

# L3, L4, AND L4S CARRIER COMMON EQUIPMENT AUTOMATIC LINE SWITCHING J68820 DESCRIPTION

| CONTENTS                                   | PAGE | CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | PAGE |
|--------------------------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1. GENERAL . . . . .                       | 1    | B. Placing Standby Line in Service . . . . .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 29   |
| 2. SWITCHING EQUIPMENT . . . . .           | 5    | C. Locking Standby Line in Service . . . . .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 29   |
| A. General . . . . .                       | 5    | D. Locking Regular Lines in Service . . . . .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 29   |
| B. Individual Equipment Units . . . . .    | 6    | E. L4 Line Terminating . . . . .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 29   |
| C. Switching Equipment Bays . . . . .      | 15   | 7. <b>STANDBY LINE TANDEM OPERATION</b> . . . . .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 31   |
| 3. SWITCHING OPERATIONS . . . . .          | 15   | A. L3 System . . . . .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 31   |
| A. General . . . . .                       | 15   | B. L4 System . . . . .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 31   |
| B. Transfer of Service . . . . .           | 15   | 8. REMOTE OPERATIONS . . . . .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 31   |
| C. Return to Normal . . . . .              | 18   | 9. ALARMS . . . . .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 31   |
| 4. TWO-LINE SWITCHING OPERATIONS . . . . . | 19   | 10. REFERENCES . . . . .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 33   |
| A. General . . . . .                       | 19   | 1. GENERAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |
| B. Transfer of Service . . . . .           | 19   | 1.01 Automatic line switching is provided in the L3 and L4 Coaxial Cable Carrier Systems to protect the regular lines. Switching transfers service from a failed regular line to a standby line. Service is transferred by coaxial switches under control of sensitive detectors that continuously monitor signal conditions on the lines. Automatic line switching <i>or</i> manual patching is used to protect the regular lines in the L4S (short L4) System. <b>L4</b> in this section is a general term for both the long-haul L4 and the L4S Carrier Systems. |      |
| C. Return to Normal . . . . .              | 22   | 1.02 This section is reissued to add reference to the L4S System, correct errors, expand the explanations, and include recent modifications                                                                                                                                                                                                                                                                                                                                                                                                                         |      |
| 5. OVERALL SYSTEM LAYOUT . . . . .         | 22   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |
| A. General . . . . .                       | 22   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |
| B. L3 Switching . . . . .                  | 23   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |
| C. L4 Switching . . . . .                  | 23   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |
| 6. MANUAL OPERATIONS . . . . .             | 29   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |
| A. General . . . . .                       | 29   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |

## NOTICE

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pertaining to message overload, noise guard, and remote individual line lockout features. Arrows are used to indicate significant changes.

**1.03** ♦A switching section consists of the coaxial cable and equipment between two main stations where switching equipment is installed and includes the coaxial switches. In an L3 Carrier System, switching equipment is provided at **switching main stations** and **terminal main stations**. In an L4 Carrier System, switching equipment is provided at all **main stations**. A terminal main station is always a pilot insertion point.

**1.04** Each direction of transmission in the switching section is independent. The switching system can restore one line in one direction and one line in the opposite direction, if required.

**1.05** Three switching arrangements, designated multiline, expanded multiline, and supermultiline are provided according to the number of regular lines protected by one standby line. A two-line switching arrangement, used for some L3 Systems, provides protection for one regular line by one standby line. Table A lists the arrangements associated with each carrier system. The multiline arrangement provides switching facilities for four regular lines which are designated group A; an expanded multiline serves eight lines which are designated group A and group AA; and a supermultiline serves up to twelve lines which are designated group A, group AA, and group AB. By installing a larger arrangement than initially needed, future additions can be provided without extensive modifications.♦

**1.06** Line pilots are monitored at the receive end of the switching section by meter relays in the L3 System and by electronic control meters in the L4 System (Fig. 1). ♦The L3 System has six line pilots at 308, 556, 2064, 3096, 7266, and 8320 kHz; the L4 System has two line pilots at 512 kHz and 11.648 MHz. Pilot indicators are located in each L3 line receiving bay and in each L4 line receiving bay. In addition, the 7266-kHz (L3) or 11.648-MHz (L4) **temperature pilot** is monitored electronically by a detector.♦

**1.07** In the **L3 System**, an automatic switch is initiated by contacts in the PIL ALM meter relay. When these contacts close, the transfer of service from a regular line to the standby line is

initiated. If one or more of the six line pilots deviate  $\pm 2$  dB from nominal, a **slow** switch will be initiated. A transfer will occur even though transmission may be impaired only for signal frequencies in the vicinity of one pilot. Initiation of a slow switch is controlled by mechanical action; and because of the inertia of the meter movement, the transfer of service is slow. In order to reduce the time required to initiate a transfer, one of the pilots (7266 kHz) is applied to an electronic control circuit. If the 7266-kHz pilot deviates beyond a range of  $\pm 3$  dB, a **fast** switch will be initiated. Any sudden change of the 7266-kHz pilot will result in the immediate transfer of service to the standby line. In either a slow or fast switch, the circuit will automatically reset when the line pilot power returns to normal.

**1.08** In the **L4 System**, an automatic switch is initiated by an electronic control meter. The two L4 pilots are continuously monitored at the receive end of each switching section. A pilot deviation greater than  $\pm 2$  dB initiates a **slow** switch to transfer service from a regular line to the standby line. A transfer will occur even though transmission may be impaired only for signal frequencies in the vicinity of one pilot. Initiation of a slow switch is controlled by mechanical action; and because of the inertia of the meter movement, the transfer of service is slow. In order to reduce the time required to initiate a transfer of service, one of the pilots (11.648 MHz) is applied to an electronic control circuit. If the 11.648-MHz pilot deviates beyond a range of +4 or -5 dB, a **fast** switch will be initiated. Any sudden change of the 11.648-MHz pilot will result in the immediate transfer of service to the standby line. In either a slow or fast switch, the circuit will automatically reset when the line pilot power returns to normal.

♦**Note:** Excessive **total energy** in the L4 message band (overload) will also initiate a request for line switch or line terminate. Excessive total energy can seriously affect transmission without causing the line pilot powers to change enough to initiate switching.♦

**1.09** Each switching section includes manual controls used to manipulate the associated lines for a desired purpose. Manual controls (Fig. 2) can be used to lock a switching section in the normal condition or to transfer service from a regular line to the standby line. Operation of the manual controls will override a previously initiated

TABLE A

## SWITCHING ARRANGEMENTS FOR L3 AND L4 CARRIER SYSTEMS

| CARRIER SYSTEM | GROUP         | NAME OF ARRANGEMENT | NUMBER OF REGULAR LINES<br>(ONE DIRECTION OF TRANSMISSION) | NUMBER OF STANDBY LINES |
|----------------|---------------|---------------------|------------------------------------------------------------|-------------------------|
| L3             |               | Two-Line            | 1                                                          | 1                       |
|                | A             | Multiline           | Up to 4                                                    | 1                       |
|                | A and AA      | Expanded Multiline  | Up to 8                                                    | 1                       |
|                | A, AA, and AB | Super-multiline     | Up to 12                                                   | 1                       |
| L4             | A             | Multiline           | Up to 4                                                    | 1                       |
|                | A and AA      | Expanded Multiline  | Up to 8                                                    | 1                       |
|                | A, AA, and AB | Super-multiline     | Up to 12                                                   | 1                       |

automatic switch. A manual operation can only be released manually. These manual operations can also be performed from a remote office via the B1 Alarm and Control System (L3) or the E1 Status Reporting and Control System (L4).

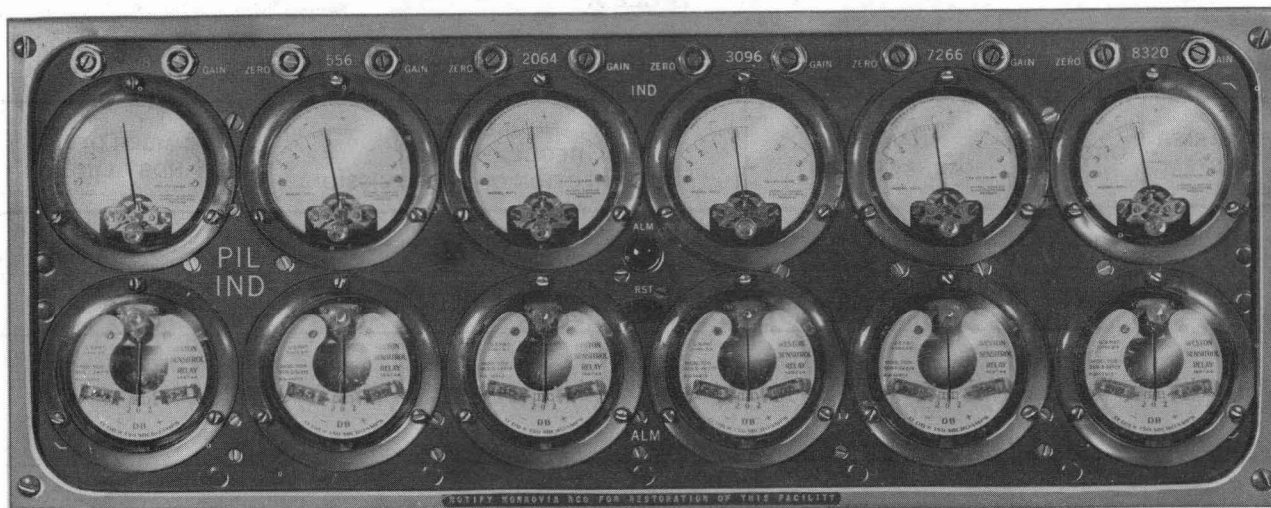
**1.10** All office alarms pertaining to a line pilot failure are operated through the circuits of the automatic switching equipment; however, the pilot indicator relays do not directly activate any of these alarms. Indicator lamps are also provided to show the status of the switching section. Some of the visual alarms (Fig. 2) are in the L3 miscellaneous bay or L4 control connecting bay. Another function of the B1 Alarm and Control System or E1 Status Reporting and Control System is to transmit alarm conditions from unattended to attended offices. A failure of the switching equipment will not affect transmission, but removes protection from that portion of the switching section.

Alarm features are provided to indicate a switching equipment failure.

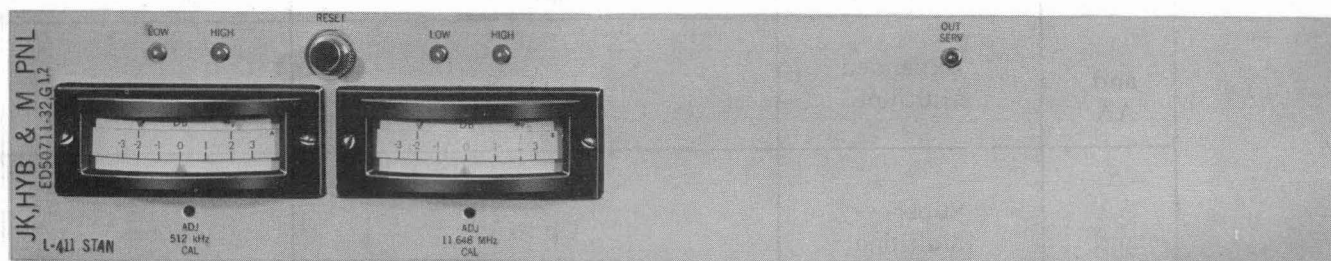
**1.11** Unequalized gain or loss in the switching signal band occurs when the signals are transmitted over an L3 or L4 line. Signal level changes at the low end of the band can prevent proper operation of the line protection switching. To compensate for these level variations, a later circuit design provides adjustable gain and loss on an individual line basis at the transmit and receive ends of a switching section.

**1.12** A new design, standard in later L3 and L4 switching equipment, provides the following equipment at the transmit end of a switching section:

- (a) Switching signal amplifier ED-52102-G1 in the common switch control circuit which



A-L3 CARRIER SYSTEM



B-L4 CARRIER SYSTEM

Fig. 1—Pilot Indicator Panels

provides  $\pm 15$  dB of adjustment for the release check signal

(b) Switching signal amplifier ED-52102-G2 in the transmitting switch control circuit which provides  $\pm 15$  dB of adjustment for the line identification and release signals

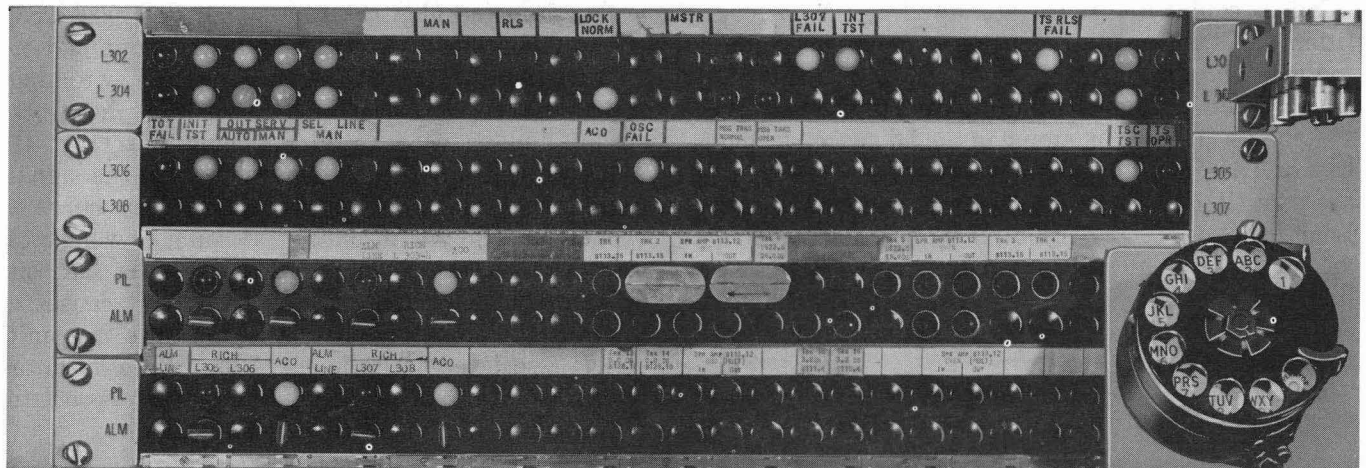
(c) Switching signal amplifier ED-52102-G3 in the director circuit which provides  $\pm 10$  dB of adjustment for the verification signal.

