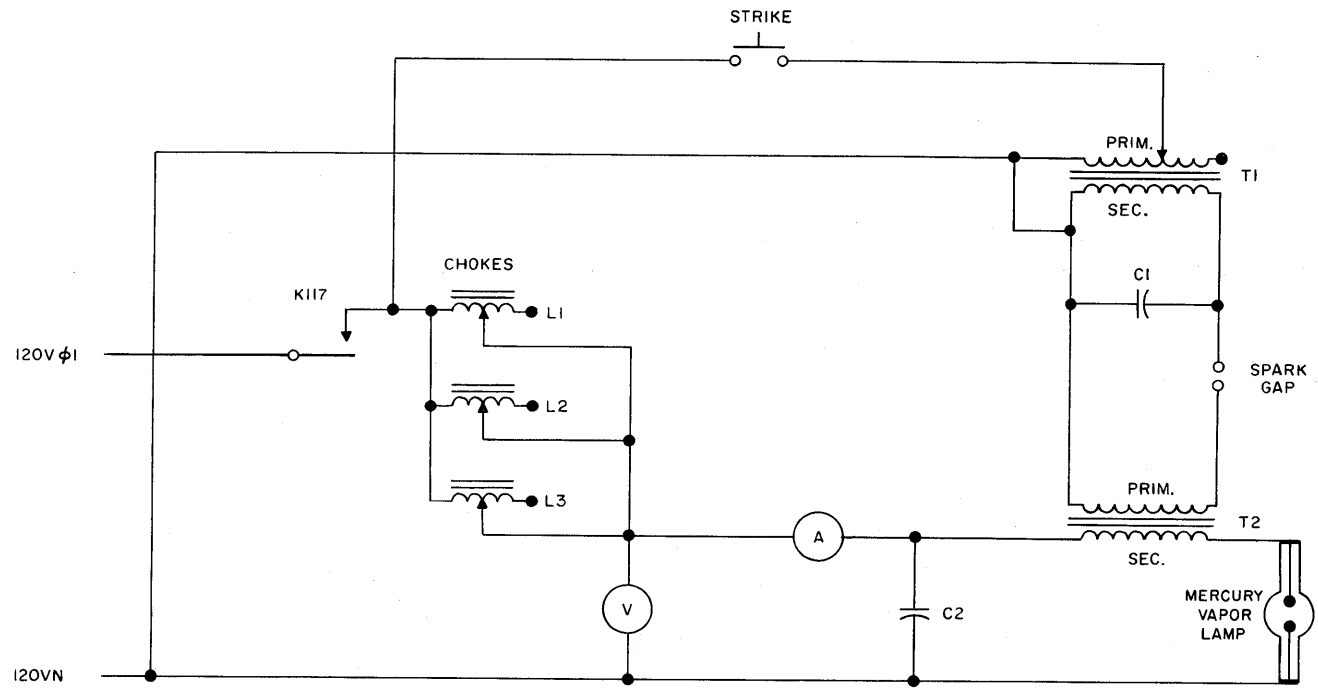


Figure 5—39. Projection Lamp Strike Circuit, Simplified Schematic

The gate casting contains the three circular apertures, arranged with their axes on the center line of the film track. They are:

a. The recorder (camera) aperture, which allows the film to be exposed to the image of the SD CRT display formed by the recorder lens.

b. The processing aperture, which contains the processing pot and jet unit.

c. The projection aperture, which allows the beam of light from the lamp housing to pass through the film and then through the projection lens.

The gate cover contains the film clamping and crimping mechanism and the projection lens mount.

5.6.1.1 Upper Section of Film Gate

The upper section can be raised and locked in the up position by placing the gate hook (anchored to the top of the solenoid housing) over the pillar that is attached to the top of the magazine support.

The clamping and crimping mechanism consists of two circular pads, a film-crimping bar, an actuator solenoid, a pressure bar, and springs. With the solenoid energized, the armature pivots about its spindle, offsetting the action of the solenoid spring and removing the load from the pads and crimper. These lift under the action of three return springs and allow freedom for the film during transport. When the solenoid is not energized, the solenoid spring pulls the armature about its spindle, applying a load of 24 pounds to the pressure bar. The pressure bar distributes the load to the crimping bar and pressure pads.

The reproducer lens is secured in a threaded focusing mount with a knurled outer edge for manual adjustment. The focusing mount screws into the upper section of the film gate (over the reproducer aperture) and travels vertically when rotated, thereby focusing the image on the Command Post screen.

5.6.1.2 Lower Section of Film Gate

The recorder (camera) aperture is a circular hole, in the lower section of the gate, that allows the film to be exposed to the image of the SD CRT.

Chemical sprays from the jet unit must pass through the aperture in order to strike the film which rests flush against the aperture. A surrounding ring of compressed air also emerges from the space between the processing pot and processing aperture. This ring of air forms a seal for the chemical sprays striking the film. It also ensures that the film is lifted from the edge of the pot as soon as the pressure is raised, so that the damp, swollen emulsion is not torn from the film during transport.

The reproducer (projection) aperture has the two final condenser elements mounted at the top of the vertical conical bore. A polished aluminum mirror is seated in a 45-degree machined offset which is formed from the lower front corner of the gate casting. Light reflected from the mirror passes up through the aperture on its way to the film frame.

5.6.2 Overall Film Drive System

Film is drawn from the magazine (figs. 5—40 and 5—42) at a constant speed by a continuously rotating feed sprocket in the film gate. During the exposure periods, the film in the gate apertures is at rest, so that the unexposed film is pulled from the feed loop and through the gate by the action of the drive unit and accumulates in another loop as the takeup loop.

When passing through the gate, the film is maintained at the proper tension by the action of a spring-loaded sprocket. If the film breaks, the tension sprocket releases and closes a switch. The FILM BREAK lamp and warning buzzer on the indicating panel then operate and a relay is energized, resulting in a cutting-off of processing fluids. With the chemical cut off, dry air is blown continuously into the processing aperture.

The takeup loop is slowly reduced during the exposure periods by the rotation of a holdback sprocket which turns at the same speed as the feed sprocket.

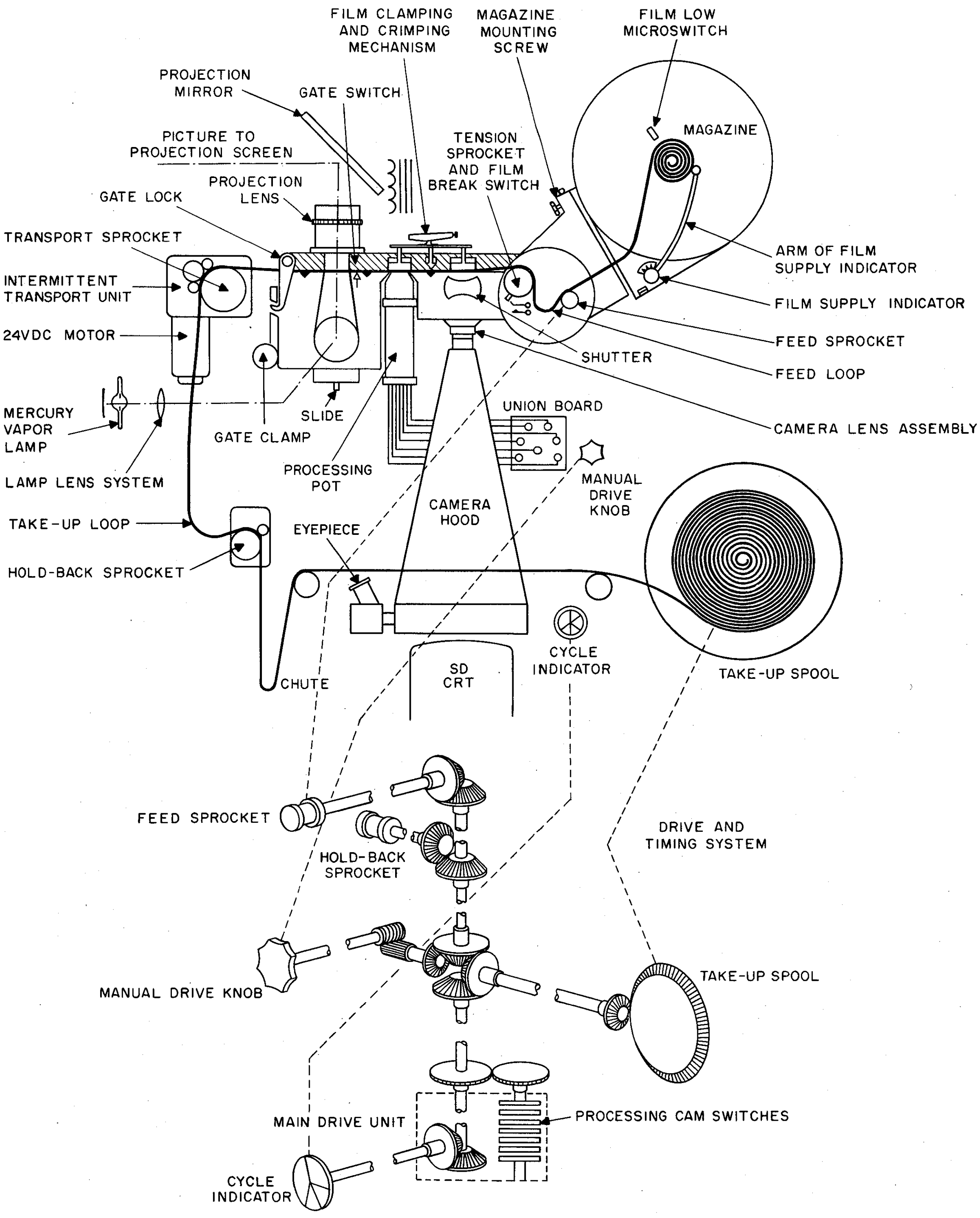


Figure 5–40. Functional Flow Diagram of PRR

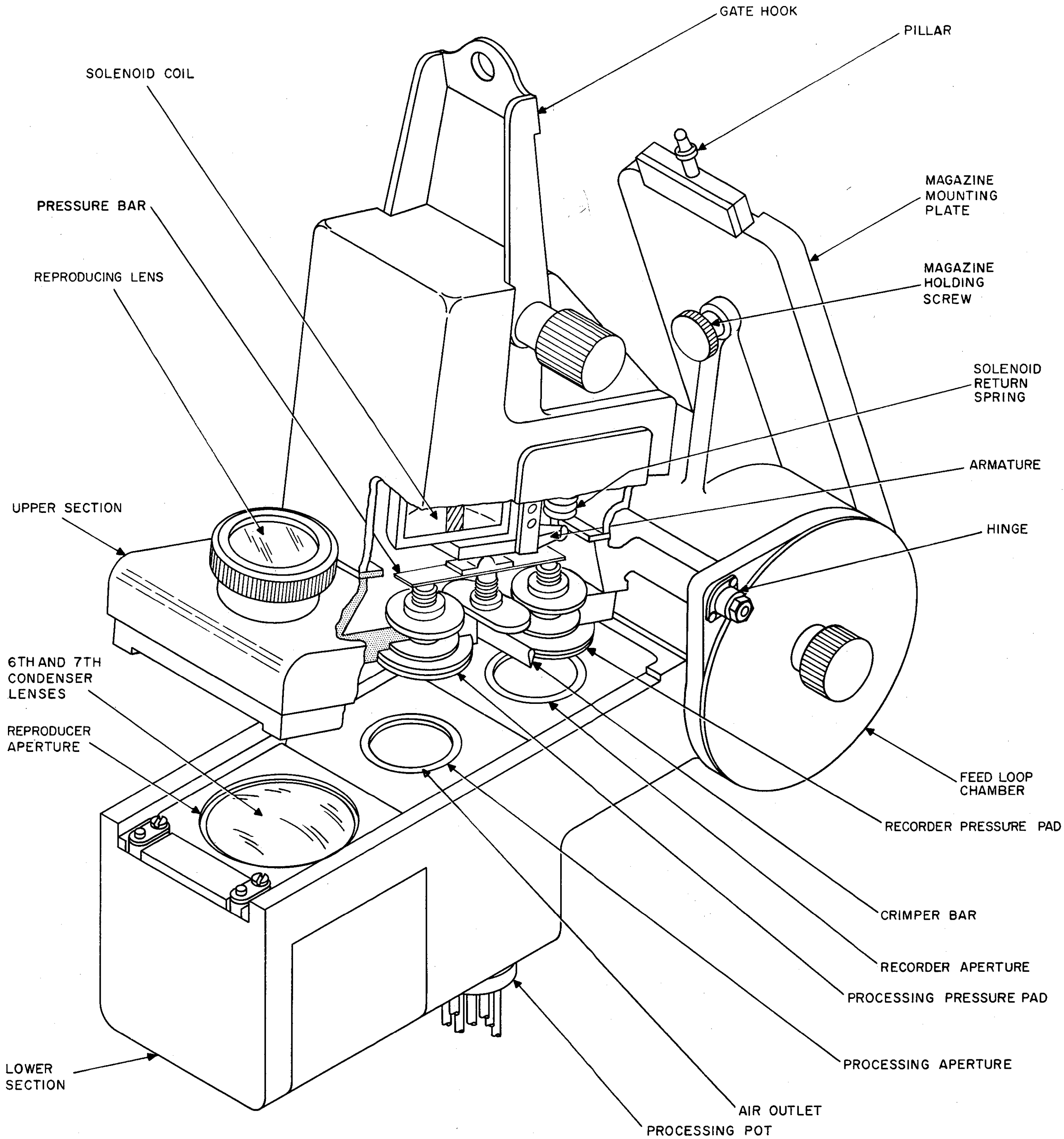


Figure 5—41. Film Gate Mechanism

After leaving the holdback sprocket, the film passes via a chute and guide rollers to the takeup spool.

The motion of the driving sprockets and the takeup spool is derived from the main camshaft, which is part of the drive unit timing system. The sprockets used are of standard 35-mm design, and each has 20 teeth. Since each frame covers 10 film perforations, it follows that one rotation of the sprockets advances the film through two frames; the sprockets therefore turn at half camshaft speed. The gearing also drives the pointer of the cycle indicator at camshaft speed.

Provision is also made for turning the mechanism by means of a manual control, to facilitate film loading and setting-up. The manual control will turn the mechanism only in the normal direction, thus preventing the camshaft from being turned in reverse. Damage to the cam-operated contacts would result if it were possible for the manual control to be turned in either direction. The control is operated by a simple spring clutch coupling to the shafts. A dial pointer geared to the main camshaft provides a visual indication of the processing cycle position (figs. 5–40 and 5–43). For film loading, the manual drive is turned to the FILM LOAD position on the dial.

The film drive can be divided into two operating modes: the feed and takeup drive (continuous drive) and the film transport (intermittent pull) mechanisms.

5.6.2.1 Film Transport Drive

The film transport (figs. 5–40 and 5–44) provides the means of intermittently pulling the film frames through successive operational steps. The energy for this cyclic frame transmission is derived from a continuous-running electric motor. This motor drives a 40-tooth transport sprocket through an intermittent gearbox. The gearbox contains a clutch which is engaged at the correct instant by the action of a solenoid-operated release arm. The solenoid is actuated by the stored energy which accumulates in a bank of capacitors during the periods when the transport sprocket is at

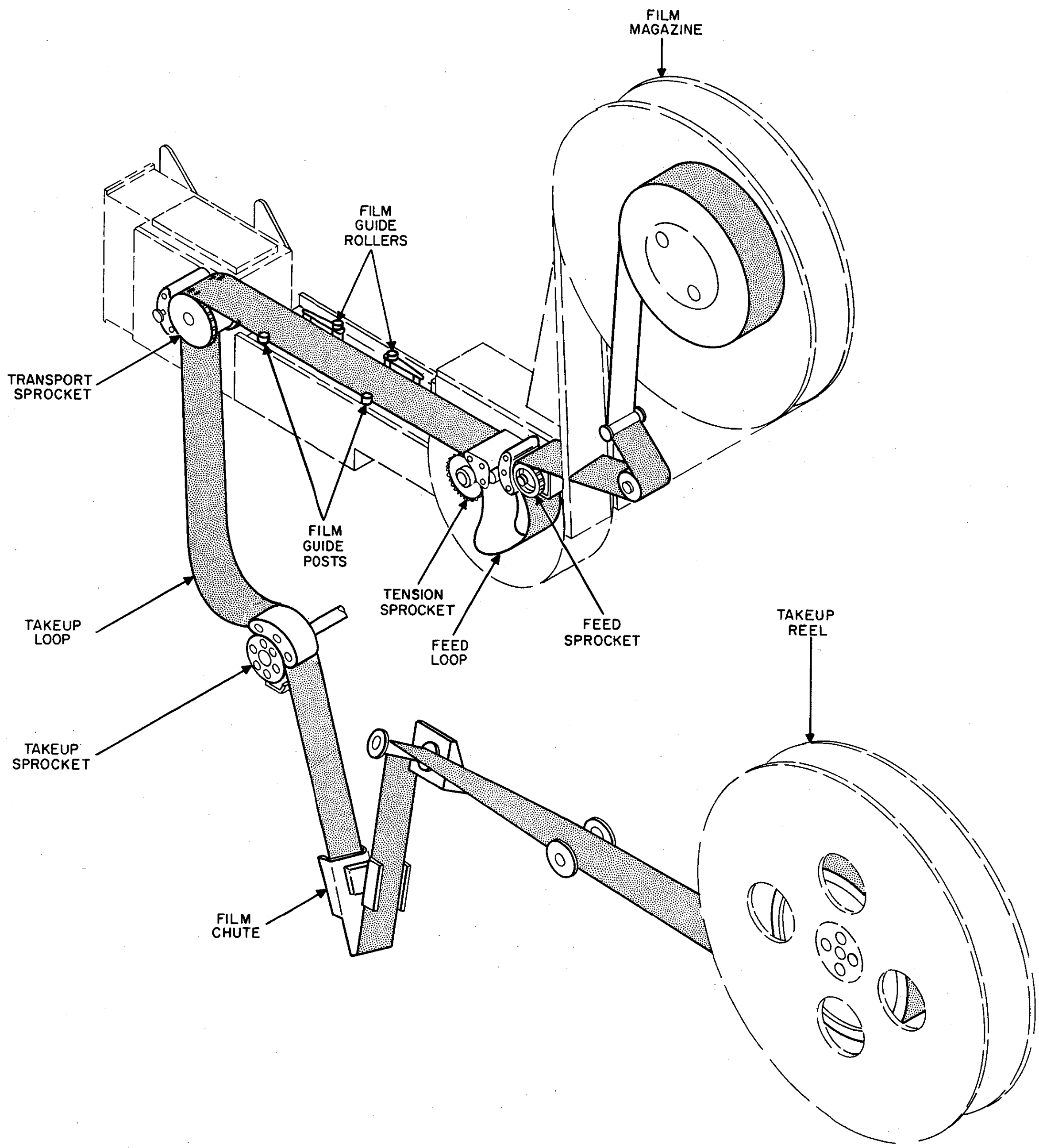


Figure 5–42. Overall Film Drive

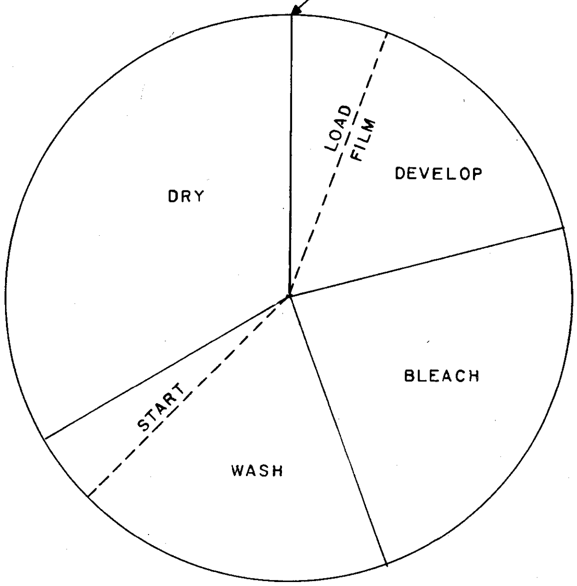


Figure 5—43. Timing Cycle Indicator

rest. The capacitor voltage is discharged by the film shift-timing contacts and applied to the solenoid.

5.6.2.2 Feed and Takeup Drive

The continuous drive system is powered by the 24Vdc shunt motor geared to a wormshaft and associated gears. The gearbox casting has a lubricating oil sump and a combination filler plug-dipstick. The oil in combination with a screw-feed metering vent lubricates the Maltese cross, clutch springs, and cams.

A gear bolted to the main shaft retains a cam with a spring mounted on one end; the other end of the spring is tied to a cam-mounted sleeve. The free internal diameter of the spring is slightly less (about 0.005 inch) than the external diameter of the sleeve. The sleeve rotates in such a manner that it tends to wrap the spring about it, thus rotating the cam and the main shaft.

In quiescent periods, the arm which is loaded by the spring engages the cam tending to unwind and allow the sleeve to slip around inside it without turning the main shaft. This mechanism acts as a clutch, permitting the drive to slip and thus function, when not being pulled, as a free-running drive. When a pulse of energy is applied to the solenoid, the cam arm is released, enabling the spring to wrap tightly around the sleeve, carrying the cam and main shaft with it. In this manner, the motive force is produced that provides the intermittent drive for frame pulling and that drives the various shafts and sprockets concerned with the overall film drive. (See fig. 5—44.)

5.6.3 Film, Magazine, and Reels

The film used, a 35-mm, blue-sensitive, high-contrast type, is reeled from a magazine by the action of the feed sprocket. The film magazine consists of two major parts: the body and a light-tight cover. The body is composed of a cylindrical casting that forms the film-retaining chamber and a mounting block that is used for attaching the assembly to a bracket on the rear of the film gate.

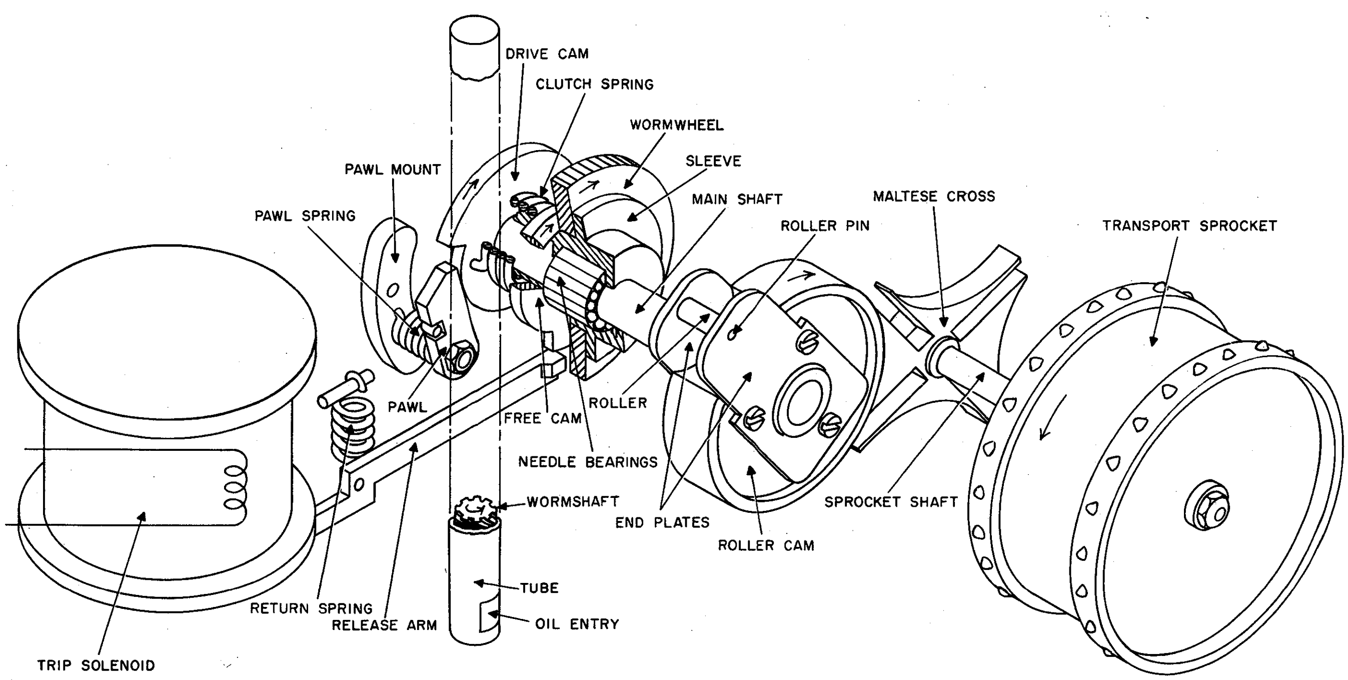


Figure 5—44. Film Transport Mechanism

5.6.3.1 Film-Low Warning

The magazine has a capacity of 2,000 feet of film but will normally be loaded with 1,000 feet. At the normal operating speed of two exposures a minute, 1,000 feet of film will last for approximately 48 hours of operation. When the quantity of film in the magazine is reduced to about 30 feet, a microswitch is actuated, setting off the FILM LOW warning light, and an audible alarm, on the main control panel. (Refer to Logic 4.8.5 for circuit operation.)

When the magazine is being mounted on the gate, it is important that the knurled head screw be fully turned home so that the magazine is securely and properly locked. This must be done to avoid fogging of the film by stray light. The film-low warning circuit may not operate correctly if the knurled screw is not completely tightened.

5.6.3.2 Film Supply Indicator

Provision has been made to estimate the quantity of film remaining on the reel in the magazine. This is accomplished by means of a film supply indicator. The indicator has an arm, the free end of which may be turned against the outside of the film roll diameter (see fig. 5–27). A pointer on an external knob indicates the approximate quantity of film remaining.

5.6.3.3 Magazine Reloading and Threading

Loading or reloading of a magazine is a simple operation which must be performed in a darkroom either in total darkness or with an approved safelight. Total darkness is recommended.

The film is threaded (fig. 5–40) by drawing the film from inside the feed-chamber entry slot across the chamber under the feed-and-tension sprocket roller carriage and thread into the gate. The film is further drawn the length of the film gate, under the intermittent sprocket roller carriage and down under the holdback sprocket roller carriage, around the film chute and over the guide rollers to the takeup spool.

If the feed loop is made too large, it will rub on the bottom of the film feed chamber and result in scratched film. If made too small, it will jump off the sprockets and break the film.

5.6.3.4 Takeup Reel

The takeup reel (fig. 5–40) is a standard 35-mm spool that reels in the exposed film for storage. The drive for the takeup spool is from the main camshaft through gearing, and it is overdriven via a slip-clutch so that the film is spooled under tension.

5.6.4 Sprockets and Clamps

The various sprockets are part of the overall film drive system. The film is drawn both continuously and intermittently by rotating feed sprockets, and tension sockets maintain film control. Crimping and clamping devices serve to hold the film in registration and also serve as light baffles.

5.6.4.1 Tension Sprocket

The tension sprocket (fig. 5–45) is located in the film feed chamber in front of the film gate. It maintains the film in the gate at the correct tension while permitting a free feed loop to build up between it and the film feed sprocket.

5.6.4.2 Film Feed Sprocket

The film feed sprocket operates in conjunction with the film roller and film stripper. It rotates at half the camshaft speed, or 1 rpm. Its function is to pull the

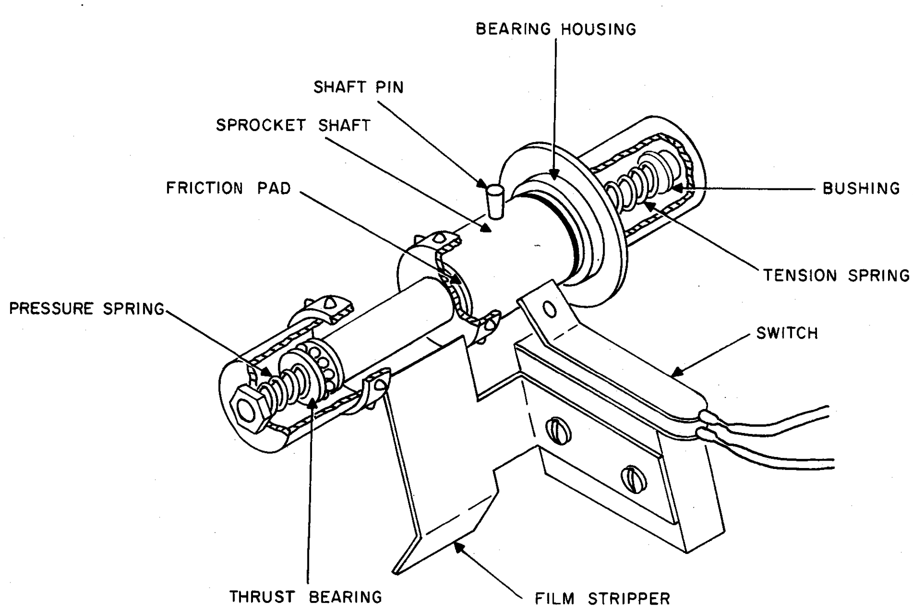


Figure 5–45. Tension Sprocket

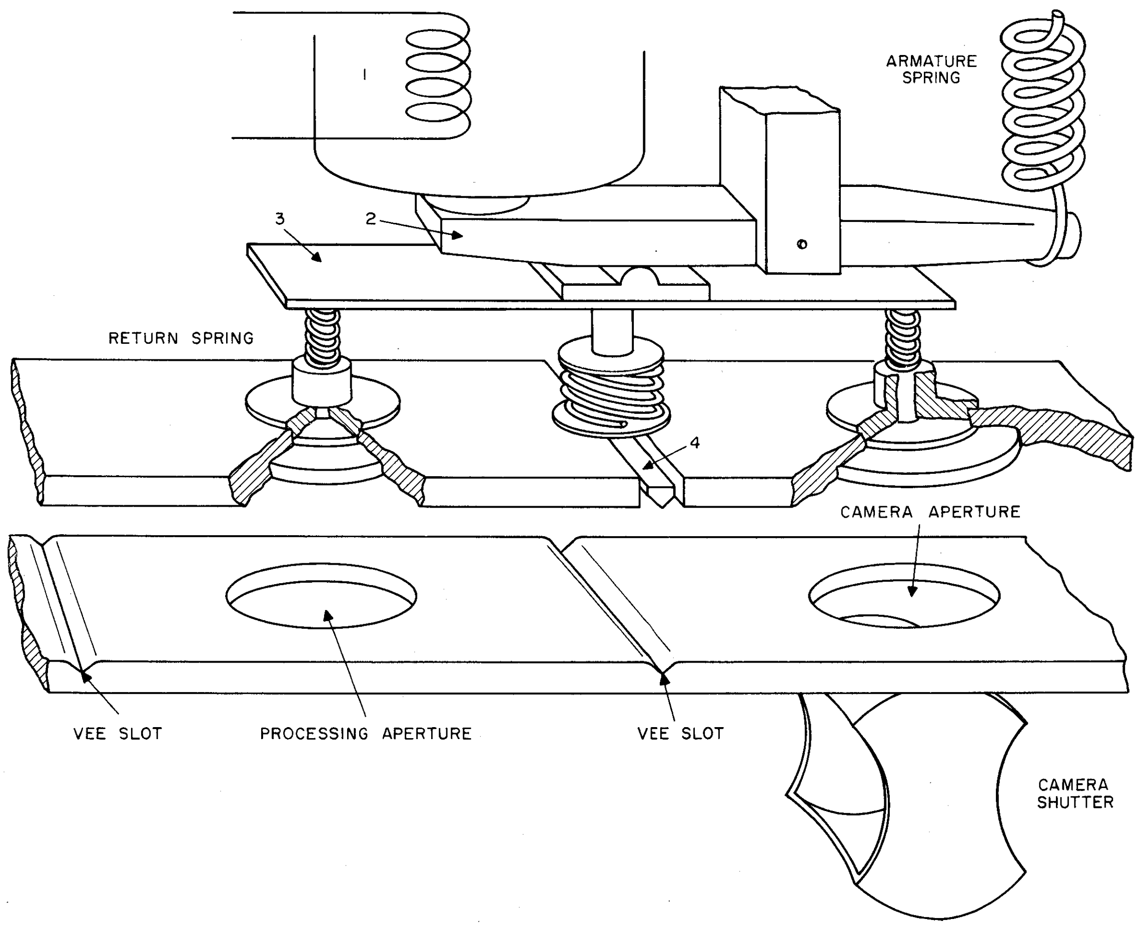


Figure 5–46. Clamping and Crimping Mechanism

film from the magazine at a cyclic rate, leaving a loop of film in the feed loop chamber. This loop is partly taken up intermittently by the transport mechanism. A feed sprocket clamp bears against the film, holding it firmly against the feed sprocket. A film stripper, a piece of sheet metal of slightly less width than the sprocket, is placed between the sprocket teeth. It functions to lift the film away from the sprocket teeth during rotation to prevent the film from tearing or snagging.

5.6.4.3 Film Takeup Sprocket

The film takeup sprocket also rotates at half the camshaft speed. This sprocket pulls film at a steady rate from the takeup loop which is fed intermittently by the action of the transport mechanism. A sprocket clamp and film stripper similar to those of the feed sprocket are also used with the takeup sprocket. The film takeup reel rotates at a speed slightly faster than that of the takeup sprocket. The action causes the film to be wound on the reel under tension. To prevent the film from tearing under too much tension, a slip clutch is installed on the takeup reel drive shaft.

5.6.4.4 Clamping and Crimping Mechanism

This mechanism is housed in the film gate cover, and it consists of two circular pressure pads and a crimper bar (fig. 5–46). It functions as a solenoid-controlled, spring-operated lever device which clamps the film at the recorder and processing apertures and also performs the special function of crimping the film between the recorder and processing positions.

The purpose of this crimp is to prevent light from the projection aperture from traveling through the film by multiple reflections, which would fog the film at the recorder and processing stations of the gate. The spring causes the film to be clamped and crimped during the whole of the exposure and processing time. It is released by the solenoid for film transport.

5.6.5 Film Transport Registration

The term "registration" denotes the accuracy with which successive frames of film are positioned. Ideally fixed objects on the display should remain relatively stationary when projected. There are primarily two types of registration.

(a) Lateral registration is governed by sidewise movement of the film in the gate. This movement is controlled by two compressive rollers keeping the film pressed against two pads.

(b) Longitudinal registration is the positioning of the film lengthwise in the gate after each film transport. It is positioned by the tension sprocket pulling the film back against the teeth of the intermittent sprocket.

Transport registration is carried out initially and from the time the intermittent gearbox and transport mechanism actuates the Maltese cross. From that point, relay-operated releases compensate for differences in manual operations and cyclic interruptions. The corrector mechanism and film longitudinal registration ensure that the Maltese cross, sprocket, and film perforation inaccuracies are compensated for, within 0.0015 inch.

5.6.5.1 Maltese Cross and Driving Cam

The longitudinal registration of the film depends entirely on the accurate rotation of the Maltese cross mechanism and sprocket. The Maltese cross (fig. 5—44) is pinned to the sprocket shaft, which drives the film transport sprocket via the corrector mechanism. The

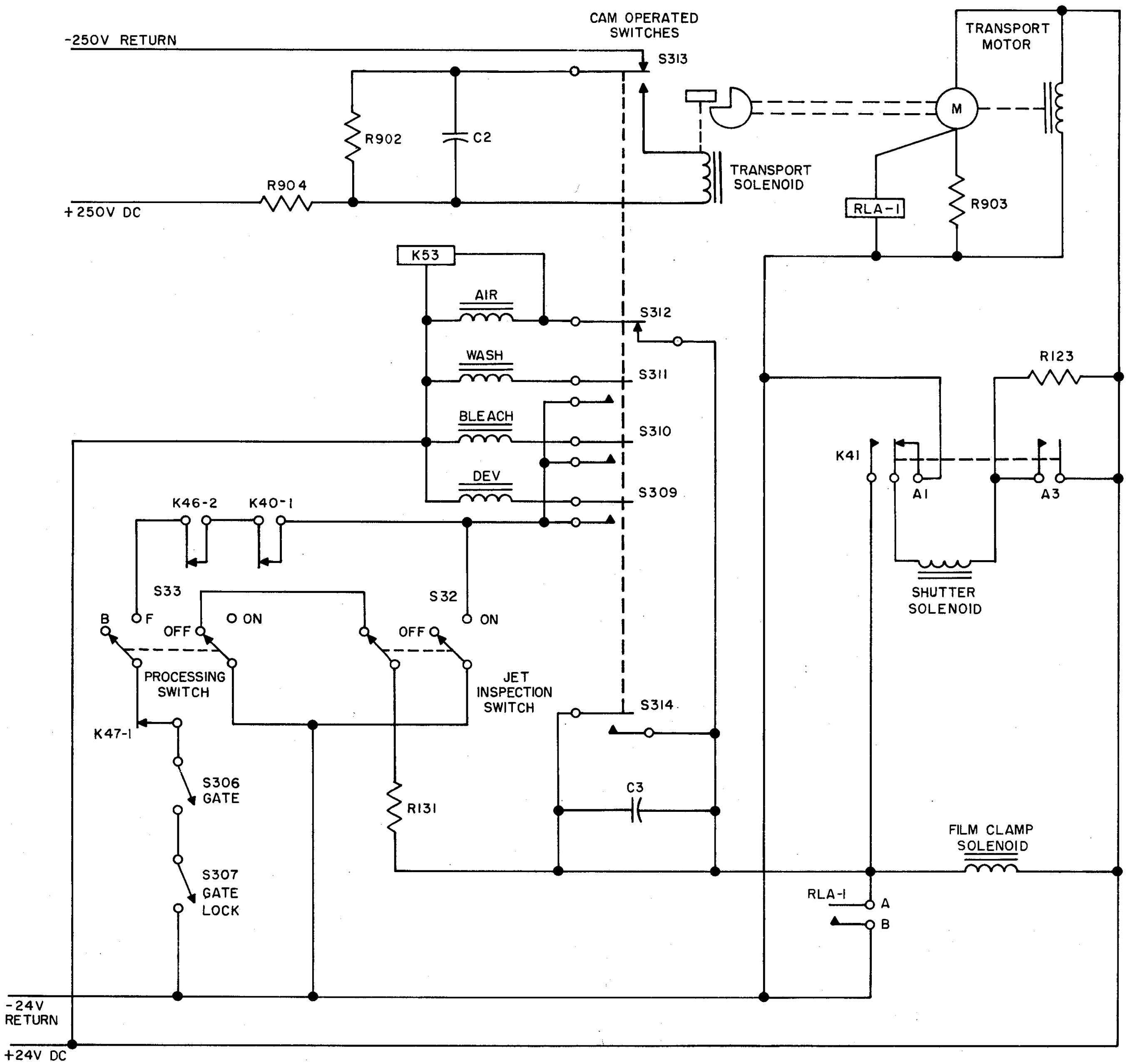


Figure 5—47. Cam-Controlled Circuits, Simplified Schematic

cam is secured to the mainshaft by a taper pin. The periphery of the cam forms a bearing surface for the curved faces of the Maltese cross, preventing the cross from turning in quiescent periods.

The cam makes one revolution each time the solenoid is energized, and the Maltese cross is driven through 90 degrees by the roller which engages in the slot presented to it (fig. 5–44). A cam corrector mechanism is employed to ensure that a 180-degree rotation of the transport sprocket is made accurately for any two successive film pulls. Transport of the film takes place in two distinct movements:

a. The accurate pullback against the transport sprocket teeth, which is accomplished by the tension sprocket.

b. Snatching of the film, leaving a free loop in the feed loop chamber.

Figure 5–47 is a simplified schematic of the cam-controlled circuits.

5.6.5.2 Corrector Mechanism

The film registration at the gate must come within the design limits of ±0.0015 inch. Since the film perforation error is just within these limits, it follows that the movement imparted to the transport sprockets by the Maltese cross and cam must be precisely 90 degrees each time the solenoid is energized. A corrector mechanism within the transport sprocket is therefore employed to cancel out manufacturing tolerances in the Maltese cross and the transport sprocket.

The corrector plate is bolted to a flange on the sprocket shaft. Backlash between the sprocket and corrector plate is taken up by the action of a spring which is tensioned between an anchor pin on the sprocket and another anchor pin on the corrector plate projecting through a large hole in the sprocket.

CHAPTER 3
SITUATION DISPLAY CONSOLE

3.1 GENERAL

The situation display console is one of two basic console types used in the Display System. The auxiliary display console is described in Chapter 5 of Part 5. The SD console, unlike the auxiliary console, usually contains an SDIS and a DDIS; the auxiliary console may have only a DDIS. The consoles and all accessories affixed to them are items of simplex equipment; however, certain consoles located in the Maintenance Control area are duplexed. Sufficient internal lighting is provided to permit inspection and servicing of interior components. Interlock circuits are a built-in feature of the consoles to assure that all interior lighting is extinguished when all covers and doors are in place. Essentially, the purpose of the SD console is to combine those equipments and functions necessary for flexibility in operator control as dictated by console station tactical needs.

3.2 TYPES OF SITUATION DISPLAY CONSOLES

Each SDIS is located in, and is the principal part of, a situation display console. There are 10 basic consoles, which differ from each other only in that they have different associated components included in, or attached to, the console. Because of this great similarity and the fact that the associated parts can be readily removed from one console and placed on another, there is no differentiating nomenclature for the various console types other than the tactical identification which is applied to the console in the AN/FSQ-7 and -8 Centrals.

The same physical cabinet is used for all situation display consoles, and the same SDIS is located within each cabinet. Table 5–12 lists the various types of consoles and their associated components. For example, console type 2 (arbitrary type number), illustrated in figure 5–48, typifies an SD console with a SDIS, DDIS, side wing, and light gun included as accessory equipment.

Most SD consoles contain both an SDIS and DDIS (refer to table 5–12), with the remainder of attached equipment determined by the console station tactical function. Except for the high-voltage power and the supply voltage lines that are fed to the console, there are no electrical connections (signal) between the two

TABLE 5–12. TYPES OF SITUATION DISPLAY CONSOLES

ARBITRARY TYPE NUMBER	SITUATION DISPLAY INDICATOR SECTION	DIGITAL DISPLAY INDICATOR SECTION	INPUT DATA SELECTION CONTROL PANEL	LIGHT GUN	AREA DISCRIMINATOR	SD CAMERA	SIGNAL DATA PATCHING PANEL
1	X	X	XX	X			
2	X	X	X	X			
3	X						
4	X	X	X				
5	X	X		X			
6	X	X					X
7	X					X	
8	X	X	X	X			X
9	X				X		
10	X	X					

Note: XX = Two per equipment.

indicator elements. The indicators are physically placed in the same console so that one operator can view both conveniently.

3.3 SD CONSOLE ACCESSORIES

The SD console accessories are provided to extend the tactical function of the console. Three of the types of components which attach to the console are part of the Input System. They are the input data selection control panels (sidewings), light gun, and area discriminator. The accessory devices are utilized to feed information back to the Central Computer System through the manual input element.

3.3.1 Input Data Selection Control Panel

The input data selection control panels attach to the sides of some of the SD consoles. It is for this reason that they are commonly referred to as "side wings." The side wings provide a means of operator-to-computer communications.

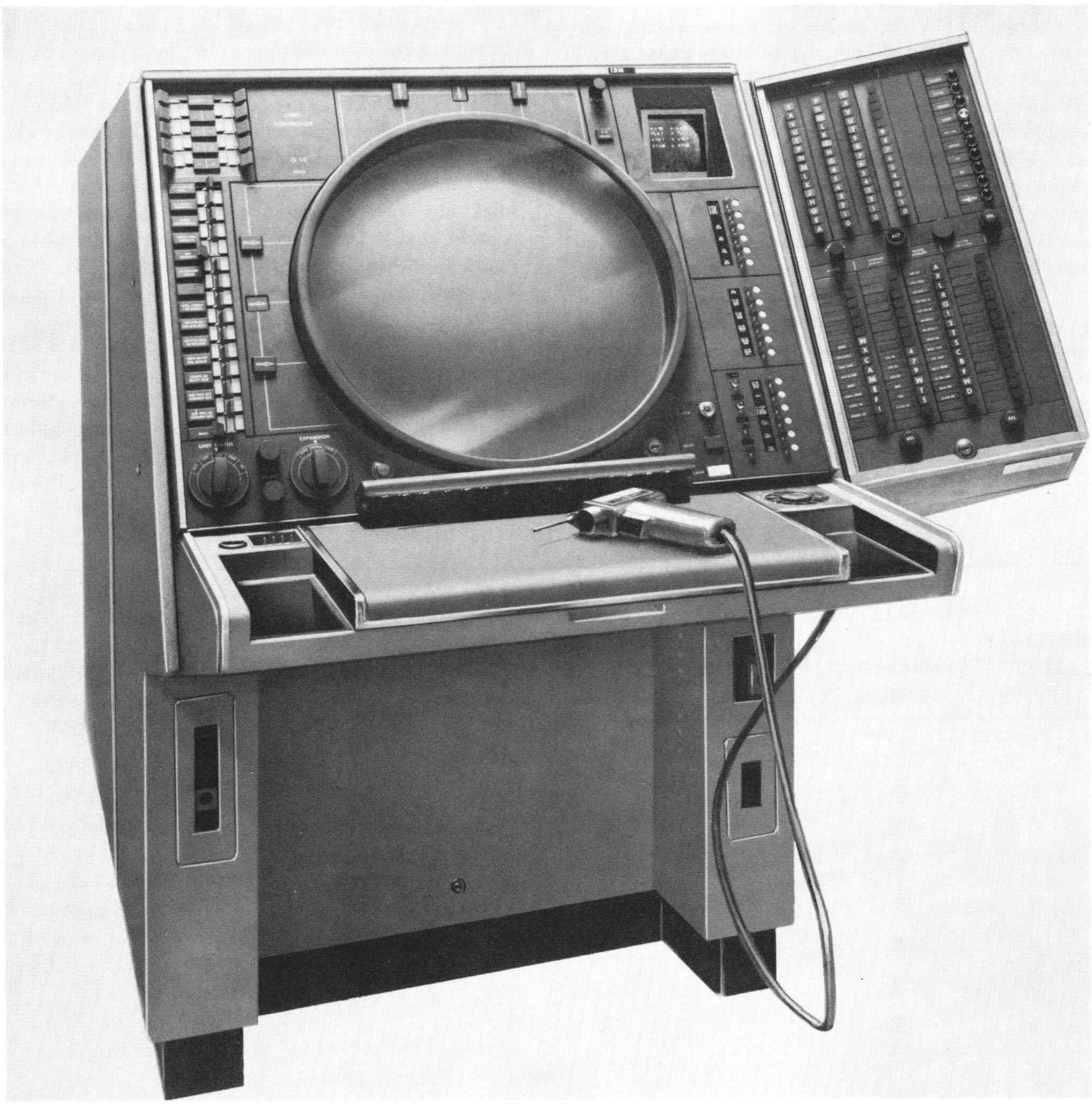


Figure 5–48. Typical SD Console (Type 2)

3.3.2 Light Gun

A data-selecting light gun is used with some consoles. It is a hand-held ~~pistol~~ shaped device and is used by the console operator to identify a particular message appearing on the SD CRT as the one he is interested in. This identity is sent to the Central Computer regarding his query or assignments. The light gun is used in conjunction with the side wing pushbutton modules.

3.3.3 Area Discriminator

The area discriminator is similar to the light gun in function and operation. The area discriminator is mounted above the SD CRT. It is used to designate, automatically, certain display data to the Central Computer. Refer to Chapter 2 of Part 6 for a detailed discussion of the area discriminator.

3.3.4 SD Camera

In figure 5–49, the SD camera is shown mounted on an SD console. It is a recording camera which photographs a selected display at those times and intervals designated by the Central Computer. Refer to Chapter 4 of Part 5 for a detailed discussion of the SD camera.

3.3.5 Signal Data Patching Panel

The signal data patching panel allows the operator of the SD console with which it is associated to select any message in the Display System. By means of the patching panel, any of the 188 DAB and category lines can be made available to the associated console. There is also means for selecting any of the DD messages so that they can be displayed on the DDIS of the SD console. The signal data patching panel is a valuable maintenance tool.

3.4 OPERATING CONTROLS AND INDICATORS

There are eight feature selection switches in two groups of four, located in the upper left section of the SD console front panel (see fig. 4–14). These lever-type switches are used by the operator to select features to be displayed on the SD CRT. Located above the feature selection switches are the BRIGHT-DIM switches. These switches control the intensification level (bright or dim) of the features selected by the associated bank of feature switches. The 15 category and DAB selection switches are of the lever type and are located along the left edge of the console. These switches select the type of information to be displayed.

The expansion selector is a rotary, 3-position switch located at the lower left and labeled CNTD (contracted), NORM (normal), and EXPD (expanded). This switch is used to select three of the four available expansion levels and certain categories associated with each level of expansion. Fourteen off-centering selection pushbuttons, divided into two groups of 7 each, are located along the top and left side of the SD CRT. These pushbuttons select the crossing of horizontal and vertical grid lines closest to an expanded display area and move the crossing to the center of the CRT display. Provisions are made to reduce each group to three switches by removal of parts.

The UNIT STATUS switch, located in the lower left section of the front panel, controls the power and signal status of the console. Three telephone key units and a warning light module are provided on the right side of the console.

3.5 ACCESS DOORS AND COVERS

The consoles have easily removable side covers and access doors on the top, rear, and front for ease of maintenance. Access doors are hinged and open wide enough to permit removal of enclosed units.

3.6 POWER OUTLETS

Convenience outlets are provided, supplying 120-volt, 60-cycle, unregulated ac consisting of two groups of two outlets. Two of these outlets are connected to power system C, and the second group is connected to power system D.

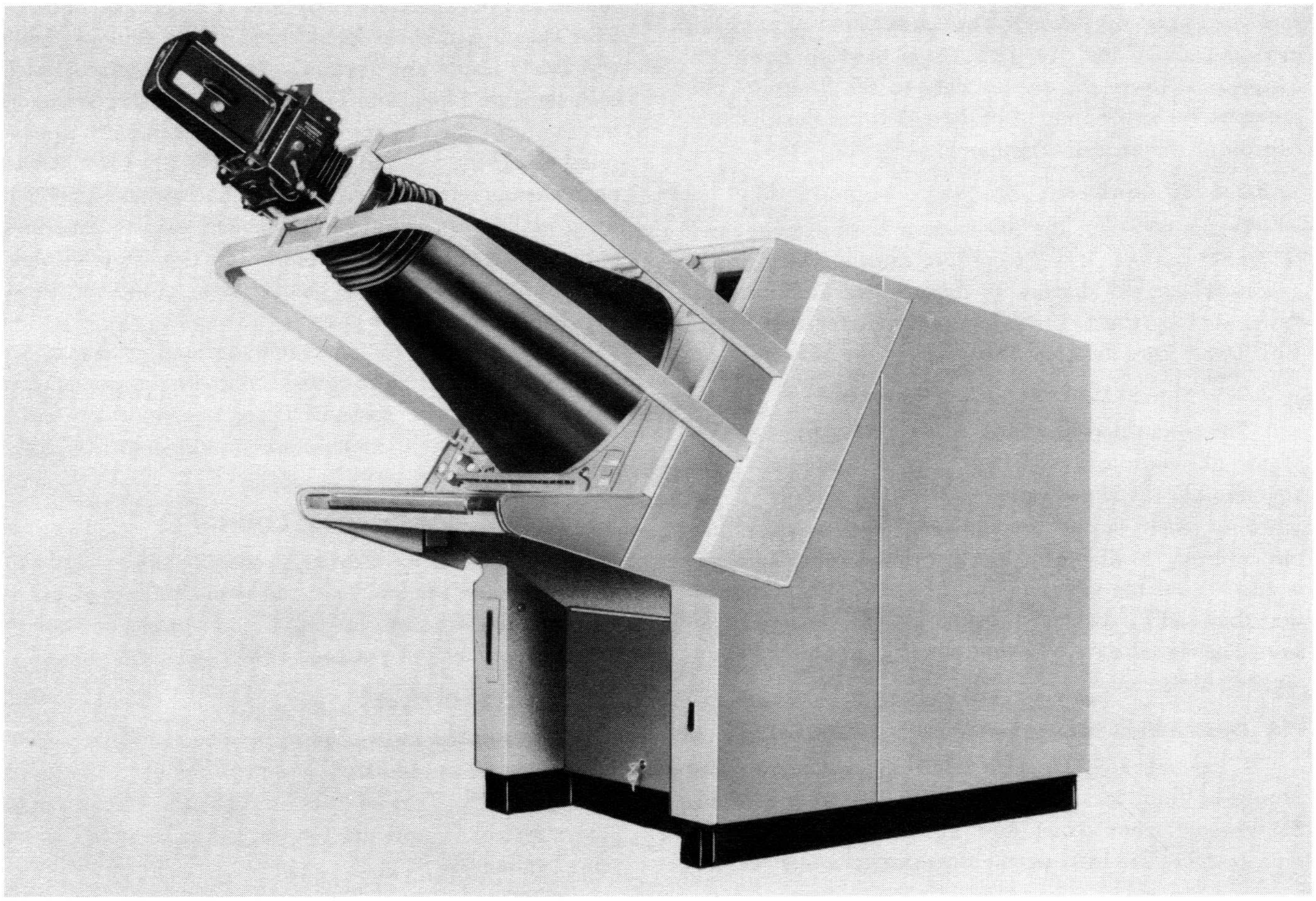


Figure 5–49. Situation Display Camera Console

CHAPTER 4
SITUATION DISPLAY CAMERA ELEMENT

4.1 SCOPE

The situation display camera element (SDCE) produces a 35-mm film record of selected situation displays. (See fig. 5–49.) This permanent film record is photographed at special display consoles containing essentially the same SD CRT as the other consoles with this exception: the phosphor is a P-11 type.

The still picture camera employed is semiautomatic. It is so controlled that signals from the SDGE to the SDCE are applied to these consoles to operate the camera. Figure 5–50 is a simplified flow diagram of the SDCE control.

Tactical or simulated situation displays generated by the active machine (computer) can thus be subsequently analyzed to check the performance and adequacy of equipment, personnel, and tactical deployment. Displays generated by the standby machine contain the results of maintenance programs and are analyzed for successful or error-indicating displays. By this means, it is possible to run off a program in continuous steps without stopping to analyze intervening displays between these steps, and the permanent record permits detection of even the slightest deviation from a standard display pattern.

Since records of both standby and active displays are required, the SDGE is duplexed. All of its physical components are located in duplicate units, designated as machine A and machine B. One of the two cameras, depending on which one is in active status, records active displays, the other records standby displays.

4.2 FUNCTIONAL OPERATION OF SDCE

The situation display camera console is an SD console with these modifications:

a. A P-11 phosphor and a white implosion shield on the CRT to improve its photographic qualities.

