L4 CARRIER
OVERALL SYSTEM
DESCRIPTION
REMOTE CONTROL SYSTEM

CONTENTS PAGE

1. GENERAL

1.01 This section explains the remote control system and describes the two main equipment units that are included: control center J68895A and loopback equipment J68895B through J68895E.

1.02 This section is reissued to add reference to an intermediate office which is a power feed station equipped with protection line termination in Parts 4 and 5. Arrows are used to indicate changes.

1.03 The L4 carrier system utilizes a wide frequency band and contains numerous unattended repeaters. Remotely controlled, adjustable equalizer networks are provided in equalizing and main repeaters so that gain deviations across the L4 frequency band may be held within required limits. A monitoring oscillator is associated with each L4 repeater to aid in trouble locating.

1.04 The remote control system permits centralized measurements of gain deviations and provides facilities for in-service adjustments of equalizer networks at remote locations. The remote control system also permits turning on the monitoring oscillators, in groups, so that the received signals may be observed for locating troubles.

1.05 Remote control system equipment includes three principal parts: sending, loopback, and receiving. This equipment is located at main stations and is connected to the L4 lines as shown in Fig. 1. Additional remote control system equipment is located at equalizing repeaters, and a monitoring oscillator is associated with each L4 repeater.

2. EXPLANATION OF TERMS

2.01 Some terms pertaining to the remote control system are explained in this part. Other terms are explained where introduced in this section.