1.13 The receive end of an L4 switching section includes **level compensation unit J68820AD** which provides an adjustment range of +24 to -21 dB. Level compensation is inserted between the output of the L4 pilot indicator circuit and the input to the switching signal filter circuit.

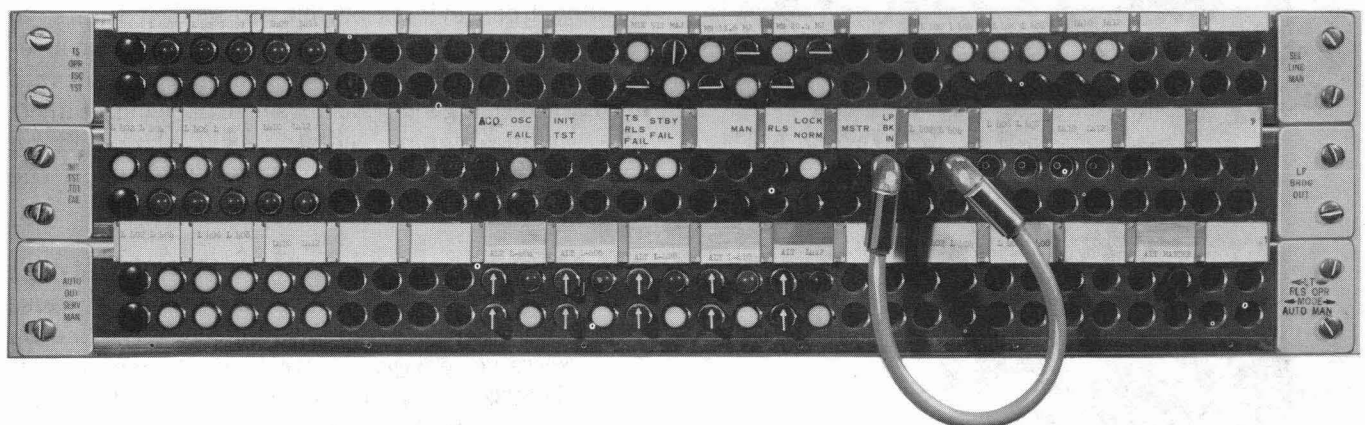
1.14 Existing switching systems for L3 and L4 can be modified with the above equipment where the problem of unequalized gain or loss is present; however, L3 Systems will not require level compensation units at the receive end of a switching section.

1.15 A **noise guard** feature has been added to prevent false operation, due to line noise, of transmitting switches while a switch to the standby line is in effect. Also, all transmitting switches can be simultaneously inhibited via remote control. Status indicators are provided both locally and at the remote control location. The noise guard feature adds the following equipment at the transmit end of a switching section:

(a) Line identification signal detector ED-52313 in the transmitting control unit



A—JACK FIELD IN L3 MISCELLANEOUS BAY



B—JACK FIELD IN L4 CONTROL CONNECTING BAY

Fig. 2—Jack Fields With Switching Controls and Indicators

- (b) Release signal blocking circuit ED-52314 in the director unit
  - (c) Diode steering circuit ED-52315 in the switching signal filter unit.
- 1.16 A **line lockout** feature has been added to provide remote inhibiting of transmitting switch operation, due to line noise, on an individual line basis. This is used when restoring service over another facility. Status indicators are provided both locally and remotely. Line lockout board ED-52386 is mounted in the manual switch control unit and utilizes equipment supplied by the noise guard feature.

1.17 The switching equipment is mounted in switch control bays. These bays are available in two sizes: 11.5-foot J68820A, AA, and AB bays and 9-foot J68820BA and BB bays. Opposite ends of a switching section must use the same types of switch control bays. Equipment arrangements for 11.5-foot switch control bays are shown in Fig. 19A and 19B. The 9-foot bays are shown in Fig. 20.

## 2. SWITCHING EQUIPMENT

### A. General

- 2.01 A switch control bay contains most of the equipment needed to transfer service from

a failed regular line to the standby line. A battery filter panel and a fuse panel are mounted at the top of each switch control bay and provide filtered battery for the switching equipment. Coaxial switches (Fig. 3) are mounted in the L3 miscellaneous bay or L4 control connecting bay. These switches are directly controlled by the switching equipment. Each panel of switching equipment can be classified as: (a) equipment which is related to a particular line, or (b) equipment which is common to all lines. A brief description of each unit is presented in the following part.

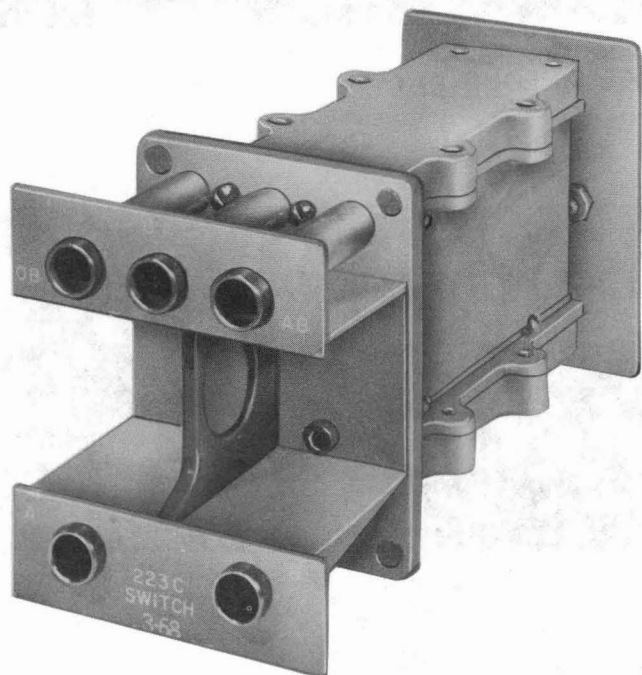


Fig. 3—223 Coaxial Switch

## B. Individual Equipment Units

### 2.02 ♦Regular line switch initiator unit

**J68820F** (Fig. 4) is provided at the receive end of each regular line. This unit recognizes a regular line failure and initiates a fast or slow switch to transfer service to the standby line. If any line pilot on the standby line is outside normal power limits, a switch will not take place.

**2.03** Each regular line switch initiator is equipped with a switching signal oscillator unit (Fig. 4). Table B lists the output frequency and the associated line for each oscillator unit. This oscillator

produces a line identification signal (284, 286, 288, or 290 kHz) which is sent to the transmit end to identify each initiator. The output of the switching signal oscillator is controlled by a relay interlock circuit and by the expander-trigger unit (Fig. 4). The expander circuit has two inputs: (a) the signal from the oscillator, and (b) a direct current proportional to the incoming line pilot power or to the total message energy. If the direct current deviates from normal, the trigger circuit causes a line identification signal to be sent to the transmit end. ♦ Associated with the operation of the initiator circuit are the supervisory functions necessary to indicate the status of the transmission.

### 2.04 Standby line switch initiator unit

**J68820G** (Fig. 5) is provided at the receive end of the standby line. The functions of the standby line initiator are to block regular line initiators from operating when any pilot on the standby line deviates beyond prescribed limits, to reset alarm relays, and to delay the return-to-service of a regular line until reasonable assurance is obtained that good transmission can be maintained. A switching signal oscillator (290 kHz) and an expander-trigger circuit also are provided in the standby line initiator.

♦**Note:** Switch initiators J68820F, List 8, and J68820G, List 6, provide options to cause a line switch or to terminate an L4 line on excessive energy. Overload trigger circuit ED-52327 in pilot indicator panel J68877BF (MD) or J68877EA will request a line switch or line terminate when the total message energy, not affecting pilots, exceeds a predetermined value. A green overload (OVL) indicator lamp is provided in the L4 control connecting bay. ♦

### 2.05 Transmitting switch control unit

**J68820H** (Fig. 6) is provided at the transmit end of each regular line. This unit will detect the line identification signal sent by the initiator of the same line at the receive end. A transmitting switch control unit is not required in a two-line switching arrangement because all line switching is performed at the receive end.

**2.06** ♦Each transmitting switch control circuit includes a line signal separation (LSS) filter, a detector, a switching signal amplifier, and a line identification signal detector. Line identification signal frequencies are listed in Table B. ♦ The line