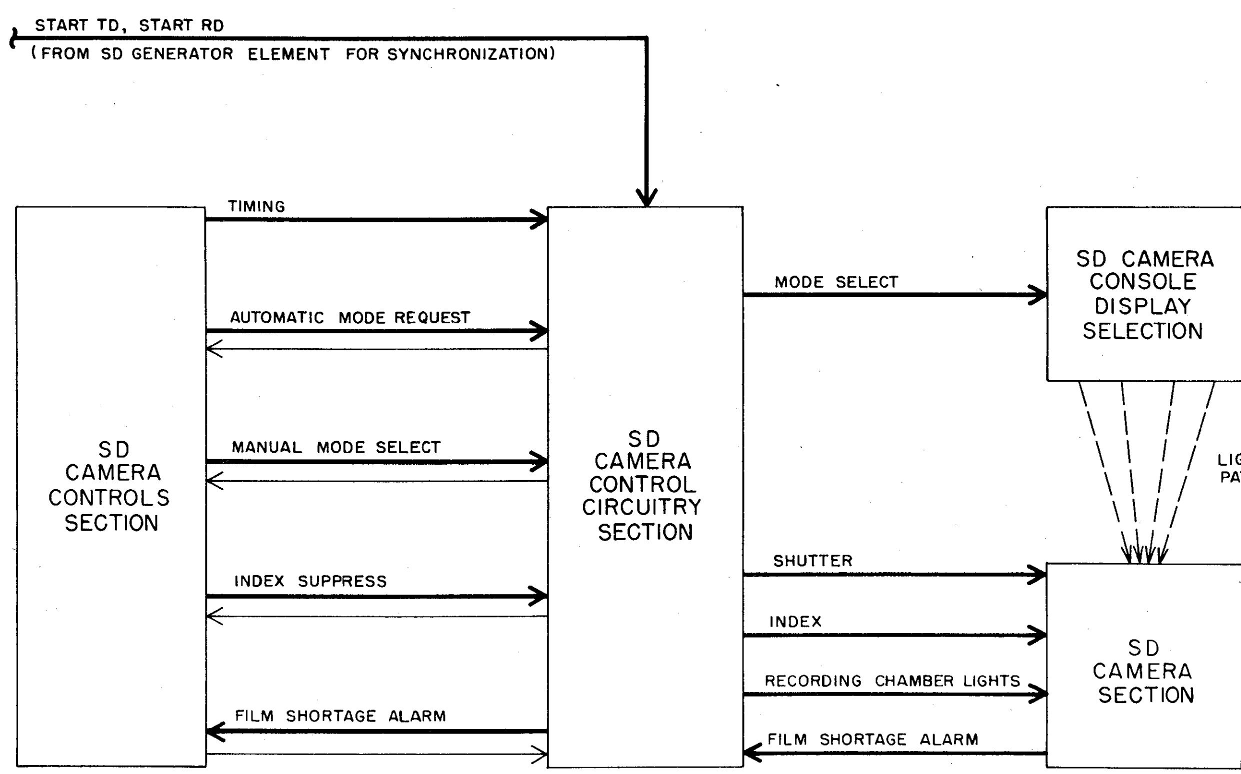


Figure 5–50. Situation Display Camera Element, Simplified Flow Diagram

b. A mounting frame for the camera and electrical connections.

c. A camera control unit occupying the space normally provided for the digital display circuits.

The console then can be said to contain a situation display indicator section (SDIS), described in Chapter 2 of Part 4, modified by the circuits of the camera control units. These modifications provide for display selection remote from the console to supplement the selection facilities normally available at the console. The supplementary display selection, called mode selection, permits messages in only one of two predetermined groups of categories and DAB's to be intensified at one time.

4.2.1 Mode Selection and Camera Timing

The selection of the mode to be displayed is normally controlled by the computer program. The circuits which provide this automatic control are located in unit 5 and act through control circuits located in unit 25. The latter circuits also control the timing and operation of the camera. Manual mode selection and camera control are possible by means of control switches on the duplex maintenance console.

The film is normally advanced, or indexed, after a frame has been exposed. The camera exposes one frame at a time, with each frame recording the display that is generated during one complete SD cycle. Indexing can be suppressed, however, to record any number of SD display cycles on one film frame.

Whenever a new frame is exposed, the camera automatically photographs the contents of its recording chamber (see fig. 1—21), which is illuminated at this time. The frame is thus identified by a data card, a clock, and a frame counter.

4.2.2 SDCE Information Flow

The CRT display will remain unintensified until such time as a camera control cycle is initiated by an operate instruction from the Central Computer System or manually from the duplex maintenance console. The instruction from the Central Computer System provides automatic control. Two instructions exist, one for each mode.

The situation display camera control section synchronizes the operation of the Display System. The section generates two types of control cycles designated as modes, which enable the SD camera to photograph two different types of messages. The desired operating mode can be selected either manually or by the Central Computer System. The operation of the camera is identical in either mode.

When both computer and manual initiation occur simultaneously, the manual instruction takes precedence. Indicator lights mounted close to the manual switches on the auxiliary console inform the operator that the camera is program-controlled in one or the other mode. Status indication signals prevent the Central Computer System from sending instructions while manual operation is in progress. All control signals, irrespective of their sources, are routed into the camera control section, where they are utilized to produce the intensification signal for the selected mode. These signals are also synchronized, with the start-RD and start-TD signals from the SDGE intensifying the display for the duration of a combined TD and RD cycle.

4.2.3 Index Suppress

The index (film advance) must be suppressed if more than one picture is to be taken on the same frame of film.

Film advance at the end of a camera cycle (index) can be suppressed by operating a switch on the duplex maintenance console.

4.2.4 Situation Display Camera

The situation display camera (SDC) shown in figure 1—21 is a semiautomatic type specifically designed to photograph the fluorescent image on the viewing screen of the 19-inch SD CRT with the P-11 phosphor. The camera assembly includes the camera body, film indexing mechanism, recording lights, camera optical and shutter system, and a film magazine.

4.2.5 Alarms

An audible and visible alarm circuit on the duplex maintenance console indicates when less than 5 feet of unexposed film remains in the camera magazine and/or if a magazine is not installed ready for use.

4.3 LOGIC OPERATION OF SDCE

The situation display camera control circuits supply the SD camera with the control signals necessary for its operating sequence. Action for mode 1 is initiated manually by depressing the START CAMERA MODE 1 pushbutton on the duplex maintenance console or automatically by the *Computer Operate* (SD camera mode 1) instruction (*PER 31*). For display in mode 1, the upper seven category and DAB switches on camera console 171 are depressed. To initiate mode 2, the START CAMERA MODE 2 pushbutton on the duplex maintenance console is depressed, or the *Operate* (SD camera mode 2) instruction, (*PER 32*), is performed by the Central Computer System. For this mode, the lower seven category and DAB switches are depressed. Usually all category and DAB switches are depressed, and the message for each mode is intensified as each mode is called for manually or automatically.

The sequence of camera control signals is as follows:

a. A mode select flip-flop initiates signals to turn on the lights in the recording chamber.

b. The camera control section next senses the following start-track-data pulse from the Drum System to determine the beginning of a display cycle.
c. After the start of a display cycle is sensed, the camera console situation display tube is intensified for the messages included in the mode selected, and the exposure begins.
d. When the display cycle completion is sensed, the camera console intensification gate goes down, the shutter closes, and the film is indexed (advanced).

With the end of the sequence described above, the camera comes to a halt, ready for the start of a new photographic sequence.

The output signals of the camera control circuits section are the same whether the sequence is initiated manually or by the Central Computer System. The control circuits are common for part of the operation when functioning in either sequence. For this reason, the operation of the camera control circuits section when manually initiated is described first. Parts of the section used only for computer operation are then discussed.

4.3.1 Manually Initiated Operation

The SD camera operation is manually initiated by depressing the START CAMERA MODE 1 pushbutton on the duplex maintenance console for photographs of mode 1, and by depressing the START CAMERA MODE 2 pushbutton for photographs of mode 2. These two operations are essentially the same; therefore, only one is described in detail in the following text. Figure 5–51, foldout, is a diagram of the circuits used in the display camera element and should be referred to during the following discussion.

4.3.1.1 Initiation

Depressing the START CAMERA MODE 1 pushbutton causes pulse generator PG 2 to send a pulse to the mode select flip-flop (FF 5). The pulse sets FF 5 and is simultaneously applied to single-shot multivibrators, SS 1. The 1-side output of FF 5 is connected to AND 1, providing one of the inputs for conduction of this AND. SS 1 sends a wide pulse to relay driver RYD 1, which energizes relay K3. This relay has four sets of contacts, three of which are normally open and one normally closed. (The term "normal" refers to the de-energizing or quiescent state of all relays in the camera control element.) Energizing the K3 relay causes the open contacts to close, lighting the lamps in the recording chamber of the camera opening shutter and applying a level to condition gate tube GT 7 via a delay network. The slow conditioning of GT 7 is shown on line 6 of the timing diagram (fig. 5–52, foldout). The delay is necessary to allow the lamps in the recording chamber to light up fully and to permit the shutter to open (lines 4 and 5 in the timing chart). The fourth set of K3 contacts opens, preventing generation of an index (completion) pulse.

4.3.1.2 Intensification

Start-TD (track data) and start-RD (radar data) pulses from the SDGE are fed to an OR so that the first to appear will pass through GT 7, setting intensify FF 6 (lines 7 and 8, fig. 5–52). The 1-side output of AND 1 (mode 1 selected) is connected through the switches of the console, causing intensification of the mode-1 display. The output of AND 1 is also applied to the vacuum tube relay driver (VRD 1), which energizes relay K9. The contacts of this relay apply voltage to an indicator lamp located on the duplex maintenance console. The lamp indicates that a photographic sequence is in progress. The second pulse (start TD or start RD) passes through GT 7 to GT 8, complementing FF 7 to the 1 state. The third pulse (start TD or start RD) passes gate tubes 7, 8, and 9 and is applied to SS 2 through an OR in the automatic index portion of the SD camera control circuits section of the control element.

4.3.1.3 Automatic Indexing of Film

The pulse that triggers SS 2 (line 9 of fig. 5–52) produces a wide pulse which is applied to RYD 2. Control relay K4 of the automatic index control is thus energized, causing three sets of normally closed contacts to open and three sets of normally open contacts to close. This results in the following action.

a. Delay action relay K5 (line 11 of fig. 5–52), energized through one of the normally closed contacts of K4, is de-energized. Nothing happens to the contacts of this relay for 200 to 300 ms because of its delayed action.
b. Relay K3 (line 3 of fig. 5–52), which is energized through one of the normally closed contacts of K4, is de-energized. The contacts of this relay are immobile for 200 to 300 ms because of its delayed action.
c. Relay K6 (line 13 of fig. 5–52), equipped with power contacts, is thus energized, and a 5-ampere current from the —48-volt supply is applied via one of the contacts of K6, causing an indicator lamp marked CAMERA INDEX on the duplex maintenance console to light.
d. The remaining two contacts of K4 disconnect a —30-volt level from relay driver RYD 3 and connect a +10-volt level instead. This action has effect only if the CAMERA INDEX SUPPRESS switch on the duplex maintenance console is closed. The action of this switch is as follows:

1. After the delay period of 200 to 300 ms has expired, the contacts of relay K5 open, de-energizing K4 and K6 in turn thereby permitting indexing of the film. De-energizing the relay K4 generation pulse inhibits PG 4 and a completion pulse which is discussed in detail in 4.3.2.1 of this chapter. (See lines 10, 11, 13, 14, 15, and 16 of figure 5—52.)
2. The circuit is ready for the next photographic sequence, which may be initiated in the manner described or by a Central Computer System instruction.

4.3.2 Computer-Initiated Operation

When the operation of the SD camera is initiated by a program instruction from the Central Computer System, the operation of the SDCE is the same as described in 4.3.1 of this chapter, with the exception of the initial depressing of the START CAMERA MODE pushbuttons. Sequence of additional operations is necessary before the circuits reach the stage equivalent to that for manual initiation.

4.3.2.1 Interlock Circuit

An operate-31 or operate-32 pulse is sent by the Central Computer System to the situation display camera mode selection section during timing pulse OT 9. The operate-31 pulse indicates that mode 1 is initiated, and the operate-32 pulse indicates that mode 2 is initiated. Either pulse passes through an OR circuit and sets request operation FF 3. Mode request FF 4 is set by an operate-31 pulse and cleared by an operate-32 pulse. Assume that relay K2 is energized and (interlock) FF 2 is set. The 1-side output of FF 2 conditions GT 2, passing TP 5 from the Central Computer System. The gated pulse sets FF 1 (sync) and is gated by GT 4, which is conditioned by the 1-side output of FF 3. The output of GT 4 is distributed on four lines to produce the following conditions:

a. Flip-flops 2 and 3 are cleared.
b. Gates 5 and 6 are sensed. Only one of these gates is conditioned by the output of the mode request flip-flop (FF 4), depending on which operate pulse has been sent by the Central Computer System. The contents of FF 4 are thus transferred to the mode select flip-flop (FF 5).
c. The single-shot multivibrator (SS 1) is triggered via an OR, starting the sequence of operation described in 4.3.1 of this chapter until the completion pulse is delivered by PG 4.
d. The pulse from GT 4 is sent to the Central Computer System, where it sets the sense-SD-camera flip-flop.

The completion pulse generated by PG 4 clears synchronizer FF 1, previously set by the gated TP 5. The 0-side output of FF 1 conditions GT 1. Timing pulse TP 1 from the Central Computer System passes through GT 1 to set interlock FF 2 via an OR.

The 1-side output of FF 2 conditions GT 2, and the following TP 5 is passed to set FF 1. This flip-flop remains set until another completion pulse has been produced either as a result of a Central Computer System operate pulse or through manual initiation of the operational sequence. The gated TP 5 is also applied to GT 3, conditioned by the 0-side output of FF 3. The output of GT 3 is sent to the Central Computer System to clear the sense flip-flop.

The sense flip-flop, located in the Central Computer System, set at the beginning of the camera cycle by the output of GT 3, indicates whether the camera cycle is in progress. The Central Computer System instruction *Sense Camera ON (BSN 35)* is used in the program to sense the flip-flop and thus to determine the progress of a photographic sequence. If the flip-flop is set, the program branches to prevent a possible loss of an operate instruction. However, provisions are made to store one operate instruction. (See 4.3.2.2 of this chapter.)

4.3.2.2 Remember Request Circuit

If a second operate pulse is sent from the Central Computer System before the first one has caused a complete operational sequence, the second pulse is temporarily stored by setting request operation FF 3 and either setting or clearing mode request FF 4. When the first cycle is completed, a second cycle is started by a TP 5 passing through GT 2. This gate is conditioned by the 1-side output of interlock FF 2, which has been set by the synchronizing circuit. While the first cycle is in operation, a third operate pulse from the Central Computer System cannot be accommodated by the remember request circuit; therefore, the third pulse supersedes the second pulse, which remains in storage.

4.3.2.3 Flip-Flop Preset Circuit

The purpose of the flip-flop preset circuit is to put all flip-flops in the state required for proper initial functioning of the control circuits. When power is applied to the system, relay K1 is energized by the +90-volt power supply. Two normally open contacts close. One of the contacts applies —48 volts to relay K2, closing its normally open contacts and allowing TP 5 to reach PG 1, thereby producing a pulse which clears FF's 3, 6, and 7 and sets FF 2. The 1-side output of FF 2 conditions GT 2, which passes TP 5. The gated pulse simultaneously sets the sync FF 1 and passes through GT 3 (conditioned by the 0 side of FF 3) to the Central Computer System, where the pulse clears the sense flip-flop (FF 8), indicating to the Central Computer System program that the camera control element is ready to begin operations.

The flip-flop preset circuit prevents the taking of undesired photographs when the power comes on. This circuit also prevents malfunctions which would occur, for example, if energizing the equipment cleared interlock FF 2 and set FF 1.

4.3.2.4 Suppress Automatic Index Circuit

This circuit provides for multiple exposures. When the CAMERA INDEX SUPPRESS switch at the duplex maintenance console is in the SUPPRESS position, relay K7 is energized, preventing relay K6 from being energized, and no power is supplied to the index solenoid. Relay K8 (line 12 of fig. 5–52) is energized by relay K4 and relay driver RYD 3. Relay K8 has three sets of contacts, two of which are normally closed and a third normally open. The two closed contacts open, preventing current flow to the lamps in the recording chamber of the camera and preventing pulse generation by PG 5. The third set of contacts lights the SUPPRESS CAMERA INDEX indicator lamp at the duplex maintenance console.

When the SUPPRESS CAMERA INDEX switch is returned to its normal (off) position, both K7 and K8 are de-energized, causing PG 5 to be turned on. The resultant pulse is applied to an OR via one set of contacts of de-energized relay K3. Automatic indexing takes place as described in 4.3.1.3 of this chapter. If a camera cycle is in progress when the SUPPRESS CAMERA INDEX switch is turned off, relay K3 is energized, and the pulse from PG 5 has no effect.

4.3.2.5 Alarm Control Circuit

The alarm control circuit (fig. 5–51) responds to two conditions of the film magazine:

a. Magazine is not in place.

b. Magazine contains less than 5 feet of unexposed film.

Either condition causes a contact to close and send a signal to the vacuum tube relay driver, VRD 3. VRD 3 energizes relay K11, whose contacts close and apply —48 volts to a buzzer and to a red indicator lamp marked MAGAZINE at the duplex maintenance console. The buzzer is connected to the normally closed contacts of relay K12. To turn the buzzer off, the BUZZER OFF pushbutton is depressed, and relay K12 is energized and remains energized, disconnecting the buzzer until the alarm condition is removed and K11 is de-energized. The indicator lamp is independent of the buzzer and remains lighted until K11 is de-energized.

4.3.3 Manual Controls

The following manual controls are located at the duplex maintenance console:

a. START CAMERA MODE 1 pushbutton

b. START CAMERA MODE

c. CAMERA SUPPRESS AUTOMATIC INDEX switches

d. BUZZER OFF pushbutton

The following three controls are located at the camera console:

a. MANUAL INDEX pushbutton

b. LAMPS, RECORDING CHAMBER control

c. MODE INTENSITY TEST switch

When the film magazine has to be removed, the MANUAL INDEX pushbutton is pressed 15 times. Each time the pushbutton is pressed, relay K6 is energized and the film advances about one foot so that the last exposed frame is ensured complete enclosure in the magazine. In the same manner, after installing a fresh magazine, the same pushbutton is depressed 15 times to run off sufficient lead film to ensure the start of recording operations with film unexposed to ambient light.

The RECORDING CHAMBER LAMPS control is a variable resistor which permits variation of light intensity in the recording chamber. The MODE INTENSITY TEST switch permits such adjustments as width centering of display, intensity of characters, etc., to be made at the camera console. The displays that can be so adjusted are those that recur without continually initiating the camera cycle by pushbutton or instruction from the Central Computer System. The switch has three positions. In the NORMAL position, displays are intensified only by depressing one of the two START CAMERA MODE pushbuttons on the duplex maintenance console or by an *Operate* instruction from the Central Computer System. In the MODE 1 *TEST* position, all categories called for by the seven upper category switches on the console are displayed once each display cycle. In the MODE 2 TEST switch position, all categories turned on by the lower seven category switches are displayed once each display cycle.

4.3.4 Situation Display Camera

The situation display camera (SDC) shown in figure 1–21 is a semiautomatic camera especially constructed to photograph situation displays on the viewing screen of the SD CRT. The camera assembly includes a camera body, film indexing mechanism, recording lights, film magazine, a data card, counters, and optical and shutter systems.

The camera is controlled by the SD camera control circuits section (SD CCC) of the SDCE. The SD CCC generates signals which control the camera recording chamber, shutter assembly, film advance mechanism (index) lamps, and film shortage alarm.

4.3.4.1 SD Camera Operations

The recording chamber contains exposure counters, a clock, and a data card, which are photographed on a portion of each negative of the situation display. The chamber is equipped with dual decimal counters so that film exposures can be numbered consecutively for identification purposes. These counters are mounted one above the other, with their dials facing in opposite directions so that the results of one counter are visible from the outside while the reading of the other counter is being photographed. The data card in the recording chamber contains pertinent information to be recorded on the film, and the clock has a 24-hour dial to provide a chronological record for each exposure. To record this information, lamps in the recording chamber are lighted as dictated by the mode of operation.

4.3.4.2 SD Camera Shutter

The shutter of the SD camera is in the open position at the end of an exposure. It closes to prevent film exposure for a period of time sufficient to permit the camera to recycle and transport film for the following exposure. The shutter remains closed until a new cycle has begun. However, since the images on the viewing screen of the CRT are intensified only during a camera operation cycle, the camera remains idle until the next camera operation cycle is initiated, whether the shutter is open or is closed.

4.3.4.3 SD Camera Lens

The lens assembly consists of an f/2.3 lens with an adjustable iris diaphragm. Exposure control is determined solely by stopping down the lens, since the intensity of the viewing screen is not varied for photographic exposure. Because of this and the fact that the viewing screen shape does not present a flat field, a diaphragm stop of f/4 is employed under all conditions.

4.3.4.4 Index (Film Advance)

The film advance mechanism consists of an electromechanical assembly controlled by signals from the camera control element. A solenoid serves as the driving force for the gear assembly which indexes (advances) a frame of film every time an exposure has been completed.

4.3.4.5 Film Magazine

The film magazine of the SD camera will store 100 feet of 35-mm photographic film. The magazine is equipped with an indicator which shows the quantity of unexposed film remaining on the reel. When less than 5 feet of unexposed film is in the magazine, audible and visual alarms on the duplex maintenance console give warning.

CHAPTER 5

AUXILIARY DISPLAY CONSOLE

5.1 FUNCTION

The auxiliary console is employed in those areas and locations of the Combat Centrals where an additional console is needed. The console can be equipped with facilities to extend the alerting alarms and voice communications beyond those in existing SD consoles. Therefore, it can be considered an auxiliary housing for additional equipment necessary to extend the range and usefulness of present consoles according to tactical needs.

5.2 TYPES OF AUXILIARY CONSOLES

As shown in figure 5–53, there are four types of auxiliary consoles: types A, B, C, and D. Except for types A and B, each console contains a DDIS. The DDIS in an auxiliary console is similar to those used in an SD console. A DDIS located in a simplex SD console is described in Part 3. In general, that description is applicable for all DDIS's, regardless of physical location. However, in the auxiliary console component designations differ, and the following two additional circuits are added to replace the corresponding SDIS circuits which are shared in an SD console.

a. The UNIT STATUS switch. (Except for designations, this is similar to the UNIT STATUS switch on an SD console described in Part 5, Chapter 8, Section 1.)

b. The high-voltage power supply incorporating model B and C high-voltage power supplies (described more fully in the special circuits manual, 3-3-0).

The subpanel of an auxiliary console is shown in figure 3–8. The AN/FSQ-7 makes use of the four types of auxiliaries; only types A and C are used in the AN/FSQ-8.

5.3 AUXILIARY CONSOLE ATTACHMENTS

The auxiliary console attachments consist of the manual input controls, commonly known as pushbutton modules, warning lights, and audible alarms. As stated above, the assignment of these modular units is determined mainly by tactical function and, in some instances, to facilitate maintenance.

5.3.1 Pushbutton Modules

When a DDIS is made a part of an auxiliary console, the console also contains manual input controls which are identical in function and form to the input data selection control panels mounted on some of the SD consoles. They are banks of pushbutton modules used to control d-c levels to the manual input element and so communicate information back to the Central Computer System. For a more complete discussion of pushbutton modules, refer to Chapter 2 of Part 6.

5.3.2 Warning Lights and Audible Alarms

The warning lights and audible alarms provided with auxiliary consoles extend the capabilities and functions of the SD console. When the auxiliary console is used independently or in a remote station location, the console operator acts upon the received information in the same manner as prescribed for an SD console. A more complete discussion of warning lights and audible alarms is given in Part 5, Chapter 8, Section 2.

5.4 MODIFIED AUXILIARY CONSOLES

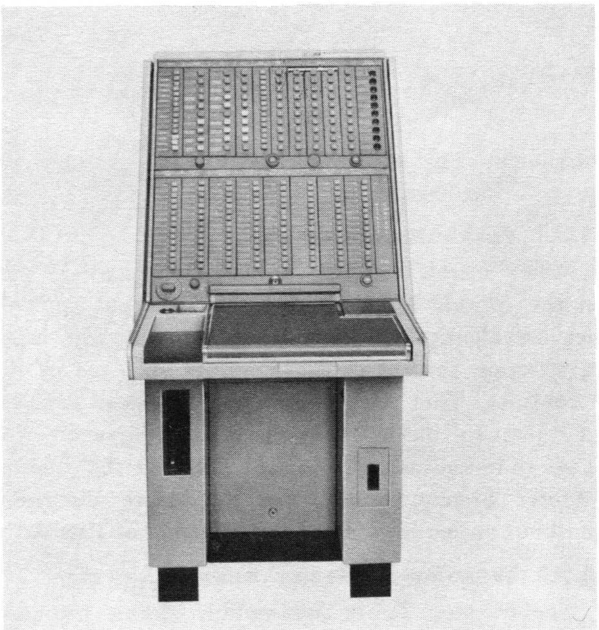
In some cases, it was found necessary to deviate from the four basic types of auxiliary consoles to enable performance of other functions. Such consoles are basic types modified to conform to modular equipment, and they are known as modified auxiliary consoles.

5.4.1 LRI Monitor Switching Console

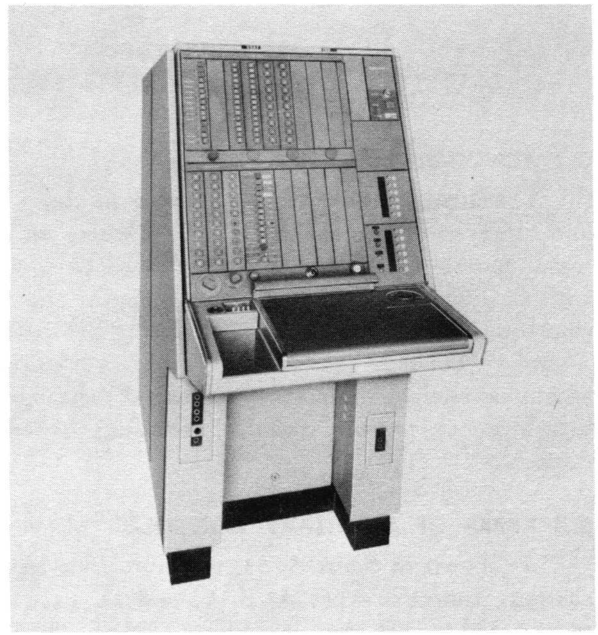
The LRI monitor switching console is a modified type C auxiliary console. It controls the operation of the LRI monitor console. Some controls and indicators are available for MDI and warning lights.

5.4.2 Duplex Switching Console

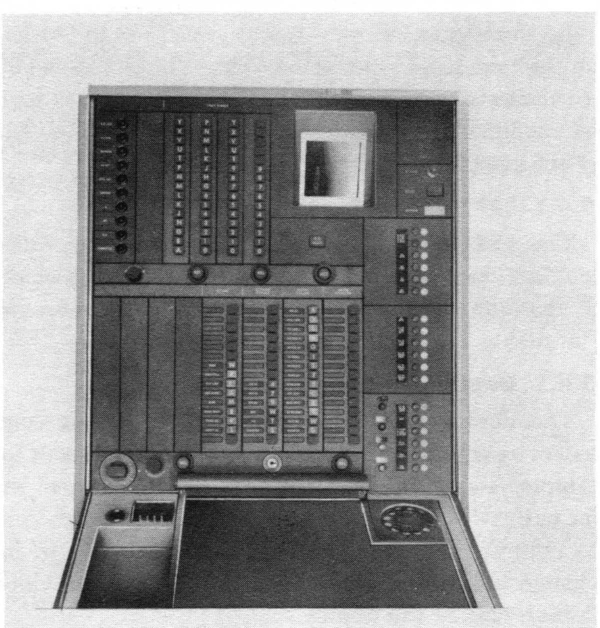
The duplex switching console (unit 45) is composed of two modified auxiliary consoles. One half of the duplex switch is associated with the A machine; the other half, with the B machine. The duplex switch contains both automatic and manual control circuits to interchange all duplex equipment. A DDIS is provided with each half of the duplex switch.



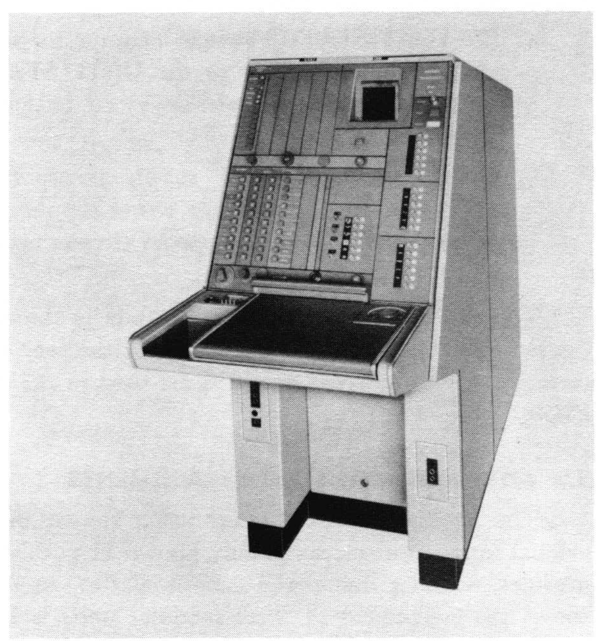
TYPE A



TYPE B



TYPE C



TYPE D

Figure 5–53. Types of Auxiliary Consoles

CHAPTER 6
COMMAND POST CONSOLE

6.1 FUNCTION

The Command Post console provides observation and control positions for the sector commander and his staff. These officers are responsible for directing and co-ordinating air defense operations at the Central. Tactical summaries of the air defense situation and supplementary data are made available to these officers, who evaluate the material and act upon it. Facilities at the Command Post console provide the means for implementing the action.

6.2 COMMAND POST CONSOLE ASSIGNMENTS

The console consists of a command desk abutted on either side by two staff desks. Each desk has accommodations for two control positions. The positions and their designations are indicated in table 5—13, and the station locations are shown in figure 5—54.

6.3 LOCATION

The Command Post console is located on a balcony in the command area of the Direction Central. A cross-sectional view of the sector command area and a portion of the floor plan of the balcony area (command level) is shown in figure 5—1. (The cross-sectional sketch is a tentative-plan view. It is subject to change to meet the varying conditions of each site.) The figure illustrates the console installed at the edge of, and conforming to, the shape of the balcony for maximum operative visibility. The console faces a large projection screen to enable the operators to view the situation display. Tactical summaries of the air defense situation, in the form of situation displays, are projected on the projection screen for the Sector Commander and his staff. The situation display is projected from the PRR, which is in the room above the balcony.

6.4 SITUATION DISPLAY CONSOLES IN COMMAND POST

There are seven situation display consoles, located behind the Command Post console, as shown in figure 5—55. The SD consoles provide additional situation displays used by the Sector Commander and his staff to supplement the situation displays presented on the projection screen. Each one of these SD consoles will have assigned to it, according to function location, specific data pertinent to the assigned console position.

6.5 TYPES OF DISPLAYS

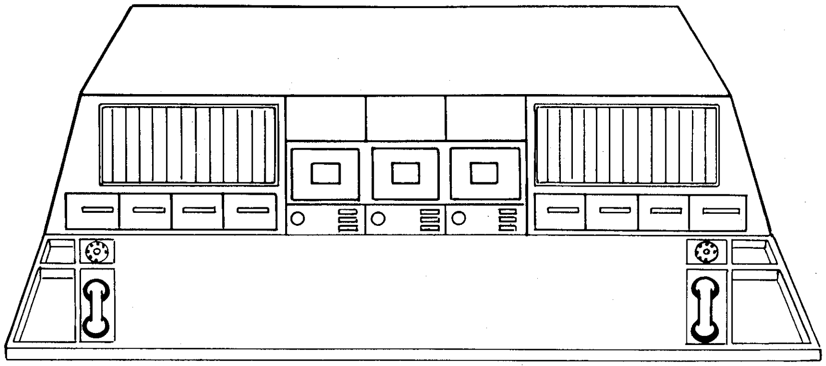
The Sector Commander and his staff receive data as visual displays. The displays are produced on the viewing screen of special cathode-ray tubes. There are two basic types of CRT displays: situation displays (SD) and digital displays (DD). Each 19-inch SD CRT with its associated circuits is termed a situation display indicator section (SDIS). Similarly, a digital display indicator section (DDIS) consists of a 5-inch DD CRT and its associated circuits. The SDIS and DDIS, taken collectively, make up the situation display indicator element (SDIE) and digital display indicator element (DDIE), respectively.

The relationship of the Display System to the other systems in the Direction Central is illustrated in figure 1—29. Air defense data is accumulated and processed by the Central Computer System (CCS) and transferred to the Drum System. The Drum System serves as a time-buffer storage device, making the timing cycles of the Display System substantially independent of the high-speed cycles of the Central Computer System. SD data and DD data are stored on separate drums and are later transferred to the SDGE and DDGE, respectively.

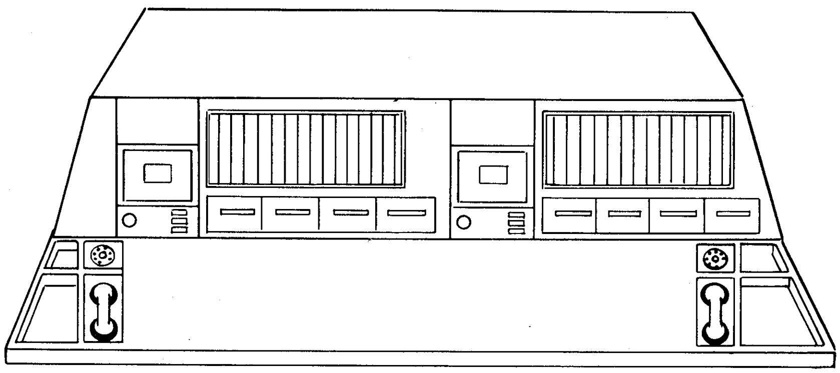
TABLE 5—13. COMMAND POST CONSOLE POSITIONS, UNIT 250, AN/FSQ-7 AND -8

DESK STATION LABEL	ABBREVIATION	*STATION LOCATION
Combat Intelligence Officer	CIO	C50
Meteorology Officer	MET-O	C51
Communications & Electronics	C & E	C52
Aircraft Control & Warning	AC & W	C53
Sector Commander	SC	C54
Director of Operations	DO	C56
Fighter Officer-Interceptors	FO-1	C57
Fighter Officer-Missiles	FO-M	C58
Anti-Aircraft Officer	AAO	C59
Spare Staff		C60

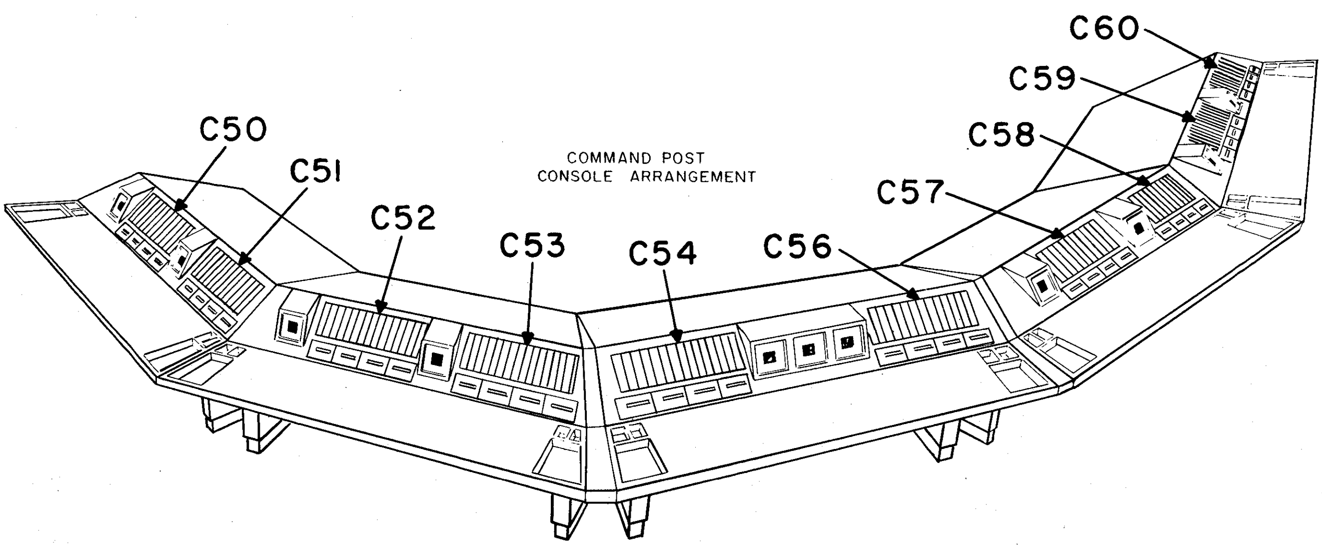
**Prefix station locations with letter "S" for AN/FSQ-8.*



COMMAND POST DESK
COMMAND POSITION



COMMAND POST DESK
STAFF POSITION



COMMAND POST
CONSOLE ARRANGEMENT

Figure 5–54. Command Post Console Positional Designations

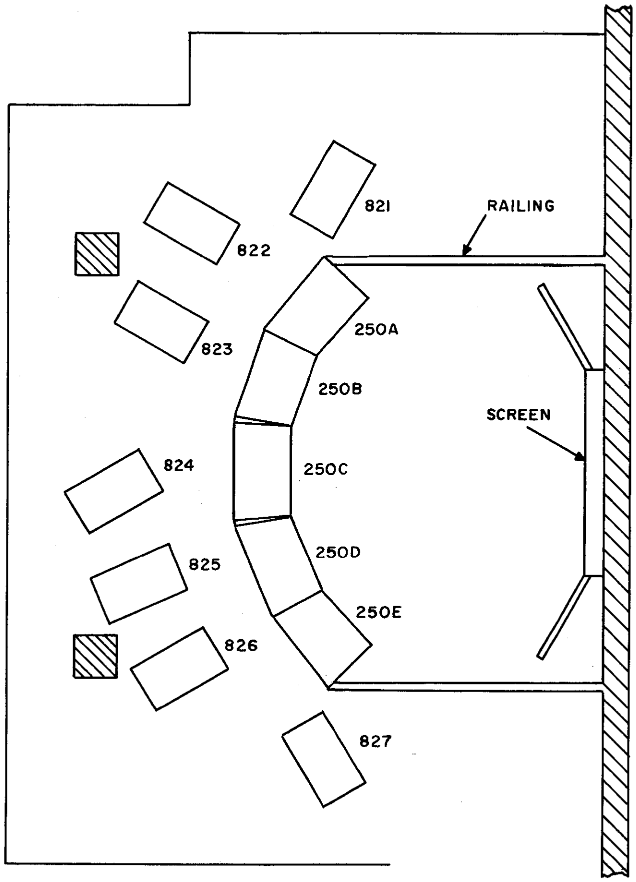


Figure 5—55. Sector Command Balcony Area, Partial Floor Plan

Transfer of SD data is cyclical; transfer of DD data is initiated by the Central Computer System. The SDGE and DDGE convert the SD and DD data into suitable forms for use by the SDIE and DDIE.

There are also methods by which an operator can send requests or messages to the CCS. This transmission is accomplished by the manual input circuits associated with specific consoles. The message to be acted on is routed through the MI element to the CCS.

6.6 COMMAND AND STAFF DESKS

The five desks, one command and four staff, provide command operating control and position for key personnel.

6.6.1 Configuration

The command and staff desks are similar in construction. They are equal in size and have a front-rear taper so that when arranged side by side, the desk sections approximate the floor cut of the balcony edge. A downward-sloping top enables the Sector Commander and his staff to observe the display on the projection screen over the tops of their desks, while seated. The facilities at each staff desk are largely duplicated, since each desk has accommodations for two operating positions. In the overall appearance, the command and staff desks differ in that the single command desk contains three centrally located DDIS's, whereas each staff desk contains one DDIS at the left of each operating position.

The DDIS's divide the front panels into two equal sections, separating the two positions.

6.6.2 Front Panel

The front panel of each position is designed to accommodate 13 standard (1-½ inches wide) panel modules, 4 telephone modules, and 1 alarm module. (See fig. 5—56, foldout.) In the figure, blank panels represent unused panel accommodations. Provisions are also provided for a UNIT STATUS switch, a DD ERASE button, and a dimmer control for panel illumination. The front panel is hinged so that it can be secured in the open position for maintenance.

6.6.3 Shelf

The shelf serves as a readily available working desk area. It is removable to allow for ease of maintenance and to permit access to components located beneath the front panel. Each end of the shelf is recessed and contains a telephone handset, an optical pointer, an ash tray, and a cigar lighter. The cigar lighter is powered from a 12 volt power supply which is fused. The shelf is illuminated.

6.6.4 Bright and Dim Controls

Separate illumination controls are provided for each position of a desk: a panel light control for panel illumination and a dimmer control to limit desk illumination. The dimmer control is mounted directly on the desk lighting fixtures.

6.7 LOGICAL RELATIONSHIP OF COMMAND POST CONSOLE TO DIRECTION CENTRAL

Besides containing DDIS's that are logically part of the Display System, the Command Post consoles include circuits that are logically associated with other systems. A representative block diagram for a single position of the Command Post console and external units is illustrated in figure 5—57. The diagram shows the relationship of warning lights and audible alarms to the Warning Light System and the association of manual input circuits with the MI element of the Input System. Warning lights and alarm signals, as well as DD signals from the DDGE, pass through the Display System signal distribution box. The signals from the manual input circuits pass through the manual input interconnection unit.

The audible alarm, UNIT STATUS switch, DD CRT circuits, and manual input circuits are common functions of each position at a command or staff desk. Brief descriptions of these functions are furnished in paragraphs 6.7.1 through 6.7.5 of this chapter. Functions peculiar to specific positions are described in paragraph 6.8.

6.7.1 Unit Status Switch Circuit

The unit status switch circuit, controlled by the UNIT STATUS switch at each position, regulates the flow of signals between positions and external circuits. The UNIT STATUS switch operates internal and external signal-switching relays. (The signal-switching switch at the Sector Commander's position controls two of the three DD CRT's and associated circuits of the command desk.)

6.7.2 DD CRT and Associated Circuits

Each DD CRT and associated circuits make up a DDIS. The DD CRT is a specially constructed 5-inch CRT, which is part of a DD unit that also contains the CRT adjustment controls and circuits. An associated unit and a DD intensification unit for each CRT unblank the CRT when a particular DD message is to be displayed at a specific position.

The associated DD circuits also include two high-voltage power supplies at each desk. The power supplies are shared by the two DDIS's of a staff desk and by the three DDIS's of the command desk. Each power supply is a separate unit.

6.7.3 Manual Input Circuits

Each position of the Command Post console is equipped with various manual input pushbutton modules which are used to send messages to the Central Computer System. The messages can consist of specific instructions, orders, or requests for information.

A message is prepared by depressing one or more pushbuttons on the MI modules. A pushbutton can represent a complete message or a part of a message. The function that each pushbutton performs is indicated by labeling or other means of identification. After a message is complete, the ACTIVATE pushbutton is de-

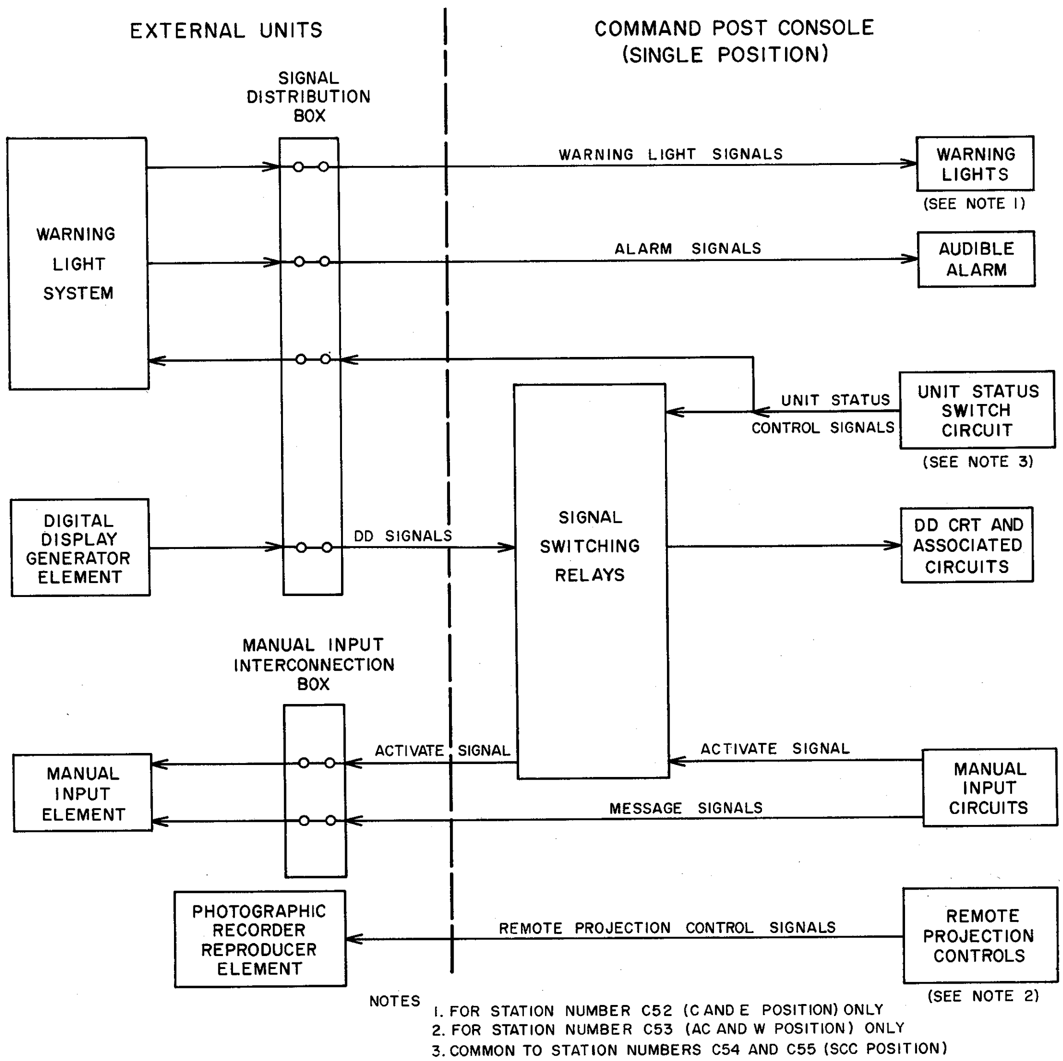


Figure 5–57. Command Post Console Position, Simplified Flow Diagram

pressed, signaling the CCS to take action on the message requested.

6.7.4 Audible Alarm Circuit

The audible alarm circuit notifies a member of the sector command that a condition at his position requires his attention or that some action by him is required. When an audible alarm is received, a bell is activated and, in addition, two neon lights on the audible alarm module are energized. One of the lights is a flashing light which is connected to a flashing mechanism. The same flashing mechanism is also connected to the bell to provide an interrupting ring. The bell can be inactivated by means of a disabling switch which is available to maintenance personnel.

The bell and flashing light are extinguished when a RESET pushbutton on the audible alarm module is depressed. The other neon light can be shut off only by the Central Computer System, usually after receipt of an appropriate message from the position involved.

6.7.5 Telephone and Communication Facilities

The telephone and communication facilities are not included in the block diagram for a single position of the Command Post console (fig. 5–57) because they are part of the Telephone and Intercommunication System, completely independent of the Central Computer System and associated systems. Both tactical and maintenance lines are brought to each desk. The tactical facilities permit the Sector Commander and his staff to communicate with other personnel inside or outside the Direction Central. The maintenance lines enable maintenance personnel to call various maintenance areas of the Direction Central directly.

The telephone switching module (or modules) is installed in a lower section of the front panel for each position. This module contains 18 pushbuttons, with associated indicator lights and labels, and 4 auxiliary pushbuttons which provide features such as hold, transfer, conference, etc. If additional facilities are required, a blank module can be replaced by a special telephone module to provide six additional pushbuttons. The direct intercommunication facilities provided by these modules supplement the automatic telephone dialing system available at each desk position.

Two types of telephone jacks, one type for maintenance and the other for staff communication, are located on each desk leg. The maintenance jacks are mounted on the inside of the right leg of each desk. The staff communication jacks are located on the front of each desk leg.

6.8 SPECIAL FUNCTIONS

The remote control of the photographic recorder-reproducer element and the warning lights are special-function circuits on the Command Post console.

6.8.1 Remote Control of the Photographic Recorder-Reproducer Element (PRR)

The projected displays appearing on the projection screen in the sector command area are produced by a photographic recorder-reproducer element (PRR) located in the projection room. Limited control of the projected displays is provided by pushbutton modules on the front panel of the AC & W desk position. The pushbutton modules are inoperative under either of the following conditions:

a. The UNIT STATUS switch at the AC & W position is set to the OFF or AC positions.

b. Two switches located on the projector element are set to the LOCAL position.

6.8.2 Warning Lights

A warning light module, containing 10 neon lights, is installed on the front panel of the C & E position. This module indicates to the C & E Officer various equipment troubles on the Direction Central.

6.9 OPTICAL POINTER

The optical pointer (see fig. 1–19) is a small pistol-shaped, hand-held device employed as a lecture pointer. That is, it is used to call attention to specific parts of the projected display by means of a small arrow head (or any other like symbol). When the trigger is pressed, the indicating symbol is optically projected from the pointer and superimposed on any desired part of the large screen display.

The pistol-trigger switch actuates an incandescent lamp that is excited from a 6.3-volt supply. The light thus produced is passed through an aspheric lens that condenses and shapes the input to a concentrated beam. The light beam, in turn, is extruded through a preformed, arrow-shaped cutout (or stencil). The arrow-formed beam is passed through a large-aperture projection lens to the beaded screen, where it can be swept to any desired placement. The projection lens is provided with a focusing mount to compensate for varying projected distances to the screen.

6.10 ASSOCIATED SD EQUIPMENT

The associated SD equipment consists of the projection element (PRRE) and the SD consoles. These elements receive their data from the SDGE.

The PRRE contains a modified SDIS, a camera and film-processing section, and a projector unit. The camera takes periodic photographs of the SD data appearing on the viewing screen of the SD CRT. The exposed film is then automatically processed. After processing, the SD data is projected on the large projection screen and examined by the Sector Commander and his staff. The selection of the SD data to be projected can be controlled either locally or remotely from the AC & W position of the Command Post console.

CHAPTER 7

DISTRIBUTION ELEMENT

SECTION 1

DISTRIBUTION BOXES

1.1 FUNCTION

Signal distribution boxes are used at many locations in the Display System to route signals to the various consoles. These boxes form the major portion of the signal distribution element (see fig. 5—58). The signals routed through the distribution boxes are light gun outputs, warning light signals, and trunk cable signals. The light gun outputs are applied to the manual data input element (unit 23). The warning light signals are supplied by the warning light interconnection unit (unit 91), and the trunk cable signals are supplied by the SDGE (unit 24); both of these signal groups are fed to the associated consoles.

The trunk cable signals are those signals necessary for the presentation of a given display on a particular console. The signals are divided into two general classifications: common and variable. Signals that are applied to all the consoles are referred to as common signals. The variable signals, based on console tactical requirements, are only fed to preselected consoles. Table 5—14 lists the common and variable trunk cable signals. The distribution boxes are designed in such a manner as to facilitate signal reassignments and to permit future expansion or revision of the Display System.

1.2 DESCRIPTION

There are 18 signal distribution boxes. Each box, 10-½ feet long, consists of two separate halves, one for each half of the duplex equipment. The half-boxes are wired identically, the only difference between the two being their physical placement. They are placed back to back (fig. 5—59), and therefore one half is a mirror image of the other half. Each section is electrically independent of the other.

The front of each distribution box is provided with four removable doors, which give access to 4 patchboards. These boards, identified as A, B, C, and D, are used to route the incoming trunk cable signals to the console output connectors. Connectors are provided at both ends of the distribution box and on top of the box. The end connectors are used for the inputs and feedthrough signals (fig. 5—59); the top connectors are used for the outputs that are fed to the associated consoles.

Sufficient output connectors are provided to serve any consoles that may be added to the Display System in the future.

The patchboard is a large, rigidly mounted, nylon-base phenolic board containing rows of terminal strips. The terminal strips contain terminals with either 3, 6 or 12 lugs to accommodate patch line connectors.

Each of the terminals, with the exception of one group of 3-lug terminals, is provided with a solder lug located at the rear of the terminal. Figure 5—59 contains an illustration of a 3-lug terminal.

TABLE 5—14. TRUNK CABLE SIGNALS

COMMON SIGNALS	VARIABLE SIGNALS
DD character selection	Slot lines 0 through 15
DD character position	Slot lines 000 through 700
DD contrast gate	TD CAT's 2 through 31
DD erase gate	MIXED RD CAT's
DD intensify gate	1 through 12
SD character selection	Supplementary drivers
SD character position	1 through 45
SD message position	DAB's 1 through 90
A, B, C, D and E features	RD CAT's 1 through 8
Bypass feature	MIX ALL CAT's
Point feature	MIX ALL DAB's
Defocus gate	Spares
Focus gate	
SD intensify gate	
Pass light gun	
TD CAT 1	
Vector intensify gate	
Spares	

The 3-lug terminals (with the solder lugs) and the 6-lug terminals are used for the incoming trunk cable signals. These terminals, as well as the other group of 3-lug terminals, are also employed as intermediate patching points during patching operations. The 12-lug terminals are used for ground connections.

1.3 PATCHING PROCEDURE

The input trunk cable signal lines are soldered to the rear of the 3- or 6-lug terminals. This connection is made to the same terminal on all four patchboards. The assignment of input signal lines to input terminals is predetermined; the assignment is the same for all distribution boxes. Patch lines are used to route the inputs to various intermediate 3- and 6-lug terminals and then to the taper-pin output connectors. The signal assignments and the associated patching information for the distribution boxes are provided in tables located in 3-183-0, *Distribution Box Signal Assignments for Display System of AN/FSQ-7 Combat Direction Central (DC-13 & Subsequent)* and 3-184-0, *Distribution Box Signal Assignments for Display System of AN/FSQ-8 Combat Control Central (CC-4 & Subsequent).*

The warning light and light-gun output signals bypass the patchboards. These signals are routed between the input and output connectors by taper-pin patch lines within the distribution box.