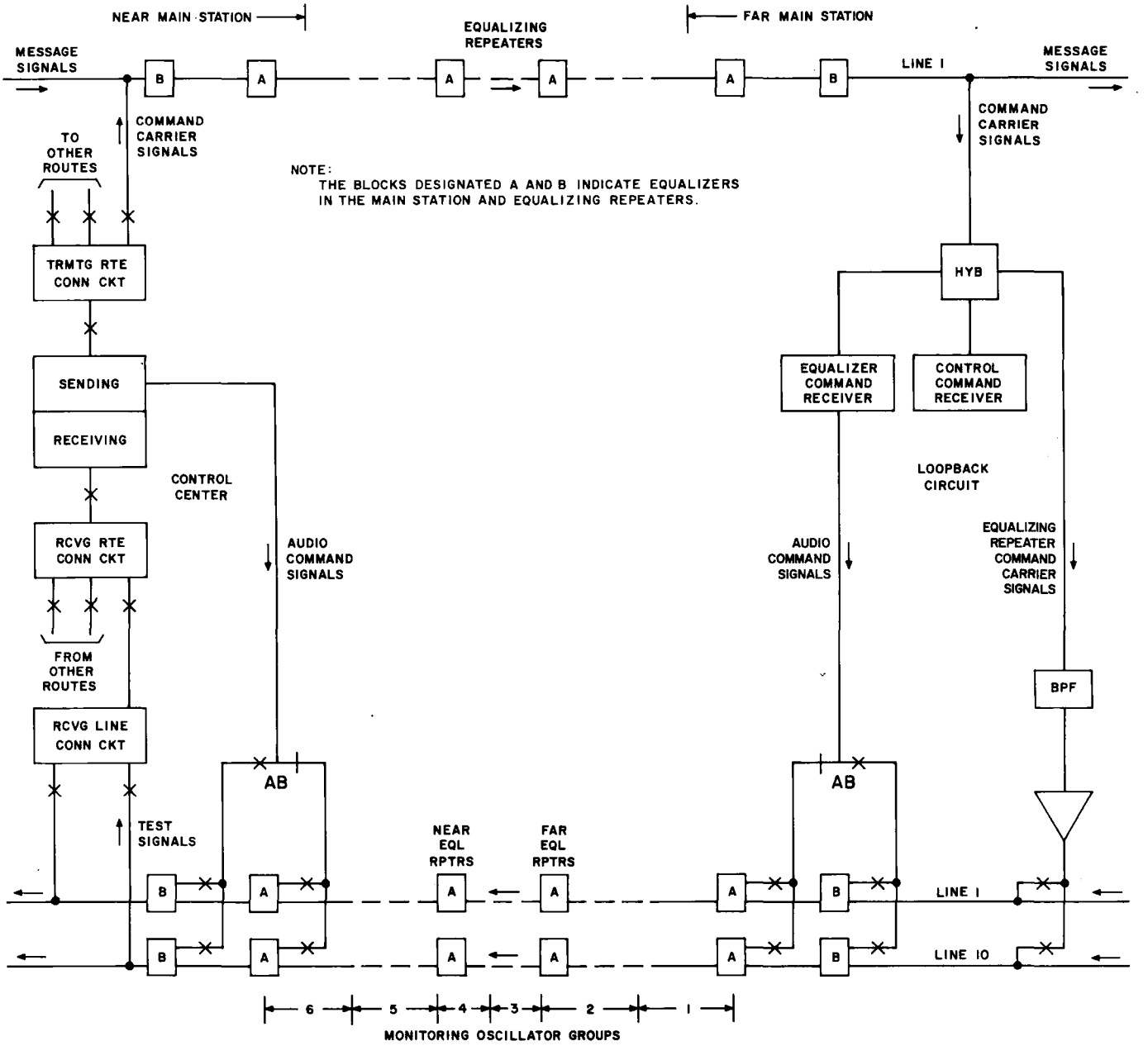


Fig. 1—Remote Control System—Simplified Diagram

A simplified control arrangement to aid in understanding the terms is shown in Fig. 1.

2.02 A ***control center***, shown in Fig. 2, includes sending and receiving circuits that permit control of remote locations, measurement of gain deviations, adjustment of equalizers, and display of received monitoring oscillator signals.

2.03 Control centers may be located at adjacent main stations, or there may be one main station between adjacent control centers. Where control extends over one main section, the section

Fig. 2—Control Center

is referred to as a ***near section.*** Where control extends over two main sections, the sections are referred to as ***near section*** and ***far section.***

2.04 A coaxial ***line*** includes repeaters at 2-mile spacing and carries signals in the L4 band from 280 kHz to 20.2 MHz. A line provides one direction of transmission.

2.05 An L4 ***cable*** may contain up to 20 coaxial lines, 10 carrying signals in each direction. In addition, the cable includes paper-insulated pairs

which are used for voice-order circuits, for dc power to monitoring oscillators, and for some other uses. Telephone communication among control center attendants is provided by order wires which appear at all main stations.

2.06 A ***route*** is the transmit and receive coaxial lines in one cable extending in one direction from the control center location under consideration. In general, a control center will be provided at each ***attended*** main station. Where an L4 cable passes through a main station having a control center, there are two routes, one in each direction. A control center will serve up to ten routes.

2.07 A control center is designed to control up to ten ***receive*** lines in each route. For a sideleg route, the control center also controls the transmit lines.

2.08 A 2-section control arrangement includes three main stations, which are referred to as near main, intermediate main, and far main.

(a) ***Near main*** refers to the main station where the control center under consideration is located.

(b) ***Far main*** refers to the main station where the adjacent control center on that route is located.

(c) ***Intermediate main*** refers to the main station that does not have a control center.

2.09 A ***program*** is set up by depressing control center pushbuttons, in a proper sequence, to accomplish desired actions at the various locations in the lines controlled. Lighted lamps in the pushbuttons depressed during programming provide a continuous indication of the program that is set up.

2.10 Desired actions are controlled by ***commands*** that are produced in the control center sending circuits during programming. Commands are combinations of audio signals sent to the various locations to establish connections, to control equalizer test oscillators, to adjust equalizers, and to control monitoring oscillators.

2.11 Commands are sent to remote main and equalizing repeaters via ***command carrier*** signals applied to a working transmit line in the selected route. Command carrier signals are in the band from 300 to 500 kHz. The required command carrier signals are sent automatically during programming.

2.12 At a remote main station, command carrier signals are looped back to the selected receive line by a ***loopback circuit.*** This loopback circuit also detects and connects audio command signals directed to equalizers at that main station.