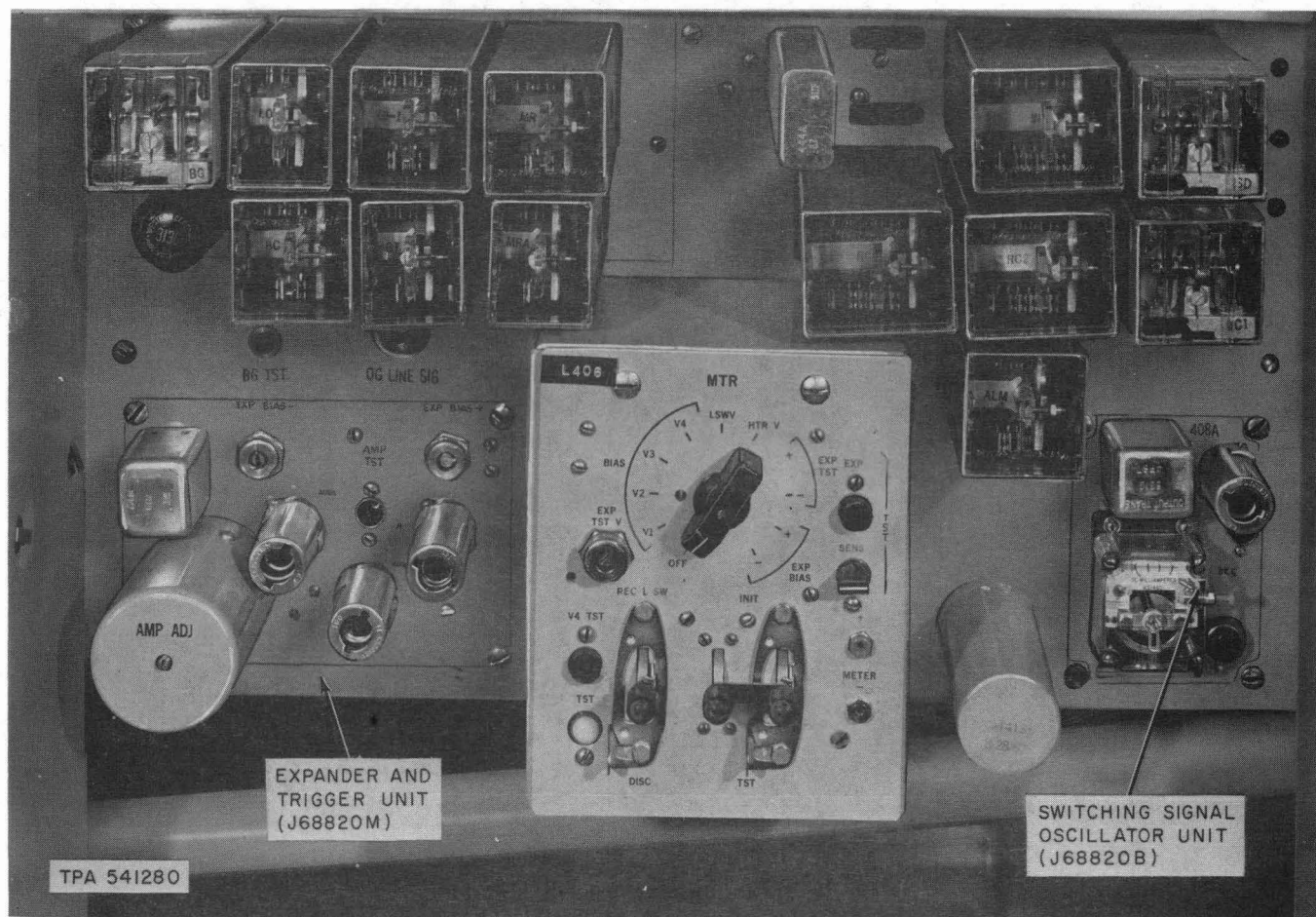


Fig. 4—Regular Line Switch Initiator

TABLE B

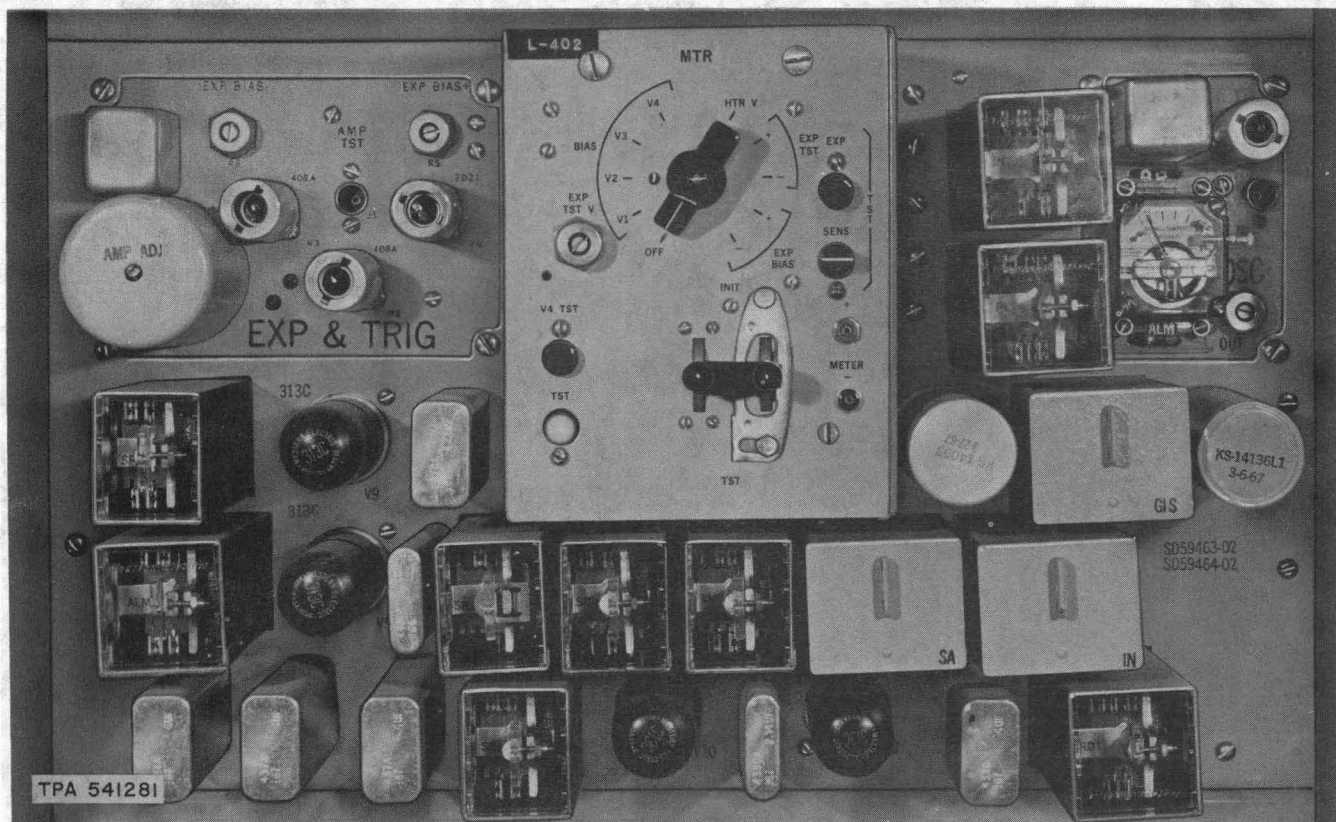
LINE IDENTIFICATION SIGNALS

| REGULAR LINE | FREQUENCY |
|--------------|-----------|
| 1            | 290 kHz   |
| 2            | 288 kHz   |
| 3            | 286 kHz   |
| 4            | 284 kHz   |

signal separation filter will pass only the identification signal associated with one regular line. All other signals are rejected. The identification signal, released by the initiator at the receive end, is passed by the proper LSS filter and converted to a direct current by the detector. This direct current

is used to operate relays which control the proper transmit switch. The switching signal amplifier provides  $\pm 15$  dB of adjustment for the line identification and release signals transmitted to the receive end. The transmitting switch control unit has several other functions which will be explained with the switching sequences in Parts 3 and 4.

**2.07 Switching signal amplifier unit J68820E** (Fig. 7) is provided at the receive end of the switching section, to amplify the switching signals received from the transmit end. A two-line arrangement does not use the switching signal amplifier. An 8-dB pad at the input of the amplifier prevents overloading when the power of the incoming switching signals is too high. One amplifier is provided for each group of lines. The amplifier provides approximately 88 dB flat gain in the switching signal band: 280 to 296 kHz.



**Fig. 5—Standby Line Switch Initiator**



**Fig. 6—Transmitting Switch Control Unit**

## 2.08 Common switch control unit J68820J

(Fig. 8), provided at the receive end of a switching section, contains seven circuits common to the operation of all switch initiators in a given arrangement. A two-line arrangement does not use the common switch control unit. Two of the main circuits in this unit are the 280-kHz release check signal oscillator and the 282-kHz release

signal oscillator. The 282-kHz release signal is sent to the transmit end to release the transmit switch when a failed line returns to normal. A gate circuit at the transmit end releases the 280-kHz release check signal when the 282-kHz release signal is detected. A switching signal amplifier at the output of the 280-kHz oscillator provides  $\pm 15$  dB of adjustment for the release check signal transmitted

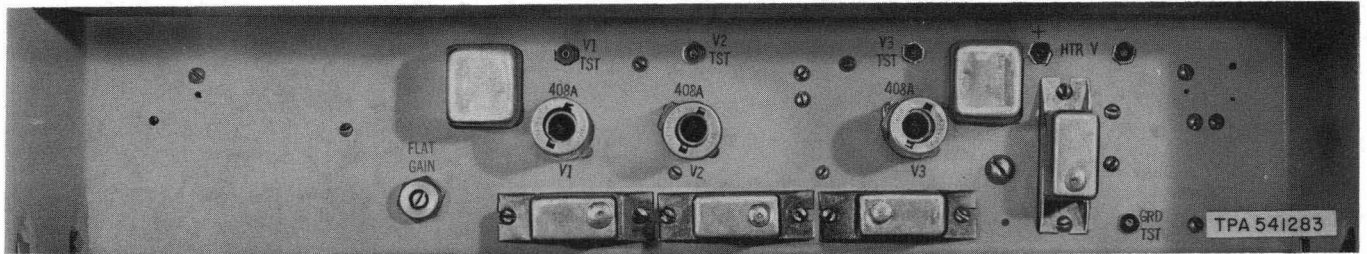


Fig. 7—Switching Signal Amplifier Unit

over the switching section to the receive end. The release check signal restores the initiator at the receive end to the normal condition.

#### 2.09 Switching signal filter unit J68820P

(Fig. 9), provided at the receive end of a switching section, separates the switching signals from the other line signals. A two-line arrangement does not use this unit. One of these units is needed for each group of lines. When fully equipped, group A has five filters and associated circuits mounted on the switching signal filter unit. Groups AA and AB can have a maximum of four filters per group. The fifth filter in group A is for the standby line.

2.10 The switching signal filter unit combines the switching signals at the output of the unit and applies these signals to the switching signal amplifier in the L3 System or to the level compensation unit in the L4 System. In addition to combining the switching signals, the switching signal filter unit has two other functions: (a) provides relays to disconnect an out-of-service line,

and (b) provides phase-correction networks to correct any signal phase differences on the associated lines. The unit also includes a diode steering circuit as part of the noise guard feature.

#### 2.11 Manual switch control unit J68820D

(Fig. 10), provided at the receive end of a switching section, is used to manually control the substitution of the standby line for any regular line. A lockout circuit is included as part of the remote individual line lockout feature. This unit consists mainly of relays and is mounted with the equipment associated with group A. Control and indicating circuits are mounted in the L3 miscellaneous bay or the L4 control connecting bay. Transfer of service is controlled from the receive end of the switching section. A manual switch operation overrides an automatic switch and can only be released manually. The actual operation of a manual switch is covered in Part 6.

2.12 Alarm unit J68820L (Fig. 11), provided at each end of a switching section, contains alarm relays required to register the office audible

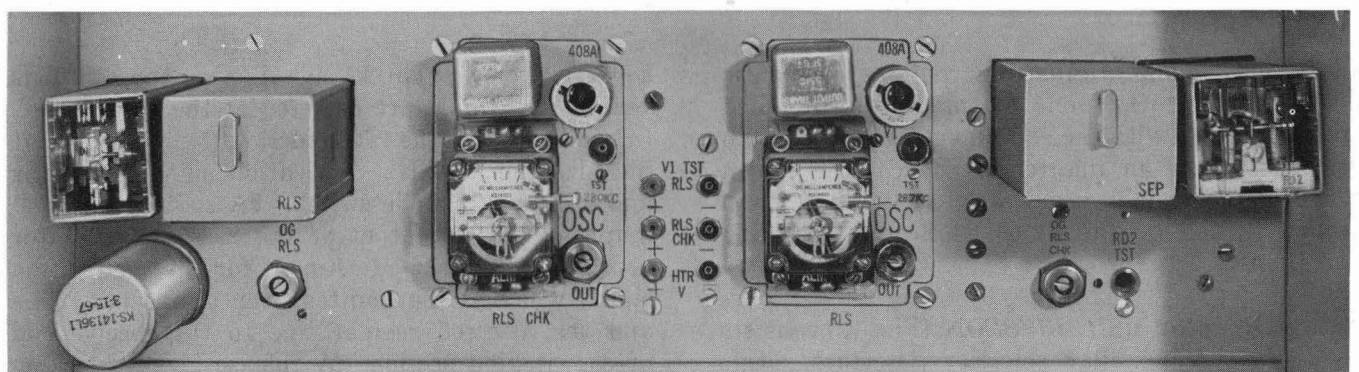


Fig. 8—Common Switch Control Unit



Fig. 9—Switching Signal Filter Unit

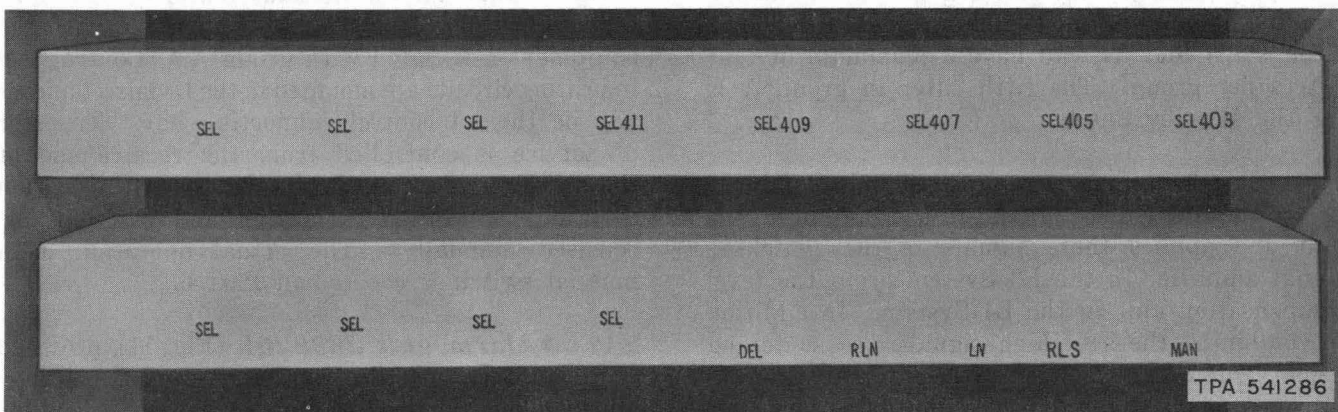


Fig. 10—Manual Switch Control Unit

and visual signals originating from the automatic line switching. Only one alarm unit is provided and is mounted with the equipment associated with group A. In an unattended office, the alarm conditions and indications are transmitted to a central station via the B1 or E1 Status Reporting and Control System.

**2.13 Director unit J68820N** (Fig. 12) consists of three similar selective detectors. One unit is used for both transmitting and receiving operations. The 282-kHz release signal is detected at the transmit end of a switching section; the

280-kHz release check signal and the 296-kHz verification signal are detected at the receive end. In addition to the detectors, the director unit includes the 296-kHz verification signal oscillator and a tube test mode switch. A switching signal amplifier at the output of the 296-kHz oscillator provides  $\pm 10$  dB of adjustment for the verification signal which is transmitted over the standby line and the affected regular line to the receive end of a switching section. A release signal blocking circuit is included as part of the noise guard feature. The mode switch provides positions for testing the tubes on the director unit and on

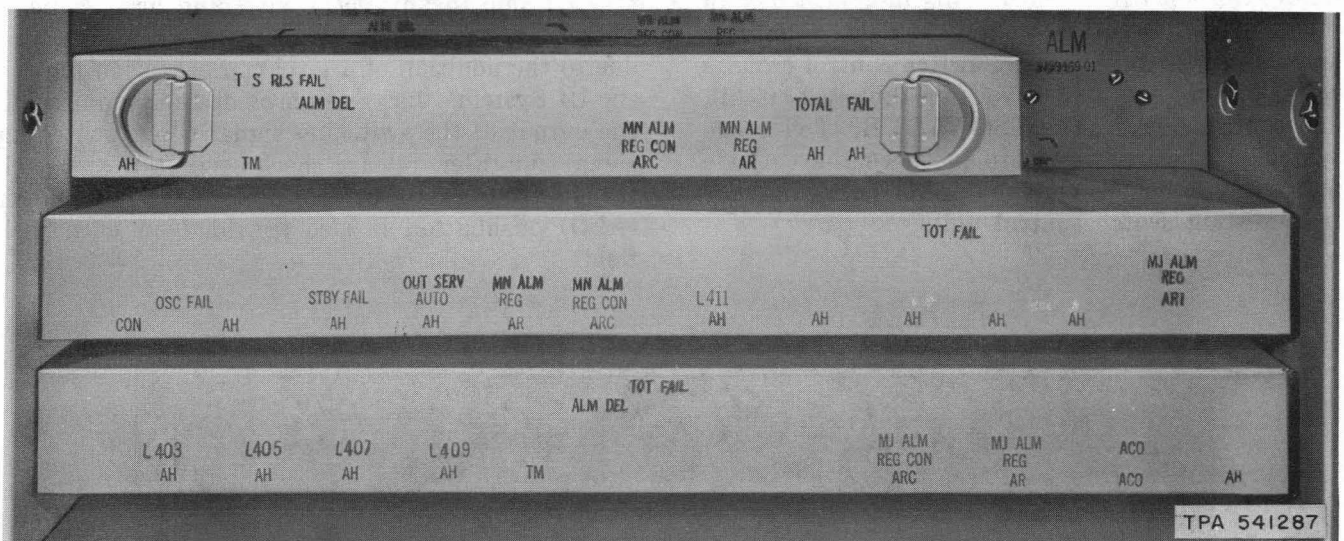


Fig. 11—Alarm Unit

transmitting switch control unit J68820H. Test jacks are placed below the mode switch for meter lead access.