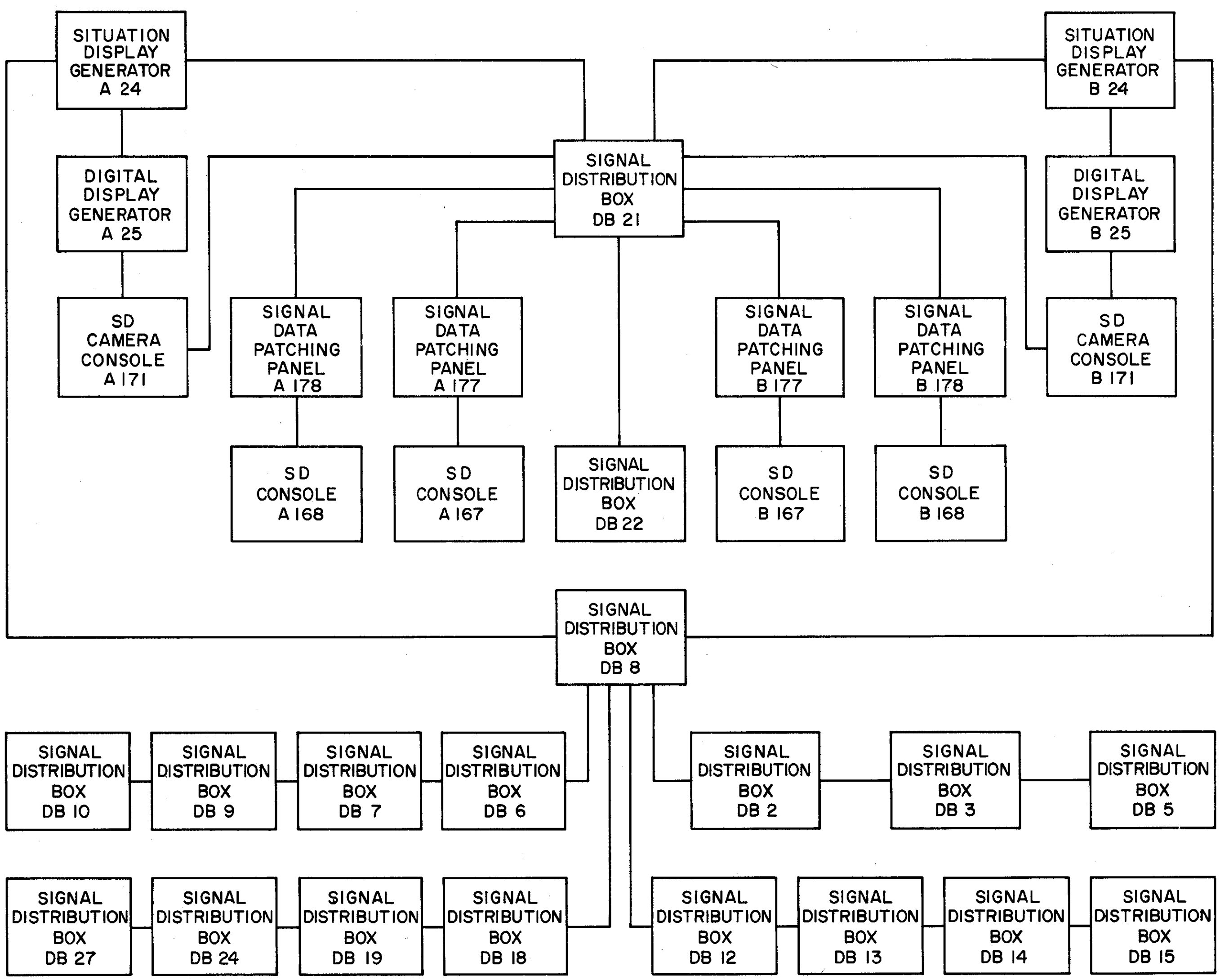


Figure 5—58. Signal Distribution Element, Block Diagram

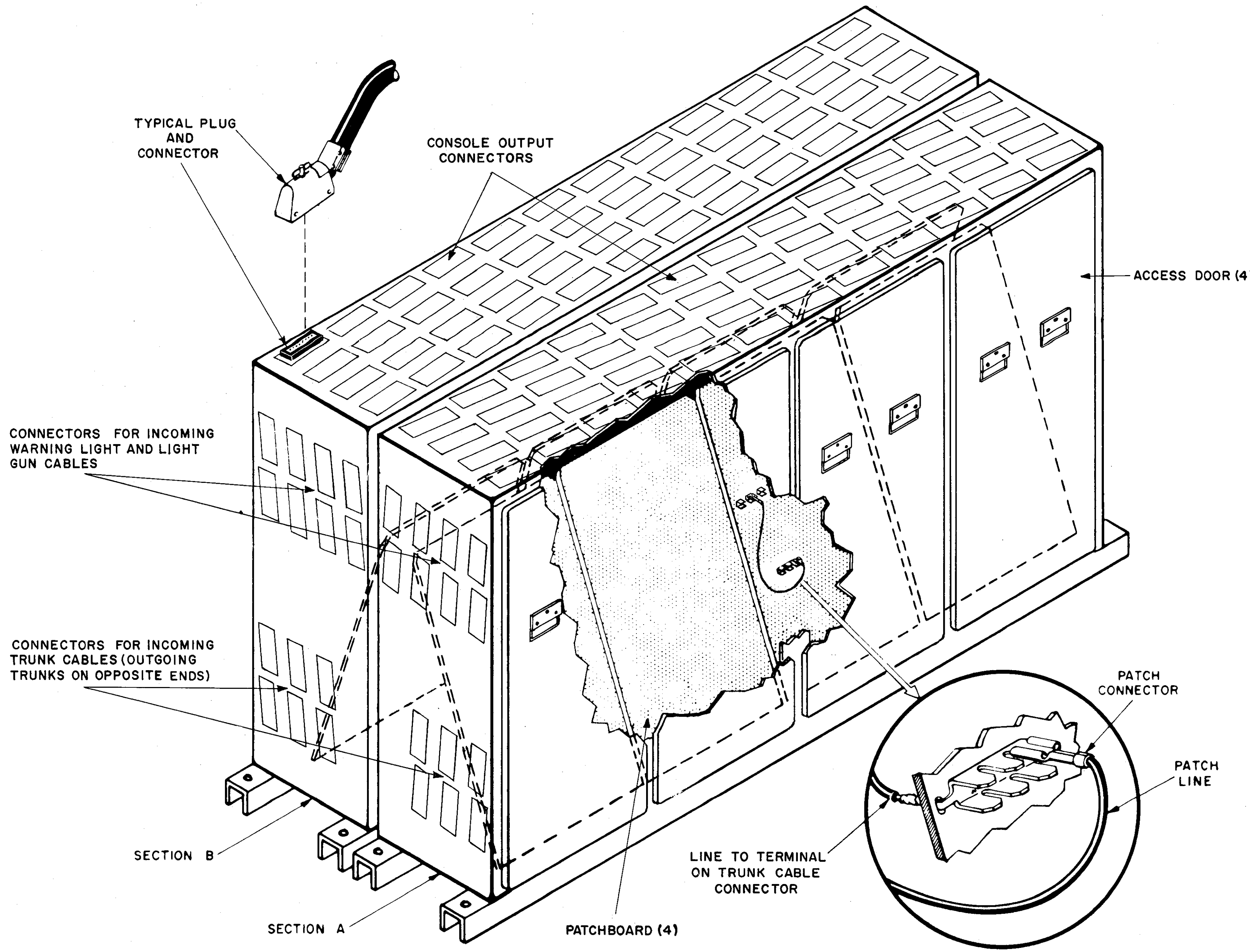


Figure 5—59. Signal Distribution Box, A and B Sections

SECTION 2
SIGNAL DATA PATCHING PANEL

2.1 FUNCTION

Signal Data Patching Panel SB-602/FSQ (see fig. 1–11) is a part of the signal distribution element. It functions as a signal distribution box for a single SD console. The patching panels are used to aid in monitoring the condition of the active Display System and to aid in monitoring the standby Display System. These units provide the means for presenting all messages which appear on any SD CRT or DD CRT on the SD console associated with a patching panel.

2.2 DESCRIPTION

Four signal data patching panels are employed in the Display System. These panels are mounted directly beside their associated consoles (see fig. 5–60). Signal data patching panel 177A is associated with SD console 167A, 177B with 167B, 178A with 168A, and 178B with 168B. Cables connect the patching panels to the SD consoles.

The signal data patching panels contain a patchboard (see fig. 5–61) and associated components and wiring to enable selection of any feature, CAT or DAB, supplementary driver, or DD slot line in the Display System for presentation on the associated SD consoles. There are two types of patchboards used in the patching panels: one type is permanently affixed to the front of the patching panel (fig. 5–60), the other (a later model), illustrated in figure 5–62, is a plug-in unit. Sig-

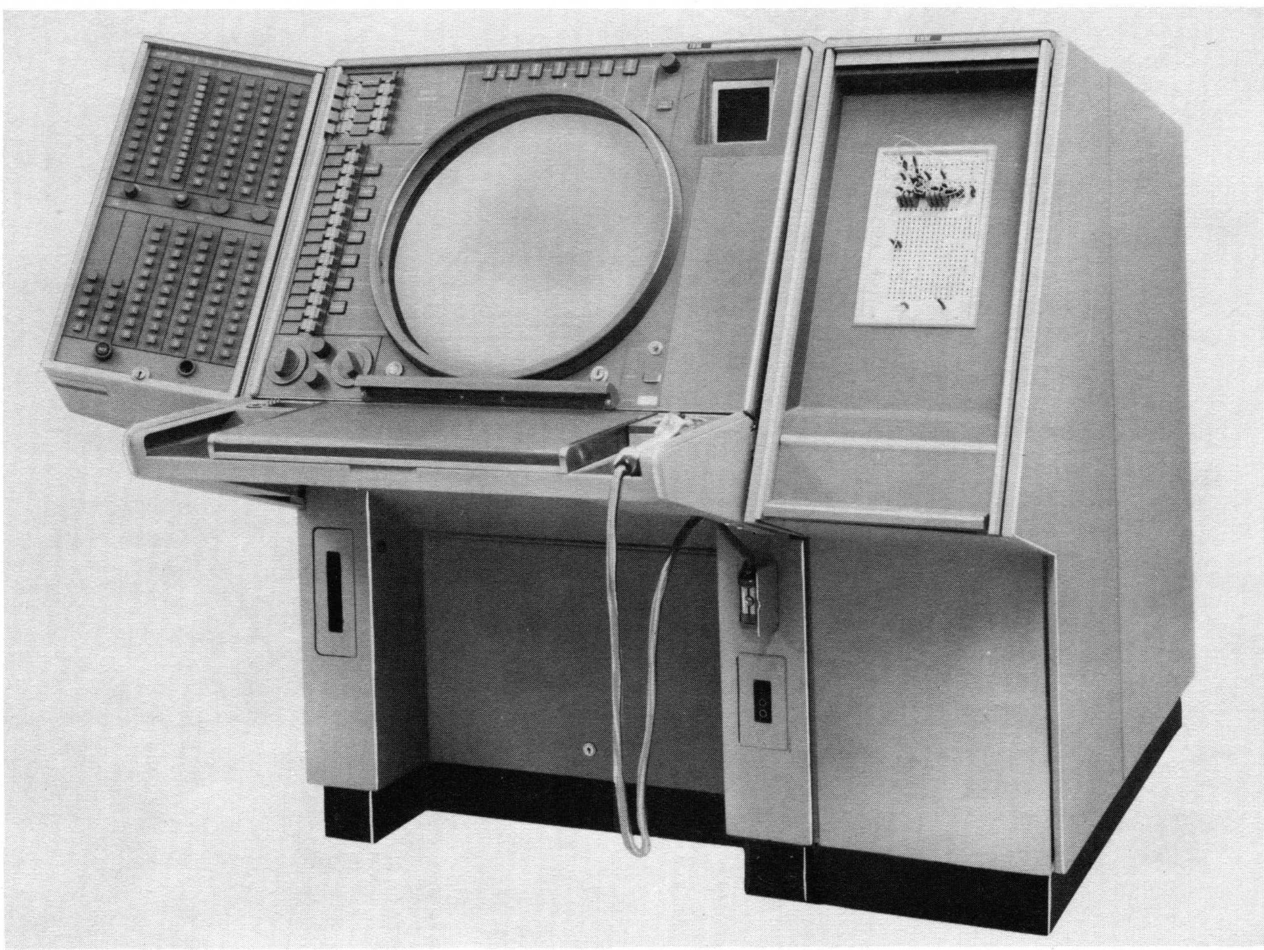
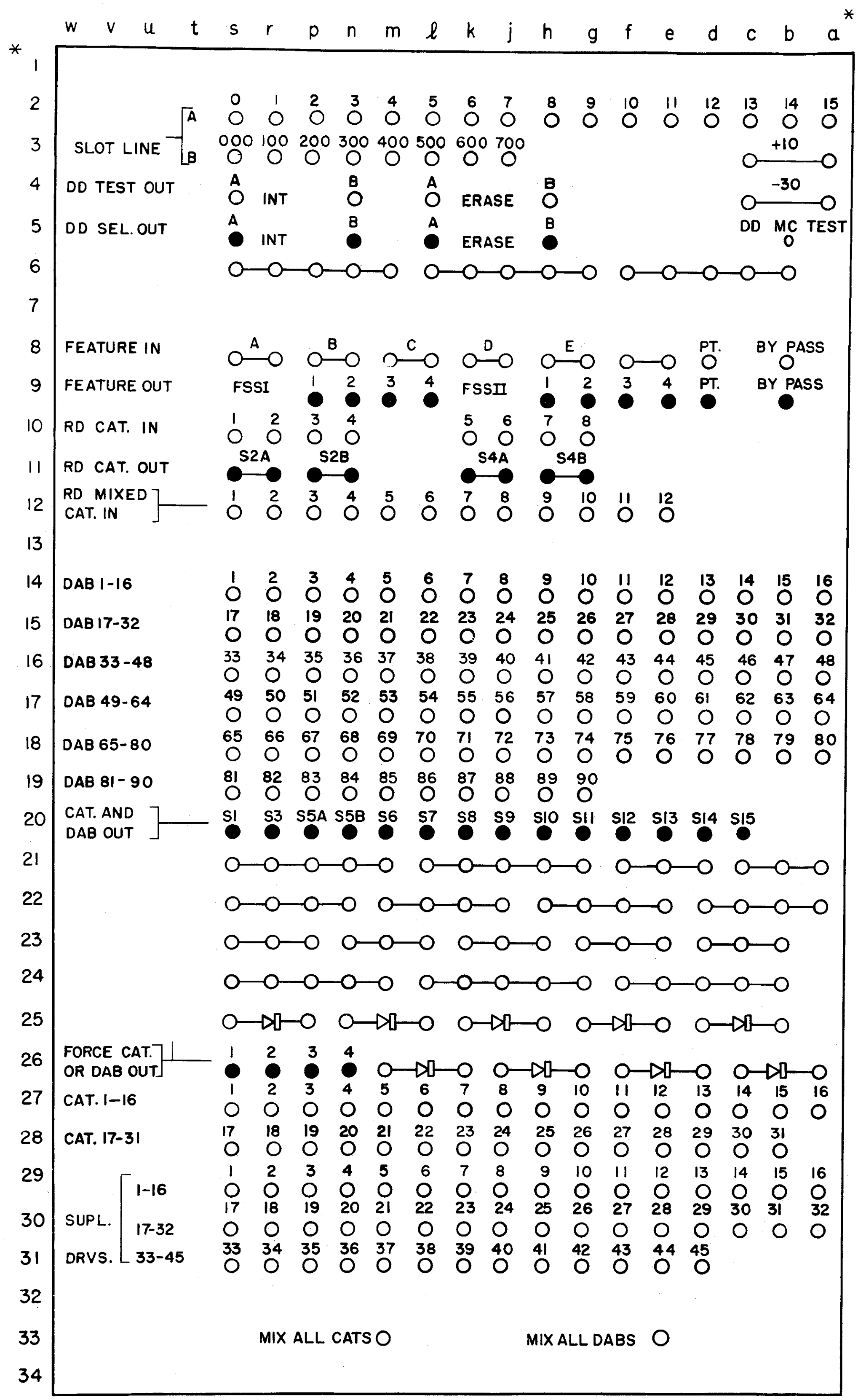


Figure 5–60. Signal Data Patching Panel with SD Console



* THE LOCATION NUMBERS AND LETTERS ARE INCLUDED ONLY FOR IDENTIFICATION PURPOSES; THEY DO NOT APPEAR ON THE PLUGBOARD.

Figure 5—61. Signal Data Patching Panel Patchboard

nals selected by means of these patchboards are fed to the SD console category plugboard. The interior of the patching panel consists of seven component boards containing diodes and resistors.

Two groups of signals are applied to the patching panel by the associated DB box. One group enables the operator to select the presentation to be displayed on his console. These signals are first fed to the component boards. and the outputs are then applied to the patchboard. The other group of signals is routed through the patching panel directly to the console, bypassing the patchboard and component boards.

2.2.1 Patchboard

The patchboard (fig. 5–61) consists entirely of jacks (sometimes called hubs). Some of the jacks are connected to the SD console; the others are connected back to the signal distribution box. Those signals fed to the console are identified in figure 5–61 by solid circles. Each patching panel is provided with a number of patching cords, enabling the operator to select any message or combination of messages for presentation on the associated SD console.

The four jacks on the DD SEL OUT row (row 5) are used for selecting any one of the DD messages in the Display System. By selecting the intensity and erase slot line assignments for any particular DD message from rows 2 and 3, and patching them into the DD SEL OUT jacks, the desired message can be displayed on the DD CRT of the associated SD console. The DD MC TEST jack (available only on the plug-in patchboard) is used to facilitate running of the DD marginal check program.

The FEATURE OUT row (row 9) contains two groups of four jacks, labeled FSS I and FSS II. Signals patched to these jacks from the FEATURE IN row are fed to the corresponding feature switches of the SD console. At the end of row 9 are two single jacks, labeled PT and BY PASS. These jacks are also connected to the SD console, but they bypass the feature selection switches.

The 15 SD console category switches are connected to the jacks of the RD CAT OUT and CAT AND DAB OUT rows (rows 11 and 20, respectively). By patching a category, DAB, or supplementary driver (rows 10, 12, 14 through 19, and 27 through 33) to these jacks, the corresponding category switch on the SD console

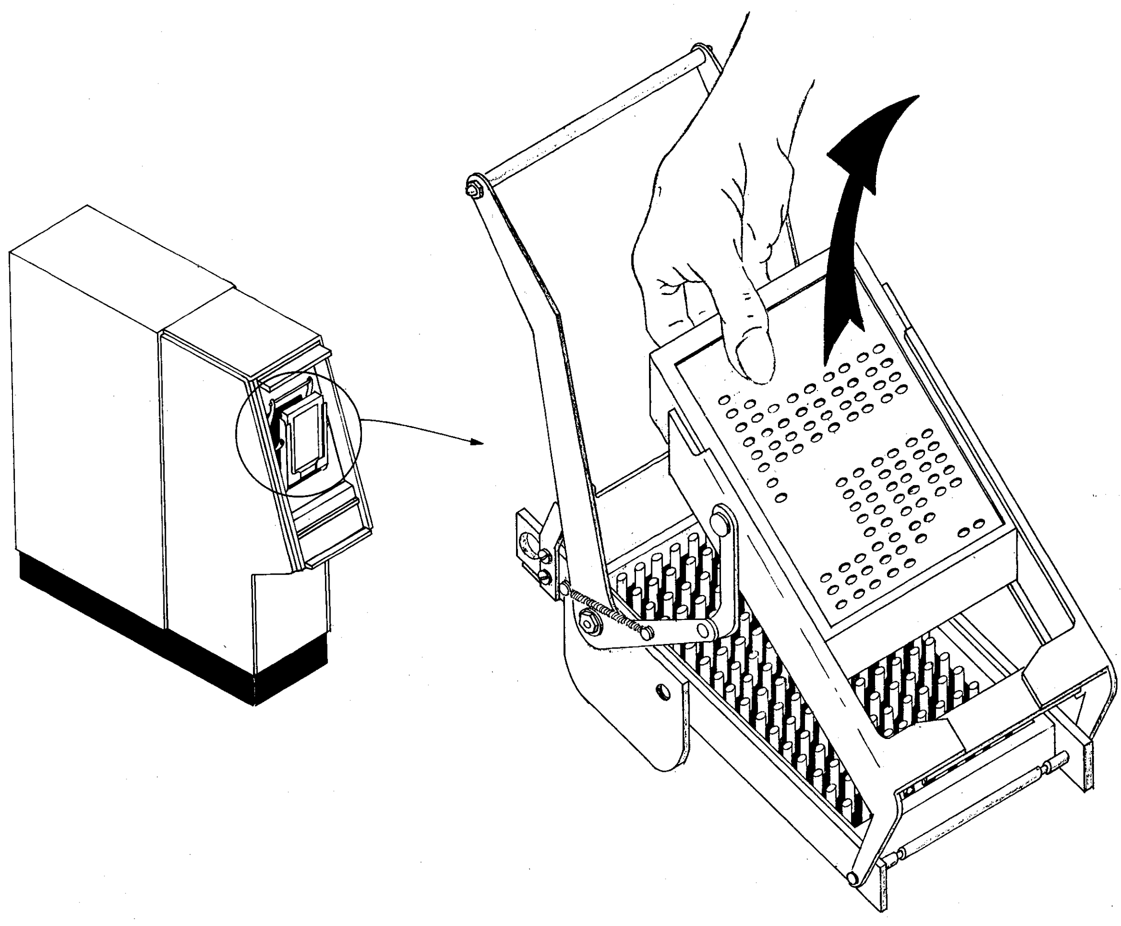


Figure 5–62. Signal Data Patching Panel with Plug-In Patchboard

can select the desired message to be displayed on the SD CRT.

The remaining jacks connected to the SD console are located in the FORCE CAT OR DAB OUT row (row 26). These jacks bypass the SD console category switches and are used to produce a forced display on the SD CRT.

The rows of unlabeled jacks are not connected to any particular point; these jacks are employed as convenience jacks during patching operations. The lines drawn between adjacent jacks denote that jacks are connected. Several of these jacks have diodes connected between them, and they also are used during patching procedures.

2.2.2 Component Boards

Each signal data patching panel contains seven component boards (see fig. 5–63).

Five of these boards contain 50 diodes each, and the other two contain 25 diodes each and associated resistor networks.

The group of 250 diodes, some of which are spares, are used as series diodes for each of the lines connected to the plug-in patchboard from the signal distribution box. They include categories, DAB's, supplementary drivers, features, and slot lines. These diodes serve to isolate the signal source (SDGE) from the patchboard.

Certain operating procedures require that a number of categories, supplementary drivers, and DAB's be mixed so that one category switch on the SD console can control a number of different types of messages. When this occurs, the series diodes discussed above will be paralleled, reducing the back resistance presented by the diodes to the point where isolation will not be effective. This effect is produced when four or more lines are mixed together; to overcome it, an additional diode is placed in series with the paralleled lines. Nine diodes are available for this purpose, and jacks connected to those diodes are provided at the plug-in patchboard.

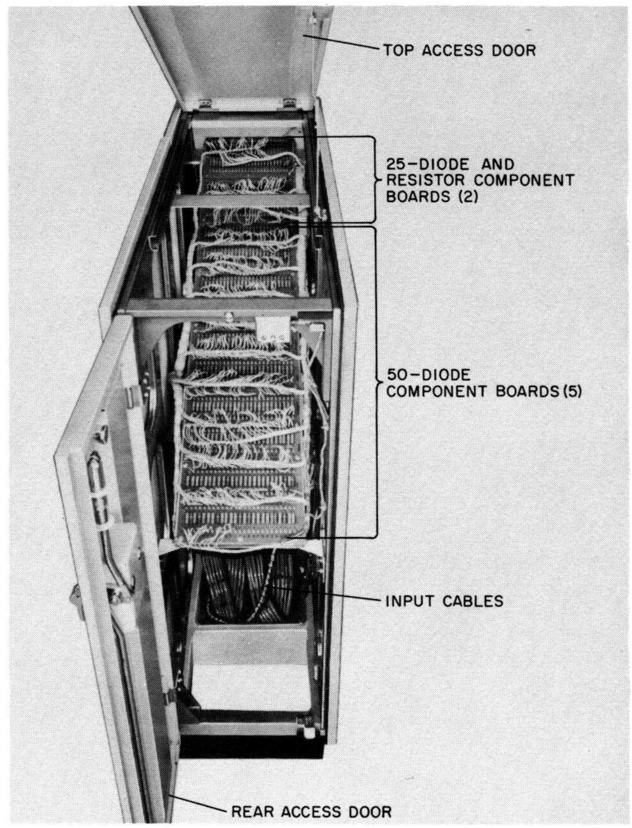


Figure 5–63. Signal Data Patching Panel, Rear View, Access Doors Open

The two remaining component boards (resistor and diode) are associated with the outputs of the patching panel. Each output jack is connected to a unique diode-resistor configuration that is employed as a decay time compensation network. The compensation network is made necessary by the increase in the decay time of the output signal, caused by shunt capacitance introduced by the patch cards employed.

CHAPTER 8
SUPPORTING COMPONENTS

SECTION 1
UNIT STATUS SWITCH

1.1 FUNCTION

Most of the SD and auxiliary consoles in the Display System are simplex equipment. Each of these consoles is capable of receiving signals from either the active or standby computer (A or B) and power from either of the two simplex power systems (C or D). The UNIT STATUS switch mounted on the front panel of the console (see fig. 4—14) enables the operator to select the signal source and power for the unit. (The status of the two signal sources and the two simplex power sources is controlled by the duplex switching console.) Signal and power selection is not necessary for the duplex consoles (units 45, 167, 168, 171, and 175) because these consoles function in the same manner as other duplex equipment. In addition, the UNIT STATUS switch of both simplex and duplex consoles enables the operator to disconnect the signal source to the console and select only ac or ac and dc power from the standby power system for maintenance purposes.

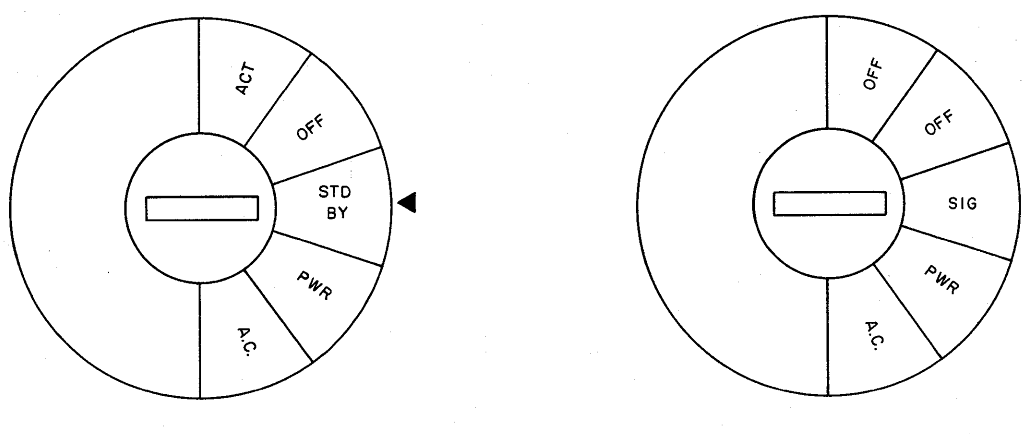
1.2 DESCRIPTION

The UNIT STATUS switch is a 5-position rotary switch made up of six ganged sections. The switches employed in the simplex and the duplex consoles are the same; however, the switch positions are labeled differently. For the simplex console, the switch positions are ACT-OFF-STD BY-PWR-AC; for the duplex console, OFF-OFF-SIG-PWR-AC. Both types of labeling are illustrated in figure 5—64.

The UNIT STATUS switch controls the operation of two sets of relays, power selection and signal selection, located in the console. The signal selection relays are located in the lower front section of the console near the input Nike connectors. The power selection relays are located in the lower rear section of the console near the high voltage power supplies (see fig. 4—16). Setting the switch to any of its different positions activates combinations of the relays, which perform in the function to which the switch is set. The switch and its relationship to the power and signal relays are shown in figure 5—65. Differences between the simplex and duplex consoles are noted in the illustration.

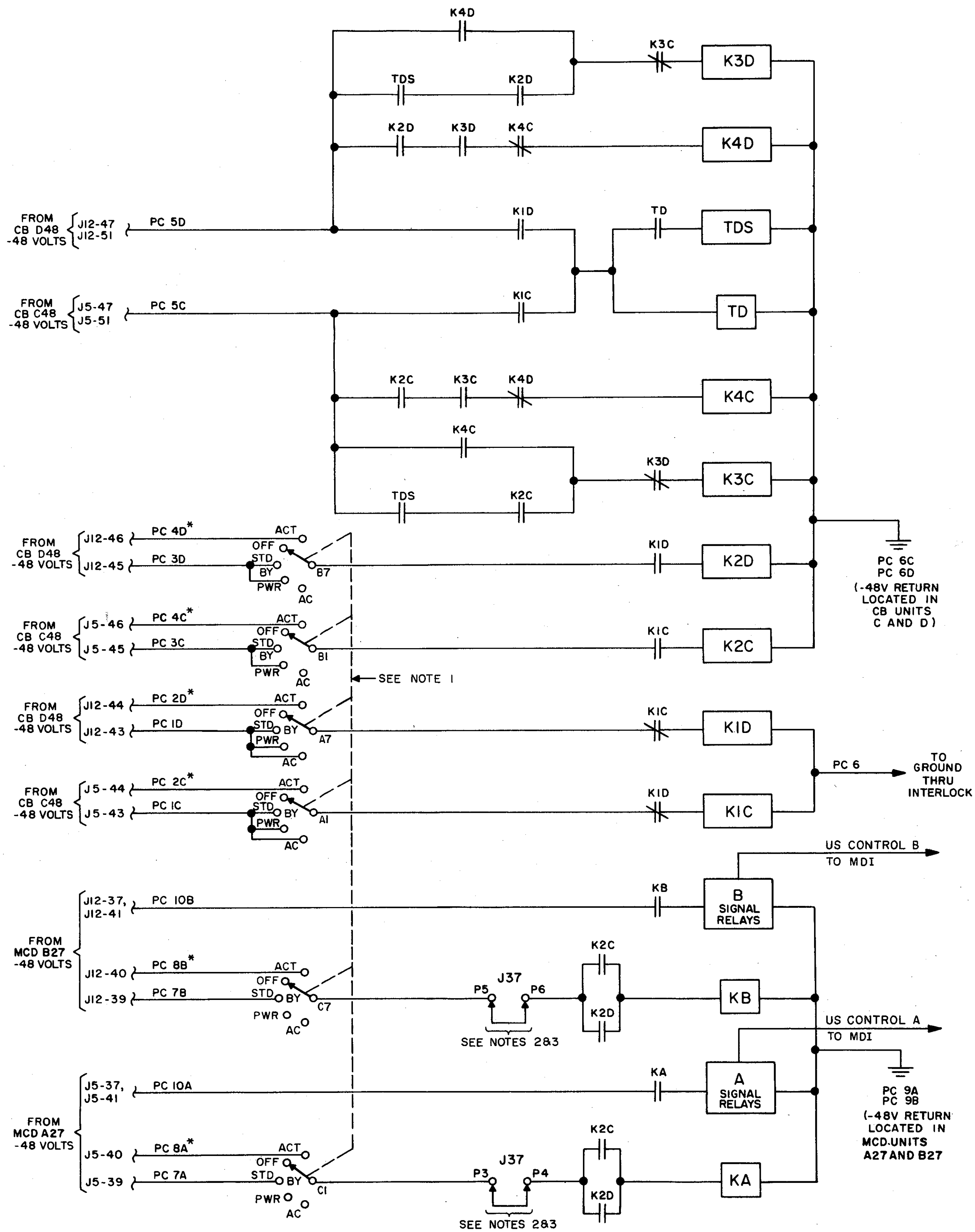
1.3 OVERALL OPERATION

All of the relays shown in figure 5—65 operate from a —48-volt supply. Four different power sources of —48 volts are brought into the console: two from marginal checking and distribution (MCD) units A27 and B27, and two from the Display System circuit breaker (CB) units C48 and D48. The MCD and CB units are duplex equipment, and therefore one of each will always



A. SIMPLEX CONSOLE   B. DUPLEX CONSOLE

Figure 5—64. Unit Status Switches



* THESE INPUTS ARE NOT PRESENT FOR DUPLEX CONSOLES.

NOTE 1. SEE FIGURE 5-64 FOR DUPLEX CONSOLE SWITCH POSITION ASSIGNMENTS.
2. THESE JUMPERS ARE REMOVED FOR AREA DISCRIMINATOR CONSOLES.
3. THROUGH WIRING, IN PLACE OF JUMPERS, USED FOR AUX CONSOLES.

Figure 5–65. Unit Status Switch, Schematic

TABLE 5–15. FUNCTION OF UNIT STATUS SWITCH POSITIONS, SIMPLEX AND DUPLEX CONSOLES

SIMPLEX CONSOLE		DUPLEX CONSOLE	
SWITCH POSITION	FUNCTION	SWITCH POSITION	FUNCTION
ACT	A-c and d-c power supplied by the active simplex power system. Signals come from the active half of duplex equipment.	OFF	All power and signals are disconnected from the console.
OFF	All power and signals are disconnected from the console.	OFF	All power and signals are disconnected from the console.
STD BY	A-c and d-c power supplied by the standby simplex power system. Signals come from the standby half of the duplex equipment.	SIG	A-c and d-c power supplied by either the active or standby simplex power system; signals come from either the active or standby half of the duplex computer. Status of duplex equipment determines signal and power source.
PWR	A-c and d-c power supplied by the standby simplex power system. No signals are connected to the console.	PWR	Same as that of the simplex console.
AC	A-c power comes from the standby simplex power system. No d-c or signals are connected to the console.	AC	Same as that of the simplex.

be in the active condition and one in the standby condition. Any of four different combinations of active units is thus possible, since one of each power source must be active in order to secure console operation.

A summary of the functions performed by the five positions of the UNIT STATUS switch for the simplex console is provided in table 5–15. The normal operational position of the switch is the ACT position. Signals from the active computer will always be seen on the SD and DD CRT's. Should the duplex switching operation be performed at unit 45, the operator need not turn the UNIT STATUS switch. Relays in the console will automatically shift over to the new computer (standby equipment is now active). Thus, regardless of which computer is in use, the ACT position of the switch always secures operation of the console from the active computer.

When it is necessary to observe a test pattern on the associated console for maintenance purposes, the switch is set to the STD BY position. This enables the operator to obtain the pattern that is produced by the maintenance program being run on the standby computer. When it is necessary to disconnect the signals fed to the console for maintenance purposes, the switch is set to either the PWR or AC positions. In the PWR position, a-c and d-c power is applied to all console circuits; in the AC position, only a-c power is applied to the console circuits.

The functional differences between the simplex and duplex console UNIT STATUS switches are best illustrated in table 5–15. Since the duplex consoles receive inputs from either the active or standby equipment (a function of console status), only one signal switch position is required. The switch position selected for this function is the center position and is labeled SIG. Since there are no inputs fed to the first switch position ACT for the simplex consoles; (see fig. 5–65), this position is labeled OFF. The functions of the other three switch positions for the two groups of consoles are the same.

1.4 DETAILED OPERATION

The following paragraphs provide a detailed discussion of the UNIT STATUS switch. This discussion is applicable for both simplex and duplex consoles; however, it is important to bear in mind the differences discussed earlier and the differences noted in figure 5–65.

1.4.1 Signal Switching Control

The UNIT STATUS switch at each console selects the active or standby computer as the source and recipient of the console signals by operating the signal switching relays. With the switch set to ACT, the console is associated with the active computer. When the switch is set to STD BY, the signal flow is between the standby computer and the console. No signals are transferred when the switch is set to OFF, PWR, or AC.

1.4.2 Signal Switching Relays

Each of the consoles has its own group of signal switching relays controlled by the UNIT STATUS switch. The relays, labeled A and B (see fig. 5—65), select the input signals from either computer A or computer B. Some of the signals are switched by relays located in the console, and the remaining signals are switched by relays located in the warning light storage units.

The sections of the UNIT STATUS switch that control the selection of the signal relays are C1 and C7. Table 5—16 indicates the voltages available at these switch sections to energize the signal relays, with either computer A or computer B active. When the switch is set at ACT, if computer A is active and either relay K2C or K2D is energized, KA and A signal relays are actuated. If computer B is active and either K2C or K2D is energized, then KB and B signal relays are operated. In this manner, with the unit status at ACT, the signal inputs enter the console from the active machine through the closed contacts of the corresponding signal relays.

With the switch set to STD BY, if machine A is active and K2C or K2D is energized, KB and B signal relays are energized. If machine B is active with K2C or K2D energized, KA and A signal relays are actuated. Thus for standby operation, the signals are sent between the standby computer and the console.

No other position of the UNIT STATUS switch permits any of the signal relays to be energized; therefore, with the switch in these positions (OFF, PWR, and AC), no signals are sent to, or received from, either computer A or computer B.

1.4.3 Power Switching Control

The UNIT STATUS switch at each console selects the source and type of power applied to the unit. When the switch is set to ACT, a-c and d-c power is obtained from the active power system. With the switch at STD BY or PWR, a-c and d-c power is received from the standby power system. With the switch set to OFF, no power is received by the console.

TABLE 5—16. A AND B VOLTAGE INPUTS TO UNIT STATUS SWITCH

PC INPUTS	JACK NUMBERS	VOLTAGE INPUT WITH A ACTIVE	VOLTAGE INPUT WITH B ACTIVE
PC 10B	J-12-37, J12-41	0	—48
PC 8B	J12-4	0	—48
PC 7B	J12-39	—48	0
PC 10A	J5-37, J5-41	—48	0
PC 8A	J5-40	—48	0
PC 7A	J5-39	0	—48

TABLE 5—17. C AND D VOLTAGE INPUTS TO UNIT STATUS SWITCH

PC INPUTS	JACK NUMBERS	VOLTAGE INPUT WITH C ACTIVE	VOLTAGE INPUT WITH D ACTIVE
PC 5D	J12-47, J12-5	—48	—48
PC 5C	J5-47, J5-51	—48	—48
PC 4D	J12-46	0	—48
PC 3D	J12-45	—48	0
PC 4C	J5-46	—48	0
PC 3C	J5-45	0	—48
PC 2D	J12-44	0	—48
PC 1D	J12-43	—48	0
PC 2C	J5-44	—48	0
PC 1C	J4-43	0	—48

1.4.4 Power Switching Relays

Each of the consoles is equipped with a set of power selection relays controlled by the UNIT STATUS switch. The relays, labeled C and D (see fig. 5—45), switch power from simplex power system C or D to the console. The C relays are associated with simplex power system C; D relays, with system D. The sections of the switch that control the selection of power relays are A1, A7, B1, and B7.

Table 5—17 lists the PC (power control) inputs, jack numbers, and the levels of input voltages when either C or D power system is active. For example, the voltage level of PC 4D on J12-46 is 0 volt when simplex power system C is active, but is —48 volts when D is active.

Table 5—18 indicates which of the power relays are energized for each of the five positions of the UNIT STATUS switch with C or D power system active. For example, with the switch at ACT and the D system active, relays K1D, K2D, K3D, K4D, TD, and TDS are energized while all other power relays are de-energized.

Since many relays are involved for each position of the switch, only one position will be explained in detail as an example of power relay operation. The other positions control the power relays in a similar manner. The energized relays can be determined from table 5—18.

TABLE 5–18. POWER RELAY OPERATION

UNIT STATUS SWITCH POSITION	ACTIVE SYSTEM	K1C	K1D	K2C	K2D	K3C	K3D	K4C	K4D	TD	TDS
ACT	C	E	D	E	D	E	D	E	D	E	E
	D	D	E	D	E	D	E	D	E	E	E
OFF	C	D	D	D	D	D	D	D	D	D	D
	D	D	D	D	D	D	D	D	D	D	D
STD BY and PWR	C	D	E	D	E	D	E	D	E	E	E
	D	E	D	E	D	E	D	E	D	E	E
AC	C	D	E	D	D	D	D	D	D	E	E
	D	E	D	D	D	D	D	D	D	E	E

E = Energized
D = De-energized

In this example, the switch is set to ACT, the D power system is active, and the C system is standby. Then, with the switch still set to ACT, the C power system is made active and the D supply becomes standby.

With the D power system active and the switch set to ACT, all the D relays are energized in the following manner (see fig. 5–65):

a. Inputs PC 5D, PC 5C, PC 4D, PC 3C, PC 2D, and PC 1C are —48-volts. The rest of the inputs are 0 volts (table 5—17).

b. Relay K1D is energized by PC 2D through normally closed contacts of K1C.

c. Relay K2D is energized by PC 4D through the closed contacts of K1D.

d. The —48-volt level of PC 5D is fed to the time delay relay (TD) through the contacts of K1D, and after one minute the TD contacts close. This action ensures that the a-c voltage is applied to the console before the d-c voltage when the UNIT STATUS switch is turned from the OFF position.

e. The time delay switching (TDS) relay is energized by PC 5D through the closed contacts of K1D and TD. The TDS contacts are used to supplement the TD relay because the TD relay has insufficient contacts.

f. Relay K3 is energized by PC 5D through the closed contacts of TDS, K2D, and the normally closed contacts of K3C.

g. Relay K4D is energized by PC 5D through the closed contacts of K2D, K3D, and the normally closed contacts of K4C.

h. The closed contacts of K4D allow PC 5D to keep K3D energized through the closed contacts of K4D and the normally closed contacts of K3C.

If the active power system is now changed from D to C and the UNIT STATUS switch remains at ACT, the power must be supplied from the C power system instead of the D power system. The change is effected by the relays in the following manner:

a. Inputs PC 5D, PC 5C, PC 3D, PC 4C, PC 1D, and PC 2D are —48 volts. The rest of the inputs are 0 volts (table 5—17).

b. Relays K1D and K2D are de-energized because they have 0-volt inputs.

c. Relay K4D is de-energized because the K2D contacts open.

d. Relay K3D is de-energized because the K4D contacts open.

e. When K1D is de-energized, K1C is energized by PC 2C through the normally closed contacts of K1D.

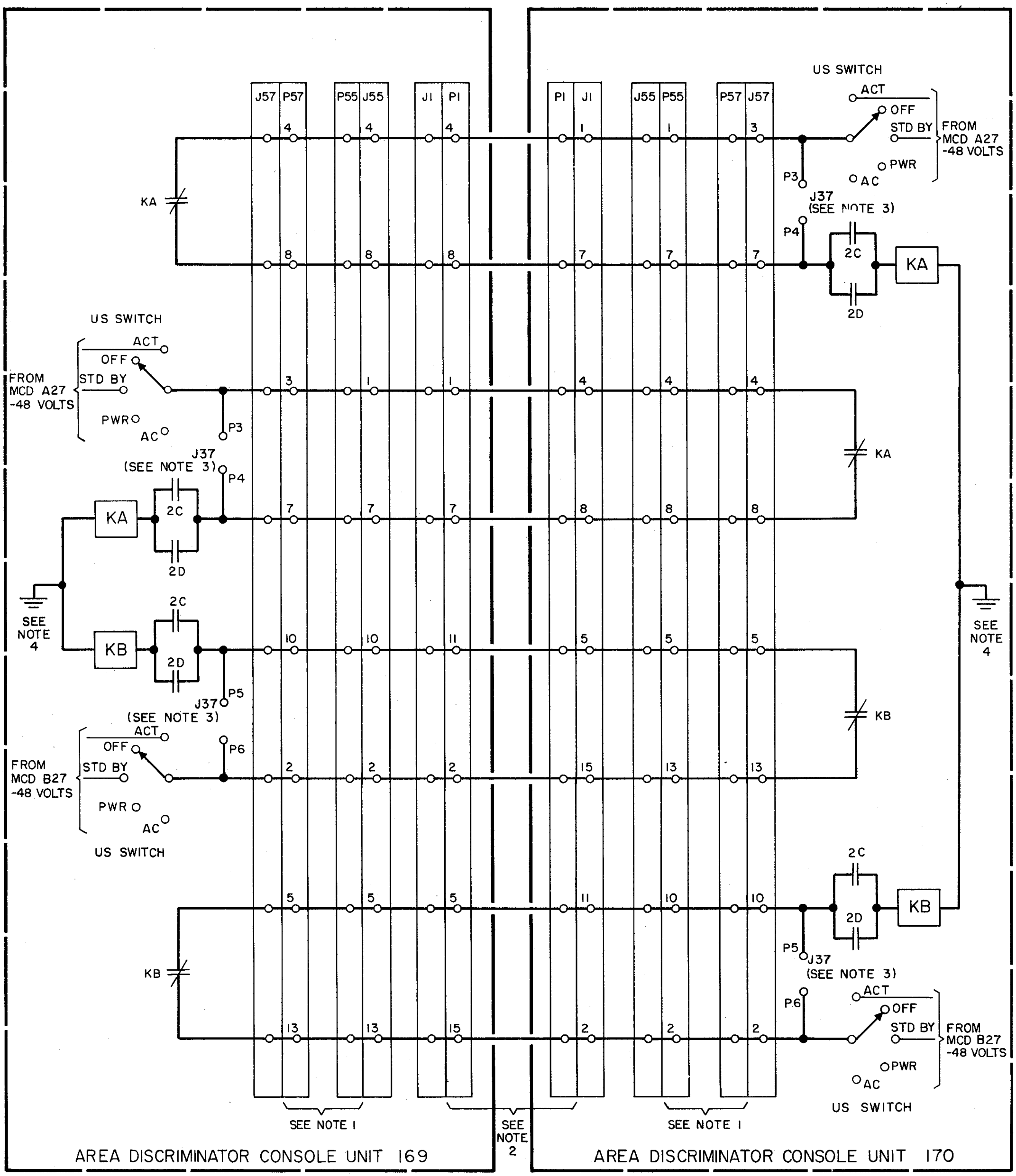
f. Relay K2C is energized by PC 4C through the closed contacts of K1C.

g. Relay TD is energized by PC 5C through closed contacts of K1C.

h. The contacts of TDS are closed by PC 5C through the closed contacts of TD.

i. Relay K3C is energized through the closed contacts of TDS, K2C, and the normally closed contacts of K3D by PC 5C.

j. Relay K4C is energized by PC 5C through the closed contacts of K2C, K3C, and the normally closed K4D contacts.



NOTES: 1. SPECIAL INTRA CONSOLE PATCH CABLE P55 TO P57.
2. SPECIAL INTER CONSOLE PATCH CABLE P1 TO P1.
3. REMOVE JUMPERS ON TEST POINT PANEL J37.
4. GROUNDED IN MCD 27 UNIT.

Figure 5–66. Area Discriminator Interlock Wiring

k. When K4C is energized, it allows PC 5C to keep K3C energized through the closed contacts of K3D.

With the relays energized in the above manner, all C relay contacts are closed, thus feeding power from the C power system, which is now the active power system.

The above example shows how the UNIT STATUS switch and the active simplex power system energize the relays. It also illustrates the operation of the relays when the active power system is changed. A similar type of relay operation will take place for the other positions of the switch.

1.5 AREA DISCRIMINATOR CONSOLES

Special provisions are made in the unit status switch circuits for the two consoles that are equipped with area discriminators (units 169 and 170). The jumpers shown in series with the A and B signal relays in figure 5–65 are removed from test point panel J37 in both area discriminator consoles. In addition, special cables are provided which use connectors that are normally used for manual inputs. (Manual inputs are not assigned to either of the area discriminators.) The circuit differences that result from this are shown in figure 5–66.

Connector J1 is normally used as the input connector to the SD console from the manual input element. For these two consoles, J1, P1, J55, and P55 are used to feed —48 volts between the two consoles in an interlock arrangement. A special cable is provided to connect P57 to P55 and another for connecting the P1 plugs of two consoles together. The interlock thus formed prevents both consoles from being in the active or standby status at the same time.

By removing the jumpers between P3–P4 and P5–P6 of test point panel J37 from the two consoles, the —48-volt path for the A signal relays goes through the special cables to a normally closed contact of relay KA of the other console. The same arrangement exists for the B signal relays. Therefore, if console 169, for example, were in the ACT position of the UNIT STATUS switch, console 170 would not produce a display unless its own UNIT STATUS switch were turned to the STD BY position.

SECTION 2
AUDIBLE ALARMS AND WARNING LIGHTS

2.1 SCOPE

An audible alarm is installed in each Command Post console desk section, and one desk section has a warning light module. The audible alarm and the warning light are both alerting devices, employed to attract the attention of assigned operating personnel. The audible alarm is a general warning device and conveys no specific information. It merely signals the operator that his attention is required. The operator must then refer to his front panel or display tube to determine the reason for the alarm. The warning light module, on the other hand, is a specific warning device. The module contains ten neon indicators, each of which is labeled and conveys a special message when energized.

The audible alarms and warning lights are physically a part of the Display System; however, they are logically a system within the Central Computer. A description of the Warning Light System is given in detail in manual 3-32-0, *Theory of Operation of Central Computer System for AN/FSQ-7 Combat Direction Central and AN/FSQ-8 Combat Control Central.* The explanation given here will be confined to that portion of the system which can be physically considered in active display.

2.2 WARNING LIGHT AND AUDIBLE ALARM DEVICES

The Warning Light System alerts the operating personnel at Display System consoles that either attention or an action on their part is required. Two types of warning devices are provided for display consoles: audible alarm units and warning light modules. Figure 5–67 illustrates both types. These devices are controlled by the Central Computer, and they produce both a visual and an aural alarm in one or more of these indicating methods: a pulsating filament lamp, a continuous glow of a neon lamp, and an audible alarm (an intermittently operating bell). The bell functions at the same repetitive frequency as the filament lamp; a bimetallic strip operating as a flasher is common to both alerting devices. The continuously illuminated neon lamp will continue to glow until the Central Computer acknowledges the resulting action (an appropriate manual input message) taken by the operator in response to the warning light indication. The operator knows the manual input message has been transferred when the neon lamp is extinguished.

Both the audible alarm and the intermittently (pulsating) lighted lamp can be inactivated by depressing the RESET pushbutton on the display console. Whether one or both alarms are in service is dependent upon the setting of a switch in each console. This switch, which de-energizes the bell only, is located in the back of the module. In the audible alarm unit the switch is on the subpanel.

2.2.1 Audible Alarms

There are two types of audible alarms. One is a normal alarm that is used at each desk section, and the other is a special alarm used if an extra audible alarm is required at a desk section. Both types operate in the same prescribed manner. Their only differences are physical. "Audible alarm" is the common term employed to mean the combination of bell, filament and neon lamp (one each), reset button, and associated circuits.

2.2.1.1 Normal Audible Alarm

When an audible alarm is received at a console, a bell is sounded intermittently, and two lamps on the audible alarm unit are lighted. One light is the continuous neon glow, the other is the flashing incandescent light. The flashing mechanism provided for the filament lamp is connected to the bell as an interrupting d-c device to enable the bell to be sounded.

Physically, the normal audible alarm lamps and RESET pushbutton are adjacent to the 5-inch DD CRT in an auxiliary console (fig. 5–67). The bell is located behind, and attached to, the manual input card rack, and the ALARM BELL switch (bell disabling switch) is located on a subpanel. The audible alarm unit is a pluggable unit that contains the circuit components associated with the audible alarm.

2.2.1.2 Special Audible Alarm

As previously mentioned, the special audible alarm functions exactly as the normal audible alarm. It, too, is used to call the console operator's attention to a situation that may require his action.

Physically, the special alarm is a package unit that conforms to the dimensions of a standard panel module so it can be mounted on the front panel of a Command Post console desk section. The bell, two lamps, bell disabling switch, and associated circuits are in a single assembly that is accessible when the front panel is raised.

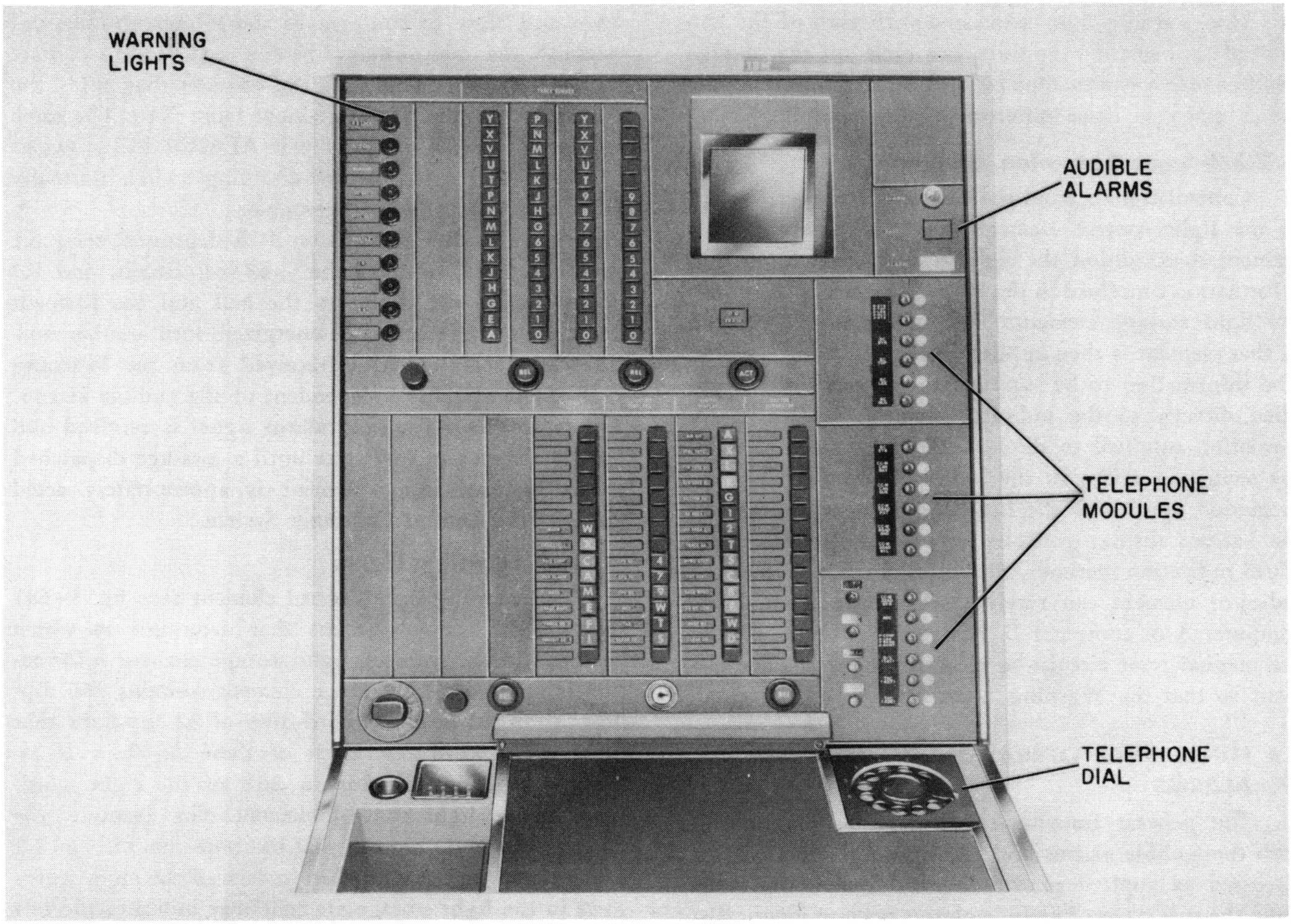


Figure 5—67. Audible Alarm Units and Warning Light Modules in Auxiliary Console

2.2.2 Warning Light Module

Unlike the audible alarm unit, the warning light module is a specific warning device. It makes use of 10 neon lamps separately labeled. When lighted, a neon lamp will be indicative of a specific message. Each neon lamp is individually controlled by the Warning Light System and cannot be extinguished by the operator. Normally, only one Command Post console desk section is equipped with a warning light module. Wiring provisions have been made so that any desk section can have a module added to it. Also, if one desk section has need for a second warning light module, special lines can be added from the Warning Light System for its operation. The 10 neon lamps are so wired from the Warning Light System that a lamp will be lighted at a signal from either computer. Figure 5—67 illustrates the Warning Light module.

2.3 WARNING LIGHT SYSTEM, GENERAL THEORY

To aid understanding of the warning alarm treatment restricted to the Display System, a brief description and explanation of the rest of the Warning Light System follows.

2.3.1 Functional Description

The Warning Light System consists of the warning light control element, the warning light storage element, and the warning light interconnection and indicator element. The warning light control element and the warning light storage element are duplex. The warning light interconnection and indicator element is simplex, but provision is made so that warning lights and audible alarms at each console can indicate information from either of the computers.

A maximum of 256 bits of information, applied from the Central Computer through the IO register, can be indicated simultaneously by the Warning Light System. Application of the proper pulses to the Warning Light System causes these bits of information to appear at the various consoles in any of the forms previously described; i.e., a continuous neon glow, an intermittently lighted lamp, or a bell alarm. The 10-bit neon warning light module has individually prescribed labels that can indicate any required tactical or functional information. The warning light indications are informative only when associated with a label.

One warning light associated with each of the 256 bits of information appears on each of the duplex maintenance consoles. One bit of information can appear on as many as three different display consoles.

2.3.2 Logic Operation, General

Control signals from the Central Computer applied to the light control element (fig. 5–68) enable that element to condition the light storage element so that information contained in the IO register can be read into the light storage element. The information contained in that element is then applied to the indicator element. The information to be supplied to simplex units is applied directly to the indicator element, while the information supplied to duplex units is applied through the switching relays to the indicator element. The information applied to the indicator element appears on the various display consoles in any one of the three alarm indication methods. Provision is made so that the indicator element can receive information from either computer A or computer B. A signal can be applied by the manual reset circuits to clear the light storage element so that the Warning Light System can be tested.

2.4 FUNCTIONAL OPERATION OF WARNING ALARMS

The general functional and logical operation of both the audible alarms and the warning lights will be discussed as applied to the Display System only. Because the two types of audible alarms operate identically, only the operation of the normal alarm will be explained.

2.4.1 Audible Alarms

The schematic for the normal alarm is shown in figure 5–69. A normal alarm-relay signal is supplied by a thyratron in the Warning Light System. This signal energizes relay K1 through the normally closed contacts of RESET pushbutton S1.

When relay K1 is energized, it connects the bi-metal flasher K3 and relay K2 through the K2 element which periodically opens a set of contacts and interrupts current flow through relay K2. The contacts of relay K2 open and close to conform to these interruptions and establish the intermittent opening and closing contact rate of relay K3. These are the contacts that apply the pulsating 28 volts to the filament lamp X10. The same voltage is applied to bell I28 if ALARM BELL switch S30 is closed. S30 is a bell-disabling switch normally for use by maintenance personnel.

When RESET pushbutton S1 is depressed, relay K1 is de-energized, opening the —48-volt circuit, and K2 opens the 28-volt circuit to the bell and the filament lamp. Relay K1 remains de-energized until another normal-alarm relay signal is received from the Warning Light System and is independent of the audible alarms. The lamp glows when an alarm signal is received and usually remains in that state until a message dispatched to the manual input element is appropriately acted upon by the Central Computer System.