2.13 There are five distinct versions of the loopback circuit, according to the control arrangement and location. Each version will be equipped for one of two sets of command carrier frequencies, according to the route served.

2.14 ***Command receivers*** are provided in loopback circuits and in each equalizing repeater. Each command receiver includes the proper bandpass filter to select one of the 12 command carrier frequencies, according to where the command receiver is installed.

2.15 Each loopback circuit includes two command receivers operating at command carrier frequencies assigned to that location.

- The ***control*** command receiver selects the commands to establish the following connections:

(a) To the desired line for loopback of command carrier signals to the equalizing repeaters in that line

(b) To the local A and B equalizers in the desired line at that main station.

- The ***equalizer*** command receiver selects the command signals directed to the local A and B equalizers at that main station.

2.16 Each equalizing repeater includes one command receiver, which selects the command carrier signals directed to that equalizing repeater.

2.17 ***Equalizer test oscillators*** produce signals used for measuring and adjusting equalizer gain. Each main and equalizing repeater includes an ***A*** equalizer and oscillators which produce the six A equalizer test signals. Also, each main repeater includes a ***B*** equalizer.

2.18 In each main station, there is a control connecting bay for each route at that main station. Each control connecting bay contains one set of ten B equalizer test oscillators, which serve all the transmit and receive lines in the associated route.

2.19 By command from a control center, the A or B equalizer test oscillators at a selected location may be turned on, and the test signals may be applied at the ***input*** or at the ***output*** of the selected equalizer. The received equalizer test signal levels are indicated on the control center equalizer adjust meters. Equalizer gain at the various frequencies can be adjusted by commands from a control center. The A and B equalizer test signal frequencies and equalizer gain-frequency characteristics are shown in Fig. 3.

2.20 A ***monitoring oscillator*** is associated with each basic, regulating, equalizing, and main repeater. A main section includes up to six groups of monitoring oscillators which are powered, from the equalizing and main repeater locations, by direct current sent over paper-insulated pairs in the L4 cable. All the monitoring oscillators in any group are powered simultaneously in response to a command from a control center. Each repeater location has an assigned monitoring oscillator frequency in the band from 18.50 to 18.56 MHz. Frequencies are assigned, in order, with the lowest frequency in a group at the east or north end. Monitoring oscillator signals are applied to four lines at a time, two in each direction.

2.21 The control center includes a spectrum analyzer for display of the received monitoring oscillator signals. In later control centers, the