**2.14** The director unit is mounted with the equipment associated with group A, and this one director unit will serve up to 12 regular lines. However, the tube test mode switch has test

positions for only four transmitting switch control units. Each additional group must be equipped with a miscellaneous control unit, which is described in the following paragraph.

**2.15** ♦ *Miscellaneous control unit J68820R* (Fig. 13), provided at each end of a switching section, performs functions common to all regular

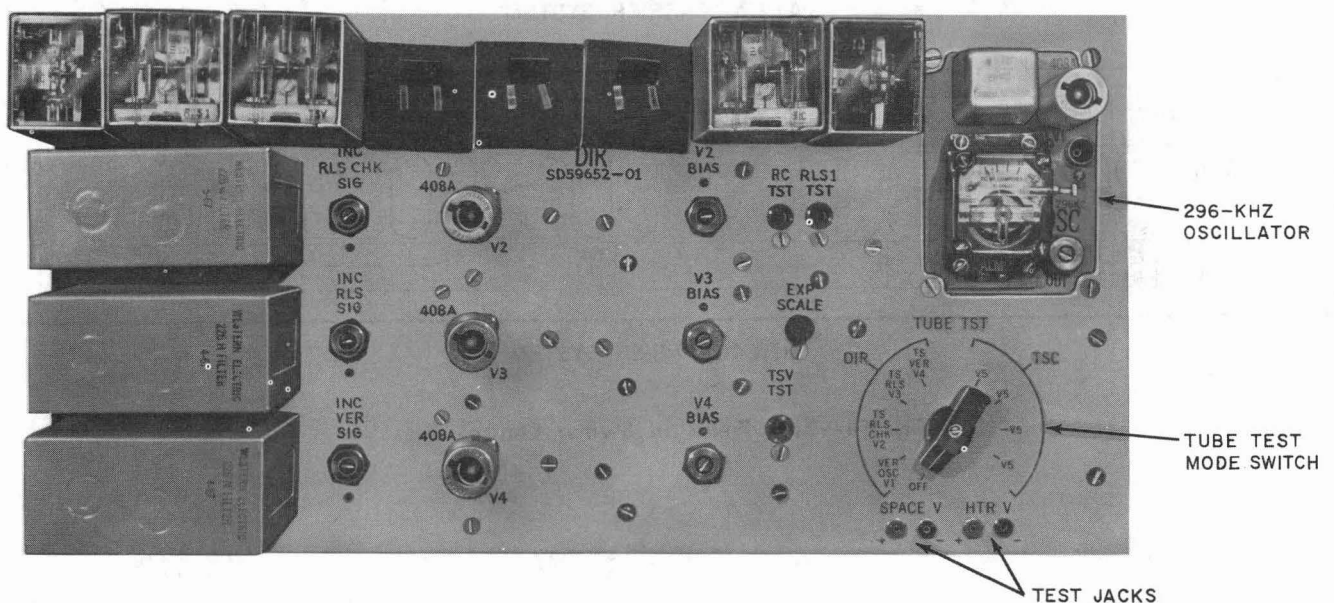


Fig. 12—Director Unit

line switch initiators and transmitting switch control units in group AA or AB. This unit provides an input circuit for all switching signals, a dummy load circuit for transmitting switch control circuits which are not equipped, a vacuum tube test circuit, and control relays. The TSC V5 TUBE TST mode switch provides positions to measure the cathode activity and heater voltage for as many as four transmitting switch control units.

**2.16 A jack field** (Fig. 14) is required for each group in any given switching arrangement. There is a small difference between the jack fields due to the addition of a level compensation unit in the L4 System. Jacks are provided for monitoring the output of the switching signal filter, switching signal amplifier, release check oscillator, and each transmitting switch control unit. An alarm cutoff (ACO) pushbutton is also provided on each jack field.

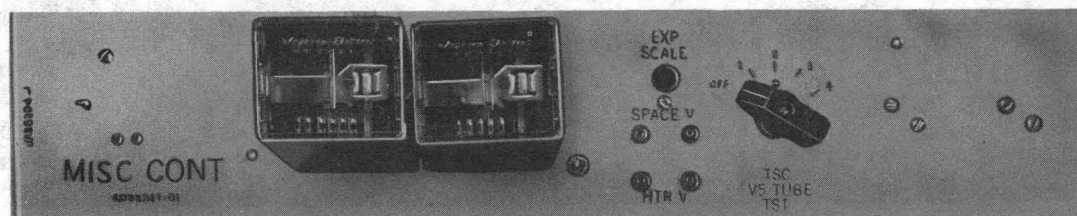
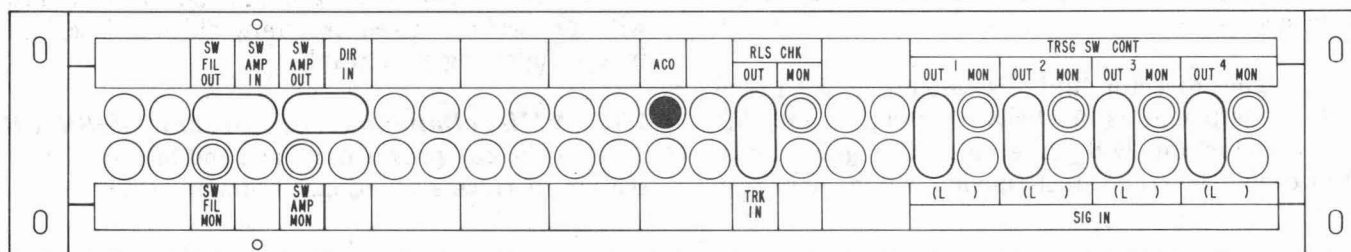
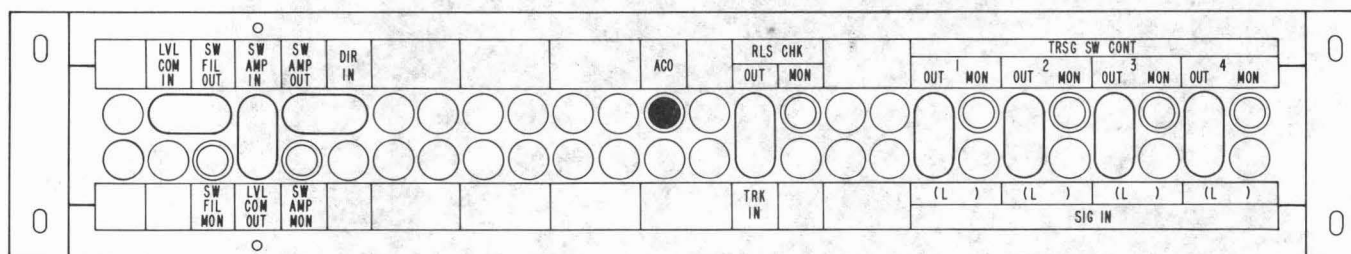


Fig. 13—Miscellaneous Control Unit



(A) L3 CARRIER SYSTEM



(B) L4 CARRIER SYSTEM

Fig. 14—Jack Fields in Switch Control Bays

**2.17 ♦ Message register panel ED-51508**

(Fig. 15) is furnished at the receive end of each switching section. ♦ This panel can be equipped with a maximum of ten 14E message registers. Each register counts the number of times a regular line transfer is completed or the number of 7266-kHz (L3) or 11.648-MHz (L4) temperature pilot hits on the standby line. The register panel can serve nine regular lines and one standby line. One terminal of each 14E message register is wired to -24V battery; the other terminal is connected to a standby line or regular line initiator. The register panel may be mounted miscellaneously.

**2.18 Level compensation unit J68820AC**

(Fig. 16A), now manufacture discontinued, is provided at the receive end only for L4 switching sections. This unit includes an amplifier and an adjustable attenuator connected in tandem between the switching signal filter and the switching signal amplifier at the receive end. Adjustment can be made manually for gain variations at the low end of the L4 band. One unit is required for each switching bay: A, AA, and AB.

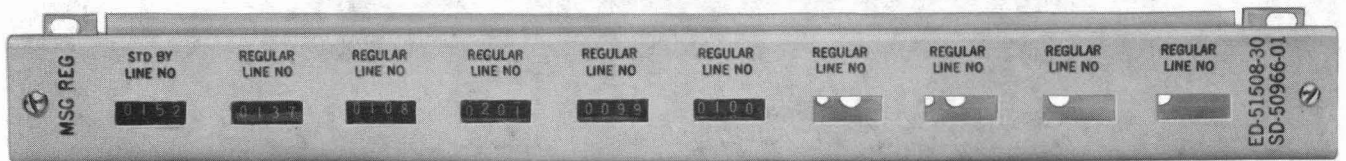


Fig. 15—Message Register Panel

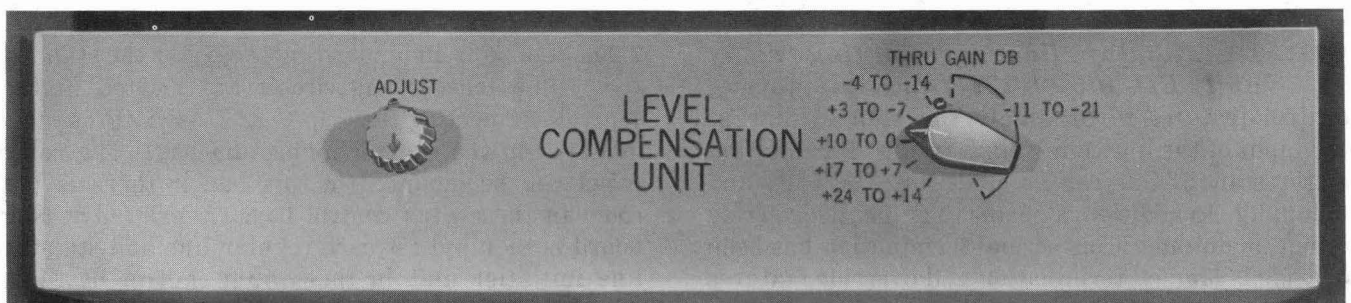


Fig. 16A—Level Compensation Unit J68820AC

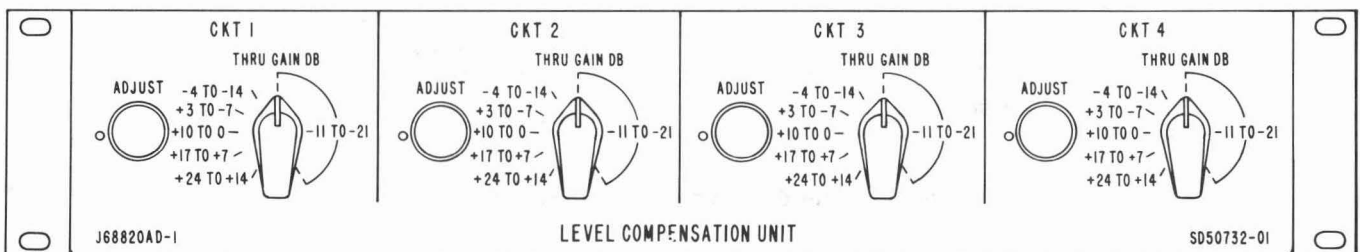


Fig. 16B—Level Compensation Unit J68820AD

**2.19 Level compensation unit J68820AD**

(Fig. 16B) is used in later L4 equipment. This unit is provided on a per-line basis and is inserted between the output of the L4 pilot indicator circuit and the input of the switching signal filters. Four J68820AD units are mounted on a single panel, and each unit provides 45 dB of level adjustment.

**2.20 L4 pilot insertion and line terminating relay unit ED-50500-31 (Fig. 17)**

provides control features to terminate an L4 regular line and insert pilots into the following switching section when a total line failure occurs. This unit can be operated automatically and manually. The circuit is under automatic control when the line terminate manual (LTM) relay is released and under manual control when the LTM relay is operated. Local operation of the LTM relay is controlled by the MODE key in the control connecting bay. Remote operation of the LTM relay is accomplished via the E1 Status Reporting and Control System.

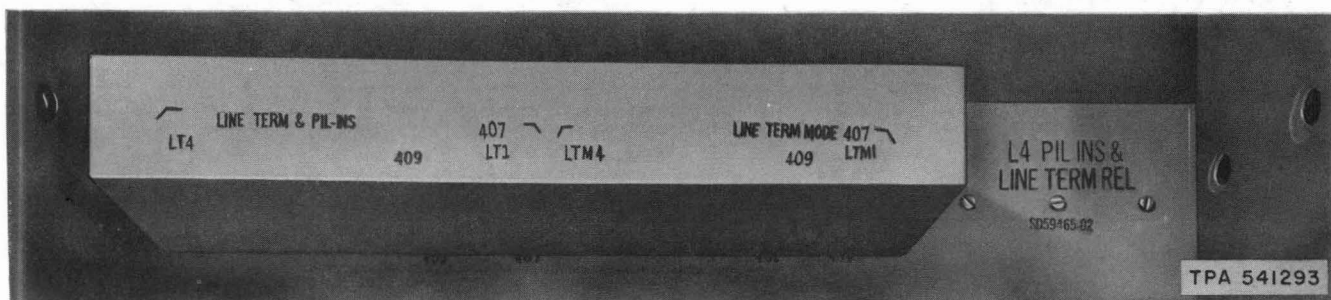


Fig. 17—L4 Pilot Insertion and Line Terminating Relay Unit

**2.21 L4 standby line terminating relay unit ED-50500-32 (Fig. 18)**

provides control features to terminate the standby line at the input of the line connecting circuit. Termination of the standby line can be made automatically and manually. In addition, a means to manually override either an automatic or manual termination has been provided. Manual termination and override features can be controlled either locally or from a remote location via the Status Reporting and Control System.