2.4.2 Warning Lights

The warning light control element (see fig. 5–68) contains the control circuits that determine to which flip-flops in the warning light storage element information is applied. This storage element contains 256 flip-flops arranged in eight word-rows of 32 flip-flops that make up a word-row. Each of these flip-flops is associated with one flip-flop in each of the eight word-rows in the light control element. For example, the flip-flop in the IO register that indicates the left sign bit is associated with the flip-flop in each of the eight word-rows in the light storage element that indicates the left sign bit. Thus the output of one flip-flop in the IO register is applied to eight flip-flops in the light storage element.

The information to be read into the light storage element is applied by the Central Computer to the IO register. The process used to read the information into the light storage element employs both complementing and clearing.

Before information can be read into the Warning Light System, a preparatory cycle is required to condition the system to receive the information. Only one preparatory cycle is required, regardless of the number of words that are to be read into the system at one time.

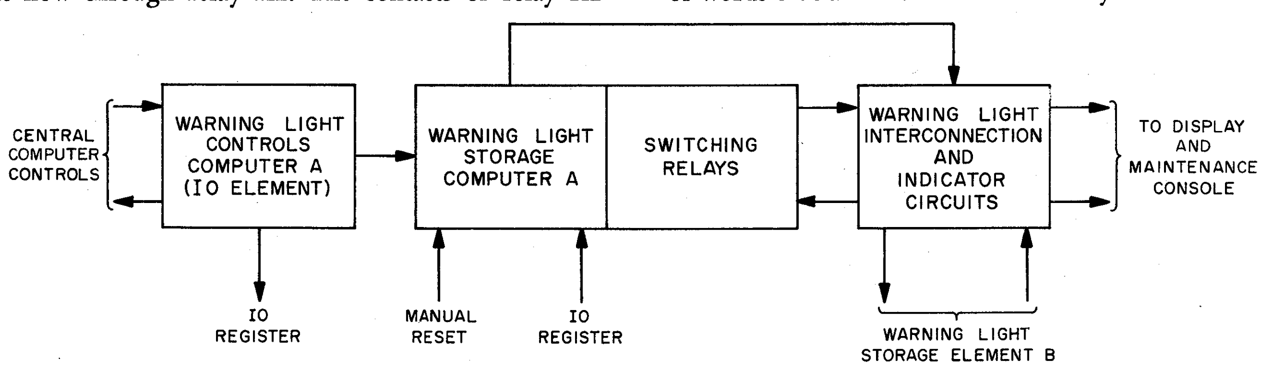


Figure 5–68. Warning Light System, General Logic

2.4.3 Signal Flow

The signal from the audible alarms and the warning light modules comes from either warning light storage unit 30A or warning light storage unit 30B. Whether the signals come from A or B depends upon the signal switching relays located in these two warning light storage units. These switching relays are energized by the unit status control signals sent by the desk sections UNIT STATUS switch.

Figure 5–70, foldout, shows the signal flow between the warning light storage units and one Command Post console desk section. This figure shows the 20 lines for the warning light module, three lines for the normal audible alarm, and two lines for unit status control signals. The broken lines show the two extra unit status control lines and the 20 extra warning light lines that must be added if a second warning light module is used at the desk section.

The lines connecting the duplex warning light storage units to the various warning devices at the console desk section pass through simplex interconnection unit 91 and through signal distribution box 5. Patching at these two places determines the number and nature of the warning signals sent to each desk section. The cable connections between the units are fixed; therefore, a patch-cord method is necessary for cable interconnections.

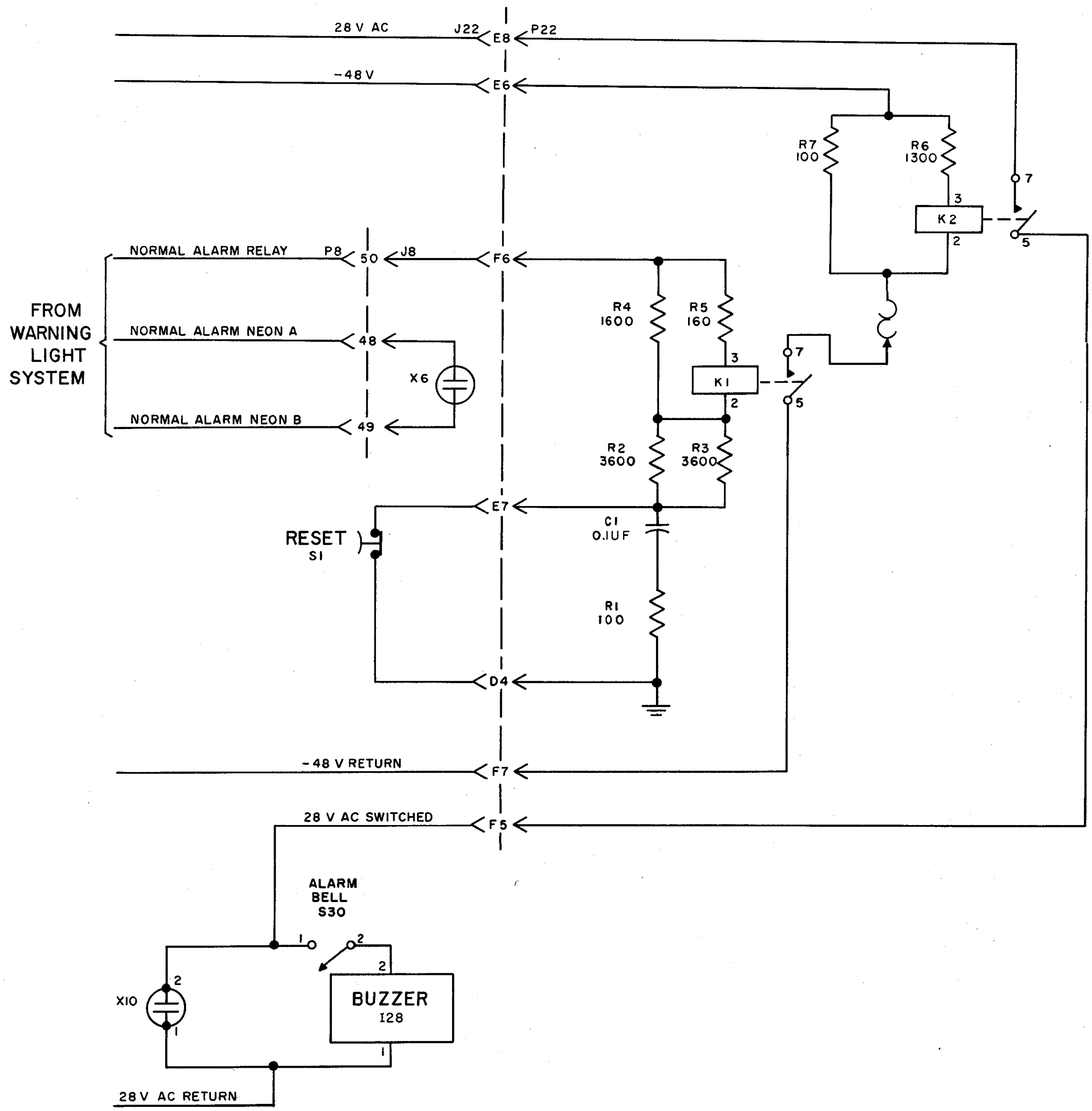
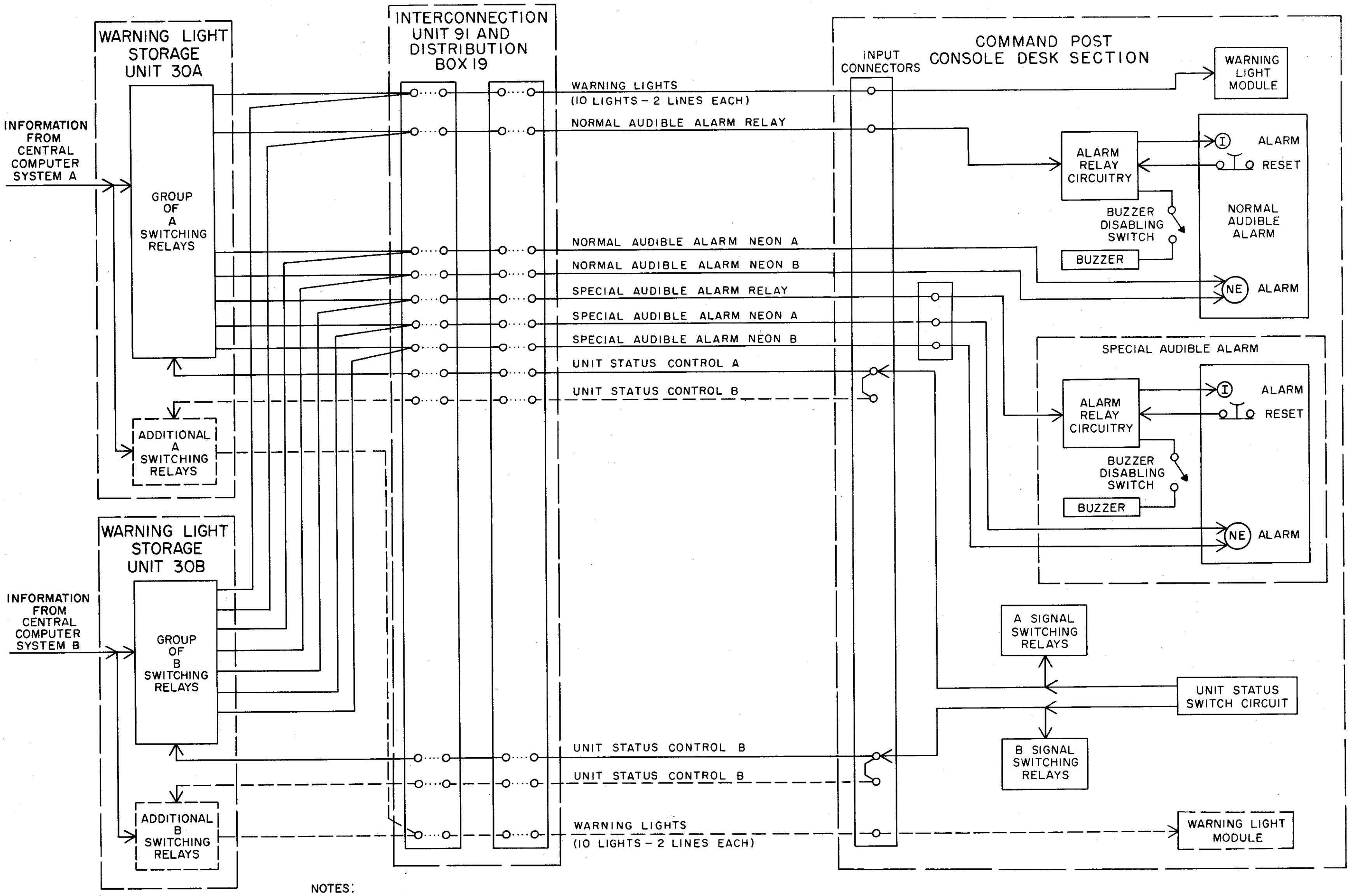


Figure 5–69. Normal Audible Alarm Unit, Schematic



NOTES:

1. ···· INDICATES PATCHING OF LINES AT WARNING LIGHT INTERCONNECTION UNIT AND DISPLAY SYSTEM SIGNAL DISTRIBUTION BOX.
2. — — — INDICATES CIRCUITING INVOLVED FOR ADDITIONAL WARNING LIGHT MODULE, IF REQUIRED.

Figure 5–70. Flow Diagram of Warning Light Storage Units and One Command Post Console Desk Section

SECTION 3
VOICE-COMMUNICATION EQUIPMENT

3.1 GENERAL

The communication equipment provides the necessary voice communication for Air Force and IBM personnel with Control Centers to other personnel inside or outside the sites. Telephone and radio equipment is provided at many SD and auxiliary consoles as a part of the tactical telephone system.

The weapons director consoles have the capacity for direct communication with interceptor planes. The auxiliary consoles can have both telephone and full radio equipment. In addition to the tactical telephone facilities, provisions are made for intercommunication within the system for maintenance purposes. The Display System is also within the coverage of a general public address system.

The voice-communication equipments are not included in the block diagram of the Command Post console (fig. 5–57) because they are a separate system, completely independent of the Central Computer. For that reason, and for established procedural policies, the operational description of the various equipments will be limited to non-maintenance scope, and then only to those portions physically in the Display System.

Other associated parts are discussed only to introduce the overall equipment for a better understanding of the limited operational description.

3.2 COMMUNICATION EQUIPMENTS IN DISPLAY SYSTEM

Internal and external communications for transmission of intelligence are largely provided for by the commercial telephone companies through the media of wire/voice circuits. External communications are grouped into four classes: data, voice, Teletype, and voice/keying. The internal types provide communication between personnel in a Center and between personnel in adjacent Centers or allied installations. This section will concern itself solely with the voice medium for both internal and external communications.

A tactical telephone system is provided within each Direction Center and Control Center. This telephone system is independent of the administrative telephone system of the base at which a Direction or Control Center is located. It is used within the operating area of a Center to augment the various automatic communication facilities, such as displays and digital links, by providing a link for messages not suited to automatic transmission.

A maintenance intercom system is provided for machine maintenance personnel. It is used at each operating console and at each bay of electronic equipment. Plug-in portable handsets and headsets enable maintenance personnel to talk to their supervisors and to each other.

3.2.1 Internal Communications

A telephone switching module is installed in the lower section of the front panel of each Command Post console (fig. 5–56, foldout). This module contains 18 pushbuttons, with associated indicator lights and labels, and four auxiliary pushbuttons which provide features such as hold, transfer, conference, etc. If additional facilities are required, a blank module can be removed and replaced with a special telephone to provide six additional pushbuttons (see fig. 5–53). The direct intercommunication facilities provided by these modules supplement the automatic telephone dialing system available at each desk position.

Maintenance and tactical jacks are widely separated, physically. Maintenance jacks are mounted on the inside of the right leg of each desk. The tactical jacks are located on the front of each desk leg (fig. 1–16).

A dial (fig. 5–67) intercom system is provided between certain key personnel and their subordinates, with callback and conference-call features. Besides the hold, transfer, and conference connection controls, a selection ringing key is included in the communication panel on the display consoles.

3.2.2 External Communications

The air-to-ground (A/G) and ground-to-air (G/A) voice communications are required in the SAGE System for the control of non-data-link-equipped interceptors and for A/G communications of data-link-equipped interceptors. In addition, voice communications are used with data-link interceptors for certain G/A communications not provided for in the automatic data-link system.

The ground-to-ground (G/G) is an automatic data circuit that is used for general-purpose transmission of information from a Direction Center. It is used for crosstelling between Direction Centers and forwardtelling to Control Centers.

The radio circuits for G/A voice will terminate at certain console positions, and a telephone set common to both telephone and radio circuits, with a push-to-talk and lockout feature, will be employed.

CHAPTER 9
DISPLAY TESTER ELEMENT

SECTION 1
INTRODUCTION

1.1 FUNCTION

The display tester element (DTE) is built-in test equipment used to facilitate the localization of faults in the SDGE, DDGE, and display consoles. The DTE simulates drum display signals that enable the Display System to operate independently of the Drum System.

1.2 DESCRIPTION

The DTE consists of a bit storage control (toggle switch) panel, a portion of the duplex maintenance console indicator panel, and logic circuits.

The toggle switch panel (see fig. 5–71) is located in module B of the duplex maintenance console. It contains eight rows (horizontal) of 32 2-position switches. Each row represents a word, and the 32 bits of each word are controlled by the toggle switches. A toggle switch in its normal position (handle perpendicular to the panel) represents a 0 bit. The toggle switch in the down position (handle pointing downward) represents a 1 bit. Any TD, RD, or DD message capable of being stored in the drums can be simulated by setting the toggle switches to the required bit positions. The DTE is limited in duplicating DD messages in that only 8-word DD messages can be simulated.

Control switches which select the mode of operation and start and stop the DTE are located immediately below the toggle switches.

The indicators, a part of the DTE, are located in the left center portion of the indicator panel in module C of the duplex maintenance console (fig. 5–72). These neon indicators are connected to flip-flops in the DTE.

The logic circuits that make up the DTE are located in pluggable units in unit 25.

1.3 CAPABILITIES

Only one TD message (eight words) can be set up on the DTE bit storage control panel. The message can be displayed at any SD console by setting up the proper CAT and/or DAB bits on the panel. This message is displayed continuously in TD operation and is repeated once every 1,040 μsec.

In RD operation, eight separate messages (one word comprises an RD message) can be set up on the DTE bit storage control panel. Unlike the contents of a test RD message, the category of the test RD message is not specifically defined by the bits of the message. In normal operation, a radar-bright or radar-dim signal accompanies the message from the drum. This signal establishes the category of the message. With DTE operation, manual means are provided for selecting a test-radar-bright or test-radar-dim signal. Test RD operations are only applicable for the AN/FSQ-7; the AN/FSQ-8 does not display RD messages.

In DD operation, the display of the message is controlled to present one cycle of displays in either the DD 1 or DD 2 group of consoles, or the display may be continuously presented in either the DD 1 or DD 2 groups until the DTE is turned off. The DD message is limited to eight words, which is sufficient to check DDGE operation.

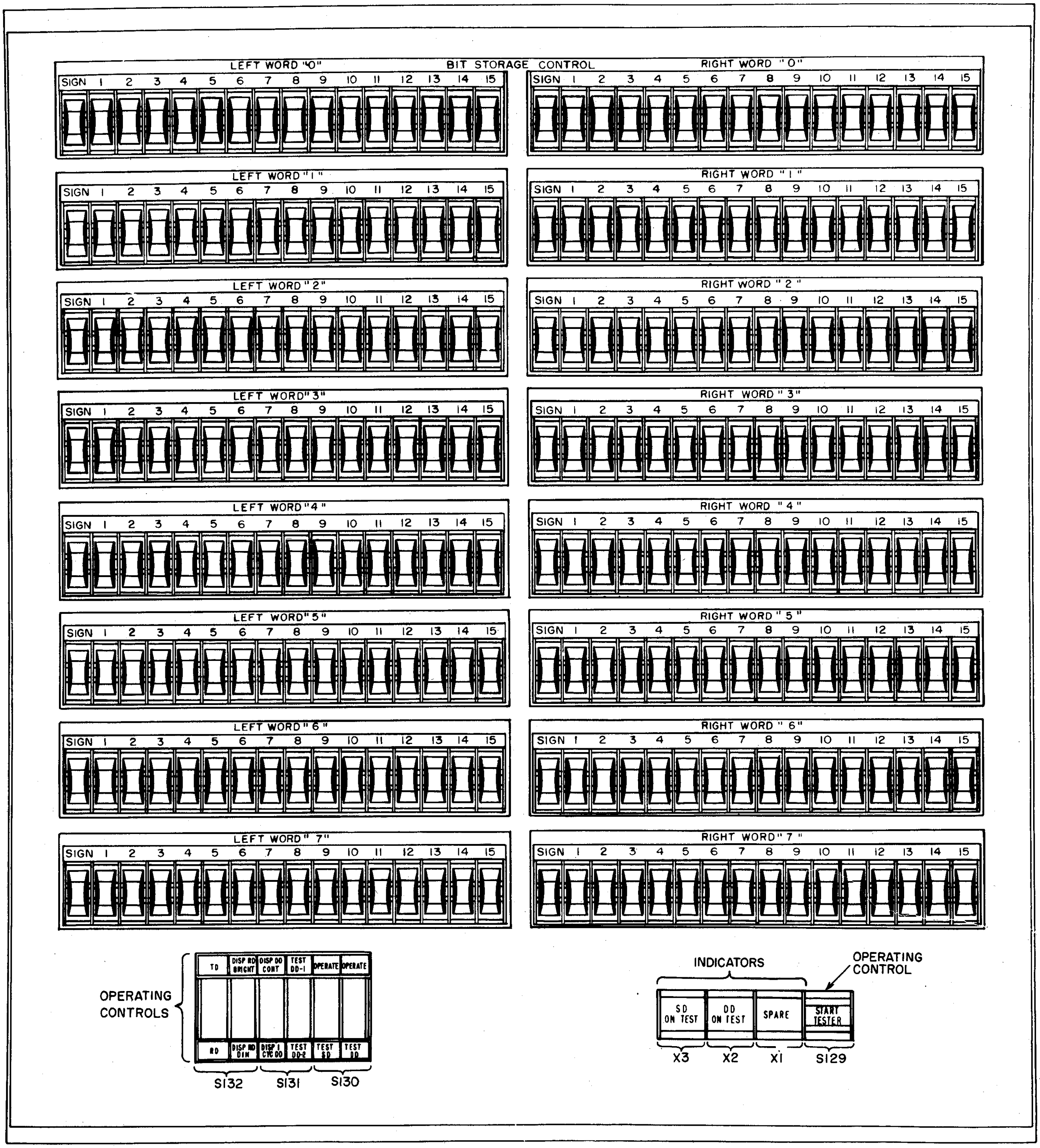


Figure 5–71. Display Tester Element, Controls and Indicators, Part of Duplex Maintenance Console

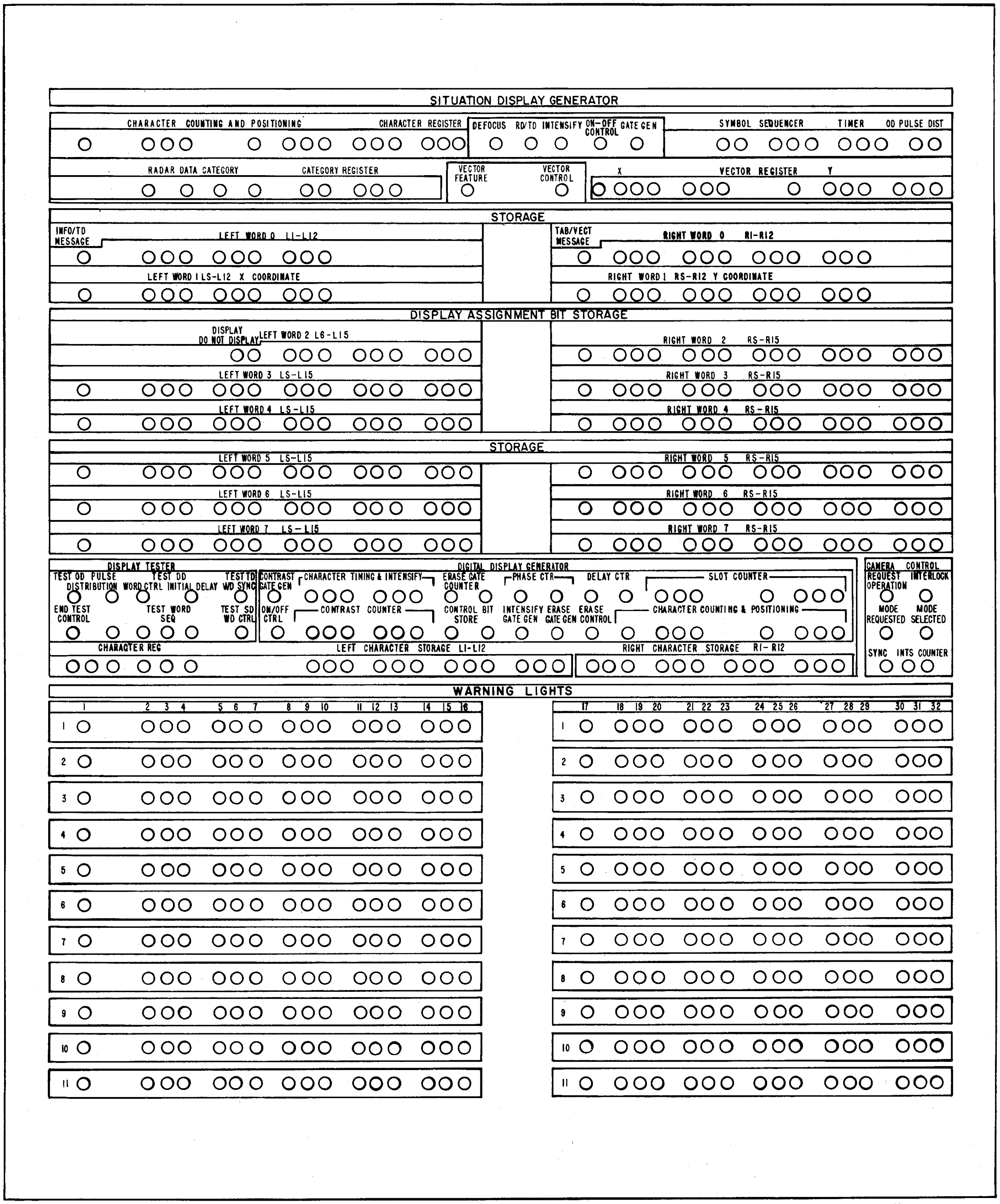


Figure 5–72. Indicator Panel with DTE Neons, Part of Duplex Maintenance Console

SECTION 2
FUNCTIONAL OPERATION OF DISPLAY TESTER ELEMENT

2.1 GENERAL

The DTE supplies the SDGE and DDGE with all the timing, control, and information signals necessary for the generation of a test message. The tester comprises four major circuits: operating controls, test control, word sequencer, and word outputs. A block diagram illustrating the relationship of these circuits is presented in figure 5—73.

The operating controls (located on the duplex maintenance console) set up the test message, set the mode of operation, and start and stop DTE operation. Interaction of relays energized by these controls prevents the generation of TD, RD, and DD messages at the same time. The test control section of the DTE provides both the situation and digital display generator elements with the necessary timing and control signals. The function of the word sequencer is to control the reading of word 0 through word 7 of the test message from the tester to the generator elements in a sequential manner. The eight words of the test display message that are set into the DTE are stored in the word outputs section. Transfers of these stored words are effected by instructions received from the word sequencer.

2.2 SDGE TESTING

When the DTE is set for SD operation, a start-test signal is sent through the test control section to the SD input switch (SDGE) as a test-start-TD or test-start-RD and test-word-on-way (WOW) signals. Simultaneously, the start-test signal is applied to the word sequencer section of the DTE, setting the word sequencer counter to 0. The test control section generates a series of pulses spaced at 2.5 μsec. These pulses are sent to the SD input switch on the test-all-OD line as a series of test-OD 1, OD 2, OD 3, and OD 4 pulses. The SDGE utilizes these signals to go through one initial SD cycle during which there is no display or transfer of information from the DTE to the SDGE. This initial cycle is 1,327.5 μsec during TD operation and 57.5 μsec during RD operation.

2.2.1 TD Mode of Operation

At the end of the initial delay cycle of 1,327.5 μsec, the SDGE generates an end-cycle signal that is applied to the test control section. This pulse initiates the TD test cycle, and the test control circuit generates test WOW and test-read-SD-word signals. The test-read-SD-word signal is gated through the word sequencer to the word outputs section as a test-read-word-0 signal. The bits set in word 0 on the bit control storage panel condition the gates in the word outputs section associated with the bit switches. The test-read-word-0 transfers the stored bits to the SD input switch. At the same time, the word sequencer counter is advanced by a count of one to gate the next test-read-SD-word signal through as a test-read-word-1 signal. Successive test-read-SD-word signals, every 10 μsec, read out the eight words set up on the bit storage panel. The test-read-word-7 pulse is returned to the test control section and inhibits further test-WOW and test-read-SD-word signals. The SDGE acts on the transferred words to produce the required displays. At the completion of the TD display cycle, the SD input switch returns an end-cycle signal to the test control section, and the DTE repeats the TD cycle. Successive end-cycle signals occur every 1,040 μsecs.

2.2.2 RD Mode of Operation

At the completion of the initial cycle (57.5 μsec), an RD end-cycle pulse generated by the SDGE is applied to the test control section. This pulse initiates the RD test cycle, and a test-WOW and test-read-SD-word signal is generated by the test control section. The test-read-SD-word pulse is gated through the word sequencer to the word outputs section as a test-read-word-0 signal, effecting the transfer of the bits stored in the word outputs section (function of the switch set-up on the bit storage panel). At the same time, the word sequencer counter is advanced by a count of one. In addition to feeding the word sequencer, the test-read-SD-word is returned to the test control section. This feedback inhibits further test-WOW and test-read-SD-word signals until another RD end-cycle pulse is received from the SD input switch. At this time, another test-WOW and test-read-SD-word is generated, resulting in the transfer of word 1 from the word outputs section. The test control section is once again inhibited by the feedback of the test-read-SD-word until an RD end-cycle pulse is applied to the test control section. Successive RD end-cycle pulses occur every 60 μsec, resulting in the transfer of an RD message (an RD message is made up of only one word) every 60 μsec. The resultant RD test pattern will be displayed as either a bright or dim display. This selection is made manually at the DTE, effecting the transfer of a test-RD-bright or test-RD-dim signal to the SD input switch.

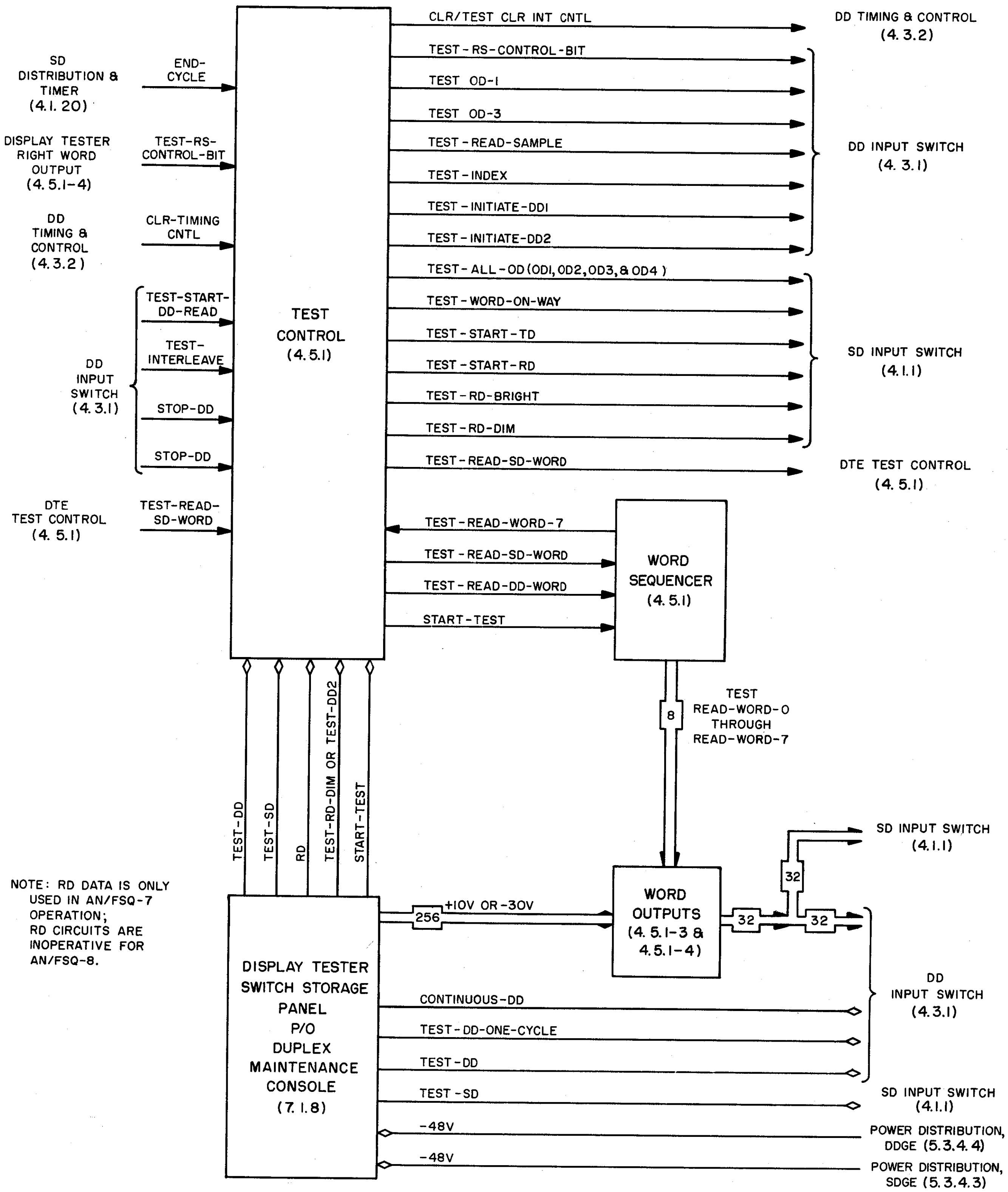


Figure 5—73. Display Tester Element, Logic Diagram

2.3 DDGE TESTING

When the DTE is set for DD operation and is turned on, the start-test pulse is generated and sent through the test control section of the DTE to the DDGE as a test-initiate-DD 1 or test-initiate-DD 2 pulse. As in SD operation, the start-test pulse sets the word sequencer counter to 0 and initiates the generation of a series of pulses spaced at 2.5 μsec. In addition, the start-test pulse sets a 2-stage DD delay counter in the test control section to 0. Alternate pulses occurring at 5-μsec intervals are selected as test-OD 1 and test-OD 3 pulses and sent out on two lines to the DD input switch. The test-OD 1 pulses are fed to the contrast gate counter in the DDGE; the 64th test-OD 1 pulse (contrast gate) is returned to the test control section of the DTE as a test-interleave pulse. These pulses occur every 640 μsec, and are used to step the 2-stage DD delay counter in the test control section. An output pulse every 2.56 ms (every fourth test-interleave pulse) is generated by this counter and fed to the word sequencer as a test-read-DD-word pulse. Successive test-read-DD-word signals step the word sequencer counter until the test-read-word-7 pulse is generated. This pulse is returned to the test control section and fed out as a test-index pulse to a delay counter in the DDGE. Successive test-index pulses (every 20.48 ms) are applied to the DD input switch. The 11th test index pulse is returned to the test control section as a test-start-DD-read pulse. In this manner, an initial erase period of 204.8 ms is provided before the transfer of the message set up on the DTE is effected. During this initial erase period, the RS control bit is inhibited to prevent stepping of the DDGE slot counter. In addition, the clear-timing-control and test-read-sample pulses are inhibited during the initial erase period.

The test-start-DD-read pulse (11th index pulse) inhibits the test-index pulses, effects the transfer of RS control bits, and conditions the gates controlling the test-clear-intensity-control pulses and test-read-sample pulses. The test-read-sample pulse prepares the DDGE

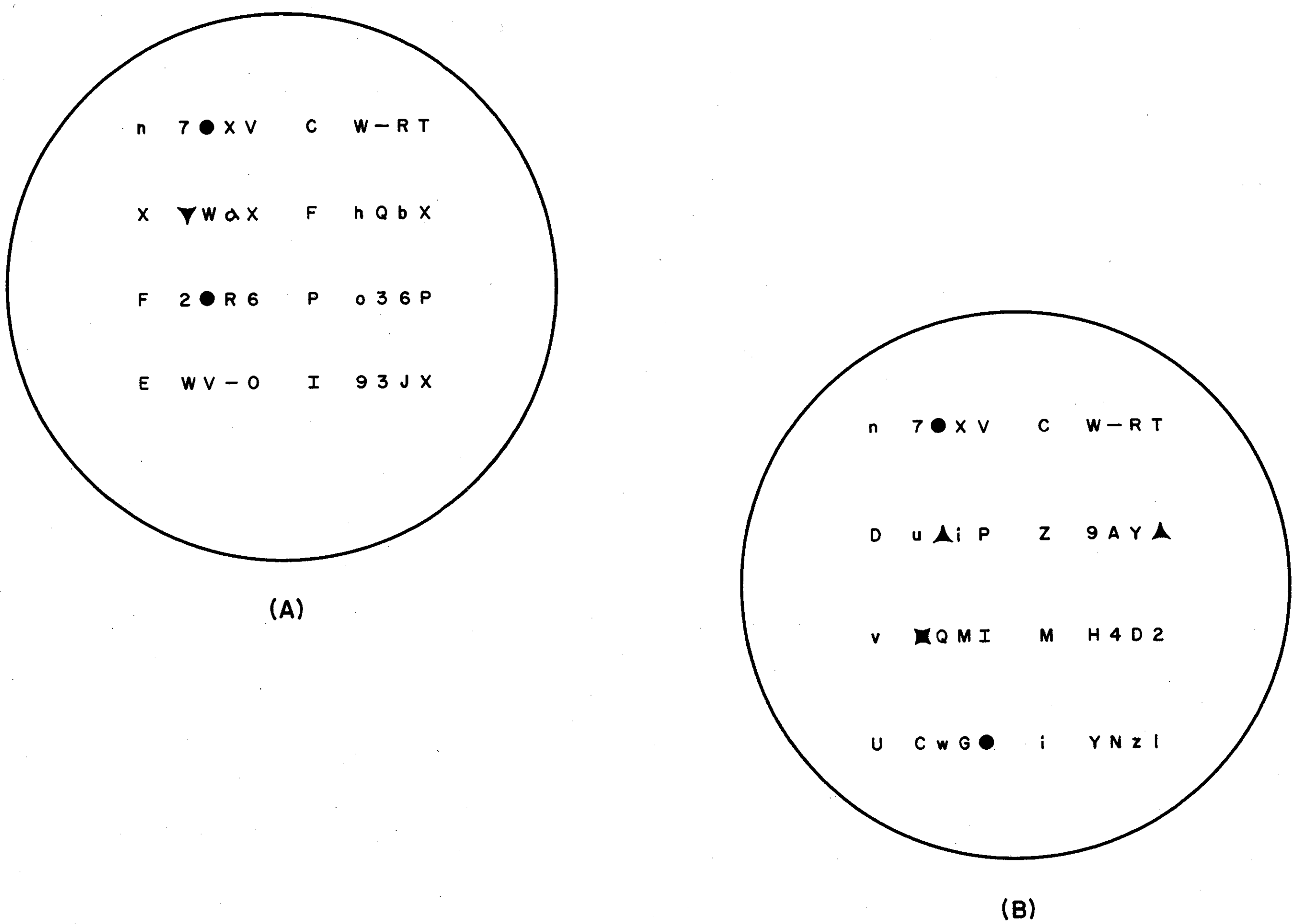


Figure 5–74. Typical DTE Digital Display Test Patterns

for the transfer of words stored in the bit storage panel of the DTE. Successive test-read-DD-word pulses (every 2.56 ms) transfer the eight words on the panel (word outputs section). The test-read-DD-word pulse also gates the test-clear-intensity-control pulse to the DD timing and control section of the DDGE, thus generating an intensification gate with each word transferred to the DDGE. A test-read-sample pulse is gated to the DDGE each time a test-interleave pulse (every 640 μsec) is applied to the test control section. This enables the DDGE to cycle through its normal operation; i.e., a word processed every 640 μsec. However, during DTE operation, a word is processed only every 2.56 ms (every fourth test-read-sample pulse). Figure 5–74 illustrates two possible patterns. Pattern A shows a word on every fifth line; pattern B illustrates the resultant message when a skip-line bit is inserted in the DD message toggle switch setup. During the time intervals that test-read-DD-word pulses are not generated, the intensification gate must be inhibited to blank the DDIS. If intensification were not inhibited during this period, the numeric character 6 would be displayed on lines 2, 3, 4, 6, 7, 8,..... of the test pattern. During this period, the x and y character selection register in the DDGE is cleared ($x = 0$ and $y = 0$), effecting the selection of the numeric character 6. For this reason, the intensification gate is only generated whenever a word is read out of the DTE.

At the conclusion of a DD cycle, a stop-DD pulse is applied to the test control section of the DTE. If the DTE is set for 1-cycle operation, this pulse will turn off the DTE. When in continuous operation, the stop-DD pulse is employed as a start-test, re-initiating the DD test cycle.

SECTION 3
LOGIC OPERATION OF DISPLAY TESTER ELEMENT

3.1 SCOPE

A detailed discussion of the four major circuits (operating controls, test control, word sequencer, and word outputs) that make up the DTE is presented in the following subparagraphs. The relationship of these circuits was shown in the block diagram of figure 5–73.

3.2 OPERATING CONTROLS

Seven controls (see fig. 5–71) located on the duplex maintenance console are used to select the mode of test operation required. Operating these controls actuates relays which in turn select the circuits required to perform the selected test operation. Figure 5–75 is

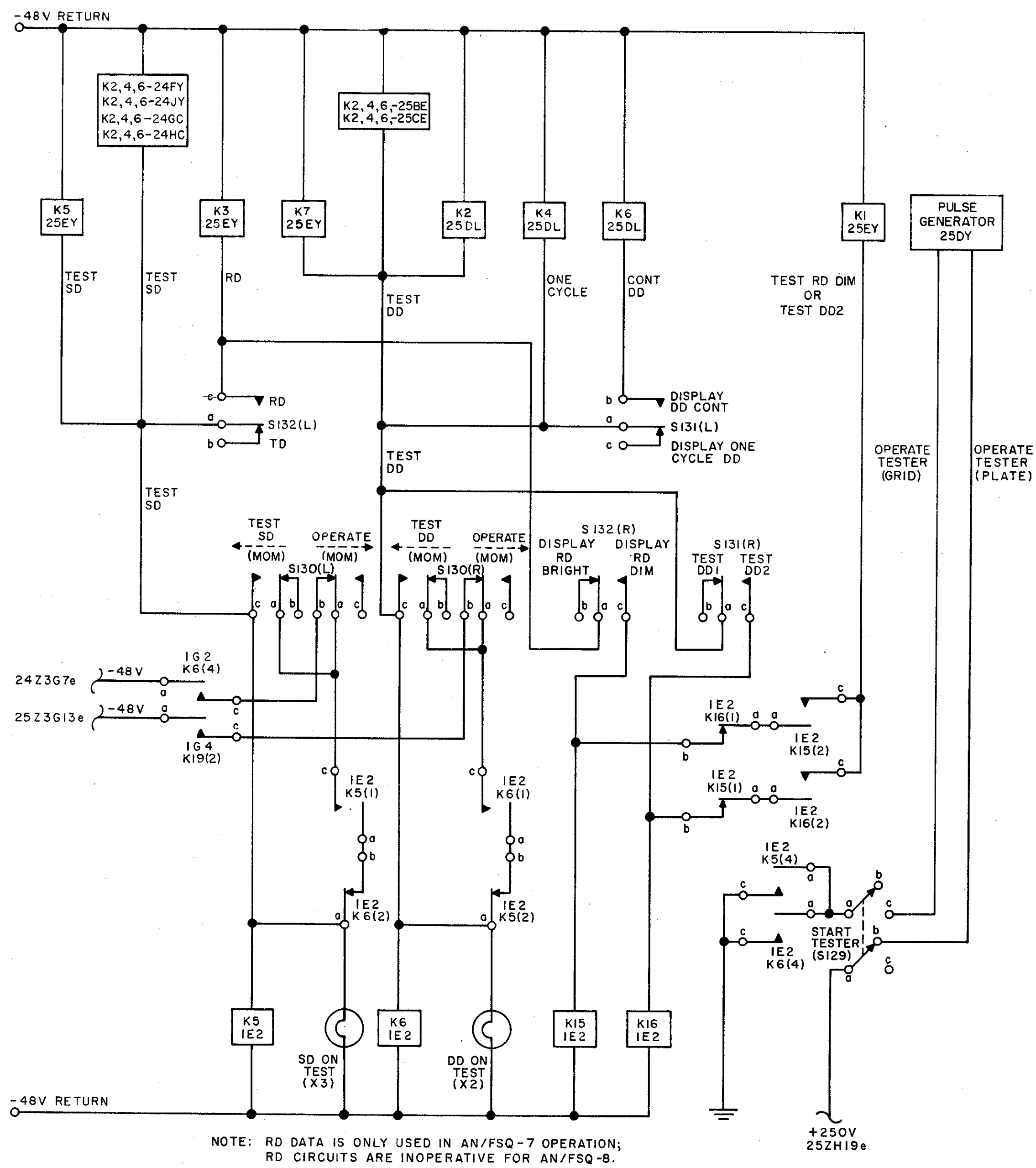


Figure 5–75. DTE Operating Controls and Associated Relays, Simplified Schematic Diagram

a simplified schematic diagram of the operating controls and the associated relays; table 5—19 lists these controls, reference symbols, switch positions, and functions.

The relays utilized in conjunction with DTE operation are divided into two categories: control relays and signal relays. The control relays, when energized, supply —48 volts to either the SD or DD test lines. These relays, their location, energizing controls, and their functions are listed in table 5—20. The signal relays, when energized, provide the necessary timing and control signals. Energizing these relays also connects the respective generator elements to the DTE in place of the Drum System. Table 5—21 lists these relays, location, energizing controls, and functions.

TABLE 5—19. DTE OPERATING CONTROLS AND FUNCTIONS

CONTROL	REFERENCE SYMBOL	POSITION	FUNCTION
TD – RD	S132 (L)	TD	Selects TD mode of operation.
		RD	Selects RD mode of operation.
DISP RD BRIGHT – DISP RD DIM	S132 (R)	DISP RD BRIGHT	Causes RD messages to be displayed bright.
		DISP RD DIM	Causes RD messages to be displayed dim.
DISP DD CONT – DISP 1 CYC DD	S131 (L)	DISP DD CONT	Causes DD test display messages to be displayed in DD 1 or DD 2 groups continuously until manually interrupted.
		DISP 1 CYC DD	Causes test display message to be displayed in either DD 1 or DD 2 group once. DTE is stopped automatically after message is displayed in last slot of either group.
TEST DD-1 – TEST DD-2	S131 (R)	TEST DD-1	Selects DDIS's in group DD 1 for display of test DD message.
		TEST DD-2	Selects DD 2 group of DDIS's for display of test DD message.
OPERATE – TEST SD	S130 (L)	TEST SD*	Energizes relays to ready DTE for SD operation. Also lights SD ON TEST indicator (X3).
		OPERATE*	Halts DTE at end of SD cycle in progress and causes a transfer in SDGE input switch from DTE to drums at that time.
OPERATE – TEST DD	S130 (R)	TEST DD*	Energizes relays to ready DTE for DD operation. Also lights DD ON TEST indicator (X2).
		OPERATE*	Halts DTE at end of DD cycle in progress when DTE is in DISP DD CONT operation and causes a transfer in DDGE input switch from DTE to drums at that time.
START TESTER	S129		Causes generation of start-test pulse which starts DTE operation.

**These are momentary contact positions. Springs return the movable arm to its center position.*

TABLE 5–20. FUNCTION OF CONTROL RELAYS ASSOCIATED WITH DTE

RELAY	LOCATION	ENERGIZING CONTROL	FUNCTION
K6 (4)*	1G2	**OPERATE COMPUTER – TEST set to TEST	Supplies —48 volts to DTE from SDGE. When de-energized, isolates DTE to prevent interference with normal computer operation.
K19 (2)*	1G4	**OPERATE COMPUTER – TEST set to TEST	Supplies —48 volts to DTE from DDGE. When de-energized, isolates DTE to prevent interference with normal computer operation.
K5	1E2	TEST SD – OPERATE set to TEST SD	Maintains test-SD line (associated signal relays) at —48 volts. A holding contact [K5 (1)] provides a lockup path for —48 volts to the relay coil; thus TEST SD – OPERATE switch (momentary contact type) no longer remains in TEST position. When energized, contact K5 (2) is opened to prevent actuating DD test circuits when DTE is in SD test operation.
K6	1E2	TEST DD – OPERATE set to TEST DD	Maintains test-DD line at —48 volts. Its operation is identical to that of relay K5.
K15	1E2	DISPLAY RD BRIGHT – DISPLAY RD DIM set to DISPLAY RD DIM	Maintains test-RD-dim line at —48 volts.
K16	1E2	TEST DD-1 – TEST DD-2 set to TEST DD-2	Maintains test-DD 2 line at —48 volts.

**The number in parentheses refers to a specific pair of contacts of the relays.*
***Control located on module G of the duplex maintenance console.*

TABLE 5–21. FUNCTION OF SIGNAL RELAYS ASSOCIATED WITH DTE

RELAY	LOCATION	ENERGIZING CONTROL	FUNCTION
K2, K4, K6	24 JY	TEST SD – OPERATE set to TEST SD	Applies DTE left-word output to SD input switch.
K2, K4, K6 K4, K6	24 HC 24 GC	TEST SD – OPERATE set to TEST SD	Prevents manual input transfer bits from entering SD input switch during SD testing.
K2	24 GC	TEST SD – OPERATE set to TEST SD	Supplies timing and control pulses from test control section of DTE to SD distributor and timer (SDGE).
K1	25 EY	TEST DD – OPERATE set to TEST DD, and TEST DD-1 – TEST DD-2 set to TEST DD-2	Passes start-test pulse as test-initiate-DD 1 pulse (K1 de-energized) or as test-initiate-DD 2 pulse (K1 energized) to DD input switch.
		TEST SD – OPERATE set to TEST SD, RD – TD set to RD, and DISPLAY RD BRIGHT – DISPLAY RD DIM set to DISPLAY RD DIM	Passes test-read-SD-word as test-RD-bright pulse (K1 de-energized) or as test-RD-dim pulse (K1 energized) to SD input switch.

TABLE 5–21. FUNCTION OF SIGNAL RELAYS ASSOCIATED WITH DTE (cont'd)

RELAY	LOCATION	ENERGIZING CONTROL	FUNCTION
K2, K4, K6	25 BE	TEST DD – OPERATE set to TEST DD	Applies DTE left-word output to DD input switch.
K2, K4, K6	25 CE	TEST DD – OPERATE set to TEST DD	Applies DTE right-word output to DD input switch.
K2, K4	25 DL	TEST DD – OPERATE set to TEST DD	Provides timing and control pulses to either DTE or DD timing and control (DDGE) circuits during DD testing.
K6	25 DL	TEST DD – OPERATE set to TEST DD and DISPLAY DD CONT – DISPLAY DD ONE CYCLE set to DISPLAY DD CONT	Provides necessary timing and control pulses to DTE and DD timing and control circuits for continuous DD testing.
K2, K4, K6	24 FY	TEST SD – OPERATE set to TEST SD	Applies DTE right-word output to SD input switch.
K3	25 EY	TEST SD – OPERATE set to TEST SD and RD – TD set to RD	Applies timing and control pulses to DTE and SD input switch during RD test operation.
K5	25 EY	TEST SD – OPERATE set to TEST SD	Inhibits end-cycle pulse from timing SD testing operation until TEST SD OPERATE control is set to OPERATE.
K7	25 EY	TEST DD – OPERATE set to TEST DD	Applies start-test pulse as an initiate-DD 1 or as an initiate-DD 2 pulse to contacts of relay K1 (25 EY).
			Applies test-clear-timing pulse (K7 energized) from DTE, or clear-timing-control pulse (K7 de-energized) from DD timing and control circuit (DDGE) to intensity control circuit (DDGE).

3.3 TEST CONTROL SECTION

The test control section of the DTE generates the timing and synchronizing pulses required by the DTE to test both the situation and digital generator elements. Figure 5–76, foldout, is a simplified logic diagram of the test control section. The circuit has been divided into smaller functional circuits to obtain a better understanding of the circuit operation. The word sequencer is included in this figure; however, it is not considered as part of the test control section. The test SD word control and TD word synchronizer circuits are not used in DD test operations; the DD initial delay counter and test DD word control circuits are not used in SD test operations. The remaining circuits are employed in both SD and DD test operations.

The test-OD pulse generator consists of two pulse sources. One of them is a 400-kc pulse generator which supplies a standard pulse every 2.5 μsec. These test-OD pulses simulate the OD pulses of the Drum System. They are utilized as basic timing and synchronizing pulses by the DTE and generator element under test. The other pulse source is the start-test pulse generator, which produces one standard pulse whenever the START TESTER pushbutton is depressed. The function of this pulse is to clear the DTE circuits to ready them for testing operations.

The output pulses of the test-OD pulse generator are gated into the test-OD distributor, which establishes them as test-OD 1, test-OD 2, test-OD 3, and test-OD 4 pulses.

The test-TD word synchronizer inhibits the start of information transfer from the DTE to the SDGE during the initial delay period (1327.5 μsec) of the TD test cycle. An end-cycle pulse from the SDGE at the completion of this delay period is fed to the TD word synchronizer, which in turn generates test-WOW and test-read-SD-word pulses. During RD test operations the end-cycle pulse, indicating the initial delay period (57.5 μsec) is completed, is fed directly to the SD word control.

The test-SD word control circuit provides the read-out signals which effect the transfer of stored words in the DTE to the SDGE for either TD or RD test operations.

The DD initial delay counter, in conjunction with the counter circuits in the DDGE, provides the DD test operation with an initial erase period (204.8 ms) that equals the initial erase period of normal display operation.

The test-DD word control circuit provides the read-out signals which effect the transfer of stored information in the DTE to the DDGE at the conclusion of the initial delay period.

The end-test control circuit controls the termination of DTE operation, which is accomplished by terminating the generation of test-OD pulses. This action occurs only at the completion of the test cycle in operation.

3.3.1 TD Test Operation

Table 5–22 lists the signals used in TD test, in the sequence in which they occur. The corresponding origin and termination of each signal and the detailed circuit operation (logic function) performed are also listed. Logic circuits discussed in table 5–22 appear in figure 5–76.

TABLE 5–22. SIGNAL SEQUENCE AND OPERATION OF TEST CONTROL CIRCUIT IN TD TEST

SEQUENCE AND SIGNAL	FROM	TO	LOGIC FUNCTION
1. TEST SD – OPERATE switch	Center position	Test SD (momentary contact)	Transfers SDGE connections from drums to DTE by energizing SD input switch relays.
			Inhibits end-cycle signal to test-OD pulse generator by applying —30 volts to GT 14 through contacts of energized relay K5.
2. START TESTER switch	Depressed		Causes generation of single (start-test) pulse by PG.
3. Start-test pulse	PG	FF 3	Sets FF 3 to 1, conditioning GT 13 to permit 400-kc standard pulse output to feed the test-OD distributor.
		FF 1 and FF 2	Clears FF 1 and FF 2 to 0, conditioning GT 1 to pass first 400-kc oscillator pulse.
		FF 8	Clears FF 8 to 0, deconditioning GT's 16 and 17.
		SD input switch	Applied as test-start-TD through contacts of K3 (RD – TD set to TD) and test-WOW signals. These signals prepare the SDGE for TD message presentation.
		FF 4, FF 5, and FF 6 (word sequencer)	Clears word sequencer, preparing word sequencer for production of read-word-0 through read-word-7 signals.
4. First test-OD generator pulse	Test-OD pulse generator	Test-OD distributor	Pulse gated through conditioned GT 13. Strobes GT's 1 through 4; gated through conditioned GT 1 as test-OD 1.
5. Test-OD 1	GT 1	SD input switch through OR 1	Part of timing pulse train applied to SDGE on test-all-OD line.

TABLE 5–22. SIGNAL SEQUENCE AND OPERATION OF TEST CONTROL CIRCUIT IN TD TEST (cont'd)

SEQUENCE AND SIGNAL	FROM	TO	LOGIC FUNCTION
		FF 1	Sets FF 1 to 1, deconditioning GT 1 and, in conjunction with FF 2, conditions GT 2.
6. Second test-OD generator pulse	Test-OD pulse generator	Test-OD distributor	Strobes GT's 1 through 4; gated through conditioned GT 2 as test-OD 2.
7. Test-OD 2	GT 2	SD input switch through OR 1	Part of timing pulse train applied to SDGE on test-all-OD line.
		FF 2	Sets FF 2 to 1, deconditioning GT 2 and in conjunction with FF 2, conditions GT 4.
8. Third test-OD generator pulse	Test-OD pulse generator	Test-OD distributor	Strobes GT's 1 through 4; gated through conditioned GT 4 as test-OD 3.
9. Test-OD 3	GT 4	SD input switch through OR 1	Part of timing pulse train applied to SDGE on test-all-OD line.
		FF 1	Clears FF 1 to 0, deconditioning GT 4 and, in conjunction with FF 2, conditions GT 3.
		GT 15	Test-OD 3 pulse gated through GT 15 and fed to FF 8 through contacts of de-energized relay K3. Pulse sets FF 8 to 1, conditioning GT 16 and GT 17.
	GT 15	FF 7	Pulse clears FF 7 to 0, deconditioning GT 15, preventing passage of succeeding test-OD 3 pulses.
10. Fourth test-OD generator pulse	Test-OD pulse generator	Test-OD distributor	Strobes GT's 1 through 4; gated through conditioned GT 3 as test-OD 4.
11. Test-OD 4	GT 3	SD input switch through OR 1	Part of timing pulse train to SDGE on test-all-OD line.
		GT 16	Gated through GT 16 and fed to SDGE through SD input switch as test-WOW.
		FF 2	Clears FF 2 to 0, deconditioning GT 3 and, in conjunction with FF 1, conditions GT 1.
12. Signals 4 through 11 repeated to end of TD test operation	DTE	SDGE	Provides a continuous train of pulses spaced 2.5 μsec apart for SDGE and DTE timing and control.
13. End-cycle	SDGE	FF 7	Sets FF 7 to 1 (through contacts of de-energized relay K7), conditioning GT 15 to pass test-OD 3 pulse.
14. Test-OD 1	GT 1	GT 17	Pulse gated through conditioned GT 17 to word sequencer (GT's 5 through 12) as test-read-SD-word. This is repeated seven times (once every 10 μsec). The eighth pulse returns to the SD word control circuit as test-read-word-7.