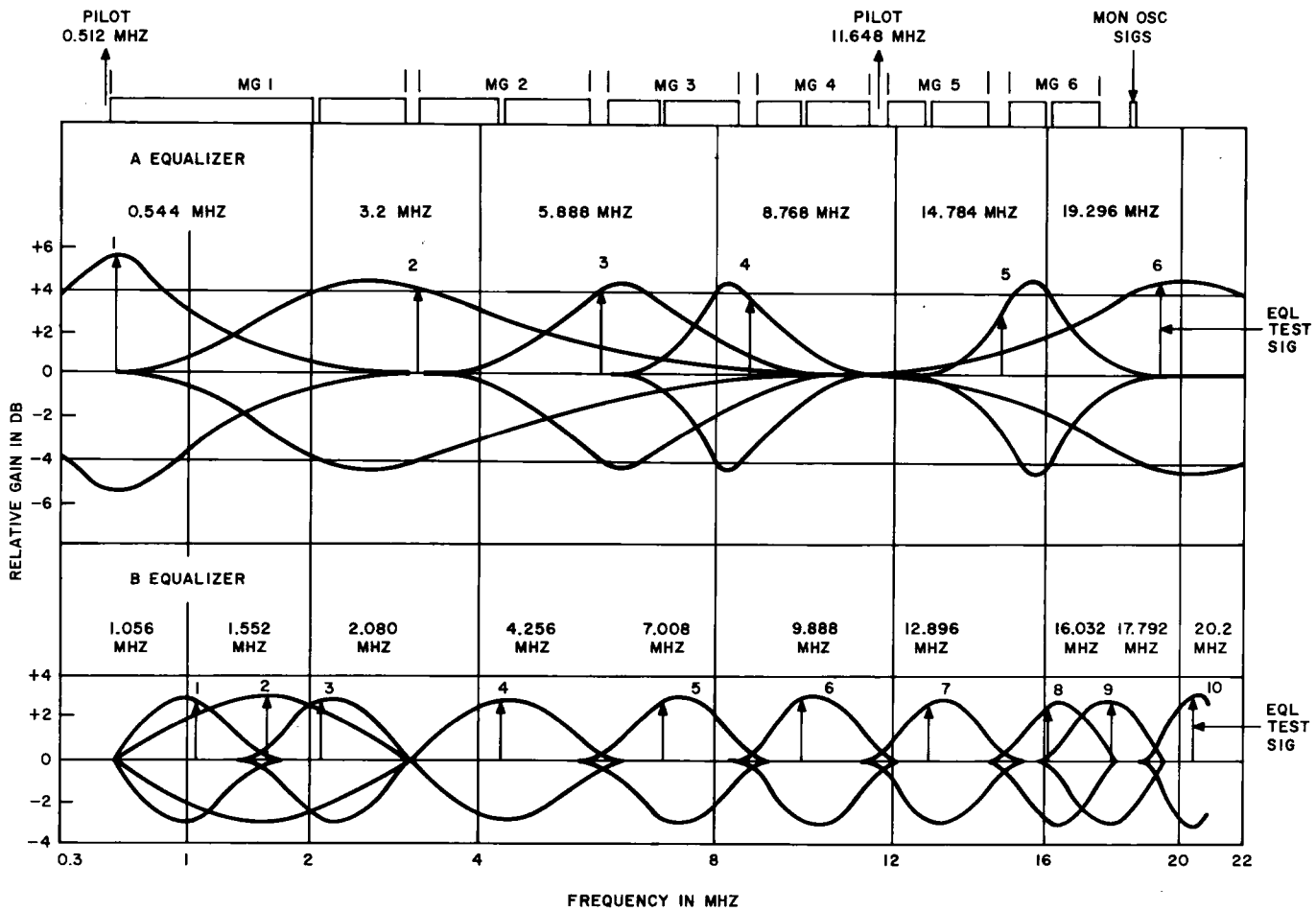


Fig. 3—Gain-Frequency Characteristics of A and B Equalizers

spectrum analyzer consists of a modified Tektronix storage oscilloscope with modified plug-in units.

2.22 The center frequency of this spectrum analyzer can range from 18.01 to 18.99 MHz in the HF band and from 10 to 990 kHz in the LF band. Two displays can be made: one above and one below the horizontal axis of the tube. For example, a frequency-domain display can be stored on the upper or lower half with a real-time display on the other half, or two separate displays in the same domain can be stored.

3. FUNCTIONAL DESCRIPTION

3.01 The remote control system permits two main actions.

(a) Measure gain deviations and adjust equalizers to compensate for these gain deviations.

(b) Locate troubles in the L4 repeaters through use of monitoring oscillator signals.

These actions are accomplished at a control center. In addition, tests may be made at control center jacks using external test equipment.

3.02 The ***sending*** portion of a control center enables the attendant to transmit command signals to remote locations to control the following actions:

(a) Establish the required connections.

(b) Turn on A and B equalizer test oscillators in the selected receive line.

(c) Adjust A and B equalizer networks at the selected remote location.

(d) Turn on any desired group of monitoring oscillators for trouble location.

3.03 The ***receiving*** portion of a control center enables the attendant to perform the following actions:

(a) Measure the equalizer test signals received on the selected receive line from the selected remote location.

(b) Observe the monitoring oscillator signals received on the selected receive line from the selected group of repeaters.

(c) Connect external test equipment to measure signals on the selected receive line.

3.04 Front-panel controls and indicators permit a control center attendant to set up the desired programs, make the required measurements and adjustments, and provide continuous visual indication of the status of the control circuits. To perform tests, measurements, and adjustments, a control center attendant first sets up the desired program by depressing pushbuttons.