**2.22** Controls and indicating lamps for the standby line terminating circuit are located in the control connecting bay. A 223C switch is also mounted in the control connecting bay. The relay panel can be mounted in this bay if there is not room in the switch control bay. A printed wiring board is required for each regular line and standby line initiator unit in the switch control bay. In addition, a K relay is needed for each regular line initiator unit. This relay may have been previously provided for the message register panel.

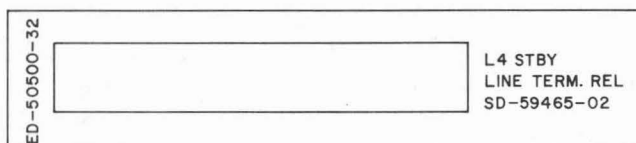


Fig. 18—Standby Line Terminating Relay Unit

### C. Switching Equipment Bays

**2.23** The switching equipment is mounted in the switch control bays. The number of bays required depends upon the number of regular lines to be protected. There are two sizes of switch control bays: 11.5-foot and 9-foot bays. All of the bays accept 19-inch wide panels.

**2.24** In the 11.5-foot bay configuration, a maximum of three bays is required for a fully equipped 20-line cable (Fig. 19). A J68820A bay can mount switching equipment for as many as four regular lines and a standby line. A J68820AA bay provides mounting space for four more regular lines, and a J68820AB bay provides mounting space for the last four lines. To serve the 20 lines in an L4 coaxial cable, the maximum size of a supermultiline arrangement is nine regular lines and one standby line in each direction of transmission.

**2.25** In the 9-foot bay configuration, a double bay, J68820BA, is used which serves a maximum of three regular lines and one standby line. An additional bay, J68820BB, is needed for an expanded multiline, and a fourth bay is required for a supermultiline arrangement. Figure 20 shows the equipment arrangement used for both the L3 and L4 Systems.

## 3. SWITCHING OPERATIONS

### A. General

**3.01** The two-line switching arrangement is used for the L3 System only and is described in Part 4. A multiline, expanded multiline, or supermultiline switching arrangement is activated when a line pilot power exceeds the specified limits. In the following paragraphs, the sequence of events during an automatic transfer of service and return to service on a failed regular line are explained.

### B. Transfer of Service

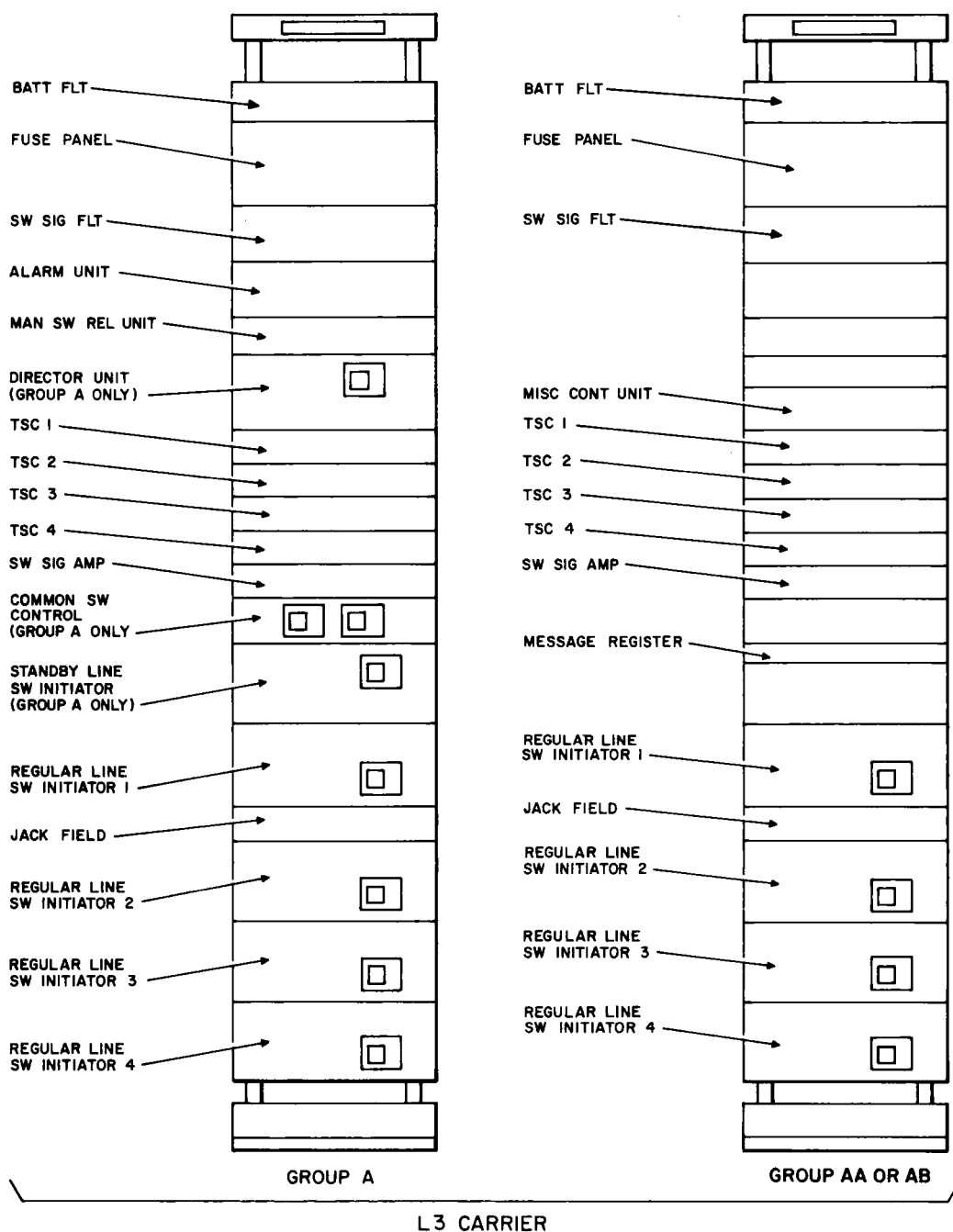
**3.02** Figure 21 is a block diagram showing the transfer of service from a failed regular line to the standby line. The block diagram is comprised of the receiving repeater, the switching signal control circuit, and the transmitting repeater. All even lines are from terminal A to terminal B; all odd lines are from terminal B to terminal A.

**3.03** Assume that all lines and the switching are normal. If an even line fails, the failure is detected by the switch control circuit at the receive end (terminal B). The regular line initiator unit associated with the failed line produces the following sequence of events:

- (1) Releases a line identification signal (284, 286, 288, or 290 kHz) which is transmitted over specified odd lines to the transmit end (terminal A)
- (2) Furnishes a signal to block the succeeding section of the failed line from switching
- (3) Sets up a partial path to the windings of the receive 223 coaxial switch. This path will be completed when a verification signal is received from the transmit end
- (4) Disables all other regular line initiator units
- (5) Activates the reset circuit which will sample, at regular intervals, pilot power received on the failed line. The initial reset operation takes place within 0.5 second after any pilot failure, and the pilot power is then sampled every 40 seconds thereafter.

**3.04** At the transmit end (terminal A), the line identification signal for the failed line enters the switch control unit through a pilot hybrid. The transmit switch control unit associated with the failed line selects the identification signal which is applied to a detector. A dc output from the detector activates the transmit switch control circuit which:

- (a) Operates the transmit 223 coaxial switch. When this switch is operated, the line signals on the failed regular line also are applied to the standby line.
- (b) Release the 296-kHz verification signal. This signal is transmitted over the standby line and the affected regular line to the receive end (terminal B).
- (c) Furnishes a signal to inhibit all other transmitting switches.
- (d) Furnishes a signal to operate the release signal blocking circuit in the director.



NOTES:

1. SOME EARLY L4 INSTALLATIONS MAY RESEMBLE THE L3 ARRANGEMENT.
2. IN SOME L4 ARRANGEMENTS, THE LEVEL COMPENSATION UNIT AND THE PILOT INSERTION AND LINE TERMINATING RELAY UNIT MAY BE MOUNTED MISCELLANEOUSLY.
3. IN BOTH THE L3 AND L4 ARRANGEMENTS, THE MESSAGE REGISTER MAY BE MOUNTED MISCELLANEOUSLY.

Fig. 19A—Equipment Arrangement for L3 Carrier

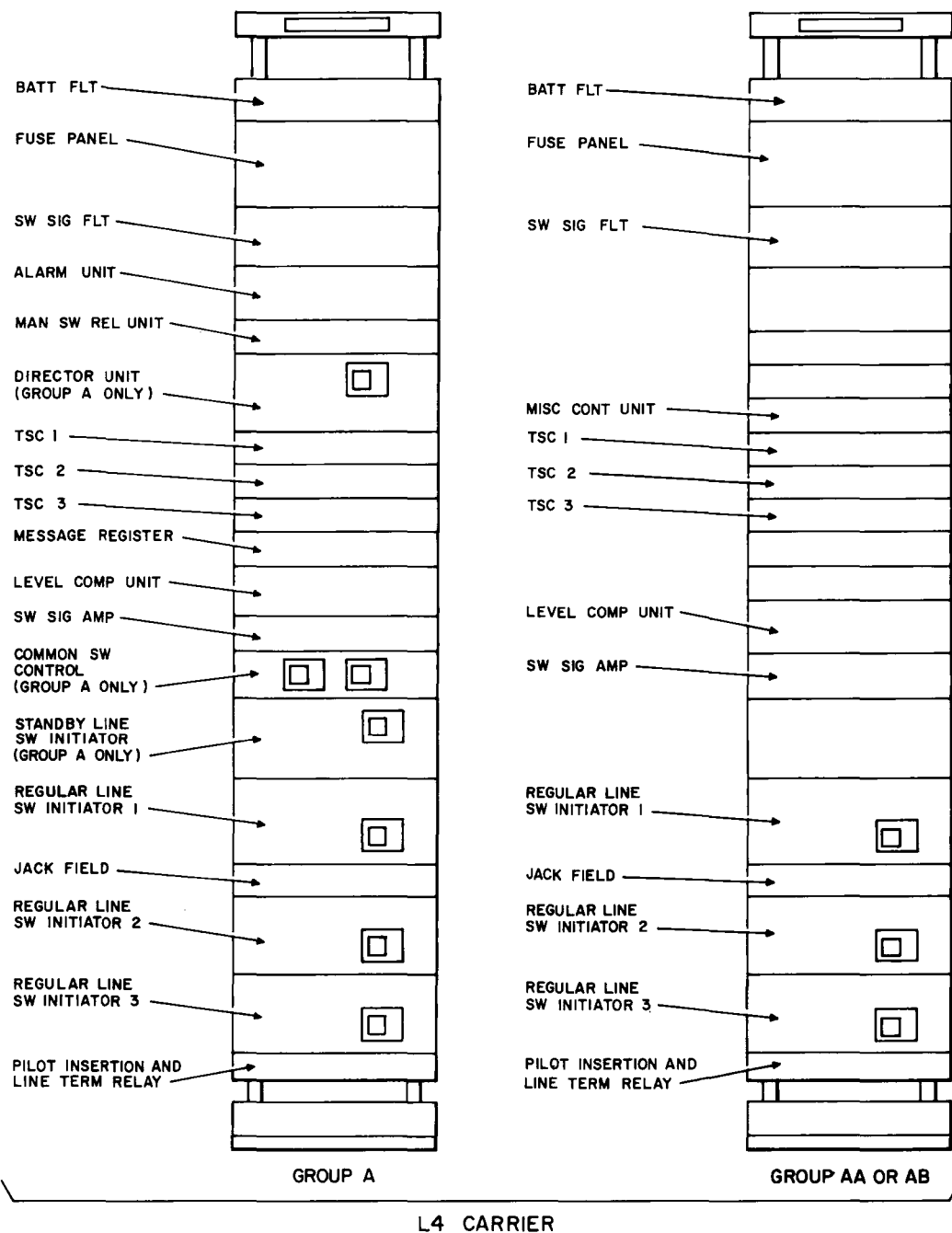


Fig. 19B—Equipment Arrangement For L4 Carrier

## SECTION 359-100-100

**3.05** At the receive end (terminal B), the verification signal is passed to the switch control unit. The 296-kHz signal activates a control circuit which operates the receive coaxial switch. Reception of this signal verifies that the transmit end (terminal A) has transferred service to the standby line in the even direction. With the coaxial receive switch operated, the following actions occur:

- (1) The failed or faulty regular line is terminated into 75 ohms.
- (2) The standby line is connected to the line connecting circuit for the failed regular line.
- (3) The office minor audible and visual alarms operate, and the out-of-service automatic lamp lights.
- (4) ♦All other transmitting switches are inhibited.
- (5) The release signal blocking circuit in the director operates.

### C. Return to Normal♦

**3.06** When the fault on the failed line clears (Fig. 22), the associated pilot indicator relays (terminal B) will remain released following the next reset operation. After a delay of approximately 20 seconds, the regular line switch initiator causes the following sequence:

- (1) The receive 223 coaxial switch restores the regular line to normal and terminates the standby line into 75 ohms.
- (2) The out-of-service automatic lamp extinguishes.
- (3) The release circuit is activated.

**3.07** When the release circuit operates, the following sequence of events occurs:

- (1) A gate at the output of the release oscillator is opened, and the 282-kHz release signal is applied to all lines in the odd direction.
- (2) All initiators at terminal B are disabled. These initiators are disabled to prevent a transfer of service while the release signal is being transmitted.

- (3) The transmit switch release fail (TS RLS FAIL) alarm is delayed for approximately 5 seconds.