TABLE 5—22. SIGNAL SEQUENCE AND OPERATION OF TEST CONTROL CIRCUIT IN TD TEST (cont'd)

SEQUENCE AND SIGNAL	FROM	TO	LOGIC FUNCTION
15. Test-read-word-7	Word sequencer (GT 12)	FF 8	Pulse fed through contacts of de-energized relay K3 to clear FF 8 to 0, deconditioning GT 16 and GT 17, inhibiting test-WOW and test-read-SD-word signals.
16. End-cycle	SDGE	FF 7	Sets FF 7 to 1, conditioning GT 15, and repeats TD test cycle.
			When TEST SD — OPERATE switch is set to OPERATE, relay K5 is de-energized, and GT 14 is conditioned (+10 volts). The next end-cycle pulse is gated through GT 14, clears FF 3, and deconditions GT 13. This action, in effect, turns off the DTE by inhibiting further inputs to the test OD distributor.

3.3.2 RD Test Operation

Table 5—23 lists the signals used in RD test, in the sequence in which they occur. The corresponding origin and termination of each signal and the logic function performed are also listed. Logic circuits discussed in table 5—23 appear in figure 5—76. The TD word synchronizer is not used in RD test operations.

3.3.3 DD Test Operation

The TD word synchronizer and SD word control circuits of the test control section are not used in DD test operation. Table 5—24 lists the signals used during DD test, in the sequence in which they occur. The corresponding origin and termination of each signal and the logic function performed are also listed. Logic circuits discussed in table 5—24 appear in figure 5—76.

3.4 WORD SEQUENCER SECTION

The word sequencer section, a 3-stage counter (see fig. 5—76), consists of 3 flip-flops, eight AND circuits, and eight gate tubes. The 3 flip-flops control the order of test-read-word signals produced by the sequencer. Each AND circuit output conditions an associated gate tube. The AND circuits are connected to the 3 flip-flops so that each gate tube is conditioned in sequence as the flip-flops are stepped from 0 to 7. The eighth pulse sets the flip-flops to zero to start a new cycle. Table 5—25 provides a detailed analysis of circuit operation. The logic circuits discussed in this table are shown in figure 5—76. The operation of the circuits is basically the same for both SD and DD tests. The rate at which the test-read-word pulses are generated by the word sequencer depends on the type of test (RD, TD, or DD) performed; tables 5—22, 5—23, and 5—24 provide information on this timing process.

3.5 WORD OUTPUTS SECTION

The word outputs section consists of the BIT STORAGE CONTROL switch section and associated capacitor-diode gates (CDG). Each switch is connected to a CDG. The 32 CDG's associated with a word on the switch panel have a common pulse input line from the word sequencer. Figure 5—77 illustrates 6 of the 32 switches of word 0 and their associated CDG's. The toggle switches are shown in their normal or 0 bit position (handle perpendicular to face of panel). A 1 bit is indicated when the switch is depressed. The movable arm of each switch is connected to the conditioning level of each CDG. The CDG is deconditioned (will not pass a pulse) when a —30-volt level is applied to it. The CDG is conditioned (will pass a pulse) when a +10-volt level is applied to its conditioning leg.

Each switch that is set to a 1 applies a conditioning voltage to the associated CDG (see fig. 5—78). A test-read-word-0 pulse from the word sequencer is applied to all the CDG's associated with the word-0 toggle switches. Conditioned gates pass the pulse to output lines connected to the SDGE and DDGE input switch sections. Gates that are not conditioned have no output. Similarly, the CDG's associated with word-1 through word-7 toggle switches will each pass or inhibit output pulses, depending upon the related toggle switch setting. The 32 output lines are common to the eight sets of CDG's. All CDG's are conditioned as soon as the respective toggle switches are set. The outputs are determined by the read-word pulse generated by the word sequencer.

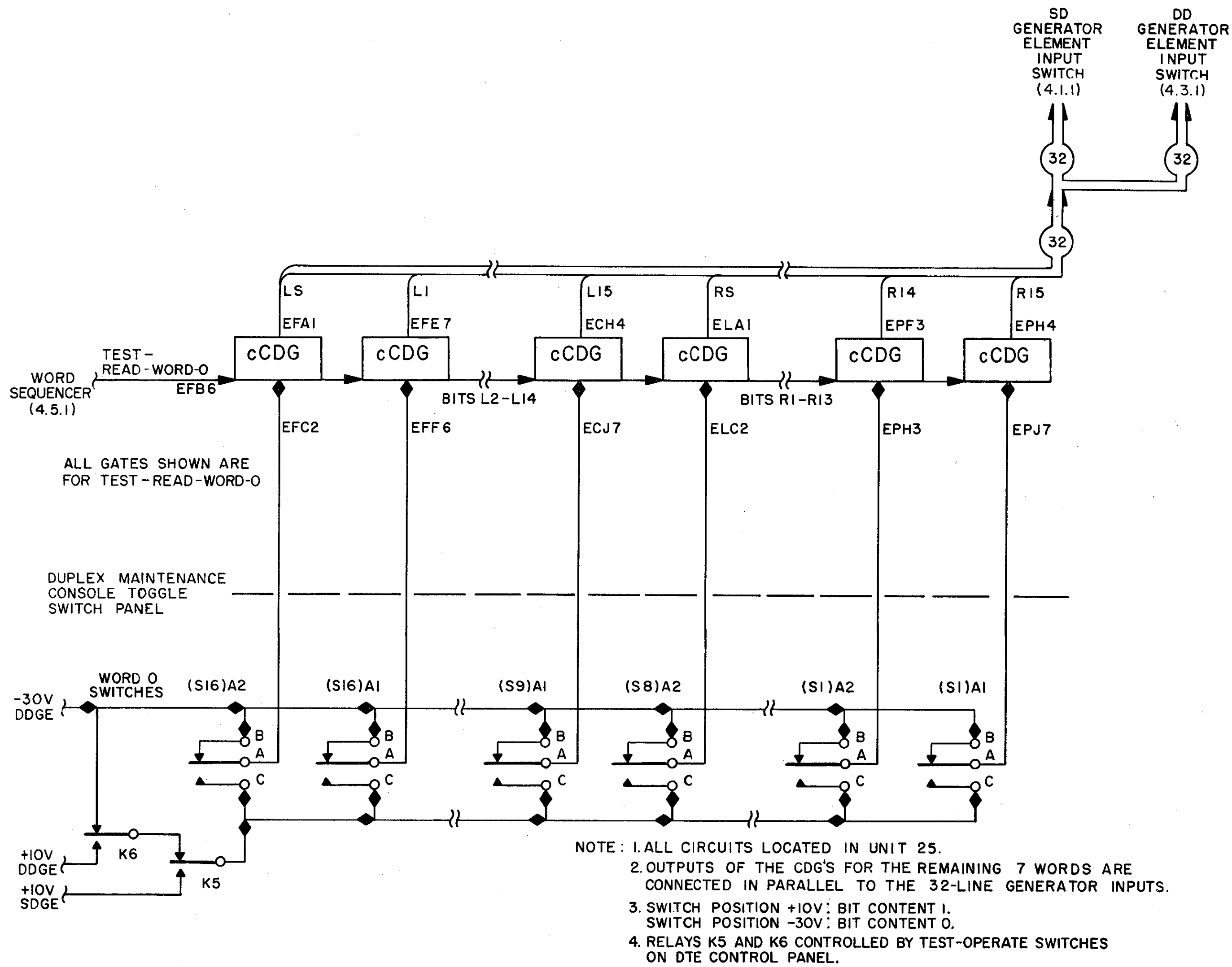


Figure 5-77. Gates Conditioned By Bit Storage Control Switches, Logic Diagram

TABLE 5-23. SIGNAL SEQUENCE AND OPERATION OF TEST CONTROL CIRCUIT IN RD TEST

SEQUENCE AND SIGNAL	FROM	TO	LOGIC FUNCTION
1. TEST SD – OPERATE switch	Center position	TEST SD (momentary contact)	Transfers SDGE connections from drums to DTE by energizing SD input switch relays.
			Inhibits end-cycle signal to test-OD pulse generator by applying —30 volts to GT 14 through contacts of energized relay K5.
2. TD – RD switch	TD position	RD position	Energizes relay K3.
3. START TESTER switch	Depressed		Causes generation of one start-test pulse by PG.
4. Start-test pulse	PG	FF 3	Sets FF 3 to 1, conditioning GT 13 to permit 400-kc standard pulse output to feed test-OD distributor.

TABLE 5–23. SIGNAL SEQUENCE AND OPERATION OF TEST CONTROL CIRCUIT IN RD TEST (cont'd)

SEQUENCE AND SIGNAL	FROM	TO	LOGIC FUNCTION
		FF 1 and FF 2	Clears FF 1 and FF 2, conditioning GT 1 to pass first 400-kc oscillator pulse.
		FF 8	Clears FF 8 to 0, deconditioning GT's 16 and 17.
		SD input switch	Applied as test-start-RD through contacts of energized relay K3, and as test-WOW. These signals prepare the SDGE for RD message presentation.
		FF 4, FF 5, and FF 6	Clears word sequencer, preparing word sequencer for production of read-word signals.
5. First test-OD generator pulse	Test-OD pulse generator	Test-OD distributor	Pulse gated through conditioned GT 13. Strobes GT's 1 through 4; gated through conditioned GT 1 as test-OD 1.
6. Test-OD 1	GT 1	SD input switch through OR 1	Part of timing pulse train applied to SDGE on test-all-OD line.
		FF 1	Sets FF 1 to 1, deconditioning GT 1 and, in conjunction with FF 2, conditions GT 2.
7. Second test-OD generator pulse	Test-OD pulse generator	Test-OD distributor	Strobes GT's 1 through 4; gated through conditioned GT 2 as test-OD 2.
8. Test-OD 2	GT 2	SD input switch through OR 1	Part of timing pulse train applied to SDGE on test-all-OD line.
		FF 2	Sets FF 2 to 1, deconditioning GT 2 and, in conjunction with FF 2, conditions GT 4.
9. Third test-OD generator pulse	Test-OD pulse generator	Test-OD distributor	Strobes GT's 1 through 4; gated through conditioned GT 4 as test-OD 3.
10. Test-OD 3	GT 4	SD input switch through OR 1	Part of timing pulse train applied to SDGE on test-all-OD line.
		FF 1	Clears FF 1, deconditioning GT 4 and, in conjunction with FF 2, conditions GT 3.
11. Fourth test-OD generator pulse	Test-OD pulse generator	Test-OD distributor	Strobes GT's 1 through 4; gated through conditioned GT 3 as test-OD 4.
12. Test-OD 4	GT 3	SD input switch through OR 1	Part of timing pulse train applied to SDGE on test-all-OD line.
		FF 2	Clears FF 2 to 0, deconditioning GT 3 and, in conjunction with FF 1, conditions GT 1.
13. Signals 5 through 12 repeated to end of RD test operation	DTE	SDGE	Provides a continuous train of pulses spaced 2.5 μsec apart for SDGE and DTE timing and control.
14. End-cycle	SDGE	FF 8	Sets FF 8 (through contacts of de-energized relay K7 and energized relay K3), conditioning GT's 16 and 17.

TABLE 5-23. SIGNAL SEQUENCE AND OPERATION OF TEST CONTROL CIRCUIT IN RD TEST (cont'd)

SEQUENCE AND SIGNAL	FROM	TO	LOGIC FUNCTION
15. Test-OD 4	GT 3	GT 16	Pulse gated through conditioned GT 16 as a test-WOW to SDGE.
16. Test-OD 1	GT 1	GT 17	Pulse gated through conditioned GT 17 as test-read-SD-word to word sequencer (GT's 5 through 12).
17. Test-read-SD-word	GT 17	SD input switch	Pulse applied to SDGE as a test-RD-dim or test-RD-bright through contacts of energized relay K3. The selection of either a bright or dim display is a function of the DISPLAY RD BRIGHT – DISPLAY RD DIM switch, which in turn controls relay K1.
	GT 17	FF 8	Pulse clears FF 8 through contacts of energized relay K3.
18. End-cycle	SDGE	FF 8	Sets FF 8 to 1, repeating RD test cycle. Each cycle (every 60 μsec) reads out a word stored in the DTE and successively stepping to the next word.
			When TEST SD – OPERATE switch is set to OPERATE, relay K5 is de-energized, and GT 14 is conditioned (+10 volts). The next end-cycle pulse is gated through GT 14, clears FF 3, and deconditions GT 13. This action, in effect, turns off the DTE by inhibiting further inputs to the test-OD distributor.

TABLE 5-24. SIGNAL SEQUENCE AND OPERATION OF TEST CONTROL CIRCUIT IN DD TEST

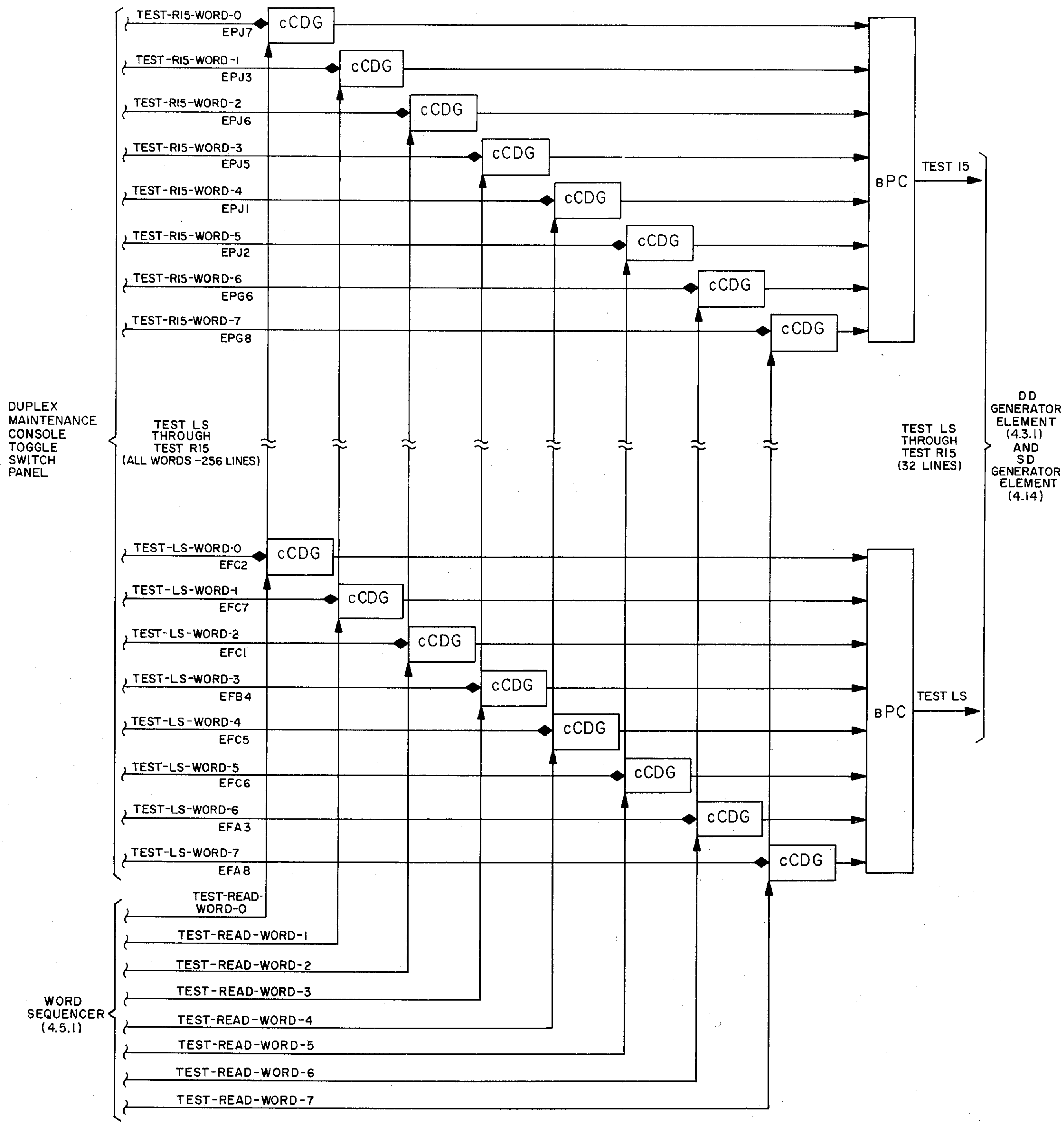
SEQUENCE AND SIGNAL	FROM	TO	LOGIC FUNCTION
1. TEST DD – OPERATE switch	Center position	TEST DD (momentary contact)	Transfers DDGE connections from drums to DTE by energizing DD input switches.
2. START TESTER switch	Depressed		Causes generation of a single pulse (start-test) by the PG.
3. Start-test pulse	PG	FF 3	Sets FF 3 to 1, conditioning GT 13 to permit 400-kc standard pulse output to feed OD distributor.
		FF 1 and FF 2	Clears FF 1 and FF 2 to 0, conditioning GT 1 through AND 1 to pass first 400-kc pulse.
		DD input switch	Applied as test-initiate-DD 1 or test-initiate-DD 2 pulse through contacts of energized relay K7. The selection is a function of the TEST DD 1 – TEST DD 2 switch, which controls relay K1.
		FF 4, FF 5, and FF 6	Clears word sequencer, preparing it for production of read-word signals.
		FF 9 and FF 10	Clears DD initial delay counter, deconditioning GT's 18 and 19.

TABLE 5–24. SIGNAL SEQUENCE AND OPERATION OF TEST CONTROL CIRCUIT IN DD TEST (cont'd)

SEQUENCE AND SIGNAL	FROM	TO	LOGIC FUNCTION
		FF 11	Sets FF 11 to 1 through contacts of energized relay K7, conditioning GT 22 and deconditioning GT's 20 and 21.
4. First test-OD generator pulse	Test-OD pulse generator	Test-OD distributor	Pulse gated through conditioned GT 13. Strobes GT's 1 through 4; gated through conditioned GT 1 as test-OD 1.
5. Test-OD 1	GT 1	FF 1	Sets FF 1 to 1, deconditioning GT 1 and, in conjunction with FF 2, through AND 2, conditions GT 2.
		DD input switch	Applied to DDGE on test-OD 1 line where: a. It is fed to contrast gate counter in DDGE, which counts 63 OD 1 pulses and feeds the 64th pulse to the DTE as a test-interleave pulse. b. It is used to prepare another counter in the DD timing and control circuit to count test-index pulses (every 32nd test-interleave pulse). The DD timing and control circuit returns the 11th test-index pulse to the DTE as a test-start-DD-read pulse.
6. Second test-OD generator pulse	Test-OD pulse generator	Test-OD distributor	Strobes GT's 1 through 4; gated through conditioned GT 2 as test-OD 2.
7. Test-OD 2	GT 2	FF 2	Sets FF 2 to 1, deconditioning GT 2 and, in conjunction with FF 2, conditions GT 4.
8. Third test-OD generator pulse	Test-OD pulse generator	Test-OD distributor	Strobes GT's 1 through 4; gated through conditioned GT 4 as test-OD-3.
9. Test-OD 3	GT 4	DD input switch	Applied to DDGE timing and control circuit for timing purposes.
		FF 1	Clears FF 1, deconditioning GT 4 and, in conjunction with FF 2 through AND 3, conditions GT 3.
10. Fourth test-OD generator pulse	Test-OD pulse generator	Test-OD distributor	Strobes GT's 1 through 4; gated through conditioned GT 4 as test-OD 4.
11. Test-OD 4	GT 4	FF 2	Clears FF 2, deconditioning GT 3 and, in conjunction with FF 1, conditions GT 1.
12. Signals 4 through 11 repeated to end of DD test operation	DTE	DDGE	The DDGE timing and control circuit counts 63 test-OD 1 pulses and returns the 64th pulse as a test-interleave pulse (every 640 μsec).
13. Test-interleave	DDGE	DD initial delay counter	Each test-interleave pulse (every 640 μsec) steps the counter by one. This action is repeated during entire DD test operation.
14. Fourth test-interleave	GT 19	Word sequencer	Applied as a test-read-DD-word pulse (every 2.56 ms) to word sequencer (GT's 5 through 12). Causes generation of test-read-word-0 pulse and steps counter by one. Each test-read-DD-word pulse produces another test-read-word signal.

TABLE 5–24. SIGNAL SEQUENCE AND OPERATION OF TEST CONTROL CIRCUIT IN DD TEST (cont'd)

SEQUENCE AND SIGNAL	FROM	TO	LOGIC FUNCTION
15. Test-read-word-7	GT 12	GT 22	Gated through conditioned GT 22 as a test-index pulse to a counter in the DDGE timing and control. Each test-index pulse (every 20.48 ms) steps this delay counter by a count of one.
16. Test-index	GT 22	DD input switch	Ten test-index pulses are counted by the delay counter in the DDGE timing and control. The 11th test-index pulse is returned to the DTE as a test-start-DD-read pulse. The 11th index pulse represents an initial erase period of 204.8 ms.
17. Test-start-DD-read read	DD input switch	FF 11	Clears FF 11, conditioning GT's 20 and 21, and deconditioning GT 22. With GT 22 deconditioned, test-index pulses to the DDGE are interrupted. In addition, clearing FF 11 enables RS control bits to be generated.
18. Test-interleave	DDGE	GT 20	Pulse gated through conditioned GT 20 as test-read-sample (every 640 μsec) to the DDGE timing and control.
19. Test-read-DD-word	GT 19	Word sequencer	Successive test-read-DD-word pulses (every 2.56 ms) cause the word sequencer to generate test-read-word pulses (words 0 through word 7).
		GT 21	Pulse gated through conditioned GT 21 as a test-clear-intensity-control pulse. This pulse is fed to the DD timing and control circuit through the contacts of energized relay K7.
20. Signals 17 through 19	DTE	DDGE	The logic functions associated with these signals occur until the conclusion of a DD 1 or DD 2 cycle.
21. Stop-DD	DD input switch	DTE	The stop-DD pulse is generated in the DDGE at the end of a DD 1 or DD 2 cycle.
			During DD 1 cycle operation, the stop-DD pulse is fed to GT 14 through contacts of de-energized relay K6. The gated pulse clears FF 3, deconditioning GT 13. The 400-kc pulses cannot pass to the test-OD distributor, and the DTE becomes inoperative.
			During DD continuous operation the stop-DD pulse is employed as a test-start-DD pulse. It is applied to OR 4 through the contacts of energized relay K6 and initiates the start of a new DD cycle. This operation continues until the TEST DD – OPERATE switch is set to OPERATE.



NOTE: 1. ALL CIRCUITS LOCATED IN UNIT 25.

Figure 5–78. Word Outputs Section, Logic Diagram

TABLE 5-25. SIGNAL SEQUENCE AND OPERATION OF WORD SEQUENCER SECTION

SEQUENCE AND SIGNAL	FROM	TO	LOGIC FUNCTION
1. Start-test	Test-OD pulse generator (test control)	Word sequencer	Clears FF's 4, 5, and 6, conditioning GT 5 through AND 5.
2. Test-read-SD-word or test-read-DD-word	SD word control or DD initial delay counter (test control)	GT's 5 through 12	Pulse strobe's GT's 5 through 12; gated through conditioned GT 5 as test-read-word-0.
3. Test-read-word-0	GT 5	Word outputs section	Initiates transfer of word 0 bits from DTE to SDGE or DDGE.
		FF 6	Sets FF 6 to 1, deconditioning GT 5, and conditions GT 6 through AND 6.
4. Test-read-SD-word or test-read-DD-word	SD word control or DD initial delay counter (test control)	GT's 5 through 12	Pulse strobes GT's 5 through 12; gated through conditioned GT 5 as test-read-word-1.
5. Test-read-word-1	GT 6	Word outputs section	Initiates transfer of word-1 bits from DTE to SDGE or DDGE.
		FF 5	Sets FF 5 to 1, deconditioning GT 6 and conditions GT 7 through AND 7.
6. Sequences 4 and 5 are repeated five times			Test-read-word-2 through -7 are produced successively after each read pulse. At the completion of this cycle, the word sequencer is restored to its initial condition (item 1, above).

SECTION 4
OVERALL TIMING OF DISPLAY TESTER ELEMENT

4.1 SCOPE

The following paragraphs describe the exact time relationship of all major signals used in DTE testing of the SDGE and DDGE. In each case, a complete cycle of operation is shown on the associated timing diagrams, which also illustrate what happens when the TEST SD—OPERATE or TEST DD—OPERATE switch is set to OPERATE during testing operations.

4.2 SDGE TESTING

The intial delay time and the time interval between the test-read-word pulses for the TD and RD modes of operation are different. It is for this reason that the timing diagrams of the two test operations are discussed in separate paragraphs.

4.2.1 Track Data Timing

The timing diagram, figure 5—79, illustrates the relationship of all pulses used in the DTE during TD testing. The zero time axis is set by the start-test pulse (START TEST pushbutton depressed). This pulse starts the generation of the test-OD pulses (line 2) and initiates the TD delay interval of 1,327.5 μsec. At the end of this delay, an end-cycle pulse (line 3) is returned to the test-TD word synchronizer (see fig. 5—76). The end-cycle pulse conditions GT 15, allowing the next test-OD 3 pulse, 10 μsec later (line 4), to enter the test SD word control and condition GT's 16 and 17. The next pulse, test-OD 4, is gated through GT 16 as a test-WOW-word-0 (line 5). The next pulse, test-OD 1, is applied through GT 17 to the word sequencer as a test-read-SD-word (line 6). This pulse causes the word sequencer to gate out a test-read-word-0 (line 7) pulse to the word outputs section. Thereafter, at 10-μsec intervals, test-read-SD-word pulses (line 6) are fed to the word sequencer and test-read-word pulses (line 7) are fed to the word outputs section. This cycle continues until all eight words have been read out of the word outputs section (line 8) and placed in the character storage section of the SDGE. The test-read-word-7 pulse is returned to the test-SD word control to cut off the flow of test-read-SD-word pulses to the word sequencer until the next cycle begins. Word reading resumes at 1,040-μsec intervals when the succeeding end-cycle pulse arrives from the SDGE.

If the TEST SD—OPERATE switch is set to OPERATE, word reading will continue as before until the next end-cycle pulse arrives from the SDGE to halt DTE operation.

4.2.2 Radar Data Timing

The timing diagram of figure 5—80 illustrates the relationship of all pulses used in the DTE during RD testing. The zero time axis is set with the generation of the start-test pulse. This pulse initiates the generation of test-OD pulses (line 2) and the RD delay interval of 57.5 μsec. At the end of the initial delay period, an end-cycle pulse is returned to the SD word control (see fig. 5—76) conditioning GT's 16 and 17. The end-cycle pulse occurs at test-OD 3 time (line 3). The next pulse, test-OD 4, is gated through GT 16 as a test-WOW-word-0 to the SDGE (line 4). The following test-OD-1 pulse, 2.5 μsec later, is gated through GT 17 as a test-read-SD-word pulse to the word sequencer (line 5). This pulse causes the word sequencer to gate out a test-read-word-0 (line 6) to the word outputs section. This effects the transfer of the stored word 0 from the DTE to the SDGE character storage (line 7). The test-read-SD-word is returned to the SD word control and inhibits further test-read-SD-word pulses to the word sequencer until another end-cycle pulse is received 60 μsec later from the SDGE. This process is cyclical and continues until the TEST SD—OPERATE switch is set to OPERATE, and halts DTE operation.

4.3 DDGE TESTING

The timing diagram of figure 5—81, foldout, illustrates the relationship of all the pulses used in the DTE during a DDGE test. The zero time axis is taken to be that at which the start-test pulse occurs. Line 2 shows the output of the 400-kc standard pulse oscillator. Since the standard pulses are spaced 2.5 μsec apart, up to 2.5 μsec can elapse before the first test-OD 1 pulse is generated. In the timing diagram, only the test-OD 1 pulses occurring every 640 μsec are shown (time interval between test-interleave pulses). There are 63 test-OD 1 pulses generated between the test-interleave pulses.

Line 3 shows that the start-test pulse has, as a test-initiate-DD 1 or test-initiate-DD 2, conditioned the DDGE phase counter so that it will pass test-index pulses. The start-test pulse also inhibits test-read-sample and test-clear-intensity signals during the initial delay periods (line 7).

Line 4 shows the timing of the test-interleave pulses. Every 64th test-OD 1 pulse is returned from the contrast gate counter (DDGE) to the DTE. This process continues for the duration of the test operation.

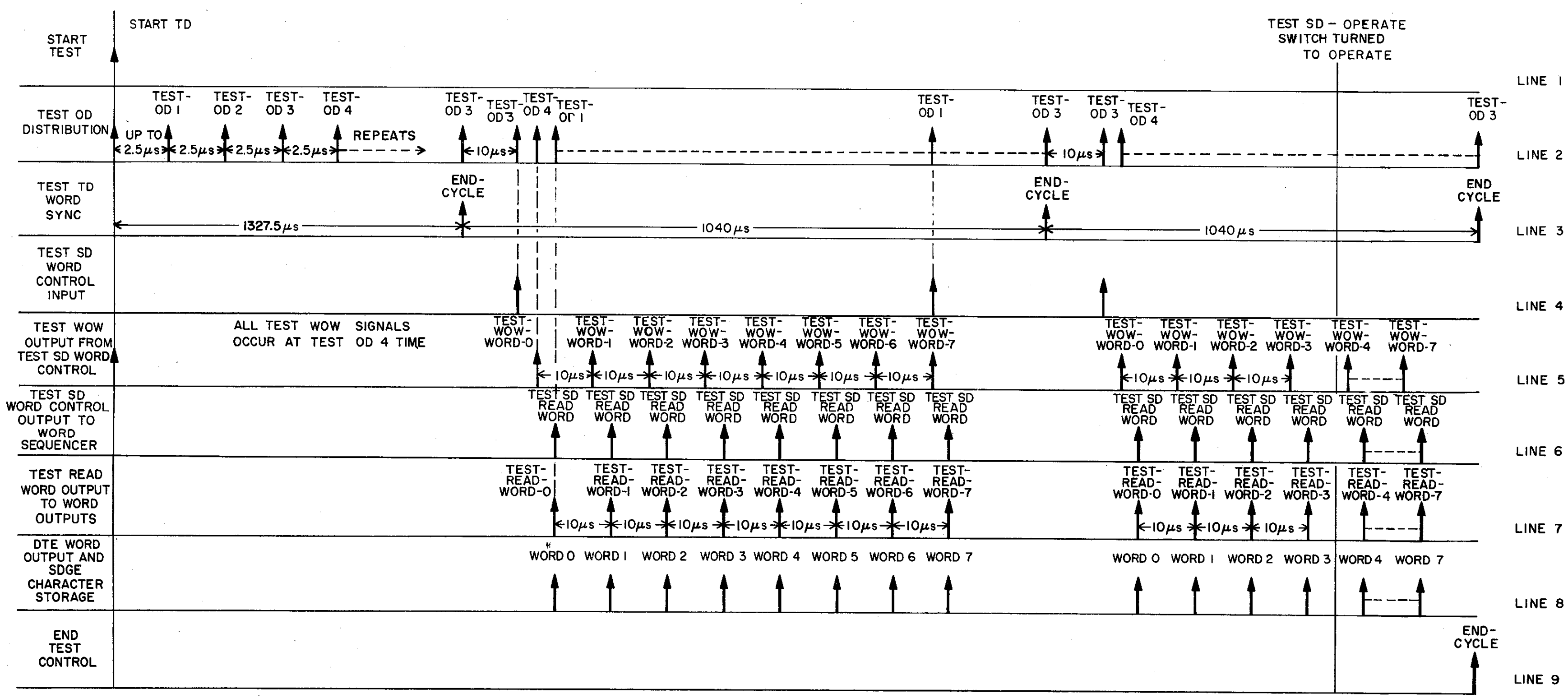


Figure 5—79. DTE Timing Diagram, TD Operation

The test-interleave pulse enters the DD initial delay counter (see fig. 5–76). Every fourth pulse produces a test-read-DD-pulse (line 5) that is applied to the word sequencer, which in turn generates test-read-word pulses (line 6). Test-read-word-7 is returned to the test-DD word control and is applied to the DDGE as the first test-index pulse (line 7). This pulse initiates the initial erase period. The DDGE counts 10 test-index pulses and returns the 11th to the test-DD word control as a test-start-DD-read (lines 6 and 7). This signal conditions GT 20 to pass test-interleave pulses as test-read-sample (line 7); conditions GT 21 to pass test-read-DD-word pulses (every fourth test-read-sample) as a test-clear-intensity pulse (line 7) to the DDGE. The test-start-DD-read pulse also inhibits further generation of test-index pulses until the start of a new cycle (line 7).

Once the initial erase period is complete, the test-read-DD-word pulse effects the generation of test-read-word-0 pulse (line 6). The test-read-word-0 pulse feeds the word outputs section and transfers the 32 bits of word 0 to the DDGE on the first slot line of whichever group is being tested. This process is repeated after every test-read-DD-word pulse (2.56-ms intervals) until the entire message is transferred. Note that the test-clear-intensity pulses are synchronized with each test-read-word pulse (line 7). The DDGE slot counter then selects the second slot of the DD group under test, and the process is repeated.

Word generation continues in this manner until all the slots in the group have been displayed. When word 7 of the test message has been sent to the last slot and placed in storage, a stop-DD (line 7) is generated which halts the test operation, provided that the DTE is in DD one cycle operation.

In DD continuous operation, the stop-DD pulse is used to initiate the start of a new cycle. Once again, after the initial inherent delay and erase period, the slots of the selected group are displayed in consecutive order. This process is repeated until the TEST DD–OPERATE switch is set to OPERATE and halts DTE operation.

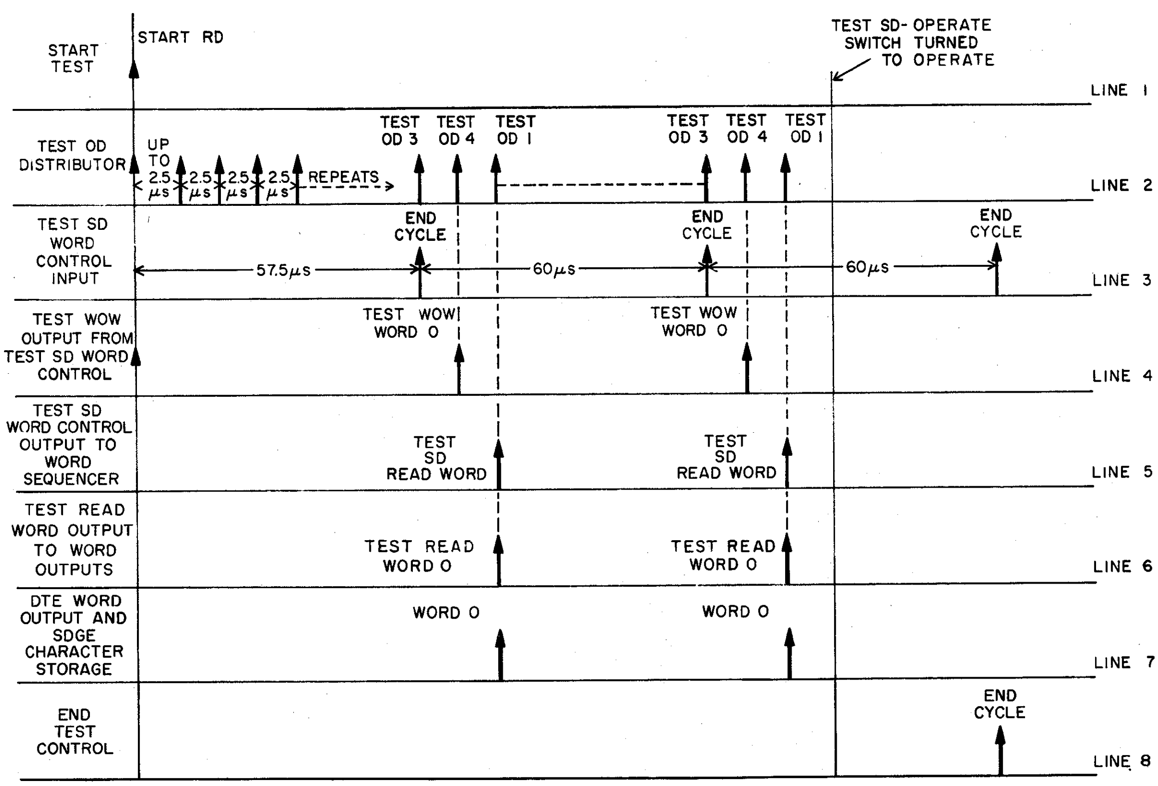


Figure 5–80. DTE Timing Diagram, RD Operation

PART 6
MANUAL DATA INPUT ELEMENT

CHAPTER 1
INTRODUCTION

1.1 SCOPE

This part contains the theory of operation of the manual data input (MDI) element. The element consists of a direct entry section, which processes data directly for use by the Central Computer, and a drum entry section, which processes data for transfer to the Drum System. Associated with one or both of these sections and, in this manual, regarded as part of the MDI element are certain apparatus involved in the transfer of input data to the element.

This chapter provides general information about the MDI element. Its purpose and the sources of input data are discussed; a brief physical description of the MDI equipment is offered; and the theory of operation is presented on an element diagram level. Subsequent chapters are devoted to the detailed theory of operation of the element: Chapter 2 deals with associated equipment; Chapter 3, with the direct entry section; and Chapter 4, with the drum entry section.

1.2 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 intervention is the MDI element and its associated devices.

1.3 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, area discriminators, 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.

1.4 PHYSICAL DESCRIPTION

To process the information supplied by operating personnel, the MDI element uses two units; namely, unit 23 (Manual Data Input Unit SN-169/FSQ) and unit 28 (Manual Data Interconnection Unit J-726/FSQ), and also various pieces of associated equipment, all described briefly below.

1.4.1 Unit 23

Unit 23 (fig. 6–1), 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.

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 spare). Physically, the core matrix is made up of 16 core cans, each containing 33 cards. Each card contains eight core bits.

1.4.2 Unit 28

Unit 28 (fig. 6–2), the interconnection unit, is a patchboard 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 wings and the unit status indication circuits in the various simplex equipments and channels. The bottom section panels receive the wires needed to set the cores in the MDI core matrix. The top and bottom panels are connected by patch cords to set up the desired core assignments.

1.4.3 Keyboard Control Panels

The keyboard control panels, or side wings (fig. 6–3), 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 con-

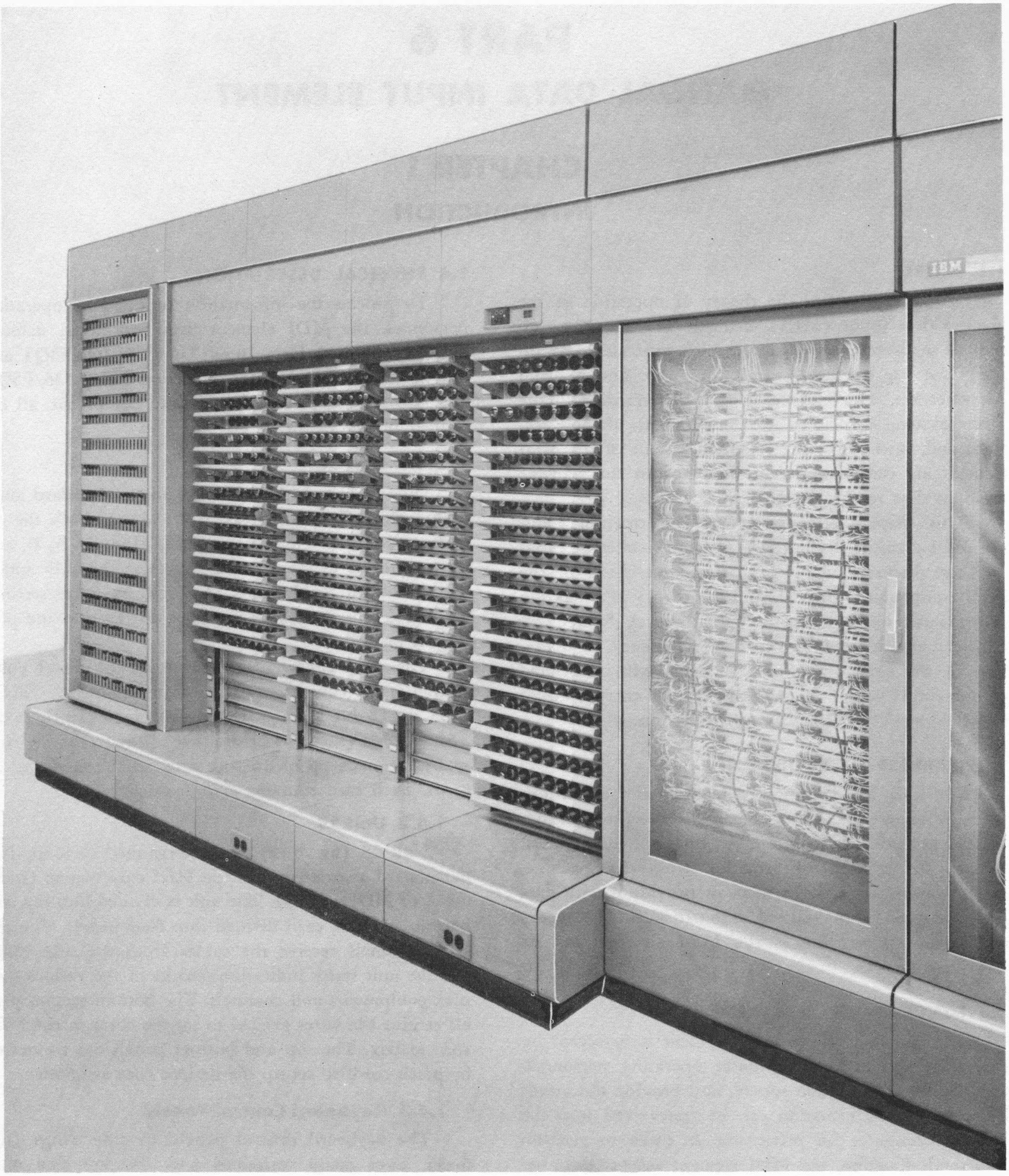


Figure 6–1. Unit 23, Manual Data Input Unit

tains 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.

1.4.4 Light Gun

The light gun (fig. 1–18) is a hand-held photoelectric device for identifying a target on a display screen to the Central Computer. It contains:

a. An aiming light to assist the operator in pointing the light gun at the proper target.

b. A trigger to activate the light gun.

c. A photoelectric device to respond to the target indication.

d. An indicator to show when the photoelectric cell has responded to a target.

Various control and amplifying circuits associated with the light gun are housed in the console or the light gun itself.

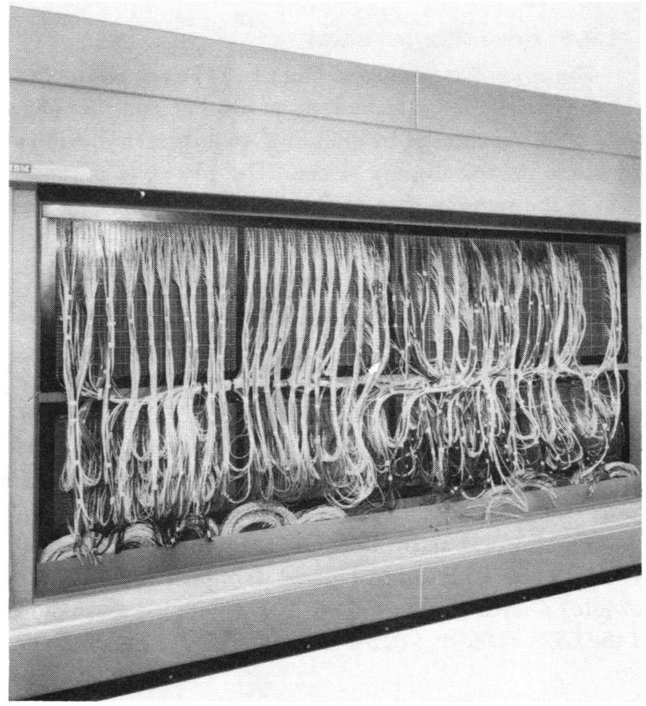


Figure 6–2. Manual Data Interconnection Unit

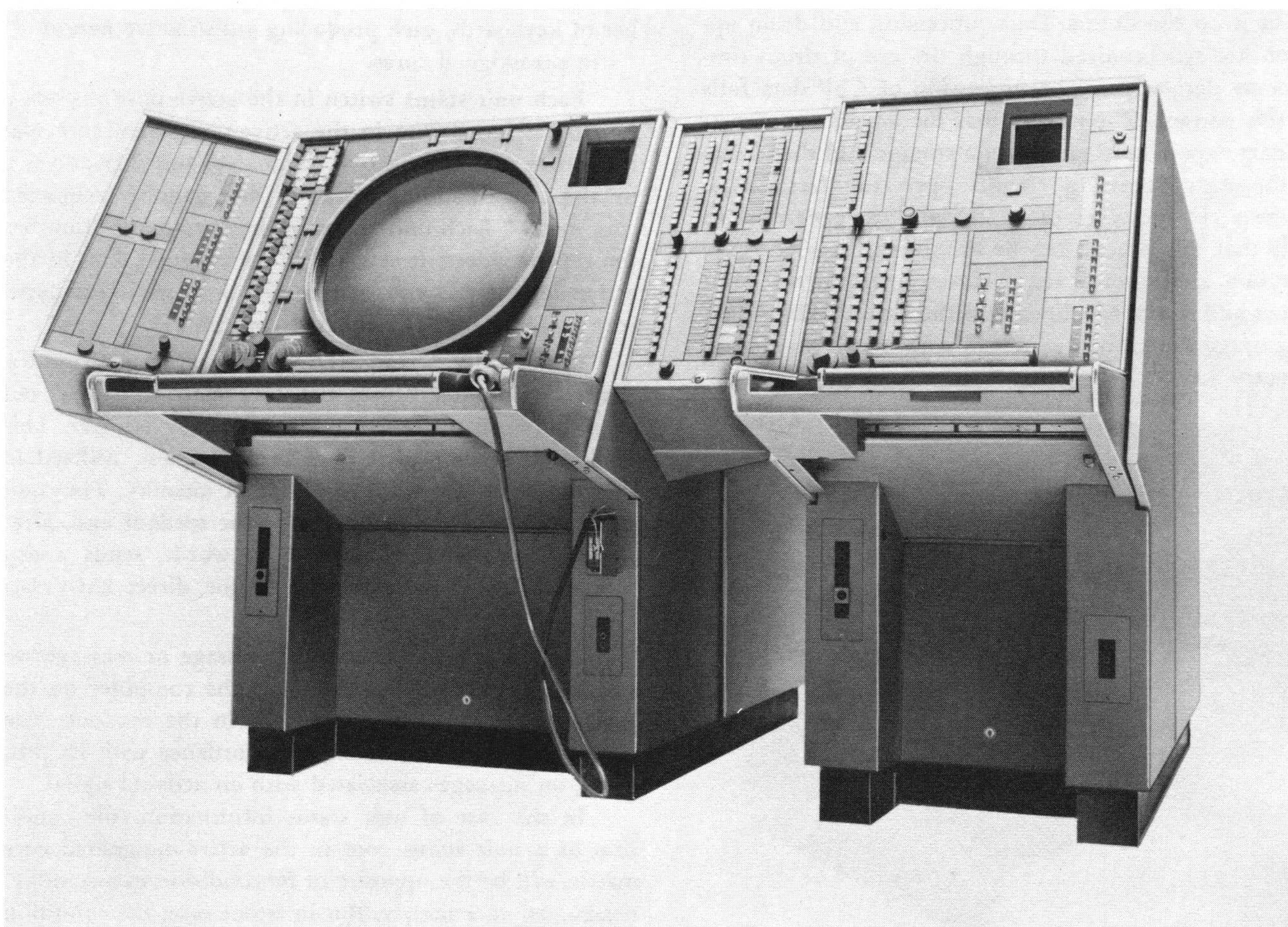


Figure 6–3. Situation Display Console, Showing Keyboard Control Panels

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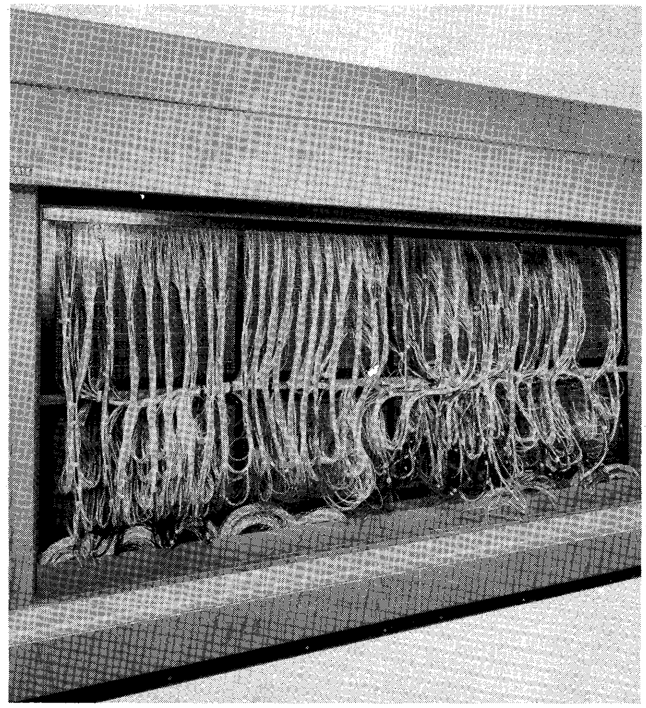


Figure 6-2. Manual Data Interconnection Unit

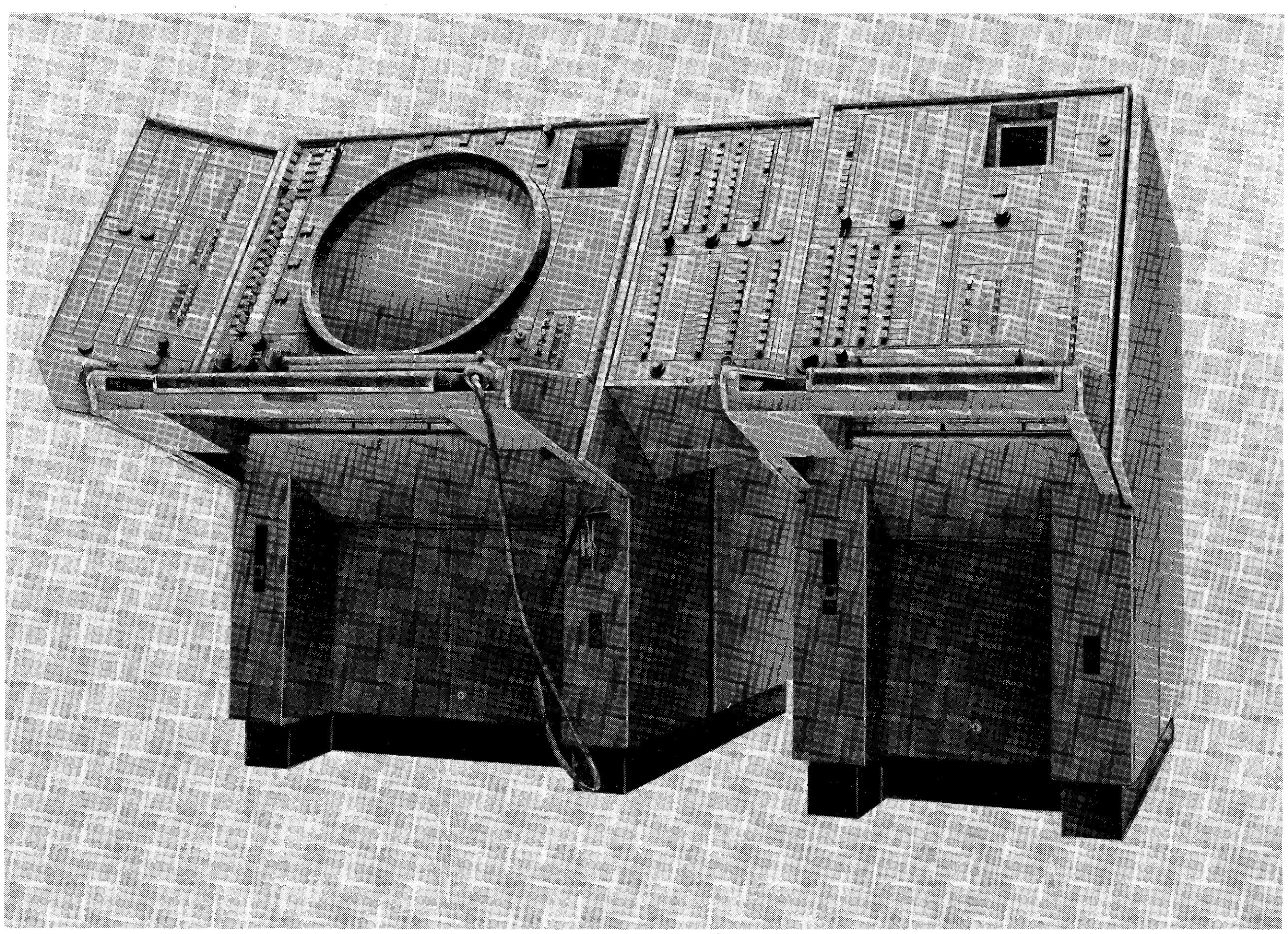


Figure 6-3. Situation Display Console, Showing Keyboard Control Panels

1.4.5 Area Discriminator

The area discriminator (fig. 1—15) is a photoelectric device rigidly attached to a display console (fig. 6—4) and capable of responding to target indications anywhere on the display screen. The principle of operation is the same as that of the light gun. Two consoles are equipped with this device.

1.4.6 Computer Entry Punch

One other device employed to feed information to the MI element is the 020 computer entry punch (fig. 6—5). 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. For a detailed discussion of the CEP, refer to 3-020-0 *Computer Entry Punch Type 020.*

1.5 FUNCTIONAL DESCRIPTION

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.

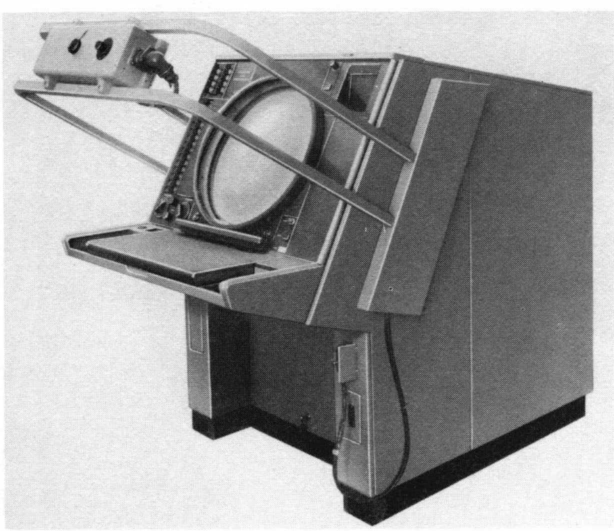


Figure 6—4. Area Discriminator Console

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.

1.5.1 Keyboard Control Panel Information and Unit Status Information

Keyboard control panel information and unit status information are similarly processed, though otherwise unrelated.

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.

Each unit status switch in the active position sets a 1 in its assigned core in the active-designated core matrix (core matrix in active-designated unit 23) and a 0 in the corresponding core in the standby-designated core matrix. Each unit status in the standby position has the reverse effect; it sets a 0 in its assigned core in the active-designated core matrix and a 1 in its assigned core in the standby-designated core matrix.