3.05 Programming establishes connections at the control center as shown in ▶Fig. 6.◀ These connections provide:

(a) A path for command carrier signals from the sending circuit to a working transmit line in the selected route

(b) A path for audio command signals from the sending circuit to the local equalizers in the receive lines in the selected route

(c) A path for L4 line signals from the receive lines in the selected route to the receiving circuit.

3.06 Programming causes the proper command signals to be produced to initiate desired actions at the selected locations. Commands are sent to the local equalizers as audio signals and to the remote locations as audio modulation on the proper command carrier. Command carrier signals are accepted by a loopback circuit at the remote main station. These command carrier signals cause:

(a) The proper signal paths to be established in the loopback circuit

(b) The proper actions to be initiated at the selected remote location in the selected receive line.

4. CONTROL ARRANGEMENTS

4.01 There are three arrangements of the remote control system: one-section, two-section, and sideleg route control. These three arrangements are similar and the main features of each will be

explained beginning with one-section control, which is the simplest.

A. One-Section Control

4.02 The arrangement for control over one main section is shown in ▶Fig. 6◀ . There is a control center at the near main station and one at the far main station.

4.03 Programming a control center performs the following functions:

(a) Connects the control center sending circuit to a working transmit line in the selected route

(b) Causes the control center sending circuit to transmit command signals to initiate desired actions at remote locations

(c) Connects the control center receiving circuit to the desired receive line in the selected route.

4.04 Command carrier signals sent over a transmit line in the selected route are accepted by the control and the equalizer command receivers and by a bandpass filter in the loopback circuit at the far main station. The loopback circuit is connected to the office side of the automatic line switch so that the command carrier signal path is maintained even when line switching has occurred.

4.05 During programming, the desired route is selected first. ***Route*** selection arranges the control center to produce the proper command carrier frequencies. In this section, it will be assumed that the route selected requires transmission of the W-E command carrier frequencies, 316 to 396 kHz. The E-W command carrier frequencies, 412 to 492 kHz, are transmitted automatically when required by the route selected.

4.06 In one-section control, the NEAR SECT pushbutton is depressed next, then the desired line is selected. ***Section*** and ***line*** selection causes a command to be sent on 316 kHz to the loopback circuit at the far main station. ***Route*** and ***line*** selection completes a signal path from the selected receive line to the control center receiving circuit.

4.07 A 316-kHz ***control*** command receiver in the loopback circuit at the far main station detects the audio command signals and causes the proper one of the line connection relays, LC1 through LC10, and the corresponding one of the equalizer connection relays, EC1 through EC10, to operate.

4.08 The next command is sent as audio modulation on 332, 348, or 364 kHz, depending upon which remote location is to be controlled. A bandpass filter in the loopback circuit passes the 348-kHz and 364-kHz command carrier signals that control the equalizing repeaters in the receive lines.

4.09 A 332-kHz ***equalizer*** command receiver in the loopback circuit at the far main station detects the audio command signals directed to the A and B equalizers at that location. If a B equalizer at the far main station is to be controlled, an equalizer selection command sent on the 316-kHz command carrier causes relay AB to operate and complete the command signal path to the B equalizer selected. Audio command signals applied to the selected A or B equalizer permit the control center attendant to perform the following functions:

(a) Connect equalizer test signals at the input or at the output of the A or B equalizer selected so that the test signals may be measured at the control center at the near main station.

(b) Adjust the A and B equalizer networks.

(c) Turn on the group of monitoring oscillators powered from the selected far main repeater (group 1 in ▶Fig. 6).◀

4.10 The ***far*** equalizing repeater contains a 348-kHz command receiver, which detects the audio command signals directed to that location to perform the following actions:

(a) Connect equalizer test signals at the input or output of the A equalizer in the line selected.

(b) Adjust the A equalizer networks.