**3.08** At terminal A, the release signal is selected by the release signal separation (RSS) filter and delivered to a detector that converts the signal into a direct current which:

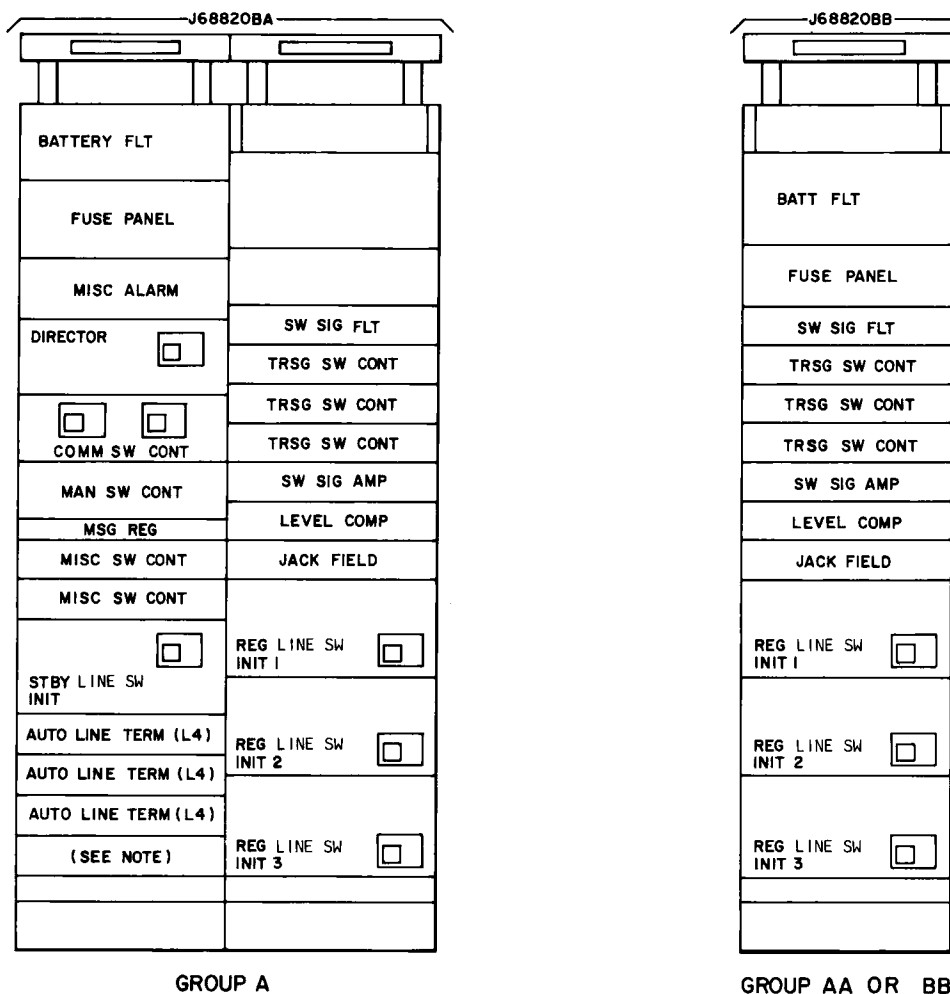
- (1) Restores the transmit switch control (TSC) circuit to normal
- (2) Releases the transmit switch
- (3) Blocks the 296-kHz verification signal
- (4) Opens a gate which transmits a 280-kHz release check signal to terminal B on the standby line.

**3.09** The 280-kHz release check signal is selected at terminal B by the standby line filter. After amplification, the release check signal is selected by the release check signal separation (RCSS) filter and delivered to a detector circuit that converts the signal into a direct current which:

- (1) Closes the gate to block the output of the release signal. The absence of the release signal deactivates the release detector at the transmit end (terminal A) which blocks the output of the release check signal.
- (2) Restores all initiators to normal.
- (3) Deactivates the transmit release switch fail alarm.

**3.10** The switching system has now been restored to normal and is ready to transfer service from another faulty regular line to the standby line.

**3.11** One important fact to remember is that the switching system can restore one line in the odd direction and any line in the even direction. Each direction of transmission is completely independent of the other.



NOTE:  
L3 PROTECTION LINE TANDEM OPERATION  
OR L4 STANDBY LINE TERMINATE.

Fig. 20—Equipment Arrangement in 9-Foot Bays

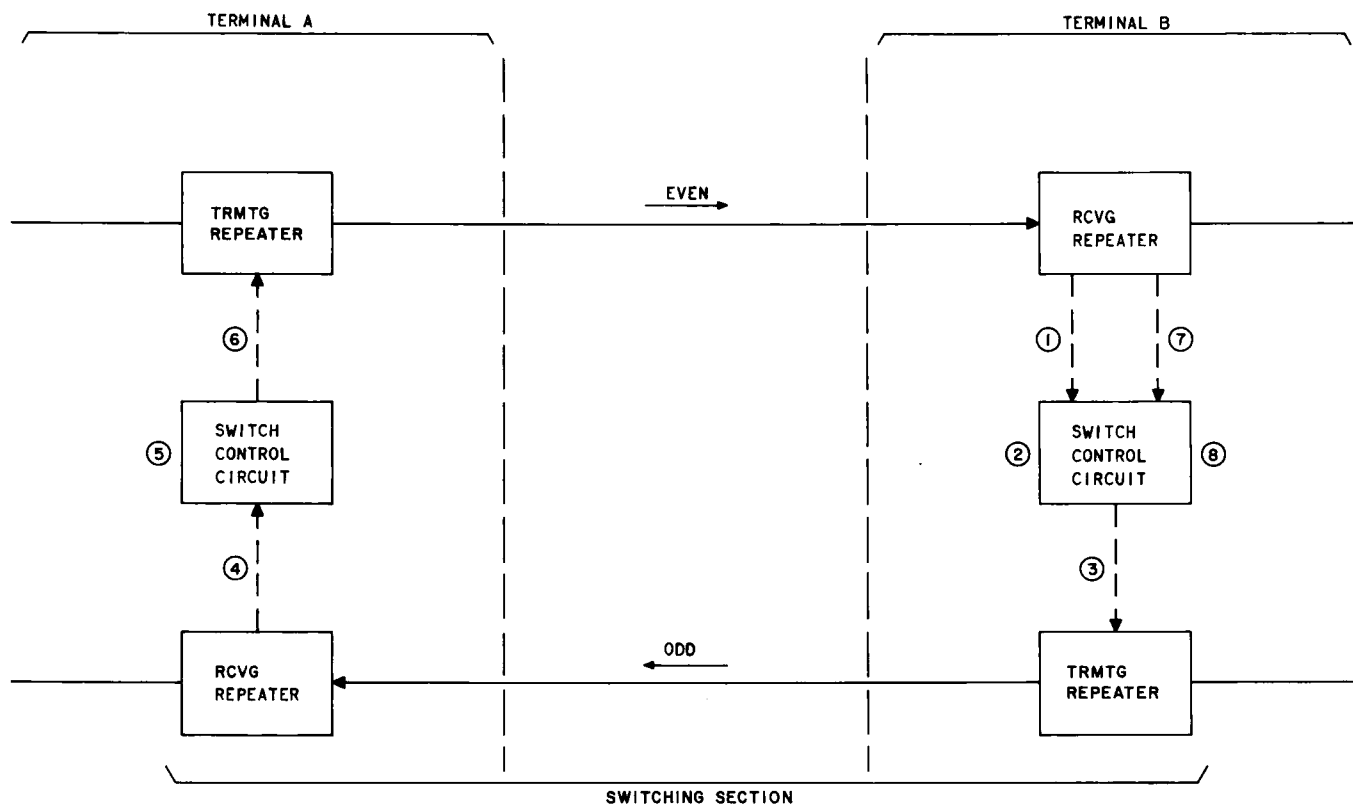
#### 4. TWO-LINE SWITCHING OPERATIONS

##### A. General

**4.01** A two-line switching arrangement consists of one regular line and one standby line in each direction of transmission. Both the regular and standby lines (Fig. 23) are fed simultaneously through the transmit hybrid. Therefore, the transmit end does not require any switching equipment. A 223 coaxial switch and all control equipment are provided at the receive end.

##### B. Transfer of Service

**4.02** When a pilot power deviates on the regular line (Fig. 23), the regular line switch initiator operates the receive 223 switch. However, if the standby line is not in a normal condition, the standby line switch initiator will not permit the transfer of service to take place. Since no switching is provided at the transmit end, no switching signals are released by the regular line switch initiator. Two other functions of the regular line switch initiator are to operate the alarm circuit and to activate the reset operation.

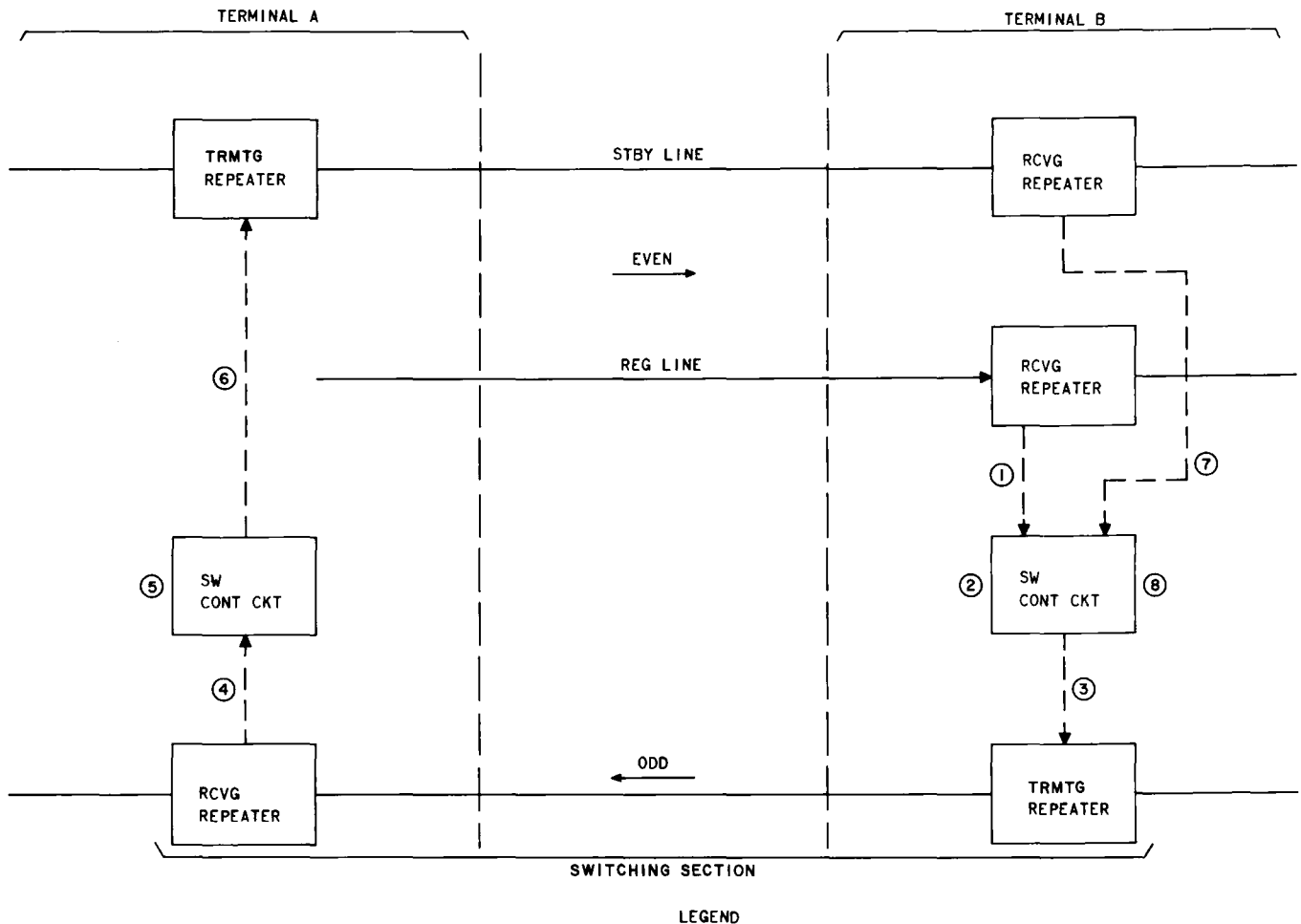


SWITCHING SECTION

## LEGEND

- ① PIL LEVEL CHANGE IS DETECTED.
- ②
  - IDENTIFICATION SIGNAL SENT OUT.
  - SUCCEEDING SECTION OF FAILED LINE BLOCKED.
  - READIES RECEIVE SWITCH FOR OPERATION.
  - DISABLES ALL OTHER REGULAR LINE INITIATORS.
  - ACTIVATES THE RESET CIRCUIT.
- ③ IDENTIFICATION SIGNAL ENTERS TRMTG REPEATER.
- ④ IDENTIFICATION SIGNAL IS PICKED OFF AT RCVG REPEATER.
- ⑤
  - IDENTIFICATION SIGNAL IS SELECTED.
  - TRMTG SWITCH IS OPERATED.
  - VERIFICATION SIGNAL IS SENT OUT.
- ⑥ VERIFICATION SIGNAL ENTERS TRMTG REPEATER.
- ⑦ VERIFICATION SIGNAL IS PICKED OFF AT RCVG REPEATER.
- ⑧
  - FAILED REGULAR LINE IS TERMINATED INTO 75 OHMS.
  - STANDBY LINE IS CONNECTED TO REGULAR LINE CONNECTING CIRCUIT.
  - AUDIBLE AND VISUAL ALARMS OPERATE.

Fig. 21—Regular Line Fails



- ① FAILED LINE CLEARS AND PILOT INDICATOR RELAYS ARE RESET.
- ②
  - COAXIAL RECEIVE SWITCH RESTORES.
  - OUT SERV AUTO LAMP EXTINGUISHES.
  - RLS CIRCUIT IS ACTIVATED.
- ③ RLS SIGNAL OUT (282 KHZ)
- ④ RLS SIGNAL IN.
- ⑤
  - TSC CIRCUIT RESTORED TO NORMAL.
  - COAXIAL TRANSMIT SWITCH RELEASES.
  - 296-KHZ VERIFICATION SIGNAL REMOVED.
  - 280-KHZ RLS CHK SIGNAL IS TRANSMITTED TOWARD TERMINAL B.
- ⑥ RLS CHK SIGNAL OUT.
- ⑦ RLS CHK SIGNAL IN.
- ⑧ RESTORES SWITCHING SYSTEM TO NORMAL BY:
  - RLS SIGNAL RELEASED.
  - ALL INITIATORS ARE RELEASED.
  - ALL ALARMS ARE RELEASED.