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.

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 messages associated with an activate signal.

In the case of unit status information, the condition of a unit status core in the active-designated core matrix will be the opposite of its condition in a standby-designated core matrix. But in either case, the condition and position of a unit status core informs the computer of the status of a particular item of simplex equip-

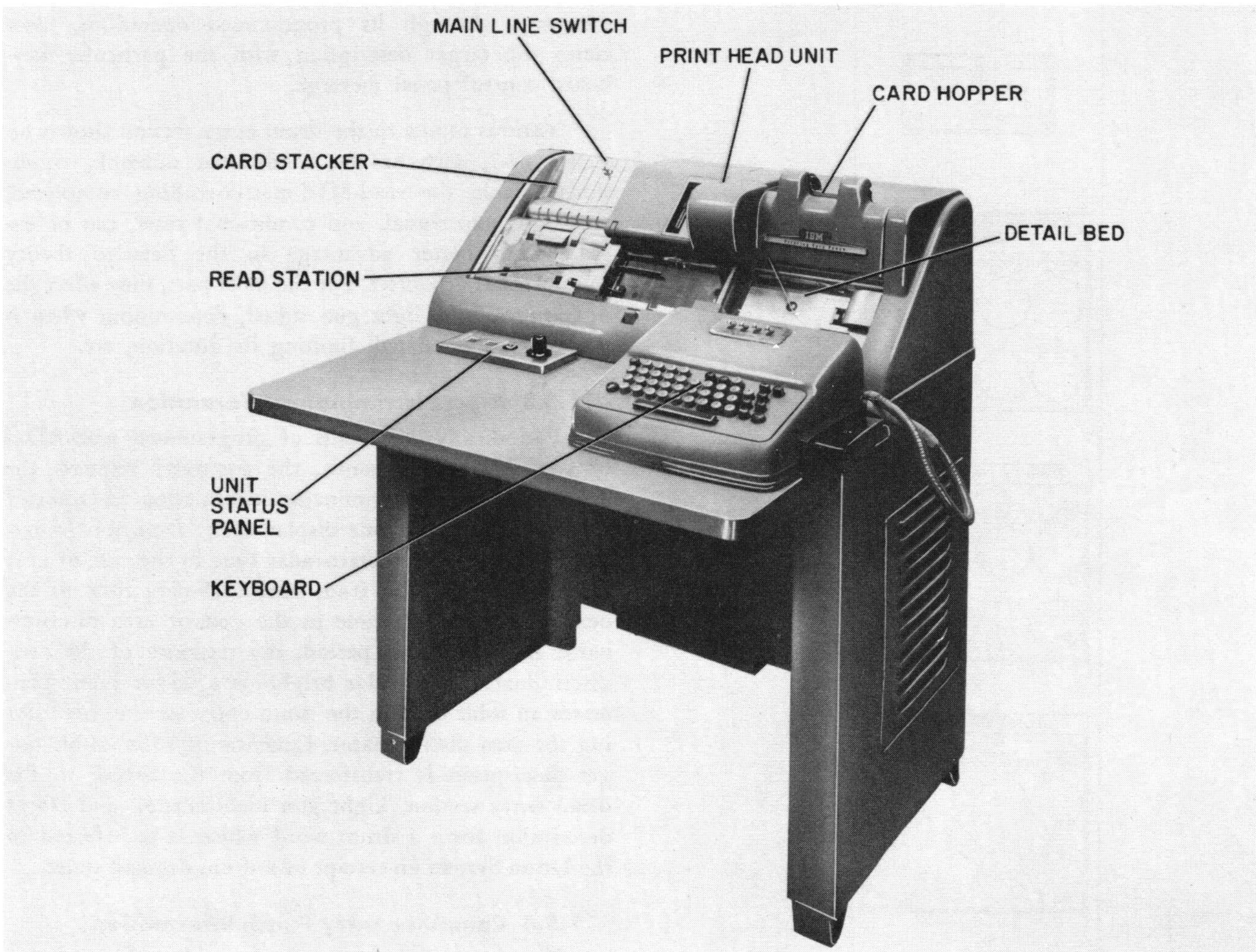


Figure 6–5. Computer Entry Punch, Model 020

ment and the total readout inventories the unit status of all simplex equipment for the computer receiving the readout. As previously stated, the use, if any, made of this information depends on program requirements.

1.5.2 Keyboard Control Panel Information Plus Light Gun Reference Information

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 re-

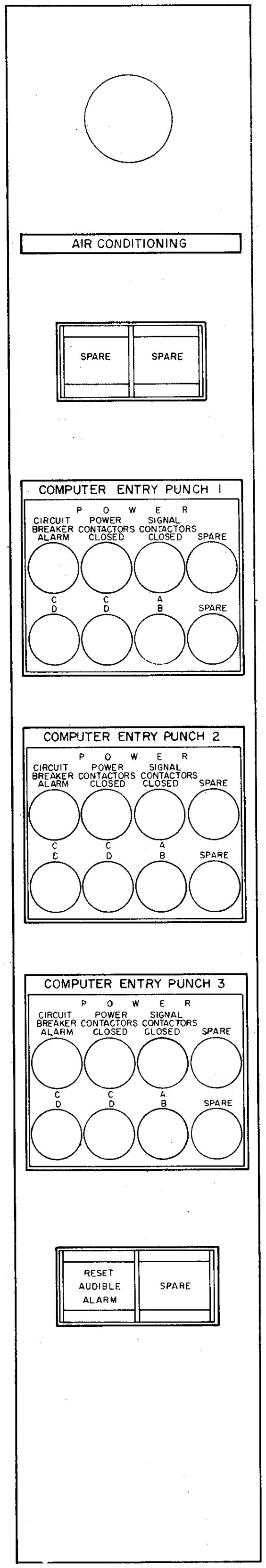


Figure 6–6. Computer Entry Punch Control Panel, Simplex Maintenance Console

sponse to a drum-demand pulse, the drum word is transferred to the Drum System and eventually to the computer.

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.

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.

1.5.3 Area Discriminator Information

Periodically, by means of programmed read-AD I or read-AD II commands, the computer requests the transfer of area discriminator information. A transfer then takes place for one display cycle: from start-radar-data time to the next start-radar time in the case of area discriminator II, and from start-track-data time to the next start-track-data time in the case of area discriminator I. During this period, the response of the area discriminator to a radar bright or a vector point generates an 8-bit code in the drum entry section, identifying the area discriminator. Concurrently, the 24-bit target description is transferred from the SDGE to the drum entry section. Light gun identification and target description form a drum word which is transferred to the Drum System on receipt of a drum-demand pulse.

1.5.4 Computer Entry Punch Information

The three CEP's operate in the same way. A column of card information (24 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 1.5.5, below, determine whether CEP information will be accepted and, if so, the CEP from which it will be transferred.

Upon receipt of a drum-demand pulse, 24 bits of card 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 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.

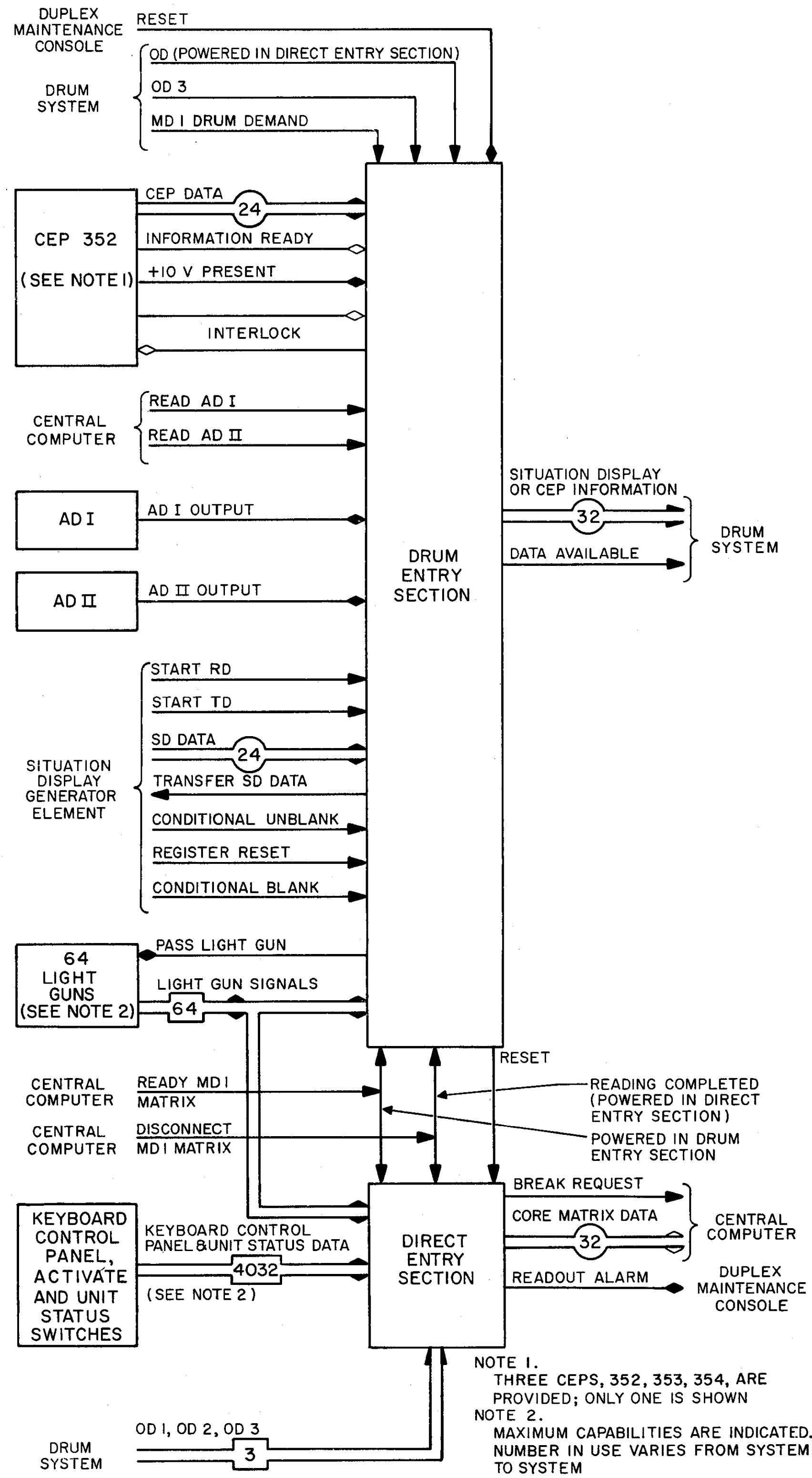


Figure 6–7. Manual Data Input Element, Block Diagram

1.5.5 Priority Circuits

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 readout 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, or a light gun and an area discriminator 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.

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 or area discriminator, 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.

1.5.6 Manual Reset

All flip-flops in the drum entry and direct entry sections are reset when the MASTER RESET pushbutton 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.

CHAPTER 2
MANUAL DATA INPUT DEVICES

2.1 GENERAL

As previously mentioned in Chapter 1 of this part, certain types of information necessary to the solution of a tactical problem must be supplied to the computer by operating personnel. This data (such as tactical decisions, requests for information, and pertinent data from outside sources) is fed to the computer through the MDI element. The transmission of information to the MDI is accomplished by one of the following: keyboard controls, light guns, area discriminators, and CEP's. This chapter provides an operational and functional discussion of these input devices whose relationship to the MDI is shown in figure 6–8.

2.2 KEYBOARD CONTROL PANEL

The keyboard control panel comprises a number of modules which contain neon warning lights, audible alarms, and MI information switches. The audible alarms and warning lights are used to attract the operator's attention to a particular situation (refer to Sect. 2 of Ch 8, Part 5). The MI information switches are employed to set up binary messages that are sent to the MI core matrix in the MI 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. 6–3). A side wing that contains a telephone/radio module is designated a special input data selection control panel.

2.2.1 Manual Input Information Modules

2.2.1.1 Description

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. Figure 6–9 illustrates these modules; they are shown without labels.

The 5-PB, 10A-PB, and 15-PB modules contain 5, 10, and 15 pushbuttons, respectively. The pushbuttons are interlocked-release buttons; i.e., pushing any button releases any button previously depressed. The 10B-PB modules contain 10 pushbuttons. Any of the first nine pushbuttons can be independently depressed; the 10th pushbutton is a common release for all other pushbuttons. The 10C-PB module is a special 10-pushbutton module, each button having independent on-off action; i.e., depressing a pushbutton once activates a circuit; depressing it a second time deactivates the circuit. The

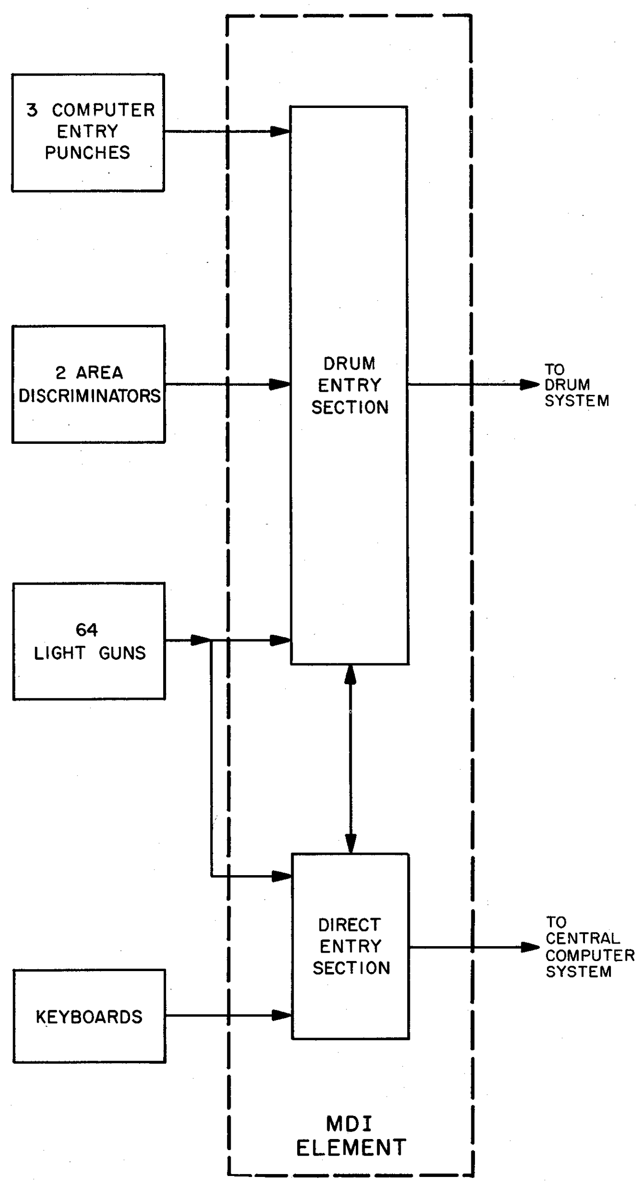


Figure 6–8. Accessory Inputs to MDI Element

2 x 5 PB module consists of two 5-PB modules mounted in one module; each section operates independently.

The HS module is a heading-and-speed module. It contains five interlocked-release pushbuttons and an 8-position rotary switch indexed at 45-degree positions. The pushbuttons are located below the rotary switch.

The ¾ B and 1-½ B modules are blank modules used to cover the open spaces that remain once the required modules are placed in the side wings or auxiliary consoles. The numerical designation (¾ and 1-½) refers to the nominal width of the modules. No provision is made for labels on these modules.

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.

2.2.1.2 Bits Encoded by Modules

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.

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.

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.

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.

2.2.2 Information Signal Flow

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.

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 unchanged. Two identical sets of outputs are developed at the outputs of the resistor cards

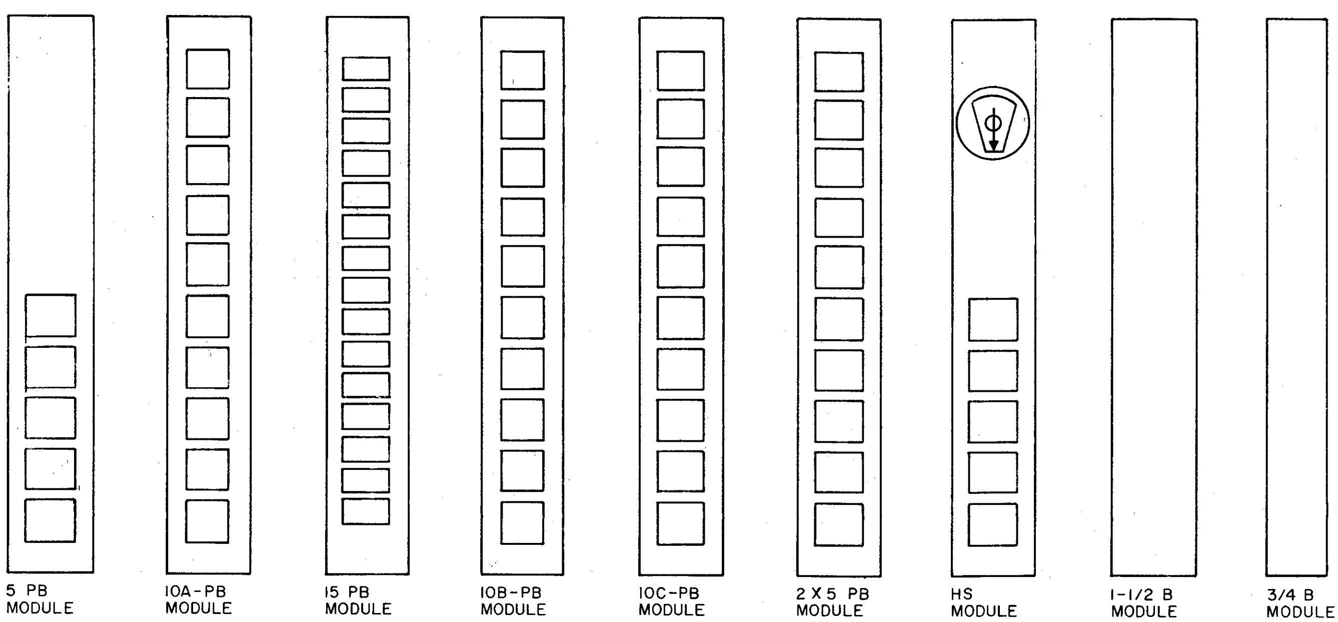


Figure 6–9. Panel Modules

(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 patchcords (a programming function), 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.

PUSHBUTTON NUMBER	BINARY CODE 2^3 BIT	2^2 BIT	2^1 BIT	2^0 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
0	0	0	0	0

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

2.2.3 Activate and Release Switches

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 (see fig. 6–13). 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 on the associated console. The readout operation of the stored activate information is destructive, whereas the MI in-

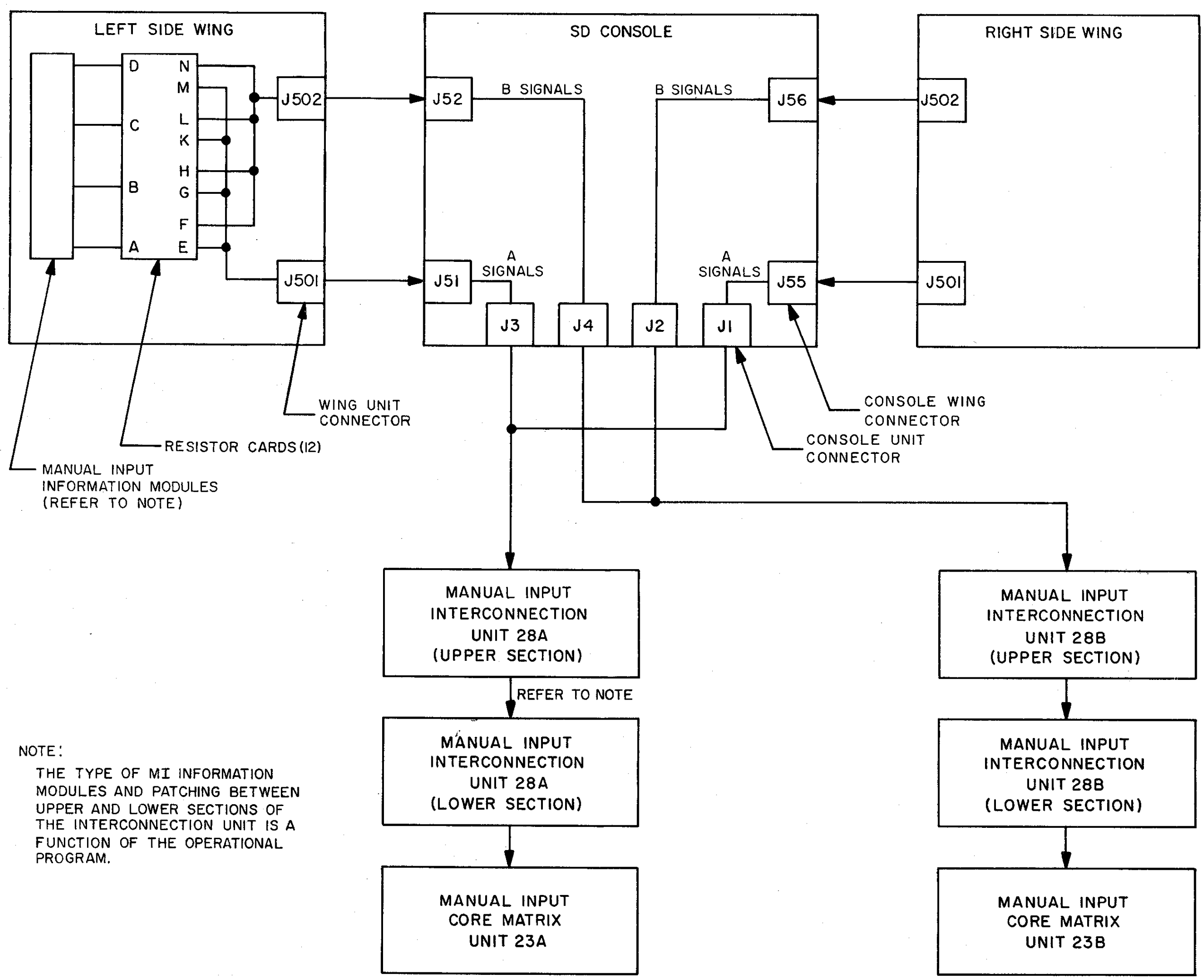


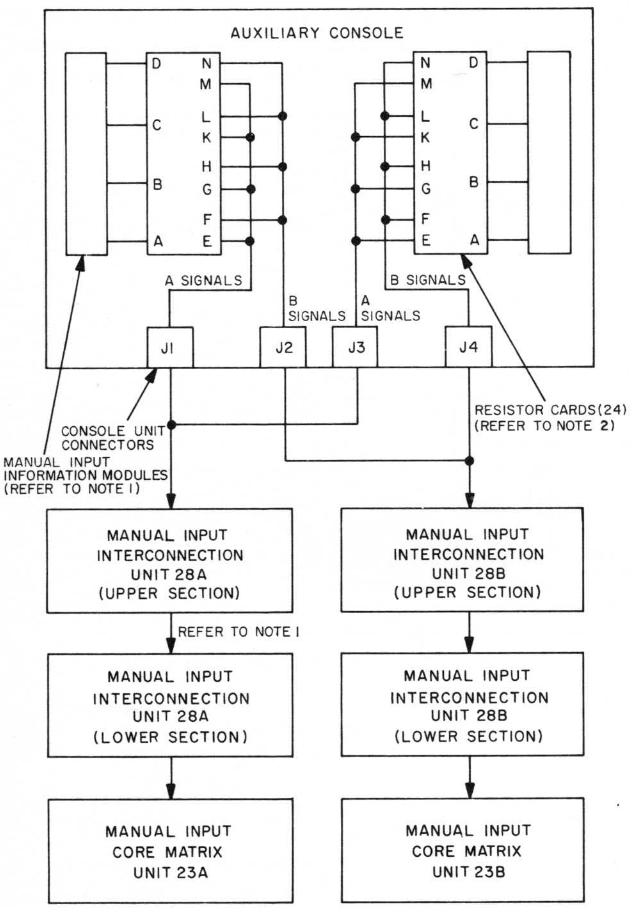
Figure 6–11. Manual Input Information Flow, Side Wings

formation cores are continuously set until the release switch is operated.

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 (fig. 6–13). 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.

2.3 LIGHT GUN

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 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 initiates the transfer of identity information to the MI element.



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

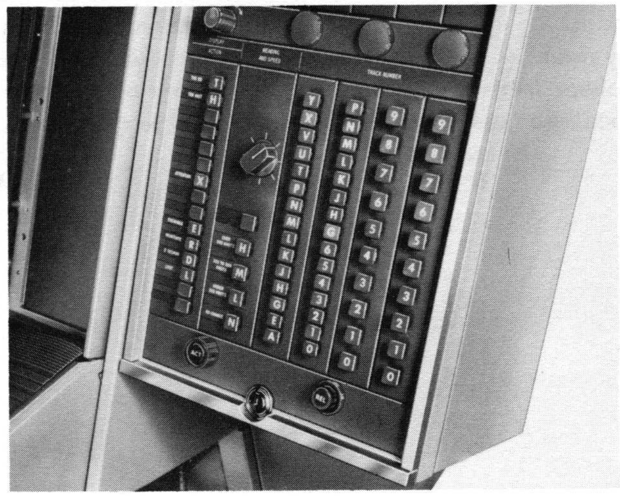


Figure 6–13. Activate and Release Buttons in a Side Wing

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.

2.3.1 Functional Description of Light Gun

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.

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.

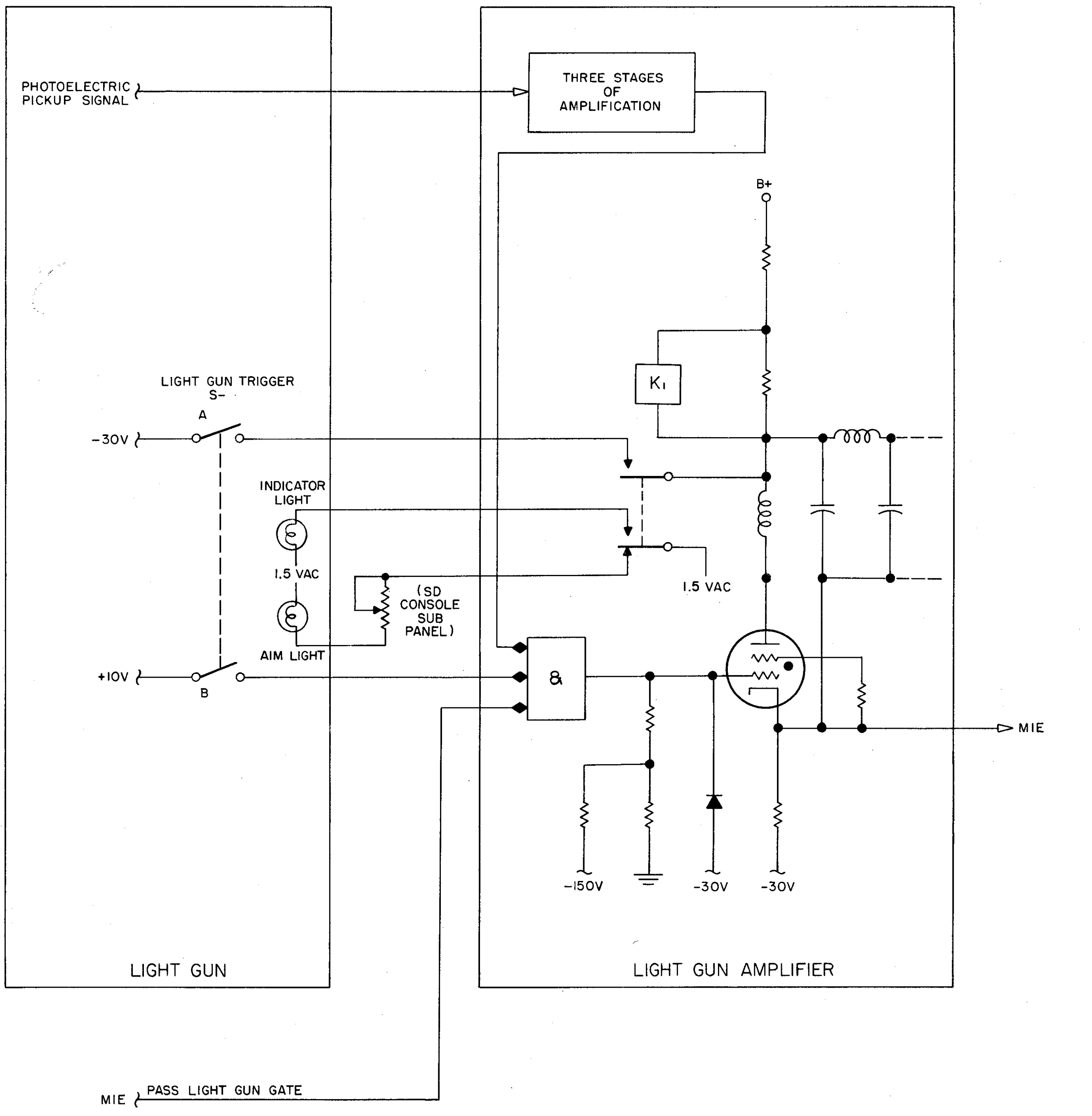


Figure 6—14. Light Gun Logic

2.3.1.1 Pickup Head

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. Figure 1—18 shows the pickup head and its associated cable and connector. The plunger (or pointer) protruding axially from the gun is used as an aid to the operator in aiming the gun (and therefore the lens element) to establish the prefocused focal distance to the lens and also for proper positioning over the target area. See figure 6—15 for the optical geometry of the light gun.

2.3.1.2 Light Gun Amplifier

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.

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-μsec level.

2.3.2 Functional Operation of Light Gun

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.

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.

2.3.2.1 Pulse Sequence

Depressing the trigger of the photoelectric pickup head applies +250V to the pulse generator and sequen-

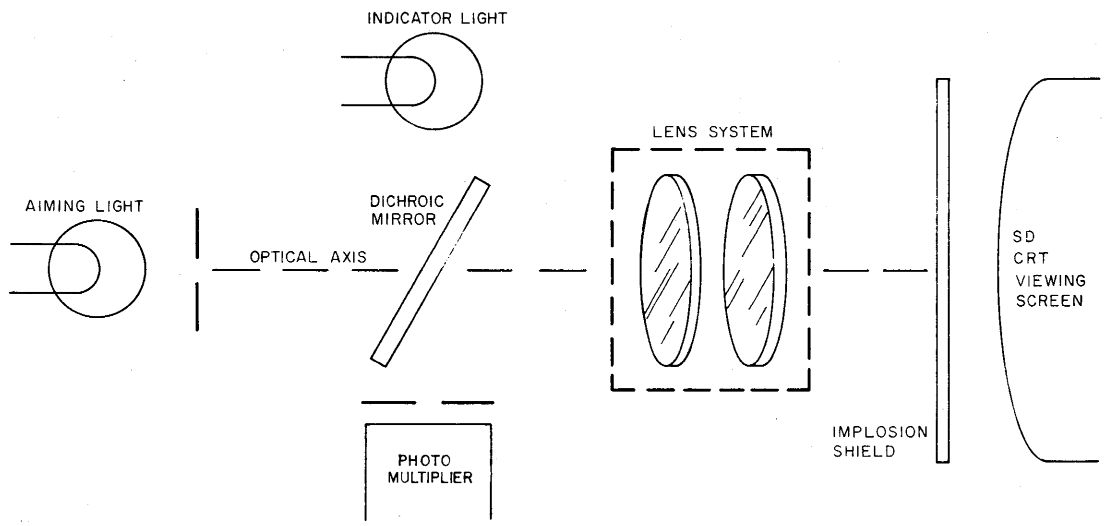


Figure 6–15. Light Gun Optical Geometry

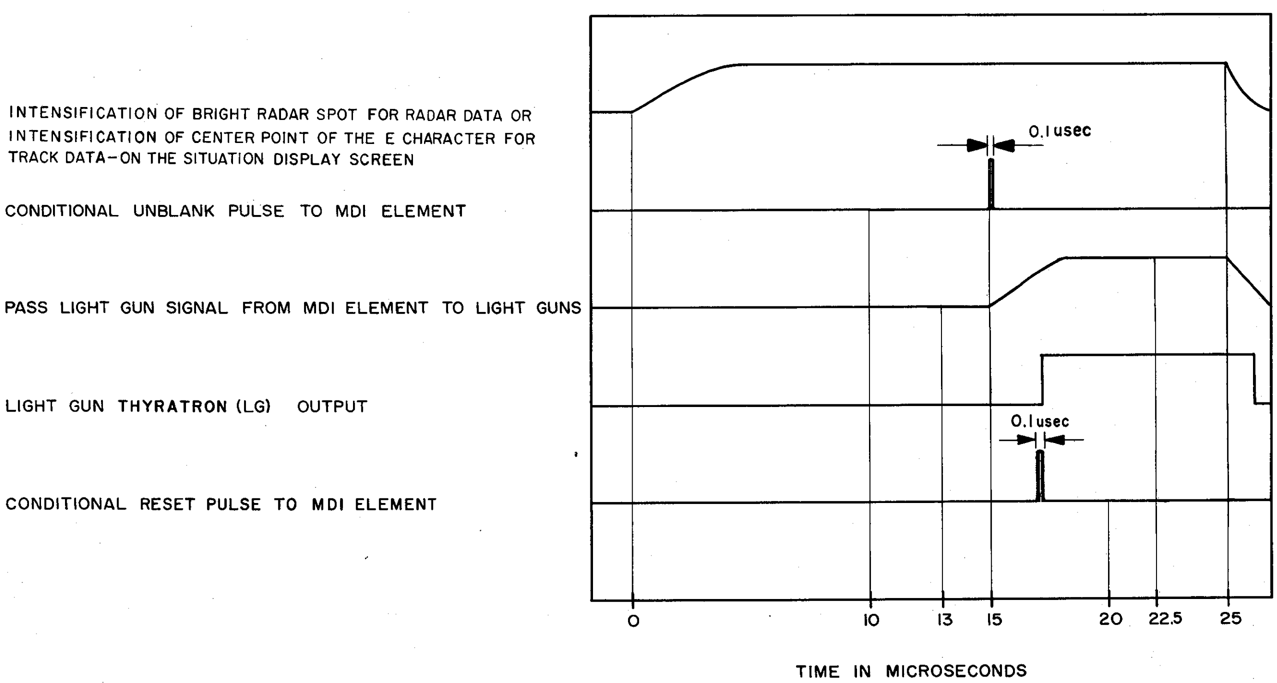


Figure 6–16. Timing Sequence Relationship of MDI Element and Display System in Light Gun Output

tially closes the contacts of a mercury-type relay. Because of its mechanical inertia, this relay effects a delay of from 4 to 10 ms in closing its contacts after the trigger switch is actuated. The later-closing contacts on the relay place a +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.

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 opens, 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.

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 aiming beam, which will not extinguish under these circumstances.

For a more detailed explanation of the circuit operation, a complete circuit analysis is given in Special Circuits Manual 3-3-0.

2.3.2.2 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 is mounted directly to the rear of the aperture on the optical 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.

2.3.3 Logic Operation of Light Gun

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.

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-μsec 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.

When the AND circuit requirements are met with resulting conduction, the control grid of the thyratron rises to +10V, and the thyratron fires. The pulsed time of the thyratron is governed by a 10-μsec delay line in the plate circuit, and a 10-μsec gate appears at the thyratron cathode. It is this output gate that is sent to the MI element.

The thyratron plate current flowing through the coil of relay K1 causes the relay to operate some milliseconds 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 thyratron, 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.

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 thyratron is now definitely at —30V. Section A now opens, removing the return path of K1, and it de-energizes (the thyratron 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.

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.

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.

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 radially 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.)

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.

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-μsec nonstandard 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-μsec 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.

2.4 AREA DISCRIMINATOR

The area discriminator, consisting of the Area Discriminator Pickup Unit F-298/FSQ (fig. 6–17) and the area discriminator SD console, is employed in conjunction with the AN/FSQ-7 to automatically initiate known friendly tracks.

The area discriminator pickup unit is similar in function and method of operation to the previously described light gun. Like the latter, it employs a photomultiplier tube to convert the light emanating from the viewing screen of the SD CRT into electrical impulses. The apparent difference between the two pickup heads is that one is a hand-held device directed at a discrete target manually; the area discriminator, on the other hand, is rigidly mounted at a fixed distance from the CRT so that its viewing field can encompass the entire display area of the SD CRT.

The console itself, that is associated with the area

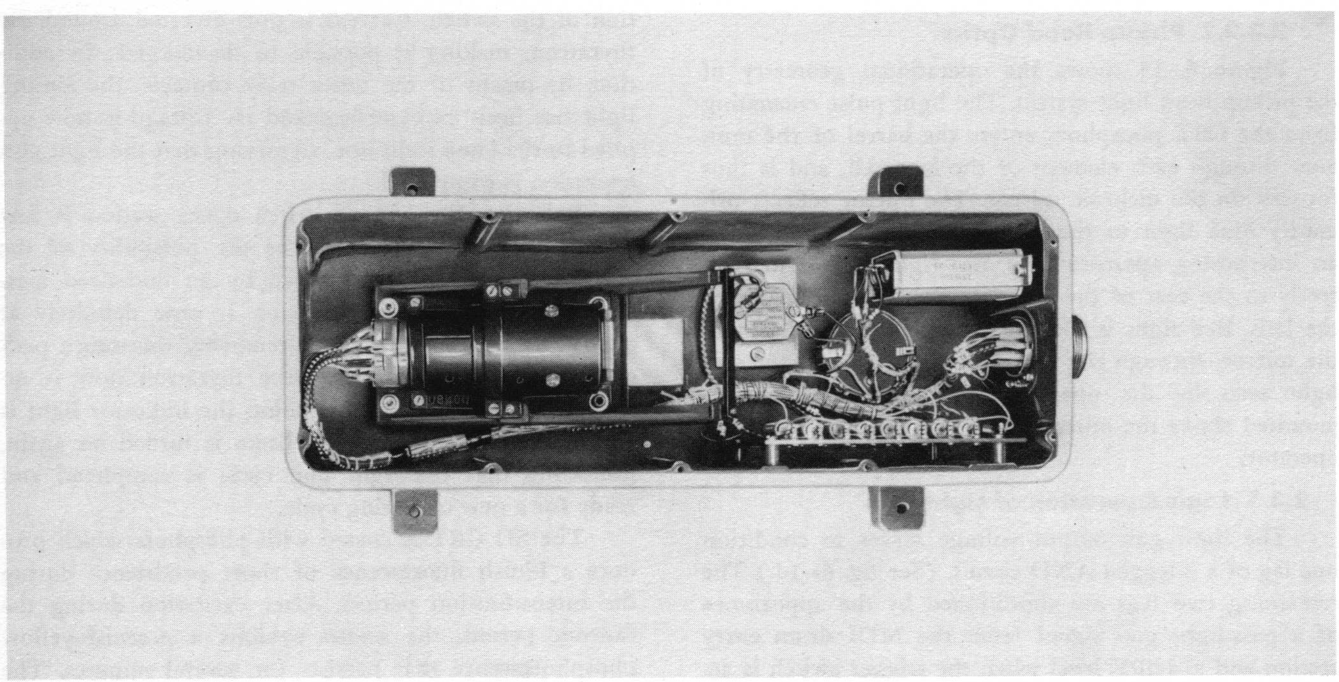


Figure 6–17. Area Discriminator Pickup Unit (Cover Removed)

discriminator pickup unit, differs from the normal SD console only in its use of a clear rather than the standard yellow implosion shield and an area discriminator pluggable unit in the space normally occupied by the pluggable unit of the light gun amplifier.

2.4.1 Functional Operation of Area Discriminator

Unlike the light gun, the area discriminator operation is completely automatic; i.e., it is controlled by the Central Computer System.

Since the pickup unit (fig. 6–18) can view the entire face plate of the SD CRT, provisions can be made to obliterate any unwanted or undesirable areas or returns on the CRT display. This is accomplished through the use of a special masking fluid, opaque to the blue luminescent flash present during the intensification of a symbol. However, the masking fluid is transparent to the ensuing yellow phosphorescent afterglow, which is a property of the phosphors used for the SD CRT. (Par. 2.3.3 provides greater detail on the relation of the phosphors' spectral output to photosensitive cathodes.) To prevent receiving this yellow light at the area discriminator pickup unit, all light inputs to the photomultiplier pass through a blue filter. The combined effect of the masking fluid and the blue filter is to prevent light originating at the masked areas from producing an output from the photomultiplier, but to be nevertheless visible to the operating personnel. The output of the photomultiplier is therefore proportional to the blue light emanating from the unmasked areas of the display viewing screen. The resulting output is a negative pulse.

2.4.2 Logic Operation of Area Discriminator

The display of an unmasked radar symbol at the area discriminator console will produce an output from the pickup unit. This output, in the form of a pulse, is received at the area discriminator amplifier where it is shaped and amplified to produce a 25-μsec, 40V positive nonstandard pulse.

The computer exercises control over the area discriminator operation at the MI drum entry section of unit 23. It does this without the necessity of human intervention (such as pressing a light gun trigger). The operation of the 25-μsec pulse previously mentioned is solely dependent upon the pickup unit's response to the unmasked light output of the CRT. Assuming the area discriminator output is generated during the SD cycle immediately following a read-AD instruction from the Central Computer, it would be gated within the drum entry section of unit 23 as an area discriminator signal. This signal enters the identity bits associated with this particular area discriminator into the encoder matrix and also allows the transfer of the 22 radar bits (11 representing the X co-ordinates and 11 signifying the Y co-ordinates) from the SDGE to the MI register. The ensuing MI operation affects the transfer of the area discriminator identification bits along with other pertinent MI data to the Central Computer.

For a more complete analysis of the circuit operation, refer to the Special Circuits Manual, 3-3-0.

2.5 COMPUTER ENTRY PUNCHES

Three model 020 computer entry punches (fig. 6–5) are associated with the MDI element. These ma-

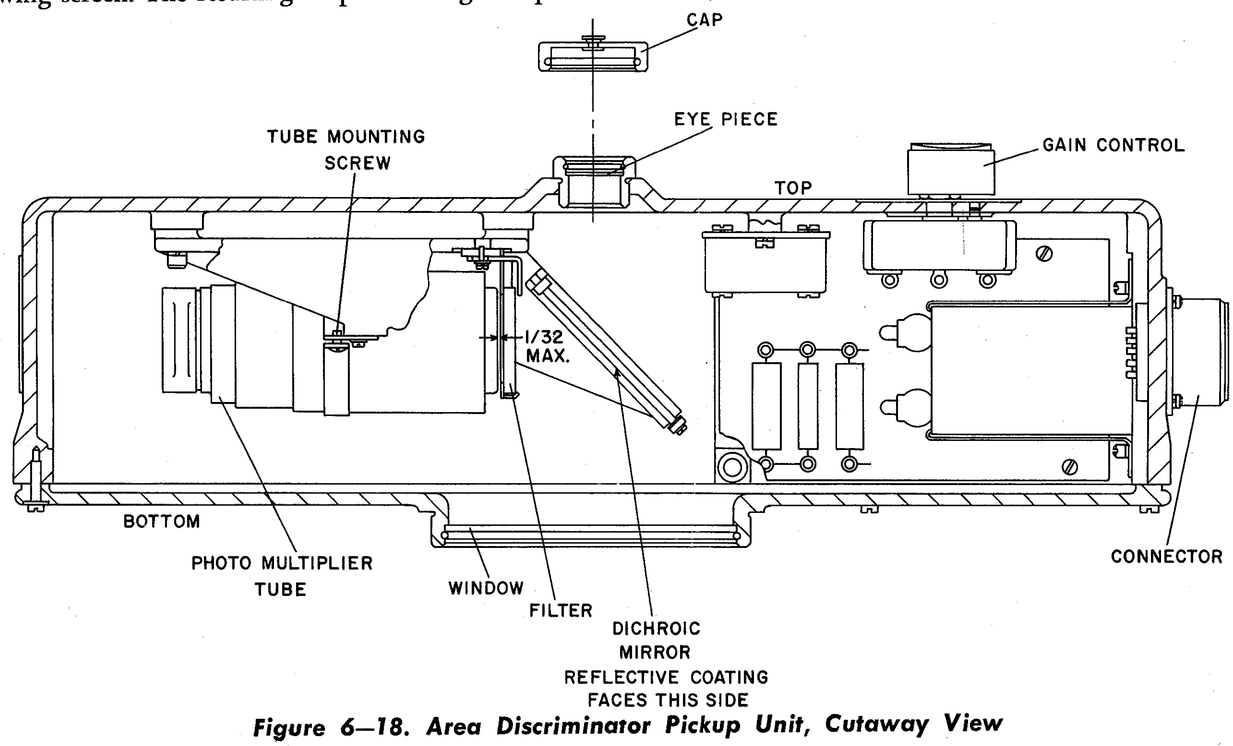


Figure 6–18. Area Discriminator Pickup Unit, Cutaway View

chines 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.

Complete details on the CEP's will be found in the *IBM Data Processing Machines Instruction Manual for the Computer Entry Punch Type 020,* 1 July 1957 edition.

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.

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 indicaton is corrected.

2.6 UNIT STATUS SWITCH

The unit status switch at each console provides the Central Computer with unit status information by operating signal-switching relays in each unit. Other functions performed by the unit status switch are described in Section 1 of Chapter 8, Part 5.

Each console is assigned a core in the MI core matrix (units 23A and 23B). Setting the unit status switch to its active position sets a 1 in its assigned core of the active-designated core matrix and a 0 in the corresponding core of the standby-designated core matrix. When a unit status switch is set to its standby position, an opposite action occurs; a 0 is set in its assigned core of the active-designated matrix and a 1 is set in the corresponding core of the standby-designated matrix. In either case, the condition and location of the unit status core inform the Central Computer, at programmed intervals, of the unit status of each console.

Provision is made to indicate the status of each CEP and Input System channel equipment to the Central Computer in the same manner as that for the auxiliary and SD consoles.

CHAPTER 3

DIRECT ENTRY LOGIC OPERATION

3.1 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.

A theory of operation of the direct entry section on the subsection diagram level (fig. 6–19) is discussed in paragraph 3.2; the discussion is in terms of the main functions performed by this section. The remainder of the chapter concerns a theory of operation on the logic level.

3.2 FUNCTIONAL THEORY OF OPERATION

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.

3.2.1 Data Input

The direct entry section receives four types of data: light gun signals (also sent to the drum entry section), activate signals, keyboard control panel data, and unit status indications. The sources of these inputs, having been discussed in Chapter 2 of this part, are reviewed but briefly at this point.

A properly conditioned light gun responds to a target indication by generating a 10-μsec light gun signal. This level is sent to the core matrix.

Keyboard control panel data is developed by push-

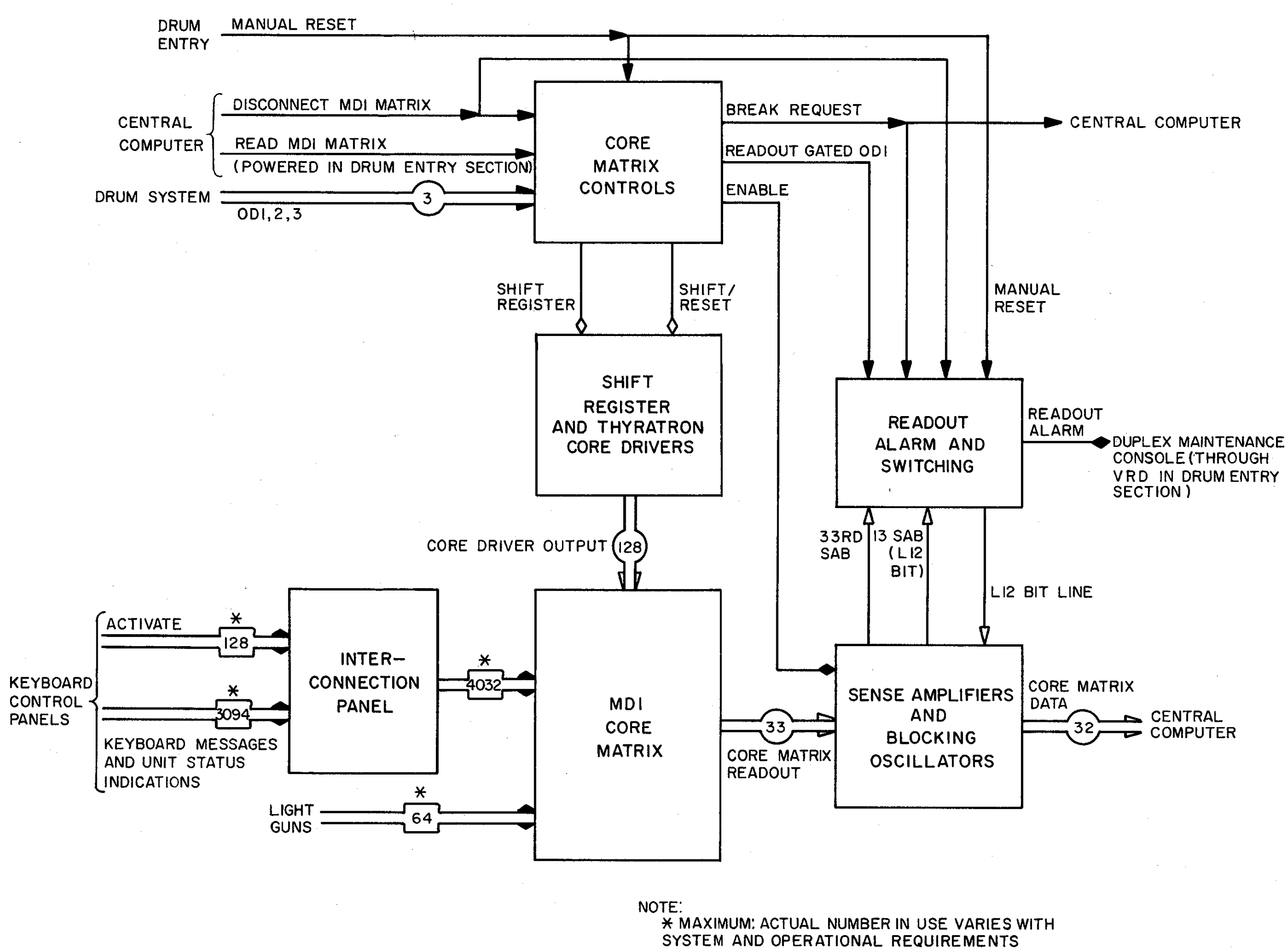


Figure 6–19. MDI Direct Entry Section, Block Diagram

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 pushbutton generates a +10V 35-μsec pulse, sent to the interconnection panel.

Each item of simplex equipment in the active or standby status sends a +10V level as a unit status indication to the interconnection panel associated with the computer in the same status and a —30V level to the other interconnection panel. Thus, if the unit status switch on a display console is set to the standby position and the A computer is standby, a +10V level is sent from the console, as a unit status indication, to the A interconnection panel (unit 28A). A —30V level is sent to the B interconnection panel.

The interconnection panel performs no logic function. It simply routes the lines from the activate, keyboard control panel, and unit status circuits to the proper cores in the core matrix. (Refer to Ch 1 of this part for a physical description of the interconnection panel.)

3.2.2 Data Storage

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 the matrix; a light gun signal sets a 1 in that core. Each activate switch is connected through the interconnection 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 interconnection panel to cores in rows 6 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). Finally, each unit status switch in the active or standby position sets a 1 or a 0 into a core in accordance with the principle described in paragraph 3.2.1. 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 and unit status indication lines. The actual number of cores employed varies with the equipment and its operational requirements.

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 their positions until manually repositioned. Unit status indications are also reinserted into their assigned cores. However, a change in the status of simplex equipment or a channel will change the state of its associated core, and a switch in the status of the duplex machines will switch all unit status cores. Light gun and activate switch cores are not reset after readout.

3.2.3 Data Readout

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 thyratron core driver sub-section. The outputs of the shift register and thyratron core drivers pulse the 128 rows of the core matrix, driving out the contents of one row, as a parallel 33-bit word, every 20 μsec. 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.

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.

3.3 CORE MATRIX CONTROL

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 and thyratron core drivers. The fall of SS 1 sets FF 1 which remains set during the entire readout, conditioning GT 1 and furnishing an enabling level to the sense amplifiers and blocking oscillators. Gate 1, FF 2, and GT 2 form a frequency divider, passing alternate OD 1 pulses to set FF's 3 and 4. Flip-flop 4 is reset by OD 2 pulses. The output of FF 4 is therefore an OD 1-to-OD 2 level, every 20 μsec: sent as a shift level to the shift register and thyratron core drivers.

The output of FF 3 (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.

The disconnect-MDI-matrix command from the Central Computer is passed as a reading-completed signal to the drum entry section, resets FF 1 and FF 2, and triggers SS 2 through OR 5. The resetting of FF 1 discontinues the enabling level to the sense amplifiers and blocking oscillators. The output of SS 2, a 215-μsec level, is processed by a reset circuit into a reset level for the shift register and thyratron core driver circuit.

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.

3.4 SHIFT REGISTER AND THYRATRON CORE DRIVER

The shift register and thyratron core driver circuit (fig. 6–21) reads out the core matrix. It consists of a 128-core shift (CS) register, 128 thyratron core drivers (TCD), one connected to the output of each CS in the register, and 16 core shift drivers (CSD), each driving eight CS's.