(c) Turn on either of the two groups of monitoring oscillators powered from the selected far equalizing repeater (groups 2 and 3 in ▶Fig. 6.)◀

4.11 Similarly, the ***near*** equalizing repeater is controlled by audio command signals sent on the 364-kHz command carrier. Monitoring oscillator groups 4 and 5 are powered from the selected near equalizing repeater.

4.12 At the ***near main*** station, audio command signals sent over office wiring permit the control center attendant to perform the following operations:

(a) Connect equalizer test signals at the input or output of the A or B equalizer in the line selected.

(b) Adjust the A and B equalizer networks.

(c) Turn on the group of monitoring oscillators powered from the selected near main repeater (group 6 in ◗Fig. 6).◖

B. Two-Section Control

4.13 The arrangement for control over two main sections is shown in ◗Fig. 7.◖ Basically, this is very similar to control over one main section; therefore, only the differences will be explained in detail.

4.14 Control is applied to the near section or far section, as determined by whether the NEAR SECT or FAR SECT pushbutton is depressed during programming. This ***section*** selection determines which set of audio command signals is placed on the 316-kHz command carrier and, in turn, determines whether command carrier loopback occurs at the intermediate or at the far main station. There is a 316-kHz ***control*** command receiver in the loopback circuit at each of these main stations. The near-section set of audio command signals serves to establish a loopback connection at the intermediate main station; the far-section set serves to establish a loopback connection at the far main station.

4.15 When the near section is to be controlled, command carrier loopback and control of the AB relay at the intermediate main station are exactly the same as for the far main station in one-section control.

4.16 When the far section is to be controlled, the far-section set of audio command signals sent on the 316-kHz command carrier controls the following:

(a) Line selection on the far side of the intermediate main station

(b) Relays AB and FM at the intermediate main station

(c) Line selection at the far main station

(d) Relay AB at the far main station.

4.17 There is an ***equalizer*** command receiver in the loopback circuit at the intermediate and far main stations. Audio commands to control the A and B equalizers are sent to the intermediate main station on the 332-kHz command carrier and to the far main station on 380 kHz.

4.18 An equalizer command receiver detects the audio commands by which the control center attendant can perform the following actions:

(a) Connect equalizer test signals at the input or output of the A or B equalizer selected.

(b) Adjust the A and B equalizer networks.

(c) Turn on either group of monitoring oscillators powered from the intermediate main station or the group of monitoring oscillators on the near side of the far main station.

4.19 Far-section equalizing repeaters contain command receivers which are exactly the same as those in the near-section equalizing repeaters. The 348-kHz and 364-kHz command carrier signals directed to far-section equalizing repeaters are blocked by filters, in the line connecting circuit for each line, between the automatic line switches at the intermediate main station. This command carrier blocking prevents signals sent for control of far-section equalizing repeaters from reaching the near-section equalizing repeaters. At the intermediate main station, blocking of 444-kHz and 460-kHz command carrier signals is provided in lines for the other direction of transmission to serve a similar function for the control center located at the far main station.

4.20 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 protection line. Line switches at the intermediate main station connect the failed ***far-section regular*** line to the ***near-section*** protection line. The control center receiving circuit can be connected to the near-section protection line by use of the receive override line selection circuit, as explained later in this section.

4.21 To provide continuity through an intermediate office which is a power feed station equipped with protection line termination, the transmitting and receiving switches must be operated at the intermediate office (Fig. 4).

C. Sideleg Route Control

4.22 An L4 cable usually bypasses large cities; the message signals to and from these cities are connected via a ***sideleg route***, as shown in Fig. 5.

4.23 In this section, it will be assumed that there will be a control center at the sideleg ***junction*** main station but not at the sideleg ***terminal*** main station. Insofar as equalizer adjustments are concerned, the sideleg route arrangement is very similar to control over two sections. The terminal main station corresponds to the intermediate main station in two-section control.