Fig. 22—Regular Line Returns to Normal

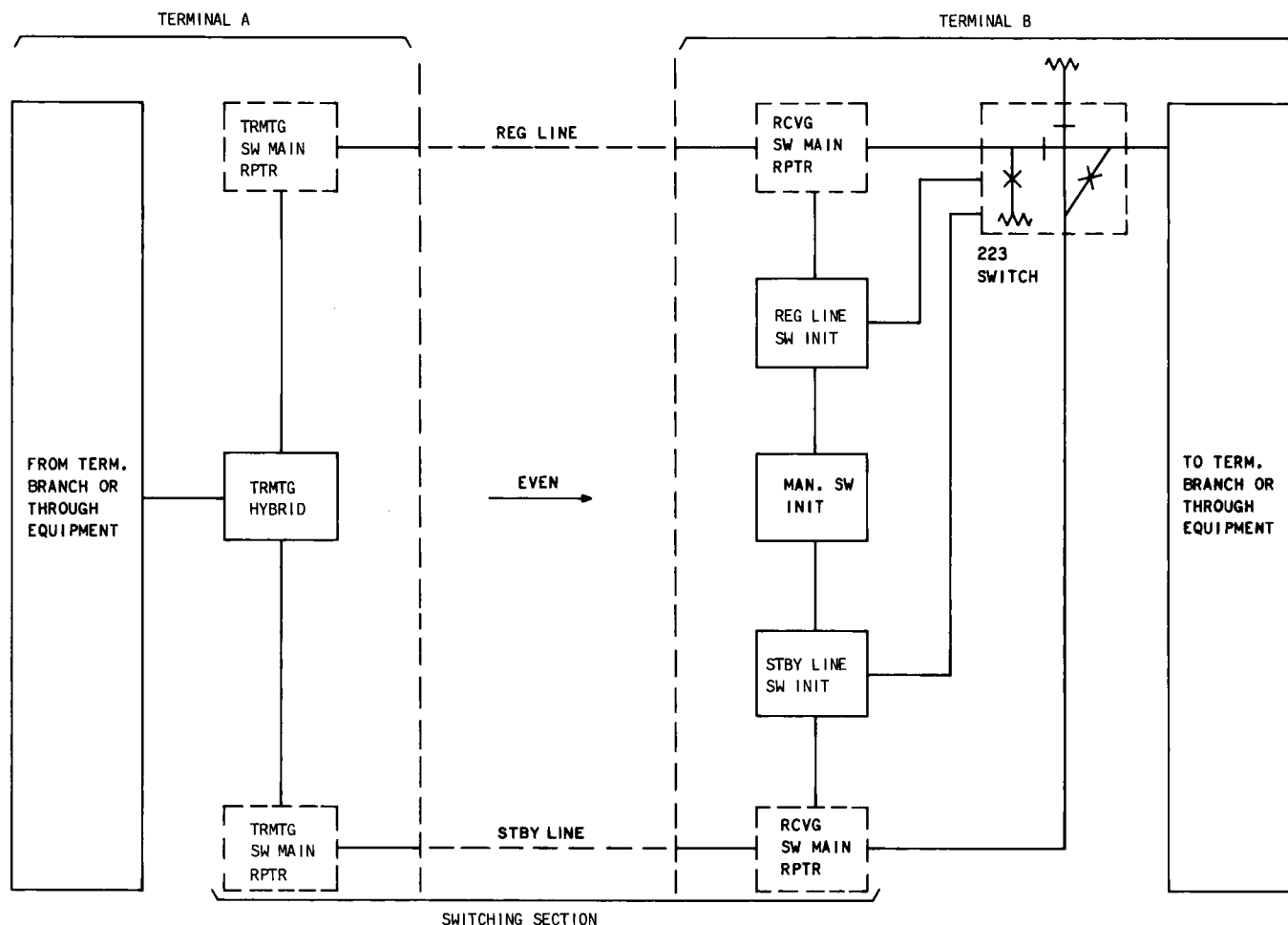


Fig. 23—Two-Line Switching Arrangement

### C. Return to Normal

**4.03** When the pilot power on the failed regular line returns to normal, the regular line switch initiator recognizes the condition and, after a short delay, releases the receive coaxial switch. The release is delayed to ensure that the trouble has completely cleared. When the receive switch releases, the alarm and reset circuits are deactivated. The switching system is now normal.

## 5. OVERALL SYSTEM LAYOUT

### A. General

**5.01** Basically, the switching operations for the L3 and L4 Systems are identical. Each system uses the same equipment with the exception

of the level compensation unit, L4 pilot insertion and line terminating relay unit, and the L4 standby line terminating relay unit. These units are described in Part 2.

**5.02** The multiline, expanded multiline, and supermultiline switching arrangements are very similar. A two-line switching arrangement, which is available only in an L3 System, is shown in Fig. 23. This arrangement does not use any switching equipment at the transmit end and requires no switching signals. The major difference between the three other arrangements is the transmission of the switching signals. The following paragraphs explain the multiline, expanded multiline, and supermultiline arrangements for both the L3 and L4 Systems.

**B. L3 Switching**

**5.03** A simplified block diagram of an overall L3 multiline switching arrangement (Fig. 24) shows the transmit and receive ends at a terminal main station and a switching main station. At the switching main station, the connecting equipment and the transmit and receive portions of the next section are also shown. This portion is shown to provide a complete transmission path through the main station.

**5.04** A complete L3 multiline arrangement can serve as many as four regular lines and one standby line in each direction of transmission. The identification signal of a failed line is transmitted over all lines, including the standby line, to the distant end. The release signal and the verification signal are also transmitted over all lines, but the release check signal is transmitted over only the standby line.

**5.05** An expanded multiline arrangement can serve as many as eight regular lines and one standby line in each direction of transmission. The line identification signals are duplicated. Line identification signals for group A lines are sent over the regular lines of that group; the line identification signals for group AA lines are sent over the regular lines of group AA. The standby line does not carry any of the identification signals; however, the standby line does carry the release check signal. The path for the release signal is over the lines associated with group A; the path for the verification signal is over all regular lines.

**5.06** The supermultiline arrangement can serve as many as 12 regular lines and one standby line in each direction of transmission. The same four line identification signals are used in each group. Thus, as in expanded multiline, each group must have a separate path for the identification signals. The paths for groups A and AA are the same as in expanded multiline. Group AB uses the regular lines of that group. The standby line does not carry any of the identification signals. The transmission paths for the verification signal, release signal, and release check signal are the same as in expanded multiline.

**C. L4 Switching**

**5.07** ♦A simplified block diagram of an overall L4 multiline switching arrangement (Fig. 25) shows a terminal main station and an intermediate main station. At the intermediate main station, the connecting equipment and the transmit and receive portions of the next section are also shown. ♦ This portion is shown to provide a complete transmission path through the station.

**5.08** A complete L4 multiline arrangement can serve as many as four regular lines and one standby line in each direction of transmission. The identification signal of a failed line is transmitted over all lines toward the distant end. The release signal and the verification signal are also transmitted over all lines, except the verification signal is picked off the standby line only at the receive end. The release check signal is transmitted over the standby line only.

**5.09** An expanded multiline arrangement can serve as many as eight regular lines and one standby line in each direction of transmission. The line identification signals are duplicated. The path for group A switching signals is the same as in the multiline system, except the receive end of the switching system is provided with filters in the standby line to pass only the release check and verification signals. The group AA line identification signals are transmitted over the regular lines only in group AA.

**5.10** A supermultiline arrangement (groups A, AA, and AB) can serve up to twelve regular lines and one standby line in each direction of transmission. The four line identification signals are used in each group. Thus, as in the expanded multiline system, each group must have a separate path to transmit the identification signals. The paths for groups A and AA switching signals are the same as in the expanded multiline system. The group AB line identification signals are transmitted over the regular lines in group AB only. Line identification signals will appear on both standby lines (odd and even) when both standby lines are in service to replace failed regular lines in the *same* group (A, AA, or AB).

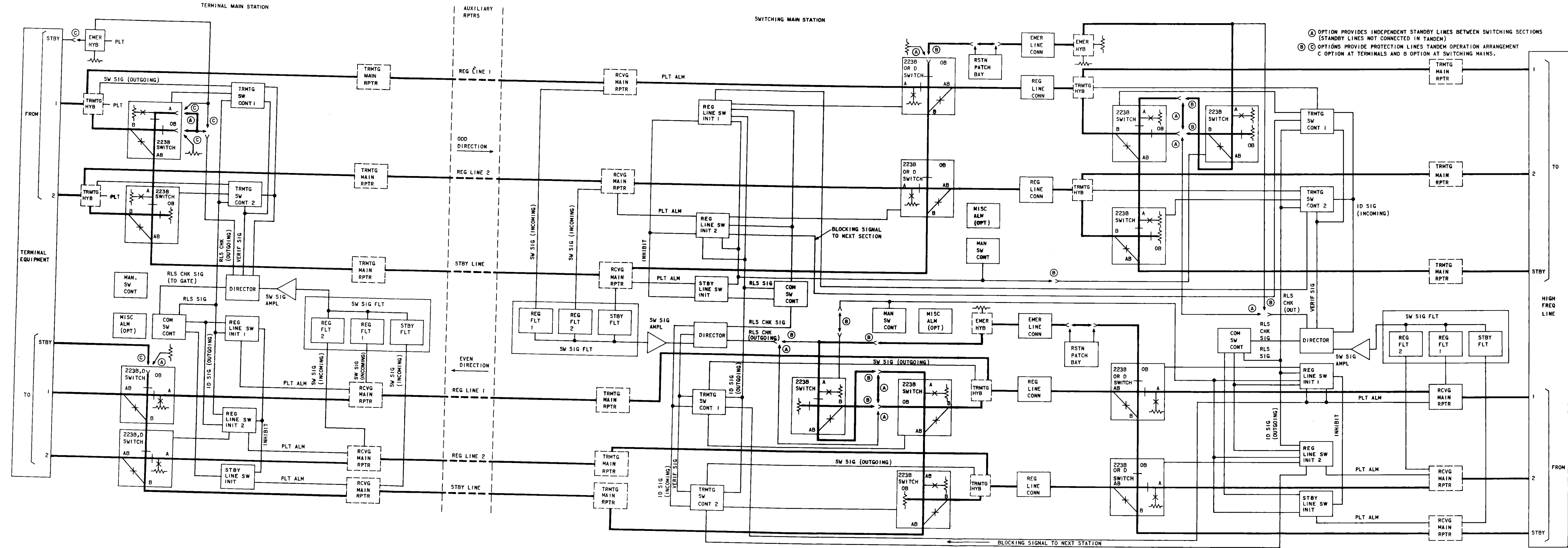


Fig. 24—Switching Arrangement for L3 Carrier

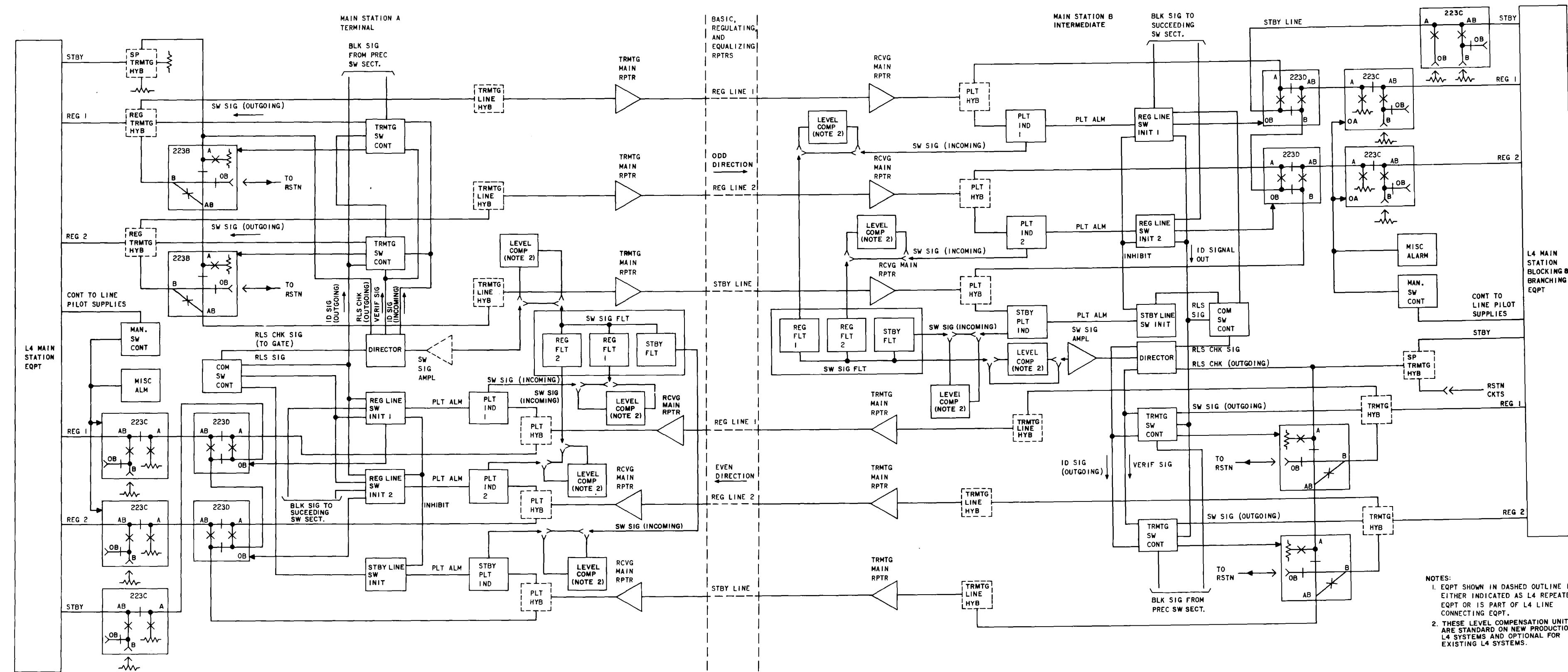


Fig. 25—Switching Arrangement for L4 Carrier

## 6. MANUAL OPERATIONS

### A. General

**6.01** The manual switch control circuit provides facilities for manually transferring service from a regular line to the standby line and for locking the regular lines normal. Manual operations supersede all automatic operations of the switching system. If an operation is performed manually, it must be released manually. In an L4 System, facilities are also available to manually terminate all lines, including the standby line.