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 μsec. 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 μsec reading out 128 rows, or the complete core matrix. The 215-μsec reset pulse (generated by the disconnect-MDI-matrix command or by a manual reset

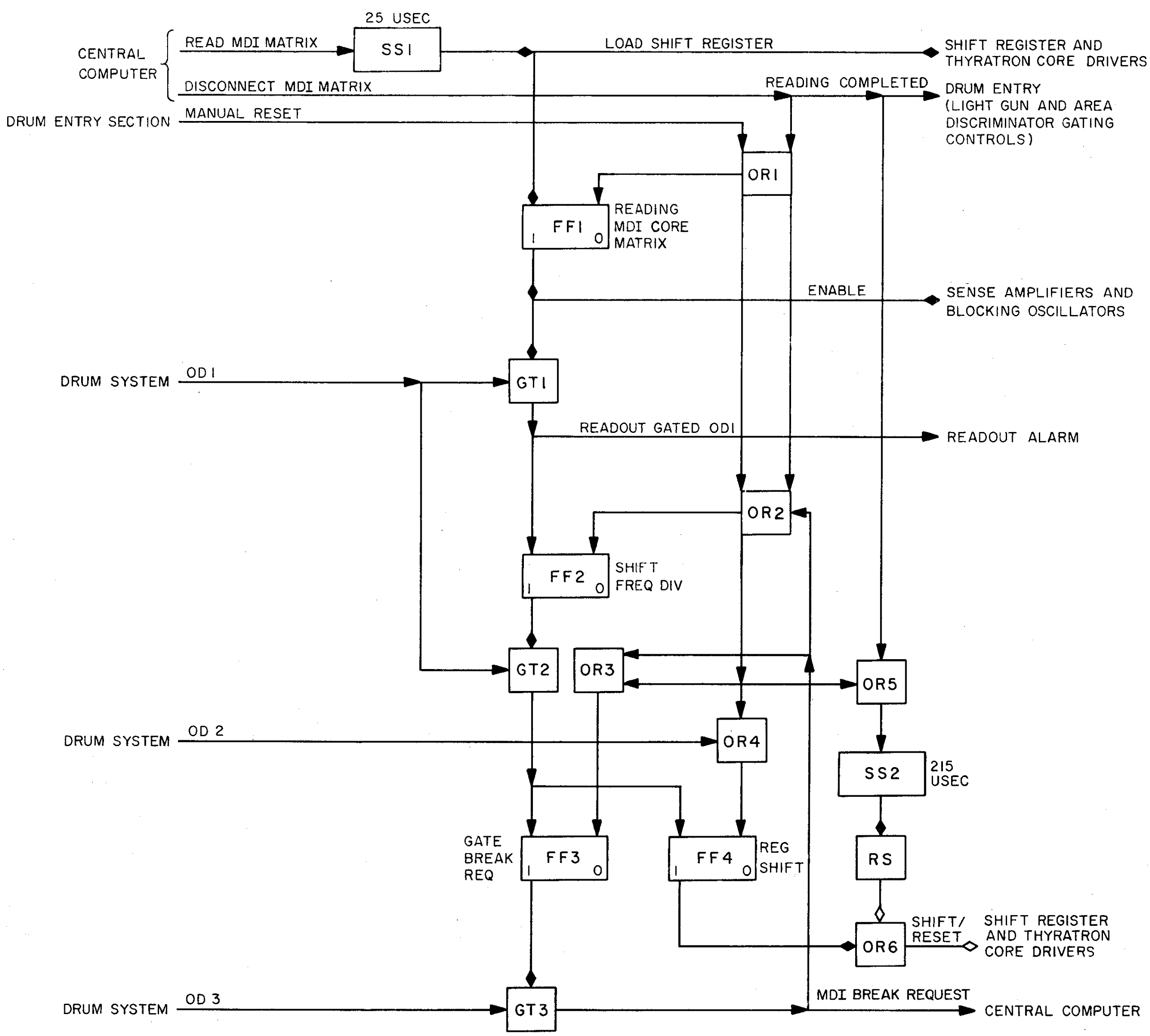


Figure 6–20. Core Matrix Controls, Simplified Logic Block Diagram

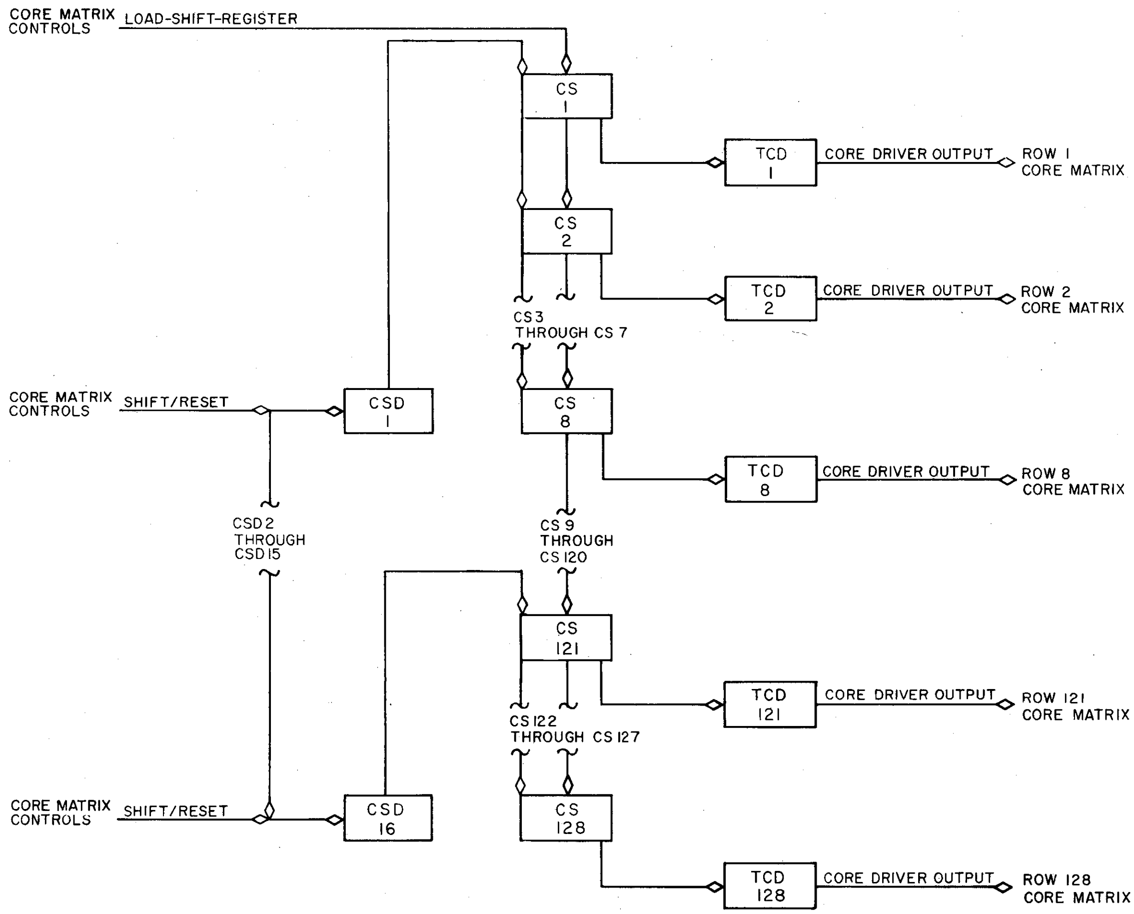


Figure 6–21. Shift Register and Thyratron Core Drivers, Simplified Logic Block Diagram

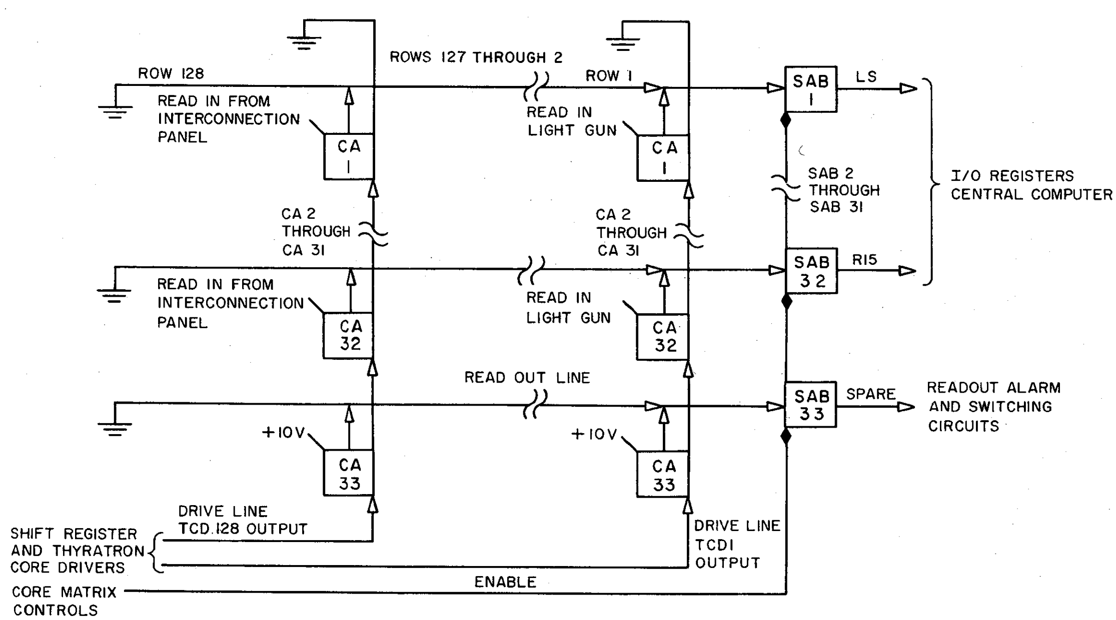


Figure 6–22. Core Matrix, and Sense Amplifier and Blocking Oscillator, Simplified Logic Diagram

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.)

3.5 CORE MATRIX AND SAB CIRCUITS

The core matrix (fig. 6–22) is composed of 128 rows of cores, 33 cores to the row, read out sequentially one row every 20 μsec. Thirty-three buses carry the readout to as many sense amplifiers and blocking oscillators (SAB). The SAB operation is described in the Special Circuits Manual, 3-3-0. 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.

3.6 READOUT ALARM AND SWITCHING CIRCUIT

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-OD 2 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 in 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.

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.

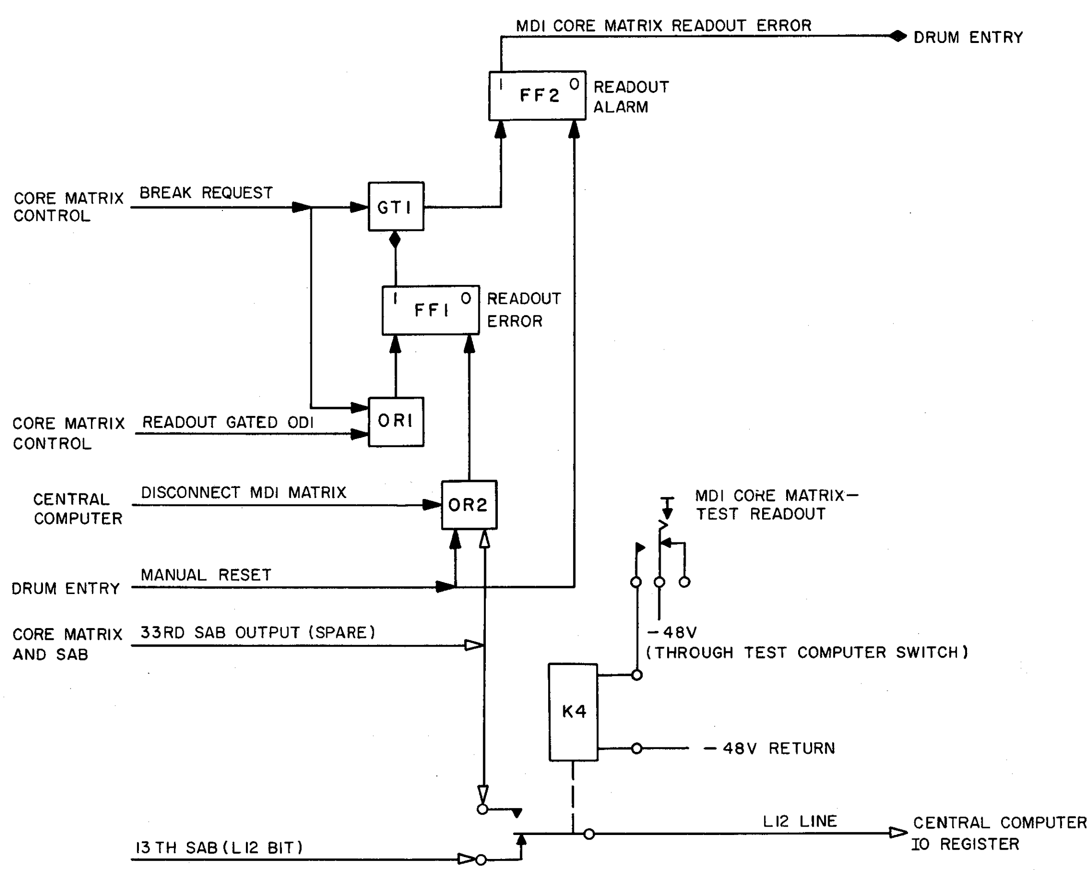


Figure 6–23. Readout Alarm and Switching Circuit, Simplified Logic Diagram

CHAPTER 4

DRUM ENTRY LOGIC OPERATION

4.1 GENERAL

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 or an area discriminator. 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. The drum word format is discussed below. A functional description of the drum entry section, on the subsection diagram level, is presented in paragraph 4.3. The remainder of the chapter is devoted to a theory of operation on the logic level.

4.2 MDI DRUM WORD FORMAT

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 or area discriminator 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)

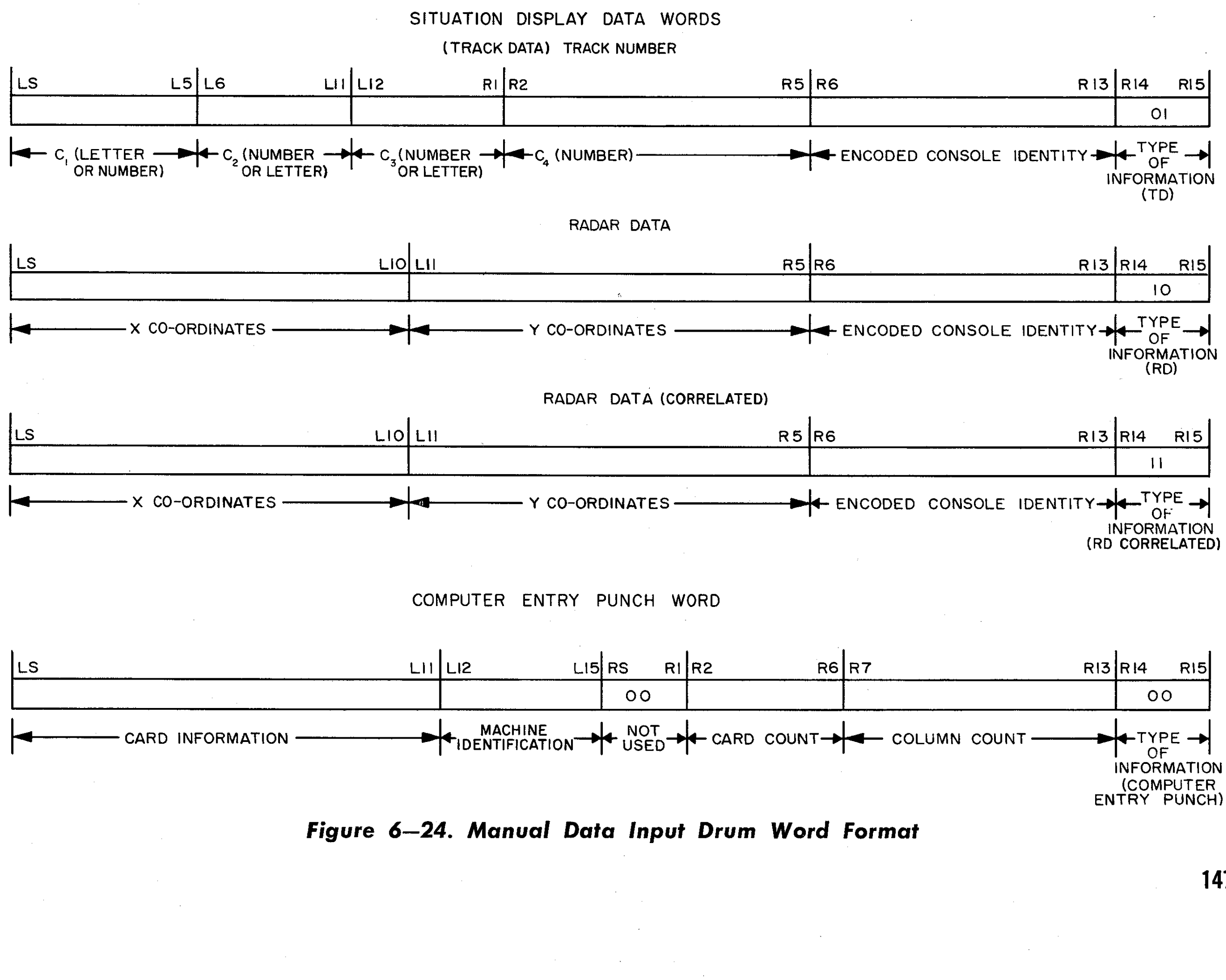


Figure 6–24. Manual Data Input Drum Word Format

4.3 FUNCTIONAL DESCRIPTION

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:

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 or area discriminator responded to a target.
c. Inhibits light gun operation during readout of the core matrix in the direct entry section (Ch 3 of this part).
d. Provides circuits to test the processing of light gun and area discriminator signals.

4.3.1 Subsections of the Drum Entry Section

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.
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.

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, and in the processing of SD data, a further distinction may be made between light gun and area discriminator data. Accordingly, the theory of operation on the subsection diagram level discusses the processing of each type of data separately: light gun, area discriminator, and computer entry punch.

4.3.2 Light Gun Data

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 μsec 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:

a. The MDI core matrix (Ch 3 of this part) 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.)
b. 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).

The pass-light-gun signal is distributed to all light guns, permitting them to respond to the intensified target. At 17.5 μsec, 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 μsec, 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 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.

It is possible for more than one light gun (or for a light gun and an area discriminator) to respond simultaneously to the same target. In that case, two light gun (or a light gun and AD) 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.

Two features in the processing of light gun data warrant 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 area discriminator output, it will be noted below, is not similarly interlocked since the area discriminators are completely independent of the MDI core matrix. (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. In the case of the area discriminators, however, the message "process all unmasked targets" is, in a sense, built into the machine; consequently, area discriminator data need not be related to keyboard data and may flow into the Drum System with no restrictions other than those exercised by the Central Computer.)

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 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

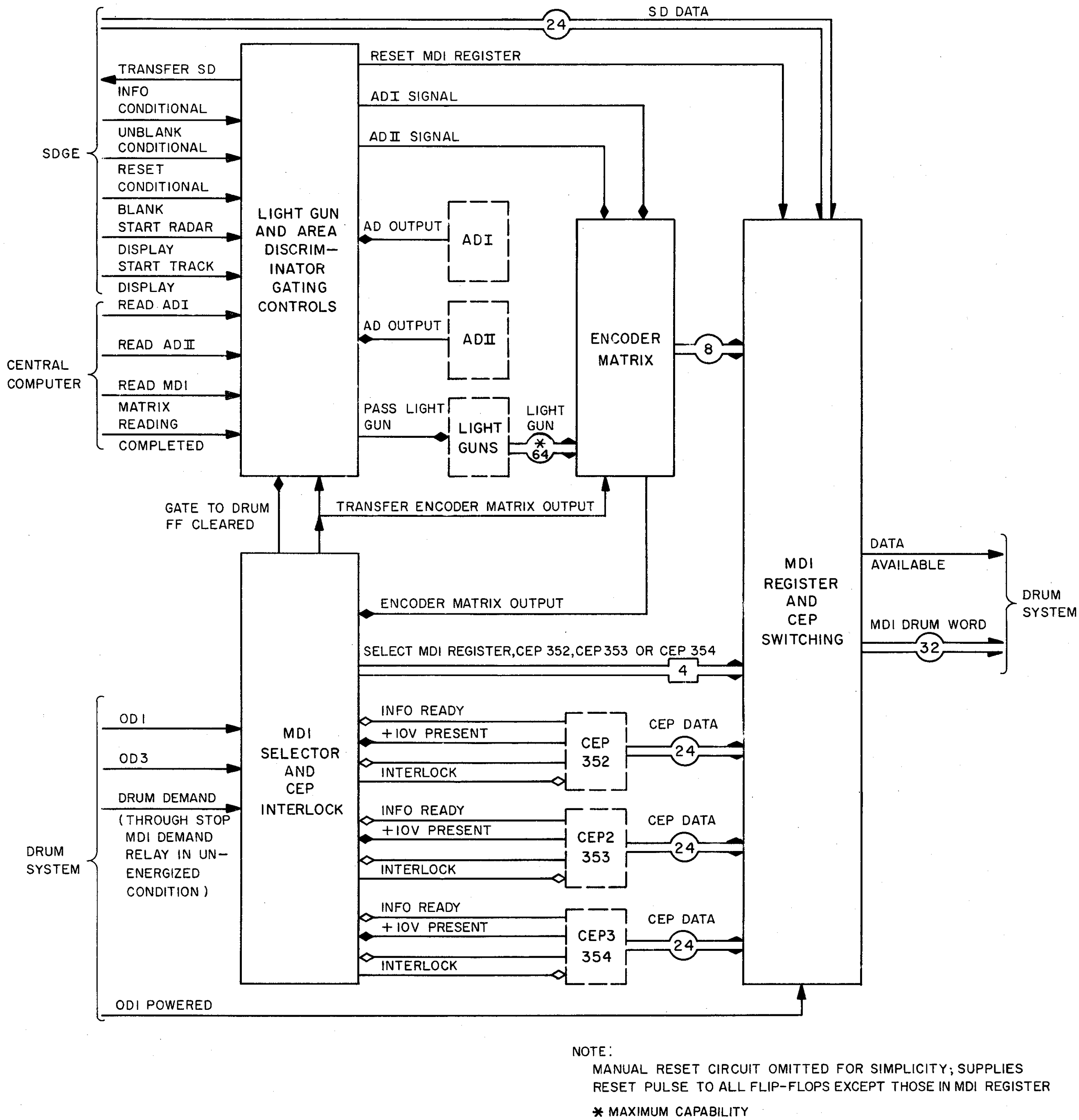


Figure 6–25. Drum Entry Section, Block Diagram

as the conditional-blank pulse will not furnish reliable timing in this application whereas OD timing, being repetitive, does.

4.3.3 Area Discriminator Data

Area discriminator data is introduced into the drum entry section through the response of an area discriminator to a target appearing at an area discriminator console. The processing of area discriminator data is similar to that of light gun data. The major differences are:

a. The flow of area discriminator data is under computer control; operators determine only the area in which targets generate data.
b. The processing of area discriminator data is unrelated to the operation of the MDI core matrix; therefore, there is no equivalent of the pass-light-gun signal.

In present usage, one area discriminator is operative and the other is spare; but circuits for both are provided in the LG and AD gating control subsection so that they may be used concurrently if that is desired. A read-AD II command from the Central Computer, followed by a start-radar-data pulse from the SDGE, activates the circuit for area discriminator II in the LG and AD gating control subsection. The circuit remains active for an entire display cycle; i.e., until the next start-radar-data signal. During this time, the response of an area discriminator to an intensified target sends an AD output pulse to the LG and AD gating control subsection. Fifteen seconds after the start of intensification, the subsection receives a conditional-unblank pulse, and, if a drum word is not already in the MI register awaiting transfer, an AD II signal is sent to the encoder matrix where it generates a 4-out-of-8 bit code, distinctive for area discriminator II. Subsequent action is the same as that in the processing of light gun data. At 17.5 μsec in the intensification period, the MI register is reset; at 22.5 μsec, the 24-bit description of the AD target is transferred from the SDGE to the MI register. OD timing drives the eight bits of console identification into the MI register and the contents of the MDI register into the Drum System.

The circuit for area discriminator I, in the LG and AD gating control subsection, is activated by a Central Computer AD I command, followed by a start-TD signal from the SDGE, and remains active during the entire display cycle; i.e., until the next start-TD signal. In other respects, action of this circuit parallels that of the AD II circuit.

4.3.4 Computer Entry Punch Data

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.

4.3.5 Significance of Priority Control

Drum-demand pulses are sent to the drum entry section at a maximum rate of once every 10 μsec; 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 μsec in the case of radar data and once every 1,040 μsec in the case of track data. On the 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.

4.4 LIGHT GUN AND AREA DISCRIMINATOR GATING CONTROL SUBSECTION

The light gun and area discriminator (LG and AD) gating control subsection (fig. 6–26) controls the flow of SD data (both light gun and area discriminator) through the drum entry section, synchronizing the action of this section with timing and control pulses from the SDGE and with computer commands. Following readout of a word from the MDI register, a gate-to-drum-FF cleared level is furnished GT 1. A conditional-unblank pulse, occurring 15 μsec 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.

Light gun data processing is discussed first. Flip-flop 2 is clear at all times, except during readout of the

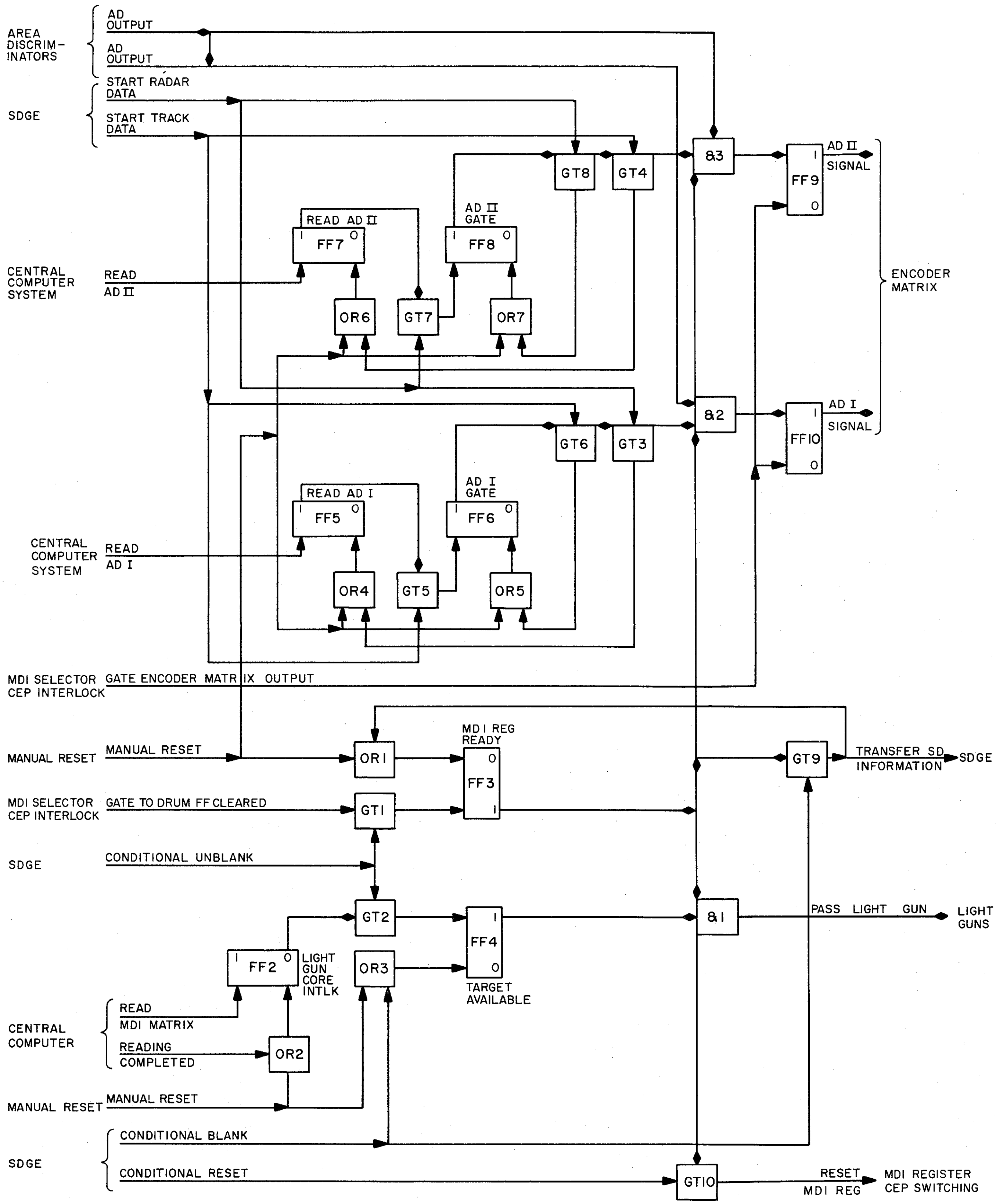


Figure 6–26. Light Gun and Area Discriminator Gating Control, Simplified Logic Diagram

MDI core matrix (Ch 3 of this part) 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 μsec 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 μsec, 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.

AD signals are controlled by logic in the upper portion of figure 6–26. Assume that area discriminator II is operational. A read-AD II signal from the 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 area discriminator's response to a target supplies a second input to AND 3. Fifteen μsec after the start of intensification, the set side of FF 3 supplies the third input to AND 3, setting FF 9, which sends an AD II signal level to the encoder matrix. At 22.5 μsec, FF 3 is cleared, and there is no output from AND 3. The gate-encoder-matrix-output pulse, which transfers the 8-bit console identification from the encoder matrix into the MDI register, also resets FF 9. The action of the circuit is complete with respect to one target and is repeated with the intensification of subsequent targets.

The start-track-data pulse from the SDGE resets FF 7; the following start-radar-data pulse resets FF 8. Area discriminator outputs now have no effect on the circuit, which is quiescent until it receives the next read-AD II signal, followed by a start-radar-data signal.

In present practice, only area discriminator II is employed; the other area discriminator is a physical spare. (For this reason, the AD outputs are tied together.) However, the spare area discriminator can be put to operational use as area discriminator I, if this is desired. The circuit serving this area discriminator (FF's 5 and 6, OR's 4 and 5, GT's 5, 6, and 3, AND 2, and FF 10) operates in the same way as the circuit for area discriminator I, but it is activated by a read-AD I signal (setting FF 5), followed by a start-TD pulse (setting FF 6). The circuit will then process AD output pulses into AD I signals until the next TD pulse is received (resetting FF 6).

4.5 ENCODER MATRIX

On receipt of a light gun signal or an area discriminator 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 or area discriminator responded to a target.

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, and both of the possible AD-signal inputs, are shown. It will be seen in this figure that the AD I signal applies conditioning levels to gates 1, 3, 6, and 8; the AD II signal, to gates 2, 4, 5, and 7. The effects of the eight light gun signals may be similarly traced.

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.

4.6 MDI SELECTOR AND CEP INTERLOCK

The MDI selector and CEP interlock subsection (fig. 6–28) 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.

4.6.1 Situation Display Data Selection

The priority of SD data processing is provided in the following manner. Assume that a light gun or an area discriminator has responded to a target. As explained in paragraph 4.5, this response sends an encoder matrix output level to the MDI selector and CEP interlock subsection. This level, produced 15-plus μsec after the start of target intensification, signifies that the message relating to the target is to be processed; it is

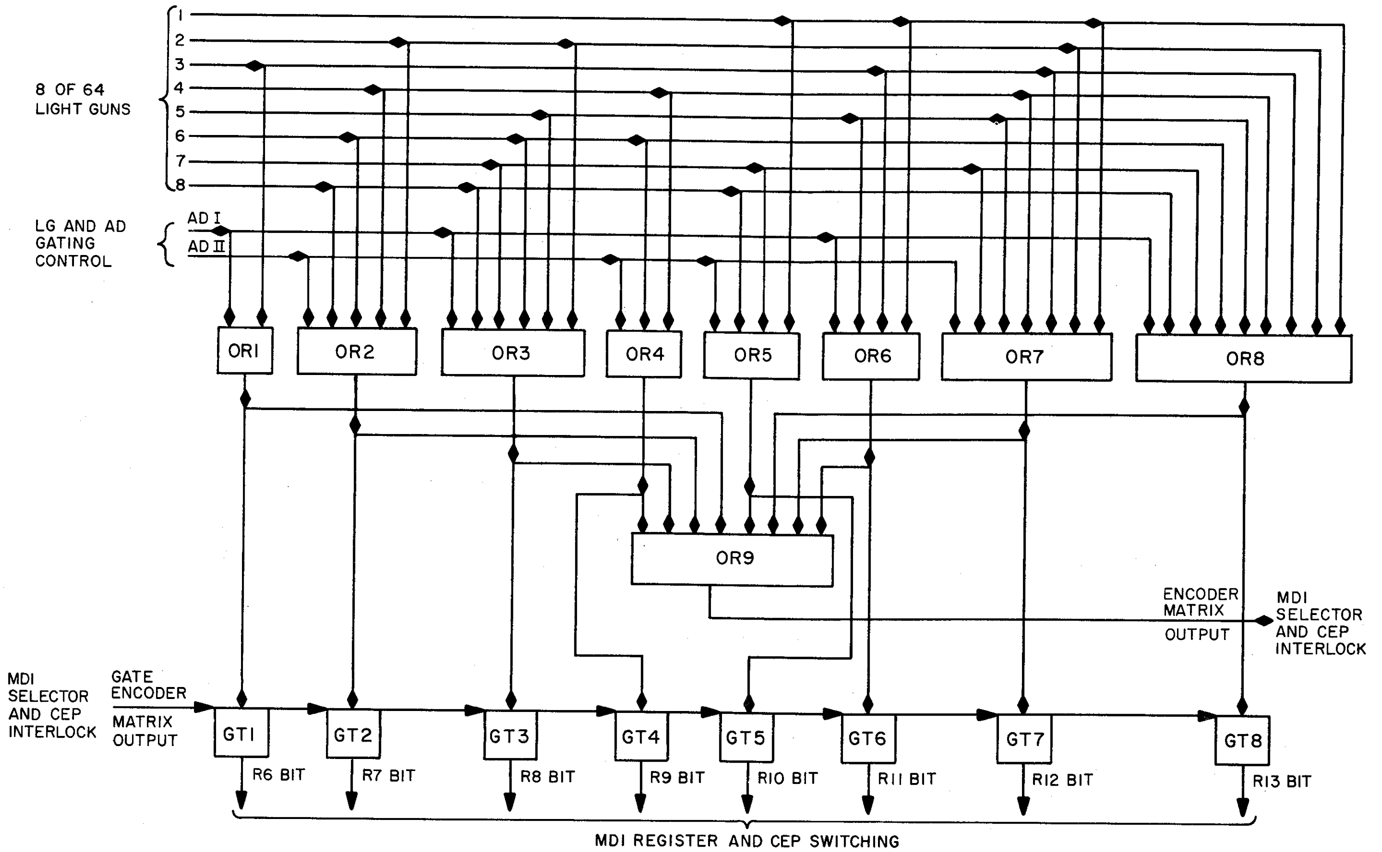


Figure 6—27. Encoder Matrix Subsection, Simplified Logic Diagram

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 μsec later (variable because the relationship between the encoder matrix output level and OD timing is fortuitous), the following effects occur:

a. 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).
b. 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.
c. 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 or AD signals until the contents of the register are transferred to the Drum System.

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, restoring the gate-to-drum-FF-cleared level to the LG and AD gating control subsection. Light gun and AD 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 μsec, GT 3 is conditioned. Thus, each light gun or area discriminator 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.

4.6.2 CEP Data Selection

Assume now that no light gun or area discriminator 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.

Since no light gun or area discriminator 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.

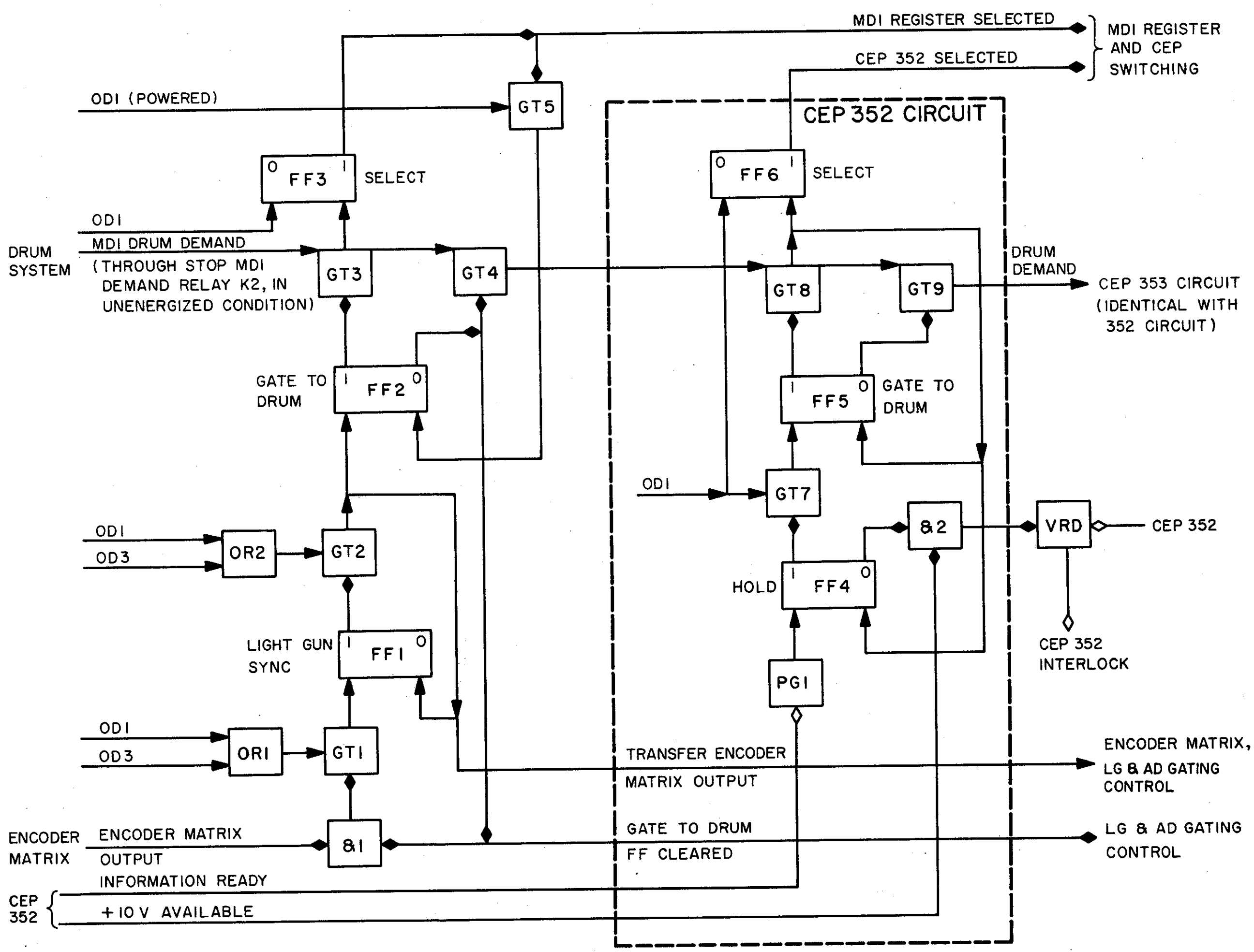
The output of GT 8 also resets FF 4, supplying one input to AND 2. The other input to AND 2, +10V present, is available whenever the CEP is associated by its unit status switch with the duplex half of unit 23 assumed under discussion. The output of AND 2 triggers the VRD, closing the interlock circuit to CEP 352. This permits the machine to advance the punched card to the next column. The pulse generator is then triggered again, 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:

a. Card information is available.

b. Drum-demand pulses are admitted to the CEP 352 selector circuit.

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.



NOTE:
MANUAL RESET CIRCUIT PROVIDES INPUT TO RESET SIDE OF ALL FLIP FLOPS THROUGH OR'S; MANUAL RESET CIRCUIT AND OR'S ARE OMITTED FOR SIMPLICITY

Figure 6–28. MDI Selector and CEP Interlock Circuit

4.7 MDI REGISTER AND CEP SWITCHING SUBSECTION

The MDI register and CEP switching subsection (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.

4.7.1 Situation Display Data Storage and Readout

The MDI register (FF's 1 through 32) is cleared 17.5 μsec after the start of each target intensification by the reset-MDI-register pulse from the LG and AD gating control subsection. At 22.5 μsec of each intensification period, 24 bits of SD data are transferred from the SDGE to FF's 1 through 24. If a light gun or an area discriminator 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

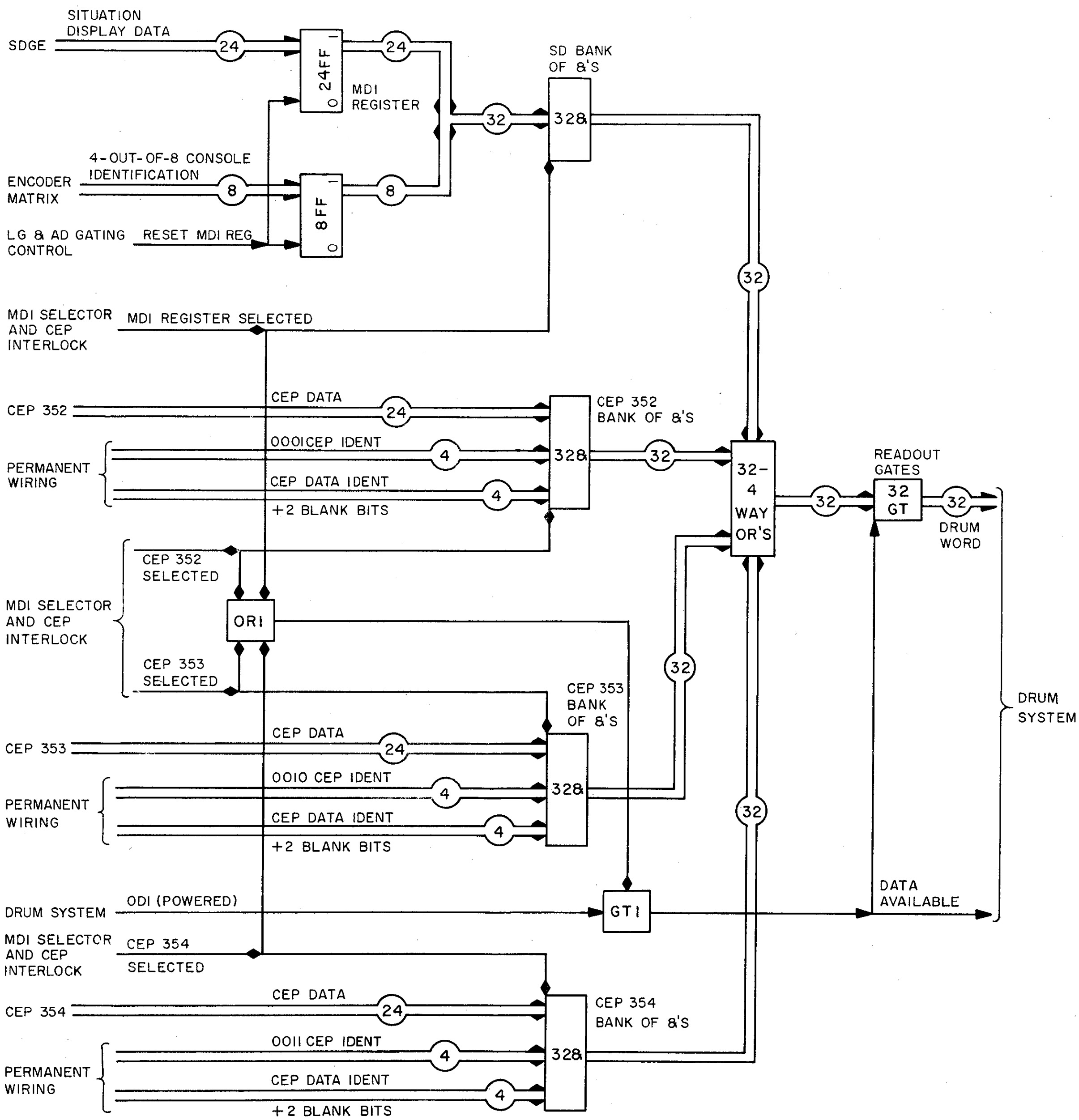


Figure 6–29. MDI Register and CEP Switching, Simplified Logic Diagram

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.

4.7.2 CEP Readout

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.

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.

4.8 MANUAL RESET CIRCUIT

The manual reset circuit consists of a pulse generator and power amplifiers. The pulse generator is triggered by depression of the MASTER RESET pushbutton 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 μsec in every target-intensification period.

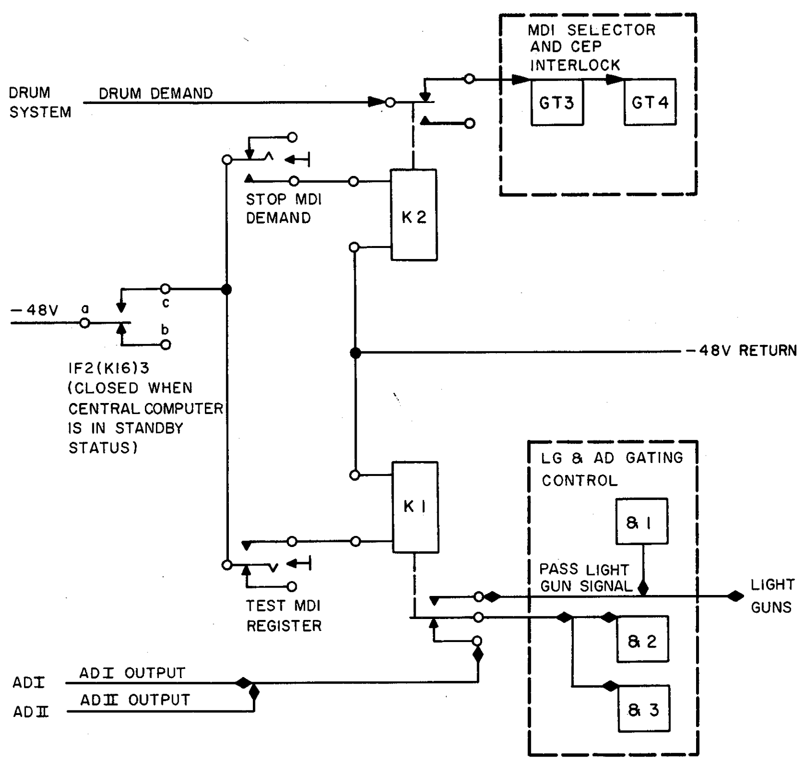


Figure 6—30. Light Gun and Console Intensification Test Circuit

4.9 LIGHT GUN AND CONSOLE IDENTIFICATION TEST CIRCUIT

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 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, substituting for the AD output signals. Activated by a read-AD II command and a pass-RD signal, this subsection operates as described in paragraph 4.4 to transform the pass-light-gun signal into a simulated AD II 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 I command and a start-TD signal will prepare a simulated AD I 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.

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.

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.

PART 7

AN/FSQ-8 COMBAT CONTROL CENTRAL ESSENTIALS

CHAPTER 1

INTRODUCTION

1.1 GENERAL

The preceding parts of this manual have been concerned with the AN/FSQ-7. Part 7 is devoted to the differences between the AN/FSQ-8 and the AN/FSQ-7. This information is necessary because the Q-8 is not just a foreshortened version of the Q-7 but is the Combat Control Central within the SAGE System. As such, it plays the important role of monitoring the activities of its Direction Centers (AN/FSQ-7) in developing the information to analyze the air situation in the areas assigned to the Control Center. The Control Center also exchanges information with adjacent control centers, orders conditions of alert for the area, and provides defense warnings for both civilian and military agencies.

The Display System's function in the Control Central is the same as in the Direction Central; i.e., the presentation of pertinent air-situation information.

1.2 PHYSICAL DIFFERENCES

The dissimilarities between the AN/FSQ-7 and the AN/FSQ-8, as stated in the introduction to this manual, relate to the processing of radar data. Tactically, radar data inputs are unnecessary to the AN/FSQ-8. The exclusion of such data, therefore, makes necessary some changes, deletions, or complete omission of equipments that are logically a part of the AN/FSQ-7. There are no type B or D auxiliary consoles in the Q-8, and because there are fewer consoles, there are fewer cables and distribution boxes. The area discriminator is omitted entirely, and although not outwardly discernable, CAT and DAB plugboards and other controls are affected from a wiring standpoint.

Table 7–1 lists the equipments and quantities that are directly affected by the lack of radar data transfer. A comparison between tables 7–1 and 1–1 (Part 1, Chapter 1) would give those differentials as a complete listing.

1.3 FUNCTIONAL DIFFERENCES

The functional differences in the Q-8 are, like the physical differences, those of omission in that equipment normal to the Q-7 is not in the Q-8. In one instance there is an addition to the Q-8 system, and that is in the Drum System. The RD drum does not exist as such; in its place, by means of circuit modifications, another TD drum was added. This TD drum has been designated TD-B and the other situation display display drum, the TD-A. The field capacity of drum TD-A may be sufficient for site needs, or drums TD-A and TD-B can be employed in alternate sequence operation. In that case, up to six additional fields are available for storage and transfer of track data to the Display System.

Display Data transfer circuits in the Q-8 are discussed in Part 4 of this manual and in Part 6 of manual 3-42-0, *Theory of Operation of Drum System for AN/FSQ-7 Combat Direction Central and AN/FSQ-8 Combat Control Central.* An overall timing approximation of the drum field sequencing circuits can be had from the SD timing cycle shown in figure 7–1.

Another significant circuit change occurs in the TD-RD flip-flop located in unit 24 MT (see logic 4.1.21). A jumper-connector between edge connectors is removed. The removal of this jumper ensures that the flip-flop is never cleared; then the flip-flop will be set to the TD side. The start-RD pulse (see extract of 4.1.21 logic in figure 7–2) is now a TD-6 pulse. To prevent the previous start-RD line now carrying signal TD-6 from clearing the control flip-flop, the connector-jumper is removed in the AN/FSQ-8, as previously mentioned, making certain that only TD circuits are activated.

The same start-RD pulse formerly used to initiate the SD camera and PRR is now, of course, the TD-6 signal.

1.3.1 Digital Display Elements

The major change in the Digital Display System results from reducing the quantity of DDIS's in the Q-8. Lessening the number of DDIS's made necessary a modification of the slot counter. The effect of this change is treated in detail in paragraph 2.1 of this chapter.

1.3.2 Situation Display Elements

The significant changes in the situation display elements are due to the disabling of the RD drum and the additional TD fields employed in its stead. The physical and circuit changes of the drums are given detailed treatment in paragraph 2.2 of this chapter.

1.4 AN/FSQ-8 EQUIPMENT LIST

The equipment units associated with the Display System of the AN/FSQ-8 are listed in table 7–1.

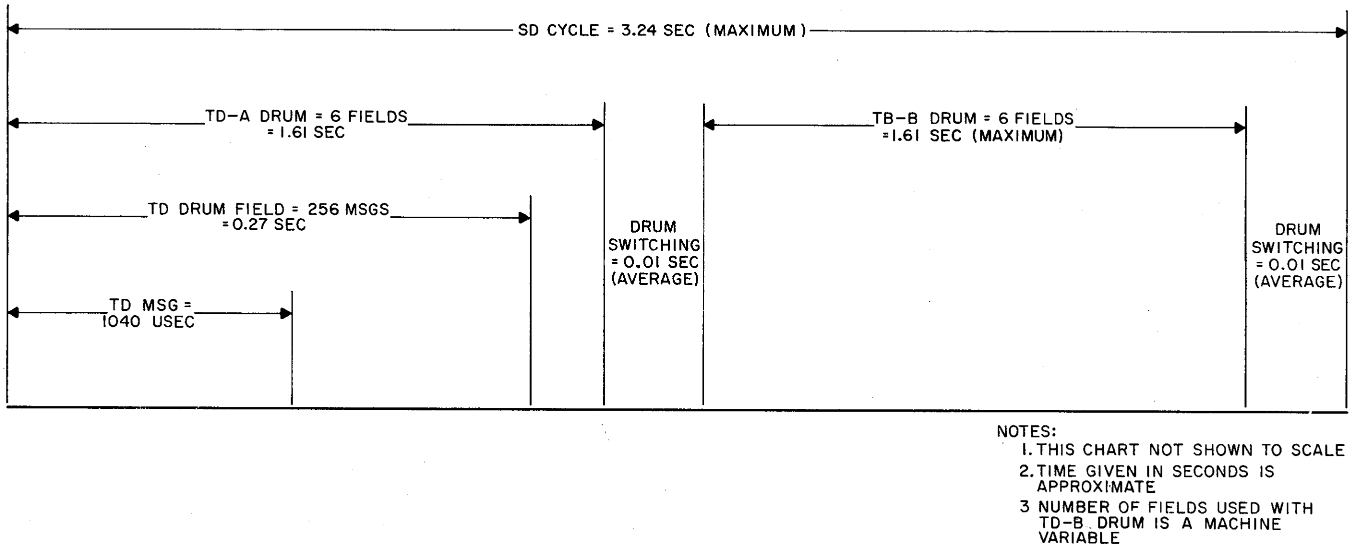


Figure 7–1. Timing Cycle, AN/FSQ-8

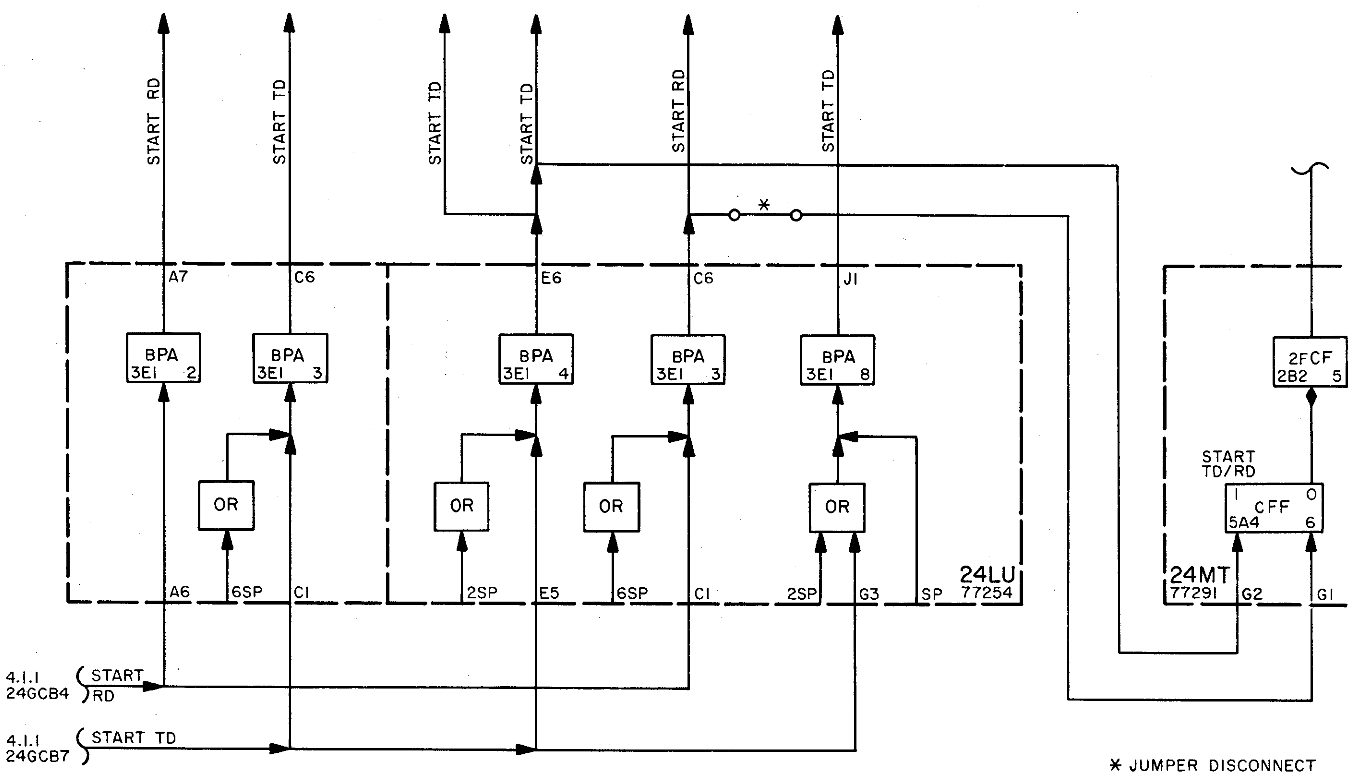


Figure 7–2. Logic Extract of Flip-Flop Disconnect

TABLE 7–1. UNITS ASSOCIATED WITH DISPLAY SYSTEM OF AN/FSQ-8

UNIT NO.	COMMON NAME	AN NOMENCLATURE	CLASS	QUANTITY
1	Duplex Maintenance Console	Duplex Maintenance Console	Duplex	2
22	Main Drum	Main Magnetic Drum Unit	Duplex	2
23	MDI	Manual Data Input Unit SN-169/FSQ	Duplex	2
24	SDGE	Situation Display Generator CV-390/FSQ	Duplex	2
25	DDGE	Digital Display Generator CV-391/FSQ	Duplex	2
28	MI Interconnecting Unit	Manual Data Interconnecting Unit J-726/FSQ	Duplex	2
30	Warning Light Data Storage Unit	Warning Light Data Storage Unit RD-31/FSQ	Duplex	2
45	Duplex Switching	Computer Switching Control C-2045/FSQ	Duplex	2
		Power Supply Set Control C-2046/FSQ	Duplex	2
47	Simplex Maintenance Console	Simplex Maintenance Console OA-1010/FSQ	Simplex	1
91	Warning Light Interconnecting Unit	Warning Light Interconnecting Unit J-727/FSQ	Simplex	1
177, 178	Patching Panel	Panel, Patching Signal Data SB-602/FSQ	Duplex	4
250	Command Post Console	Command Post Console OA-1013/FSQ	Simplex	1
251, 252	PRR	Recorder-Reproducer, Photographic KD-6 (1)	Simplex	2
352, 353	CEP	IBM 020 Computer Entry Punch	Simplex	2
	Aux Console	Auxiliary Display Console OA-1287/FSQ	Simplex*	16
	DB Box	Signal Distribution Box	Duplex	5
	DD Unit	Digital Display Unit (SD Console) IP-350/FSQ	Simplex	24
		Digital Display Unit (CP Console) IP-384/FSQ	Simplex	11
		Digital Display Unit (Type C Aux Console) IP-385/FSQ	Simplex	13
	Light Gun	Light Gun, Data Selecting MX-1900/FSQ	Simplex	31
	Optical Pointer	Lecture Pointer, Electrical MX-2090/FSQ	Simplex	10
	SD Console	Situation Display Console OA-1008/FSQ	Simplex**	33
	Semiautomatic Camera	Still Picture Camera KD-16A	Duplex	2
	Side Wing	Control Panel, Input Data Selection C-1825/FSQ	Simplex	21

**Units 45, 174, and 175 are duplex.*
***Units 167, 168, and 171 are duplex.*

CHAPTER 2
DISPLAY SYSTEM VARIANTS

2.1 DIGITAL DISPLAY ELEMENTS

The DDE's of the Display System in the AN/FSQ-8 operate in the same manner as those described in Part 3. However, since a lesser number of DDIS's are employed, modification of the slot counter was necessary. The display slots are divided into group 1 and group 2. Group 1 includes 66 slots designated 0 through 65. Group 2 includes 62 slots designated 66 through 127. The display slots in group 2 have not been assigned.

2.1.1 DDIS Selection

Each DDIS is selected for intensification only during the time that information for its display is being processed. Selection of a DDIS for intensification is a function of the count of the slot counter. The outputs of the slot counter (slot lines A and B at an up level), combined with the DD intensify gate from the DD timing and control circuit, produce an intensification gate in the DD erase and intensification circuit of the selected DDIS (see fig. 3–7, foldout). At the same time that the DDIS is intensified, the same up level slot lines are employed with a DD erase gate to erase a DDIS that will be intensified at some later count of the slot counter.

The A slot lines to the DDIS transmit 16 outputs from the A slot counter. These outputs are labeled 0 through 15. Up levels advance from this counter, in sequence, from 0 through 15. When the A counter advances from 15 to 0, the B counter is advanced one count.

The B slot lines are generated by the B slot counter and consist of eight possible outputs. Only one output can have an up level at any given time. The up level can advance in sequence from 000 through 700.

In each DDIS, the slot line signals corresponding to the assigned slot are called intensification-selection-A and intensification-selection-B signals. Correlation of A and B slot line assignments for intensification and erasure is shown in table 7–2.

2.1.2 Slot Counter Circuit Operation

The slot counter contains two ring counters (A and B) that are used to select in sequence the digital display indicator sections for intensification and erasure. Figure 7–3 is a simplified logic diagram of the slot counter with the outputs going to the line driver circuit. The A counter (0 through 15 count) is composed of FF 1 through FF 4, GT 1 through GT 4, and the 16 AND's (only three are shown) that are fed by the flip-flops. The B counter (000 through 700) consists of FF 5 through FF 7, GT 5 and GT 6, and the eight AND's (only three are shown) that are fed by the flip-flops. Each of the AND's in the counters has its inputs from the flip-flops so arranged that only one AND of each counter develops an output at a given time. For example, if the A-counter flip-flops are all set to 0 and the B-counter flip-flops are set to 100, the AND's associated with the 0 and 100 lines contain outputs.

The master control circuit generates the signals to start the display cycle as a result of either an initiate-DD-1 or initiate-DD-2 signal from the Central Computer. With the initiate-DD1 signal, the common-clear-slot-counter and clear-slot-counter signals are fed to the slot counter to set the counter for DD-1 operation (clears counter to 0). However, with the initiate-DD-2 signal, the common-clear-slot-counter and preset-slot-counter signals are sent to the slot counter for DD-2 operation (presets counter to 66).

The A counter will advance a count of one every time a new-slot pulse (add-one-to-slot-counter) arrives from the control bit sensing circuit. If the counter is set to 0 (DD-1 operation), the first input pulse will set FF 1 to 1, resulting in an output from AND 1. The next new-slot pulse will set FF 2 to 1 through conditioned GT 1 and set FF 1 to 0 (complement input). This action produces an output from AND 2. Each succeeding pulse will advance the A counter one count. After 15 new-slot pulses, all the A counter flip-flops will be set to 1 and the line-15 AND produces an output. The next new-slot pulse (the 16th) will set all the A counter flip-flops back to 0, and the 0-line AND will once again have an output. In addition, the 16th new-slot pulse will set FF 5 to 1 and the line-100 AND produces an output. The B counter will advance one step whenever the A counter goes from line-15 output state to the line-0 output state. The slot counter functions in the same manner for DD-2 operation with the exception that the counting action starts with the slot counter preset to a count of 66 (A counter set to 2, B counter set to 400).

In addition to performing DDIS selection functions, the outputs of AND 1 and AND 400 are fed to the master control circuit as end-slot-DD-1 and end-block-DD-1 signals, respectively. These signals, combined with the end-word signal, produce a stop-DD pulse in the master control circuit to end the DD-1 dis-

TABLE 7–2. SLOT LINES FOR INTENSIFICATION AND ERASE SELECTION, AN/FSQ-8

SLOT LINES		SLOT NUMBER	
A	B	INTENSI-FICATION	ERASURE
0	000	0	1–10
1	000	1	11
2	000	2	12
3	000	3	13
4	000	4	14
5	000	5	15
6	000	6	16
7	000	7	17
8	000	8	18
9	000	9	19
10	000	10	20
11	000	11	21
12	000	12	22
13	000	13	23
14	000	14	24
15	000	15	25
0	100	16	26
1	100	17	27
2	100	18	28
3	100	19	29
4	100	20	30
5	100	21	31
6	100	22	32
7	100	23	33
8	100	24	34
9	100	25	35
10	100	26	36
11	100	27	37
12	100	28	38
13	100	29	39
14	100	30	40
15	100	31	41
0	200	32	42
1	200	33	43

TABLE 7–2. SLOT LINES FOR INTENSIFICATION AND ERASE SELECTION, AN/FSQ-8 (cont'd)

SLOT LINES		SLOT NUMBER	
A	B	INTENSI-FICATION	ERASURE
2	200	34	44
3	200	35	45
4	200	36	46
5	200	37	47
6	200	38	48
7	200	39	49
8	200	40	50
9	200	41	51
10	200	42	52
11	200	43	53
12	200	44	54
13	200	45	55
14	200	46	56
15	200	47	57
0	300	48	58
1	300	49	59
2	300	50	60
3	300	51	61
4	300	52	62
5	300	53	63
6	300	54	64
7	300	55	
8	300	56	
9	300	57	
10	300	58	
11	300	59	
12	300	60	
13	300	61	
14	300	62	
15	300	63	
0	400	64	
1	400	65	
Used for DDGE timing and initial erase of group 2		66	
Group DD 2 — not assigned		67–127	

play cycle. The outputs of AND 15 and AND 700 (end-slot-DD-2 and end-block-DD-2, respectively) are employed in a similar manner to end the DD-2 display cycle.

2.2 SITUATION DISPLAY ELEMENTS

The situation display elements of the Display System in the AN/FSQ-8 are much the same as in the Q-7. The more significant changes have already been mentioned in paragraph 1.3, and, as previously explained, the AN/FSQ-8 Combat Control Central has been designed and equipped to perform every function of the AN/FSQ-7 except the processing of radar data.

2.2.1 TD-A and TD-B Drums

In the situation display elements, the drums reflect a greater change because of the lack of radar data transfer than any other element. The Drum System in the Q-8 equipment, although practically identical in design to the Q-7, has no drum facilities for radar data transfer.

In the Q-8, what would normally be the RD drum is disabled. To make use of the storage space thus made available, circuit changes to the drums have been made. As a result of these changes, the TD drum is now designated the TD-A drum and the additional TD drum made available is called the TD-B drum. The two drums can be operated in alternate sequence, or, where the field capacity of the TD-A drum would be sufficient, the TD-A alone would be employed.

2.2.2 Other Circuit Changes

A major circuit change is effected when the jumper connecting edge connector 24MT4g to edge connector 24MT3g is removed. This jumper-connector is removed to prevent the previous start-RD line, now conducting signal TD 6, from clearing the control TD RD flip-flop. (See fig. 7–2.)

With removal of the jumper the flip-flop is set to the TD side, insuring only the activation of TD circuits.

The supplementary driver signals differ to some extent from those in the AN/FSQ-7. Table 7–3 lists the supplementary driver signals and their generative sources. A comparison with table 4–9, the Q-7 counterpart in Part 4, will reveal the complete changes.

2.2.3 Other Equipment Changes

The area discriminator, described in Chapter 2 of Part 6, is employed in the Q-7 to automatically initiate the tracking of uncorrelated RD messages. Since radar data messages are not processed in the Q-8, there is no area discriminator in the Combat Control Central.

There are no special input data control panels on the AN/FSQ-8.

2.3 ASSOCIATED EQUIPMENT

Most of the associated equipment employed in the AN/FSQ-8 is the same as that used on the Q-7. The equipments that differ significantly in the Q-8 are discussed in the following paragraphs.

2.3.1 SD Camera Element

The differences that exist between the SD camera element of the AN/FSQ-8 and of the SD camera element employed in the AN/FSQ-7 are a result of the absence of radar inputs to the Q-8. It is for this reason that the start-RD pulse is replaced with a start-TD-6 pulse (see line 7 of the Q-7 SD camera timing diagram in fig. 5–52, foldout). The start-TD-6 pulse occurs at the start of the third field of the TD-A drum. The time interval between the start-TD pulse and the start-TD-6 pulse is fixed at 0.54 second; however, the time interval between the start-TD-6 and start-TD pulses is variable. This later time depends on the number of fields selected in the TD-B drum (see fig. 7–1), and it can vary from a minimum of 1.06 seconds to a maximum of 2.66 seconds. Therefore, all timing pulses shown in figure 5–52 that are dependent on this variable time interval will also vary accordingly. Except for the time and pulse differences discussed in this paragraph, the operation of the SD camera is the same as that described in Chapter 4 of Part 5.

2.3.2 Display Tester Element

The display tester element (DTE) performs the same function in the Combat Control Central Display System as in the Combat Direction Central; namely, to simulate drum display signals for maintenance purposes. Refer to Chapter 9 of Part 5 for a detailed discussion of the DTE. The logic operation of the DTE in the AN/FSQ-8 is identical to that of the AN/FSQ-7 with the exception that there is no need to set up RD messages on the DTE toggle switch panel. The DTE circuits associated with RD test operation are nevertheless retained for purposes of design conformity but are never activated.

2.4 MANUAL DATA INPUT ELEMENT

The manual data input element of the Combat Control Central is similar to that in the Combat Direction Central. (Refer to Part 6 for the MDI element theory of operation.) The Combat Control Central employs a smaller number of certain input devices and circuits, such as light guns, keyboard control panels, and unit status circuits. However, Part 6 describes the MDI element in terms of its maximum capabilities with respect to input lines, and these capabilities remain the same in the Combat Control Central.

The differences between the Combat Control Central and the Combat Direction Central which do affect theory of operation are described below.

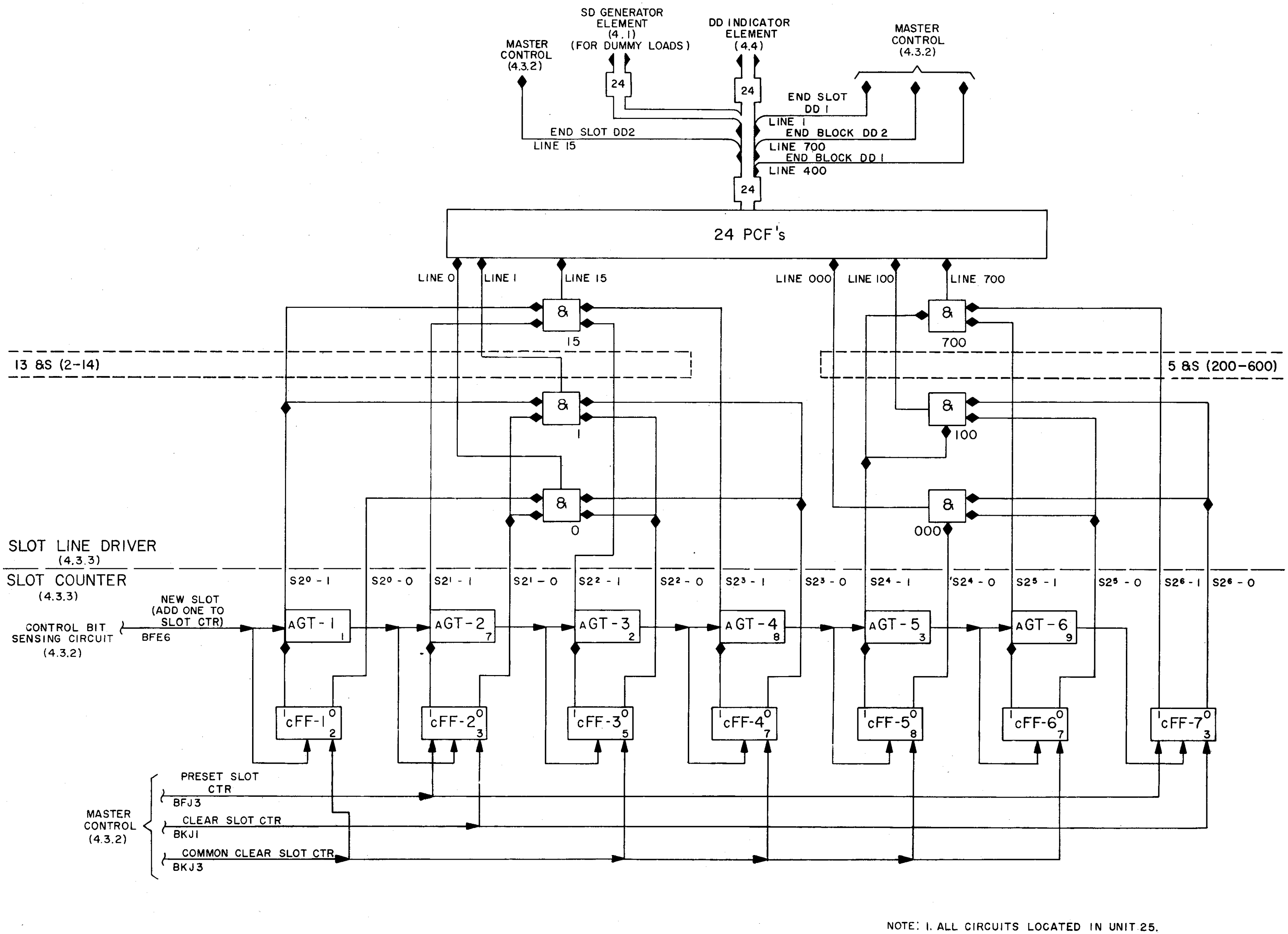


Figure 7—3. Slot Counter and Slot Line Drivers (AN/FSQ-8), Logic Diagram

2.4.1 Computer Entry Punch Circuits

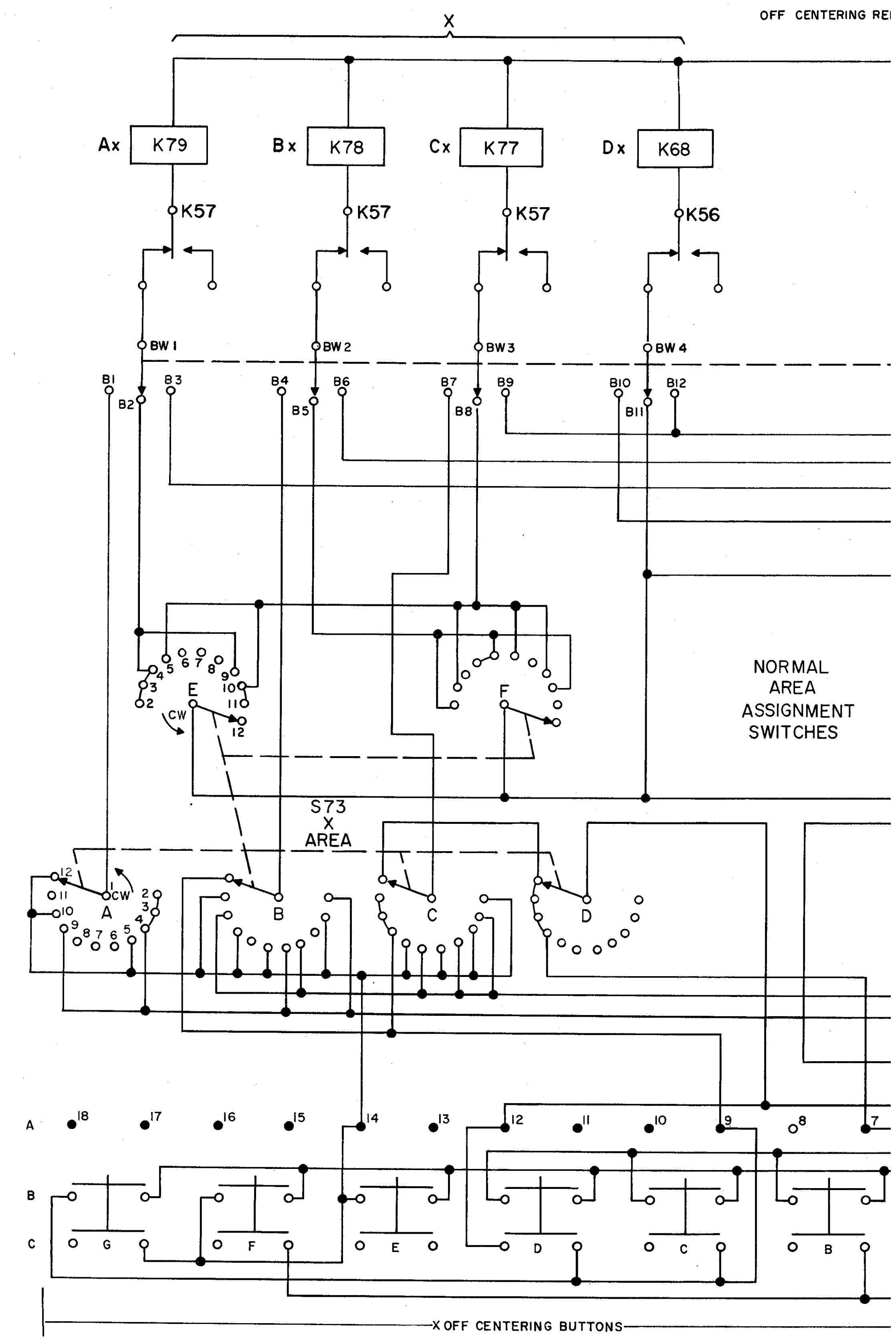
Only two computer entry punches are employed in the Combat Control Central. The circuit required to service a third CEP is retained as spare for purposes of design uniformity, but it is not operational. These spare circuits are located in the MDI selector and CEP interlock, and the MDI register and CEP switching subsections. They are used to process CEP 354 data in the Q-7.

2.4.2 Area Discriminator Circuits

No area discriminators are provided in the Combat Control Central. However, the circuits which process the outputs of the area discriminator are retained. These circuits are found in the light gun and area discriminator gating control subsection, described in Chapter 4 of Part 6 and illustrated in figure 6–26. The circuits are used in the light gun and console identification test procedures described in 4.9 of that chapter and illustrated in figure 6–30. In the test procedures, the pass light gun signal is employed as a simulated area discriminator output; when the TEST MDI REGISTER switch (fig. 6–30) is operated, the pass light gun signal is applied to AND 2 and 3, in place of the AD output signals. A start-TD-6 pulse replaces the start-radar-data signal, (which is unavailable in the Combat Control Central) and the Central Computer provides programmed read-AD-I and read-AD-II signals. Operation of the circuit is then the same as in the Combat Direction Central. The circuit supplies simulated AD-I and AD-II signals sequentially to the encoder matrix. Together these signals thoroughly exercise the encoder matrix and provide indications of the reliability of the console identification circuits. Refer to Chapter 4 of Part 6 for the detailed theory of operation.

TABLE 7–3. GENERATION OF SUPPLEMENTARY DRIVER SIGNALS, AN/FSQ-8

SUPPLEMENTARY DRIVER	GENERATED BY	SUPPLEMENTARY DRIVER	GENERATED BY
1	Not used	22	TD CAT's 19, 20, 21, 22
2	Not used	23	Not used
3	Not used	24	Not used
4	TD CAT's 6, 7	25	TD CAT's 19, 21
5	TD CAT's 6, 7, 8	26	TD CAT's 20, 22
6	TD CAT's 11, 12, 13	27	TD CAT's 19, 20, 23
7	Not used	28	TD CAT's 16, 18
8	TD CAT's 15, 17	29	TD CAT's 16, 17
9	TD CAT's 15, 18	30	TD CAT's 21, 22
10	Not used	31	TD CAT's 24, 25
11	Not used	32	Not used
12	Not used	33	Not used
13	TD CAT's 15, 16, 17, 18	34	TD CAT's 3, 4, 5
14	TD CAT's 19, 20	35	TD CAT's 3, 4, 5
15	SUPL DRIVER 13 (TD CAT's 15, 16, 17, 18) SUPL DRIVER 14 (TD CAT's 19, 20), TD CAT's 21, 22, 24, 25	36	TD CAT's 9, 10
		37	Not used
		38	Not used
		39	Not used
16	TD CAT's 26, 27	40	TD CAT's 3, 4
17	TD CAT's 27, 28	41	TD CAT's 3, 4
18	TD CAT's 26, 27, 28	42	TD CAT's 12, 13
19	Not used	43	Not used
20	Not used	44	Not used
21	Not used	45	Not used


X
OFF CENTERING RE
Ax K79
Bx K78
Cx K77
Dx K68
K57
K57
K57
K56
BW 1
BW 2
BW 3
BW 4
NORMAL AREA ASSIGNMENT SWITCHES
S73 X AREA
X OFF CENTERING BUTTONS

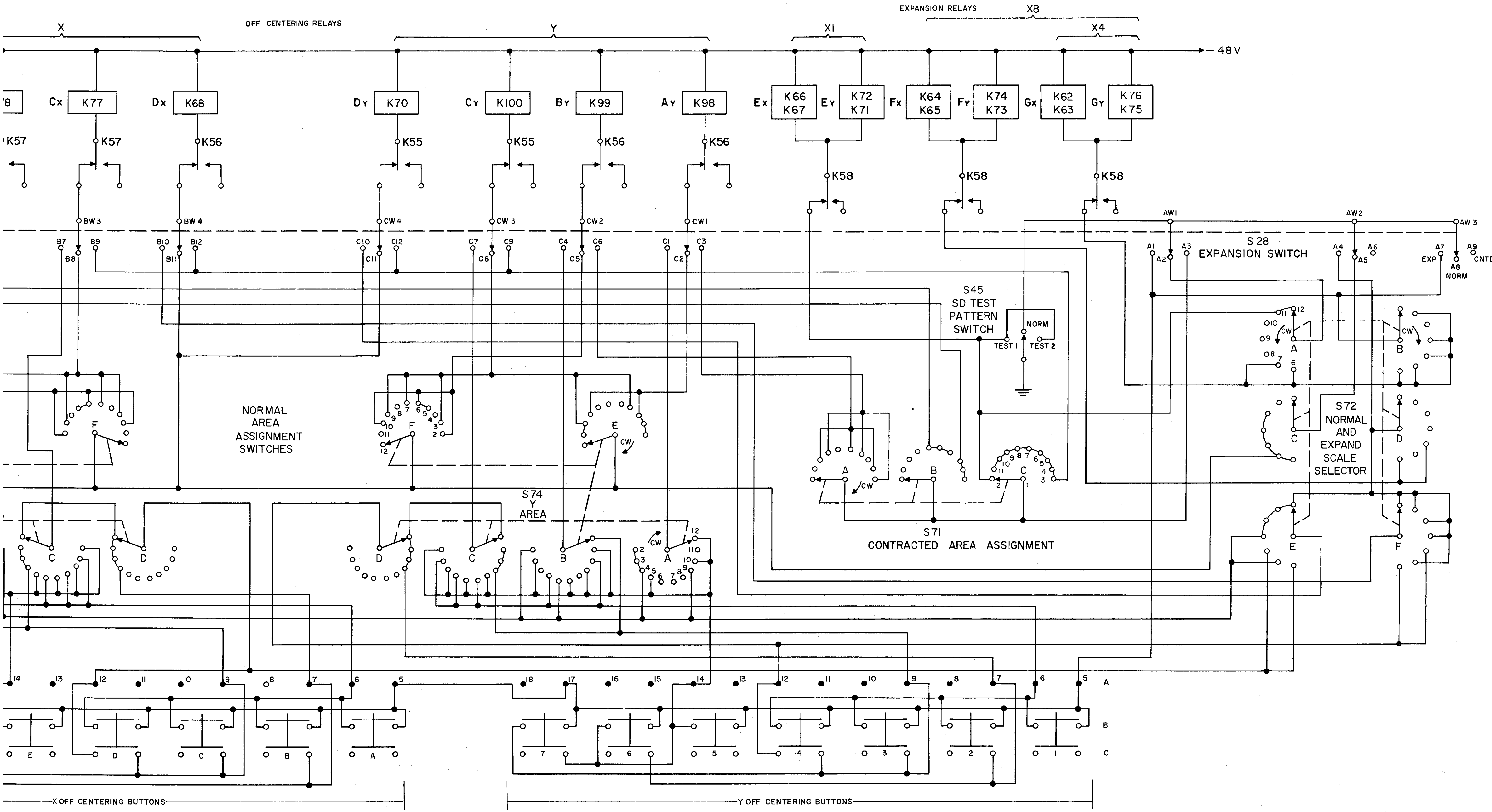
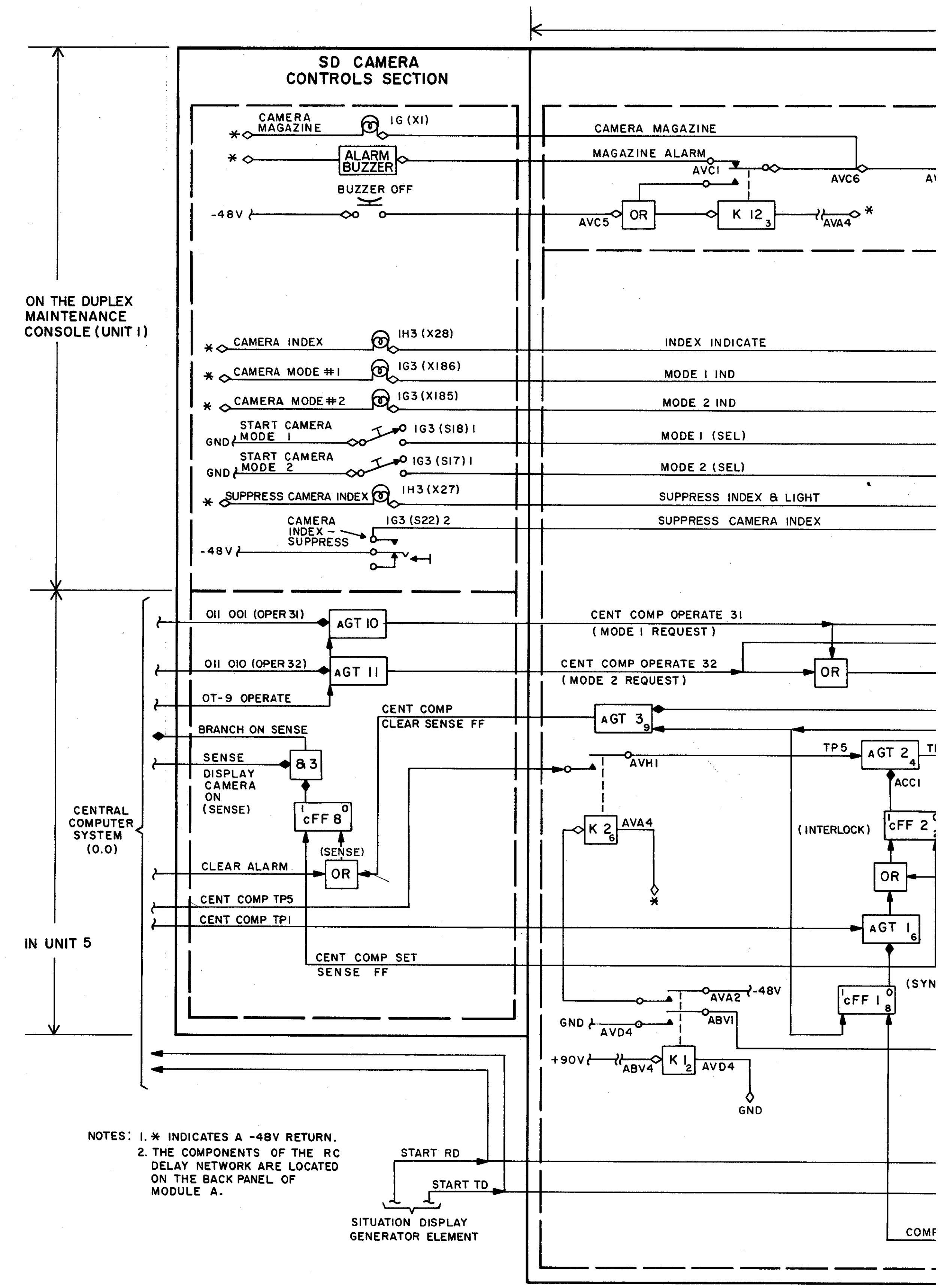


Figure 5-21. PRRE Expansion and Off-Centering Rotary Switches, Schematic



NOTES: 1. * INDICATES A -48V RETURN.
2. THE COMPONENTS OF THE RC DELAY NETWORK ARE LOCATED ON THE BACK PANEL OF MODULE A.

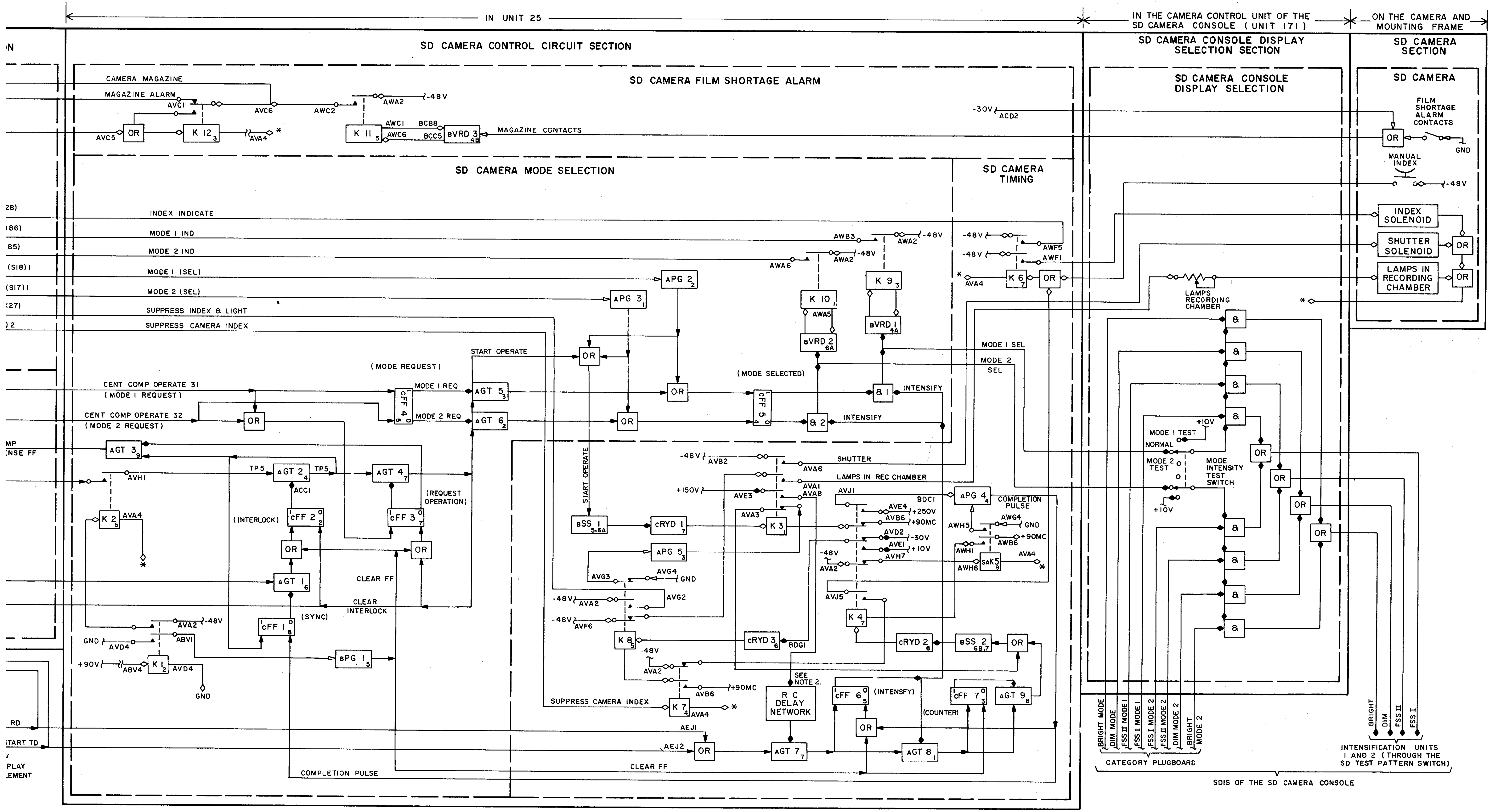


Figure 5–51. Situation Display Camera Element, Logical Diagram

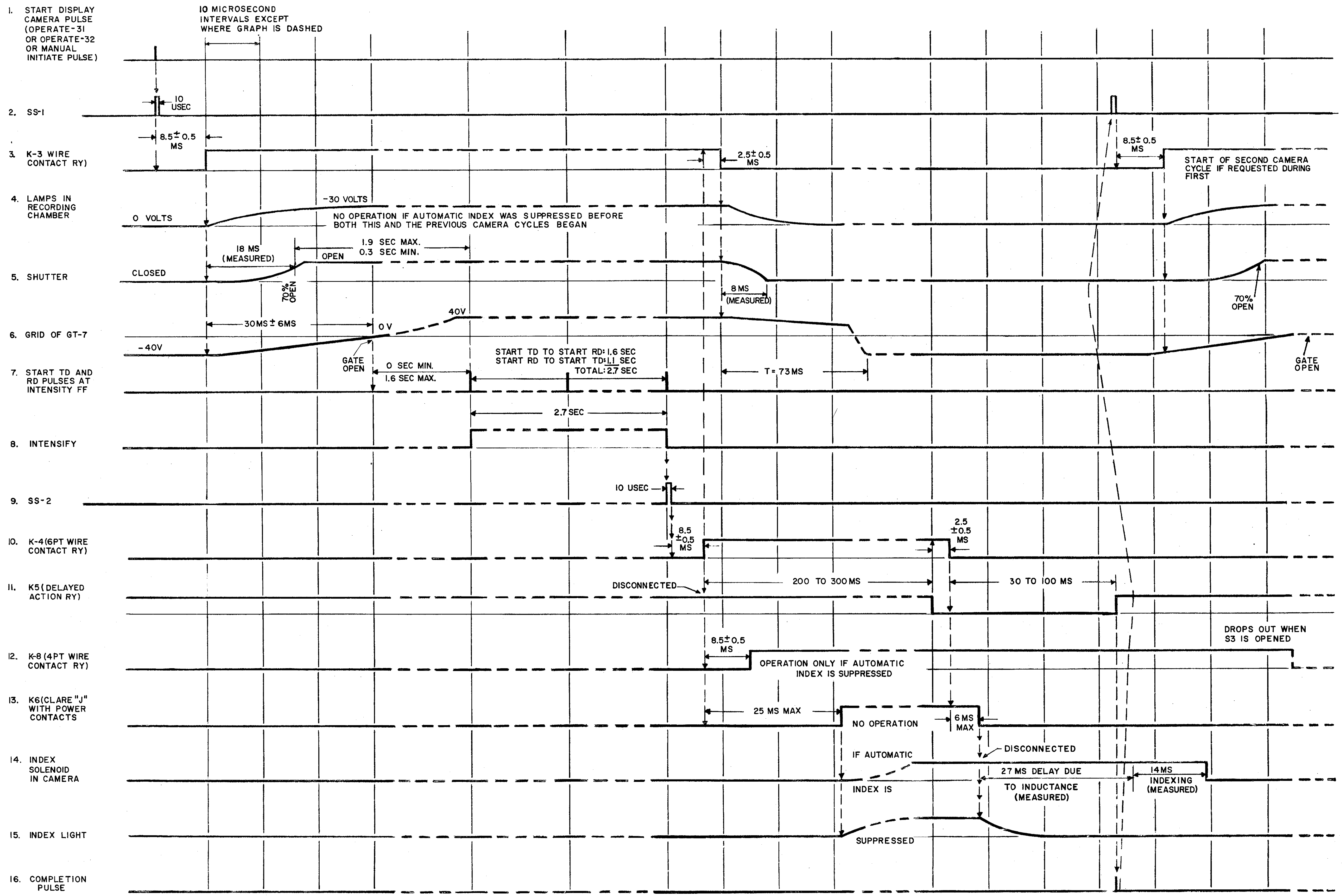
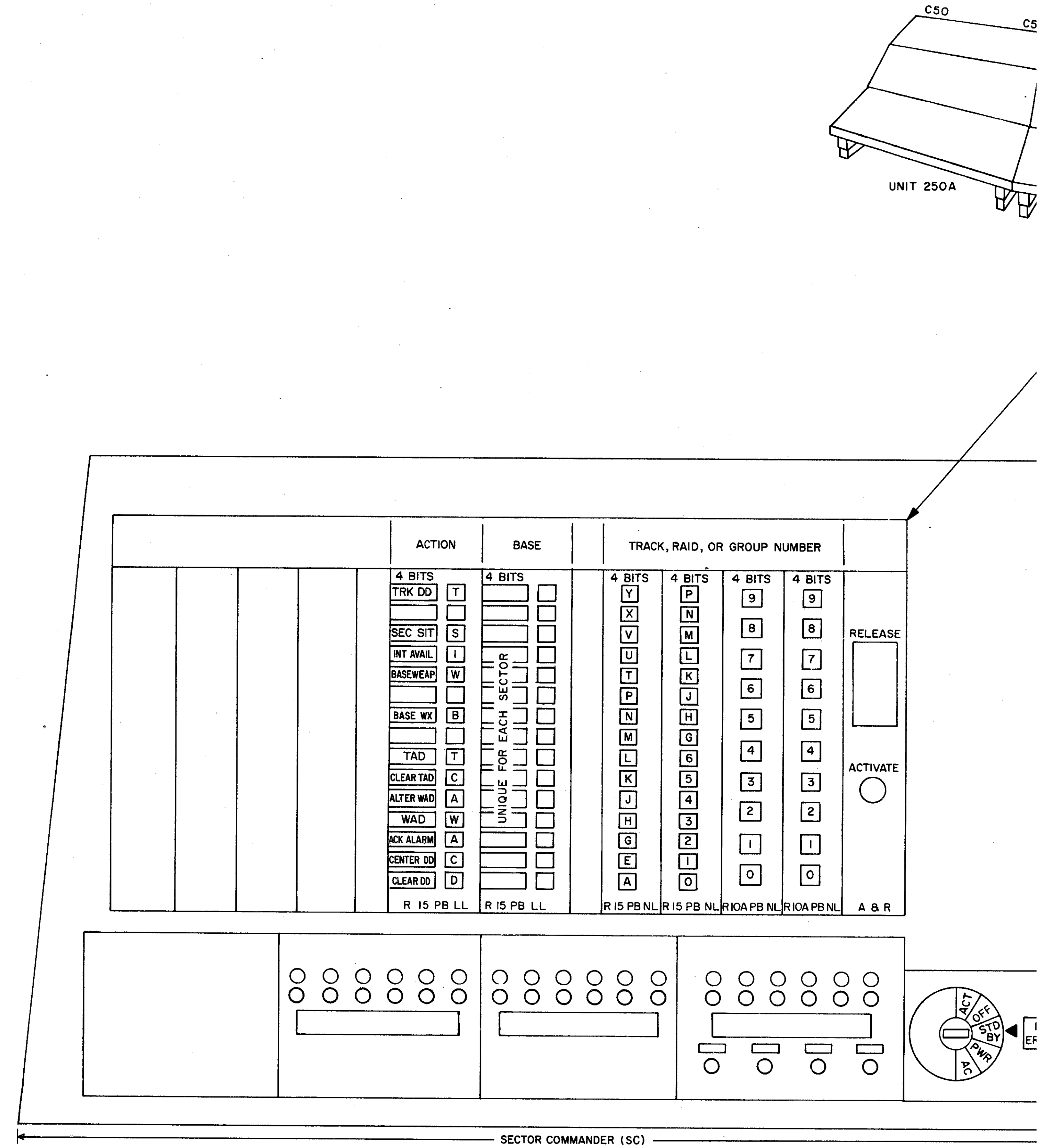


Figure 5—52. Situation Display Camera Control, Timing Diagram



C50
UNIT 250A
ACTION
BASE
TRACK, RAID, OR GROUP NUMBER
4 BITS
TRK DD
SEC SIT
INT AVAIL
BASEWEAP
BASE WX
TAD
CLEAR TAD
ALTER WAD
WAD
ACK ALARM
CENTER DD
CLEAR DD
T S I W B T C A W A C D
UNIQUE FOR EACH SECTOR
Y X V U T P N M L K J H G E A
P N M L K J H G 6 5 4 3 2 1 0
9 8 7 6 5 4 3 2 1 0
RELEASE
ACTIVATE
R 15 PB LL
R 15 PB NL
R10A PB NL
A & R
ACT
OFF
STD BY
PWR
AC
SECTOR COMMANDER (SC)

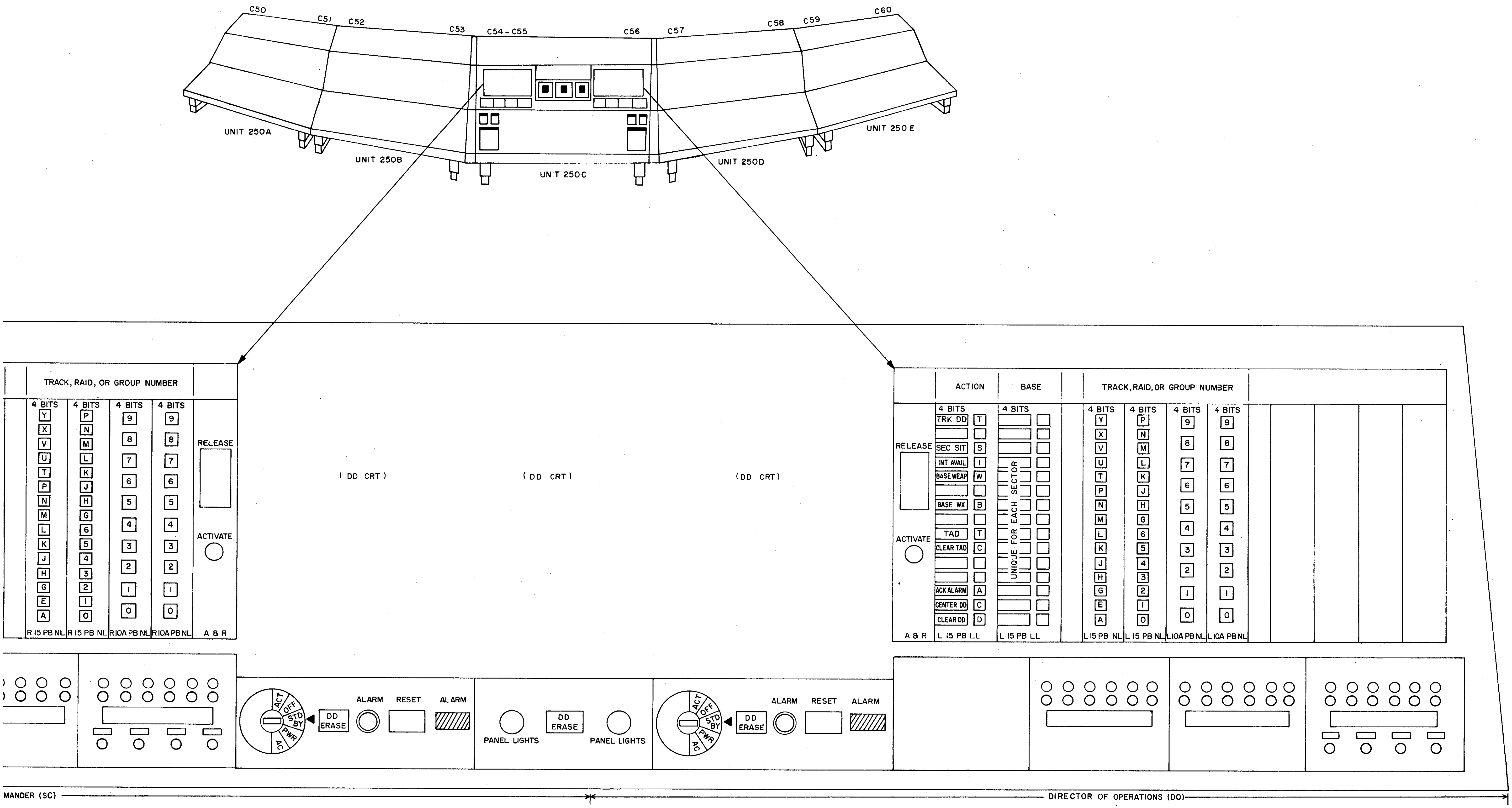


Figure 5–56. Command Post Console, Unit 250, Sector Commander and Director of Operations Positions

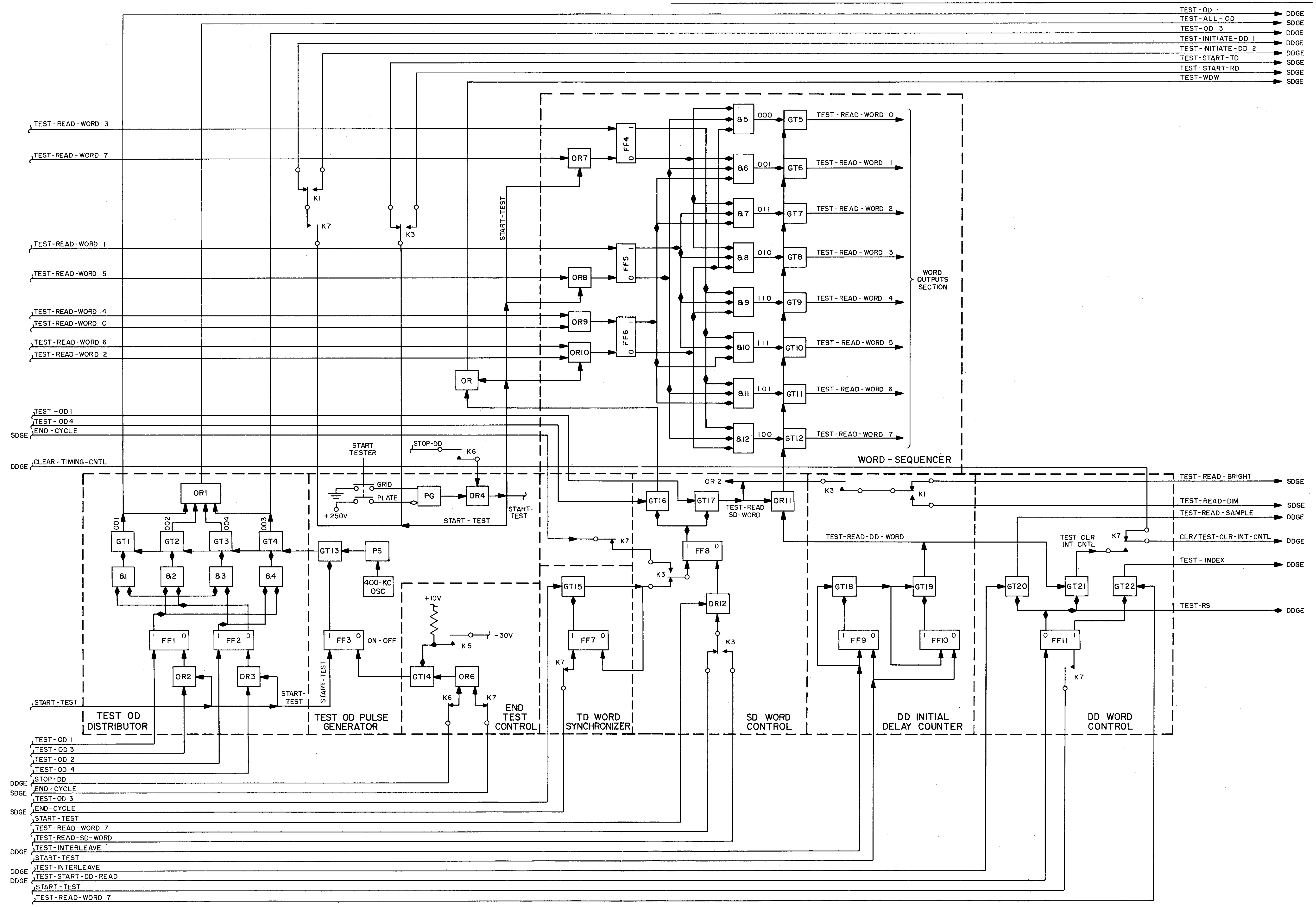
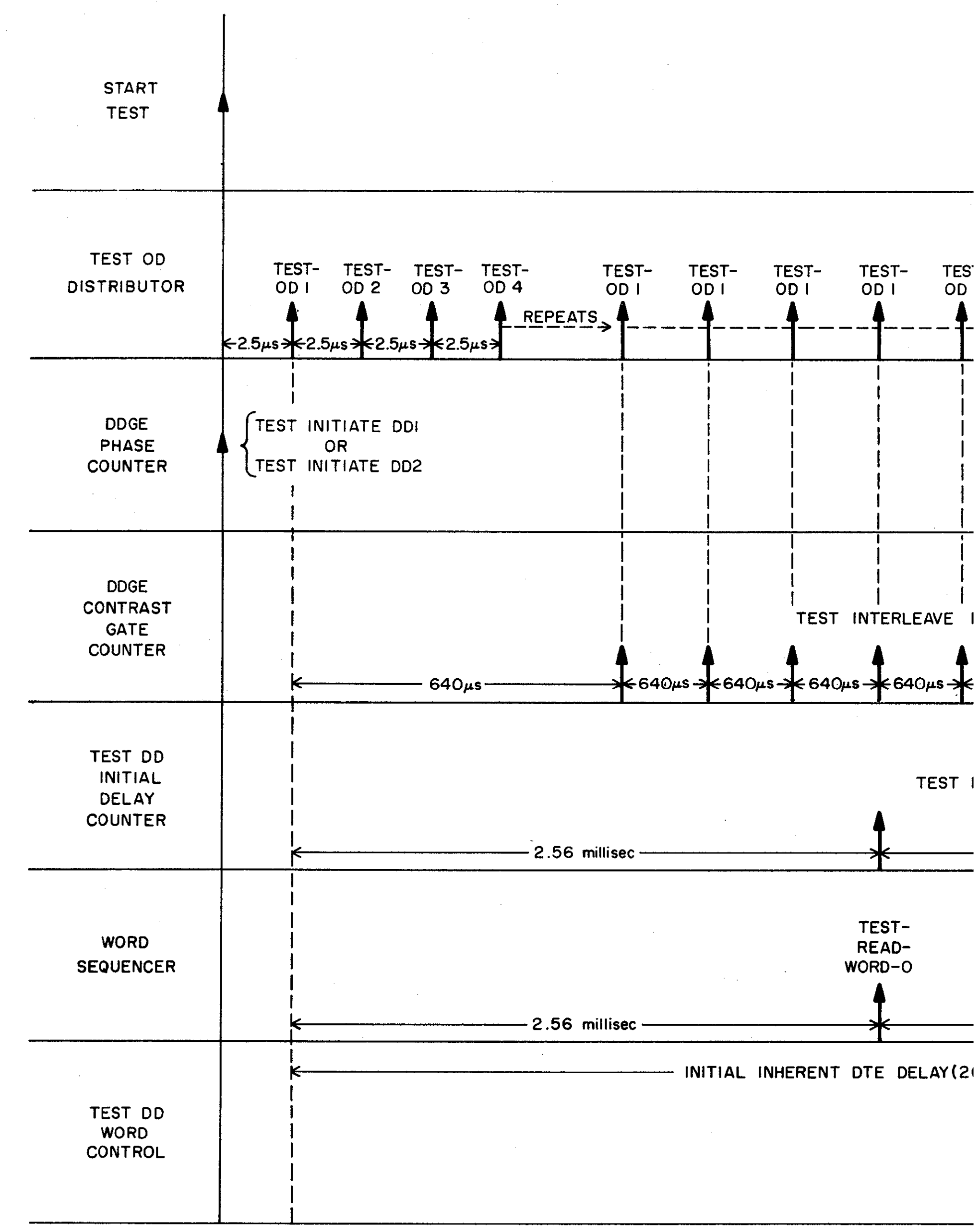


Figure 5-76. DTE Test Control and Word Sequencer, Simplified Logic Diagram



START TEST
TEST OD DISTRIBUTOR
TEST- OD 1
TEST- OD 2
TEST- OD 3
TEST- OD 4
REPEATS
2.5μs
DDGE PHASE COUNTER
TEST INITIATE DD1 OR TEST INITIATE DD2
DDGE CONTRAST GATE COUNTER
TEST INTERLEAVE
640μs
TEST DD INITIAL DELAY COUNTER
2.56 millisec
WORD SEQUENCER
TEST- READ- WORD-O
TEST DD WORD CONTROL
INITIAL INHERENT DTE DELAY

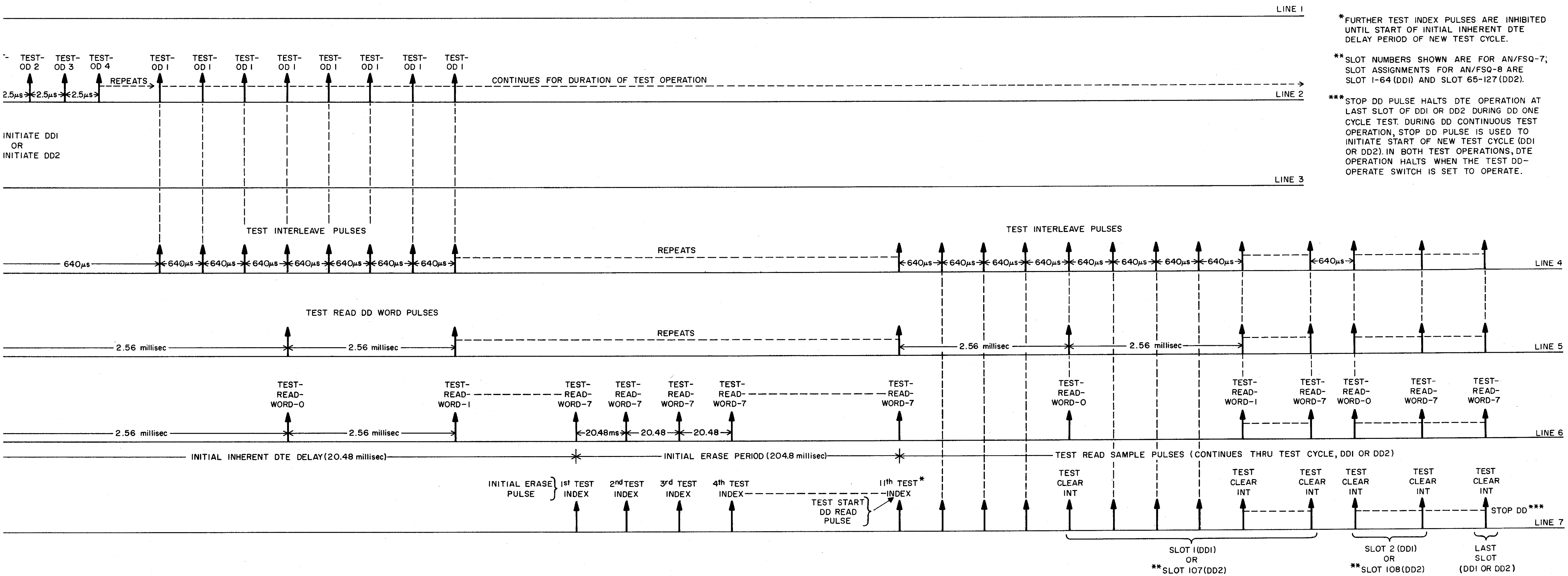


Figure 5–81. DTE Timing Diagram, DD Operation

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INDEX (cont'd)

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INDEX (cont'd)

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INDEX (cont'd)

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