**6.02** ♦Manual operations are initiated by simultaneously operating two nonlocking key switches located in the jack field (Fig. 2) mounted in the L3 miscellaneous bay or in the L4 control connecting bay. Indicator lamps light to show that the manual operations have been completed. Table C summarizes the manual switching operations.

### B. Placing Standby Line in Service

**6.03** To perform maintenance or trouble investigation, manually transfer service from a regular line to the standby line. The manual transfer of service is accomplished as follows:

- (1) Momentarily depress the SEL LINE MAN pushbutton of the line to be transferred. The associated SEL LINE MAN lamp lights.
- (2) Simultaneously depress the MSTR and MAN pushbutton. The OUT SERV MAN lamp lights, and the OUT SERV lamp lights in the line receiving bay.

**6.04** To place the regular line back in service, simultaneously depress the MSTR and RLS pushbuttons. All lamps will extinguish. The switching system is now in the normal condition.

### C. Locking Standby Line in Service

**6.05** This procedure is used to lock service on the standby line after an automatic transfer has taken place. Locking the standby line in service may be necessary during corrective maintenance to control the amount of time that service remains on the standby line. ♦After an automatic transfer

has taken place, service can be locked on the standby line by depressing the SEL LINE MAN pushbutton for the regular line and then simultaneously depressing the MSTR and MAN pushbuttons. This action replaces the automatic transfer with a manual transfer.

**6.06** To release the locked standby line, simultaneously depress the MSTR and RLS pushbuttons.♦

### D. Locking Regular Lines in Service

**6.07** ♦Service can be locked on the regular lines by simultaneously depressing the MSTR and LOCK NORM pushbuttons. If the standby line is in service during this operation, the service will be removed from the standby line and placed back on the regular line. The entire switching system will be in a nonoperative condition (locked normal) until released.

**6.08** The lock normal condition can be released by momentarily depressing the MSTR and RLS pushbuttons.♦

### E. L4 Line Terminating

**6.09** The L4 line terminating circuit is provided for both the standby and regular lines. During a total fail condition, the line terminating circuit is activated to prevent noise from entering the following section. The standby line terminating switch and the regular line terminating switches (one for each regular line) are shown in Fig. 25.

**6.10** Operation of a terminating switch is accomplished either automatically or manually. For both modes of operation, provisions are made to insert line pilots on the succeeding section. Provisions are also included for remote operation and status reporting.

**6.11** An override feature for the standby line is provided to manually release the terminating switch when either a manual or automatic termination is in effect. Control is via the standby line terminate override relay and may be accomplished either locally or from a remote location. Release of the override will result in an automatic line termination unless the lines have restored to normal.

♦TABLE C♦

## MANUAL SWITCHING OPERATIONS

| SWITCHING<br>FUNCTION                                                  | PUSHBUTTONS IN<br>L3 MISCELLANEOUS BAY AND<br>L4 CONTROL CONNECTING BAY |      |     |              |     |            |            | LAMPS IN<br>L3 MISCELLANEOUS BAY AND<br>L4 CONTROL CONNECTING BAY |                    |              |              |             |            |
|------------------------------------------------------------------------|-------------------------------------------------------------------------|------|-----|--------------|-----|------------|------------|-------------------------------------------------------------------|--------------------|--------------|--------------|-------------|------------|
|                                                                        | SEL<br>LINE<br>MAN                                                      | MSTR | MAN | LOCK<br>NORM | RLS | LT<br>OPR* | LT<br>RLS* | SEL<br>LINE<br>MAN                                                | OUT<br>SERV<br>MAN | LOCK<br>NORM | OUT<br>SERV† | TOT<br>FAIL | LT<br>OPR* |
| Lock service on regular lines<br>(lock normal)                         |                                                                         | X    |     | X            |     |            |            |                                                                   |                    | X            | X§           |             |            |
| Switch service to standby<br>line (lock to standby)                    | X                                                                       | X    | X   |              |     |            |            | X                                                                 | X                  |              | X†           |             |            |
| Return regular line to<br>service or remove a<br>lock normal condition |                                                                         | X    |     |              | X   |            |            |                                                                   |                    |              |              |             |            |
| Operate line terminating<br>switch (L4 only)                           |                                                                         | X    |     |              |     | X          |            |                                                                   |                    |              |              | X¶          | X¶         |
| Release line terminating<br>switch (L4 only)                           |                                                                         | X    |     |              |     |            | X          |                                                                   |                    |              |              |             |            |

X Pushbutton is depressed or lamp is lighted.

\* L4 system only.

† This lamp is in the line receiving bay.

‡ On regular line taken out of service.

§ On standby line.

¶ On regular line which cannot be protected. TOT FAIL indicates that line terminating is required.

## 7. ♦STANDBY LINE TANDEM OPERATION♦

### A. L3 System

**7.01** Some L3 systems may connect adjacent standby line sections together to form a protection line. This arrangement is referred to as tandem operation. The tandem standby lines can be used for emergency restoration. For tandem operation, each switching main station must be equipped with an emergency 223 coaxial switch, an emergency hybrid, and an emergency line connector.

**7.02** The emergency 223 switch is mounted in the first regular line on the transmit side of the switching main station. The emergency switching circuit features both automatic and manual control. Manual operations can be controlled either locally or remotely. The circuit also includes an override feature.

### B. L4 System

**7.03** ♦In L4 System, including a remote control system, the standby line is connected through the intermediate main station in the two-section control arrangement. This is required so the control center attendant can observe signals on the far-section standby line during equalizer adjustments and when using monitoring oscillator signals.

**7.04** Automatic line switching at the intermediate main station is arranged so that a failed far-section line can be investigated from the control center for trouble location. When a far-section regular line fails, the transmission normally carried by that line is switched to the far-section standby line. Line switches at the intermediate main station connect the failed far-section **regular** line to the near-section **standby** line. The control center receiving circuit can be connected to the near-section standby line by use of receive override line selection pushbuttons on the control center.♦

## 8. REMOTE OPERATIONS

**8.01** The B1 Alarm and Control System or the E1 Status Reporting and Control System provides arrangements for an attended station to manually control an unattended or partially attended station. The supervisory functions of a control system include the following:

- (a) Registers the presence of an alarm condition at an unattended station
- (b) Orders specific operations at an unattended station
- (c) Receives a visual indication from an unattended station which confirms completion of an order.

**8.02** Table D shows the remote operations and the resulting alarm indications which are transmitted over the B1 Alarm and Control System or the E1 Status Reporting and Control System. Some of the operations are common to both L3 and L4 Systems; some pertain to only one system.

**8.03** Two of the alarm indications associated with the L4 System are not given in Table D. The STDBY TERM AUTO lamp indicates that the standby line has been automatically terminated. The STDBY CONN NORM lamp indicates that the standby line connecting circuit is normal; the THRU lamp is also lighted.

## 9. ALARMS

**9.01** Miscellaneous alarm circuits provide facilities for activating the office audible and visual alarms. These alarm circuits also light the local alarm lamps in the L3 miscellaneous bay or in the L4 control connecting bay.

**9.02** When alarm conditions arise on the coaxial lines or in the associated switching circuits, the following alarms are registered:

- TOT FAIL—Major alarm condition which indicates that pilots of the incoming regular lines and the standby line are out of limits, that line switching cannot be completed because of switching equipment failure, or that another line has already switched
- OUT SERV MAN—Minor alarm condition which indicates the incoming standby line is in service due to a manual transfer of service
- TS RLS FAIL—Minor alarm condition which indicates that the transmit 223 switch has failed to release after service has been restored to the regular line. This does not apply to the two-line switching arrangement

◆ TABLE D ◆

## REMOTE OPERATIONS AND ALARM INDICATIONS

| SYSTEM   | OPERATION            | FUNCTION                                                                                                                                                     | ALARM INDICATION                        |
|----------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| L3 or L4 | MAN SW               | Operation locks service of an incoming regular line to the incoming standby line                                                                             | MAN SW lamp lights                      |
|          | LOCK NORMAL          | Operation locks service on the incoming regular lines                                                                                                        | LOCK NORMAL lamp lights                 |
|          | RLS                  | Operation releases the manual switch or lock normal condition                                                                                                | MAN SW or LOCK NORMAL lamp extinguishes |
|          | TRSG SW INH          | Simultaneously inhibits operation of all transmitting switches                                                                                               | TRSG SW INH lamp lights                 |
|          | TRSG LINE( ) LOCKOUT | Inhibits operation of transmitting switches on an individual basis                                                                                           | TRSG LINE( ) LOCKOUT lamp lights        |
| L3       | PI OPR               | Operation inserts pilots on an outgoing line                                                                                                                 | PIL INS lamp lights                     |
|          | PI RLS               | Operation releases the pilot insert mode                                                                                                                     | PIL INS lamp extinguishes               |
| L4       | LT REL OPR           | Operates the line terminating switch                                                                                                                         | LT OPR lamp lights                      |
|          | LT REL RLS           | Operation releases the line terminating switch                                                                                                               | LT OPR lamp extinguishes                |
|          | MODE MAN             | Operation places the system in the line termination manual (LTM) condition                                                                                   | MODE lamp lights                        |
|          | MODE AUTO            | Operation of this key and the ALT MASTER key releases the line termination manual condition and returns the line termination and pilot resupply to automatic | MODE lamp extinguishes                  |
|          | STDBY TERM MAN OP    | Operates the standby line terminating switch                                                                                                                 | STDBY TERM MAN lamp lights              |
|          | STDBY TERM MAN RLS   | Operation releases the standby line terminating switch                                                                                                       | STDBY TERM MAN lamp extinguishes        |
|          | STDBY TERM OVRD OP   | Operation overrides an operated standby line terminating switch                                                                                              | STDBY TERM OVRD lamp lights             |
|          | STDBY TERM OVRD RLS  | Operation releases the override mode                                                                                                                         | STDBY TERM OVRD lamp extinguishes       |

- STBY FAIL—Minor alarm condition to indicate that pilots of the incoming standby line are out of limits

- OSC FAIL—Minor alarm condition which indicates that the output of one or more switching signal oscillators is below the minimum requirement.

**10. REFERENCES**

- 10.01** The following drawings and sections provide additional information:

| <b>DRAWING</b> | <b>TITLE</b>                                   | <b>SECTION</b> | <b>TITLE</b>                                |
|----------------|------------------------------------------------|----------------|---------------------------------------------|
|                |                                                | SD-95072-01    | Distribution Fuse Alarm Circuit             |
|                |                                                | SD-96188-01    | Audible and Visual Alarm Circuit            |
|                |                                                |                |                                             |
|                |                                                | 359-010-100    | L3 Carrier System Description               |
|                |                                                | 359-010-105    | L3 Carrier System Repeaters                 |
|                |                                                | 359-010-130    | L3 Carrier System Line Connecting           |
| SD-50731-01    | L4 Pilot Indicator Circuit                     | 359-100-500    | Automatic Line Switching Tests              |
| SD-50732-01    | L4 Level Compensation Circuit                  | 359-100-501    | Removal and Replacement of Coaxial Switches |
| SD-50966-01    | Register Circuits                              | 359-100-502    | Switching Signal Oscillator Tests           |
| SD-53171-01    | Miscellaneous Control Circuit                  | 359-100-503    | Expander and Trigger Circuit Tests          |
| SD-59095-01    | Filter Circuit—24-Volt Battery                 | 359-100-504    | Switching Signal Amplifier Tests            |
| SD-59371-01    | Decentralized Plate Battery Filter Circuit     | 359-100-505    | Detector Circuit Tests                      |
| SD-59461-01    | Switching Signal Amplifier Circuit             | 359-100-506    | Receiving Switch Operation Tests            |
| SD-59463-02    | Common Switch Control Circuit                  | 359-100-507    | Transmitting Switch Operation Tests         |
| SD-59464-02    | Switch Initiator Circuit                       | 359-100-508    | Manual Operation Tests                      |
| SD-59465-02    | Manual Switch Control and Indicating Circuits  | 359-100-509    | Switching Signal Level Adjustment Tests     |
| SD-59466-01    | Transmitting Switch Control Circuit            | 359-100-510    | L4 Level Compensation Circuit Tests         |
| SD-59468-01    | Switching Signal Oscillator Circuit            | 359-100-511    | Phase Correction Tests                      |
| SD-59469-01    | Alarm Circuits                                 | 359-200-100    | L4 Carrier System Description               |
| SD-59634-01    | Automatic Line Switching Application Schematic | 359-200-102    | L4 Main Station Transmission                |
| SD-59652-01    | Director Circuit                               | 359-200-104    | L4 Line Connecting                          |
| SD-59743-01    | Switching Signal Filter Circuit                | 359-230-100    | L4S Carrier System Description              |
| SD-90614-01    | Audible Alarm and Pilot Lamp Circuit           |                |                                             |