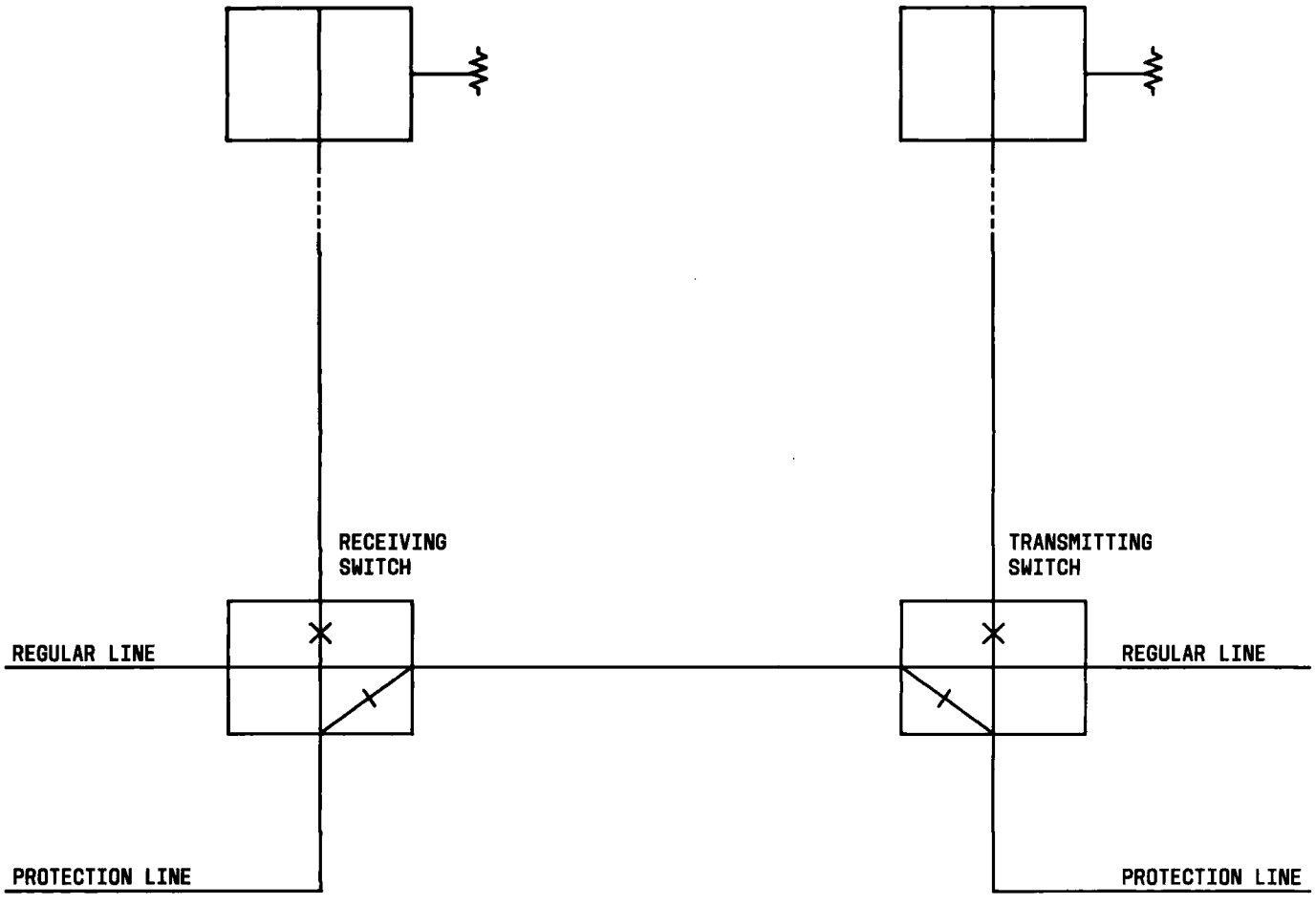


Fig. 4—Protection Line Termination

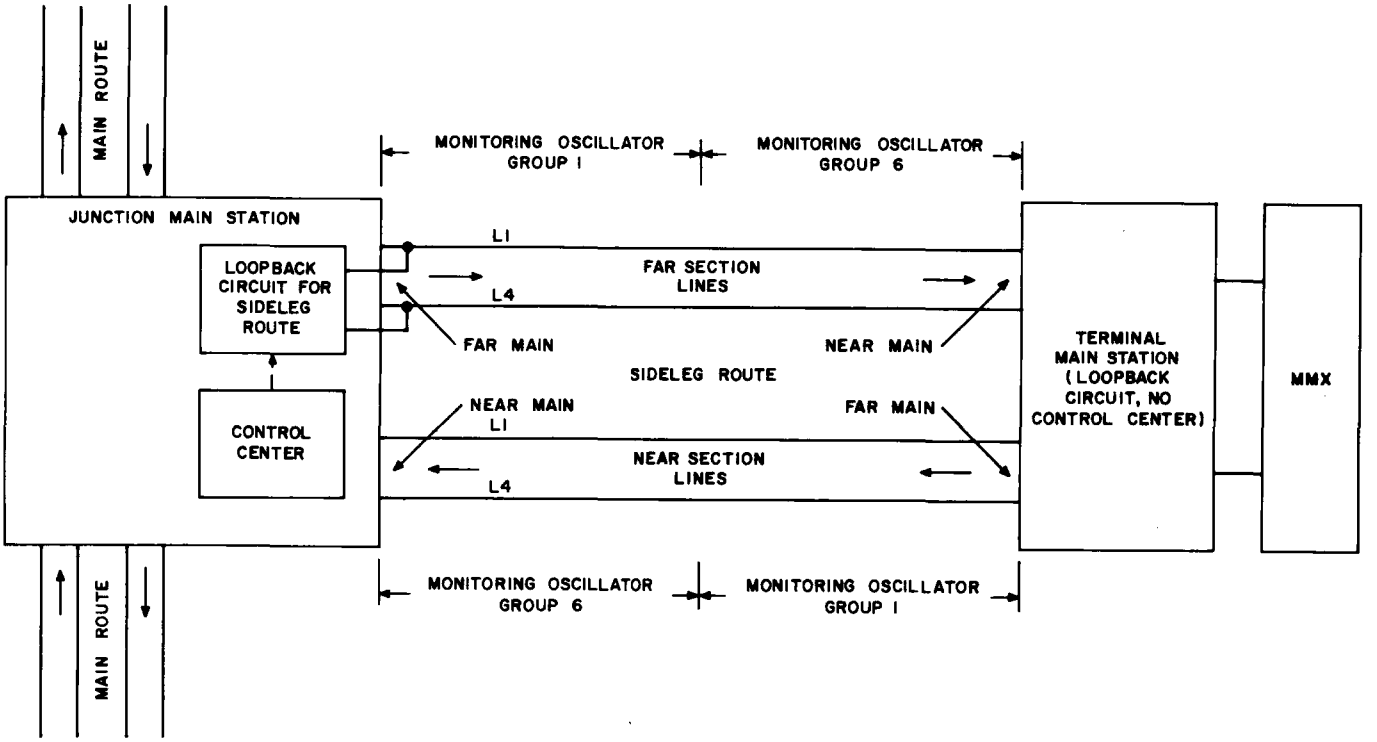


Fig. 5—Sideleg Route Control

4.24 At the control center, the sideleg receive lines are considered to be the near section and the transmit lines are considered to be the far section. When a far-section line is selected, the loopback circuit at the sideleg terminal station establishes a signal path from ***that*** far-section line to the near-section protection line. This signal path includes filters which pass the A and B equalizer test signals only. The control center receiving circuit can be connected to the near-section protection line by use of the receive override line selection circuit, as explained later in this section. Four equalizer locations that must be controlled are shown in ⧫Fig. 5⧫ and are controlled as follows:

(a) ***Receive*** line equalizers at the ***junction*** main station are controlled by means of audio command signals sent to them over office wiring, exactly as in one- and two-section control.

(b) ***Receive*** line and ***transmit*** line equalizers at the ***terminal*** main station are controlled by means of audio commands on the 428-kHz command carrier, exactly as in two-section control.

(c) ***Transmit*** line equalizers at the ***junction*** main station are controlled by means of audio commands on the 476-kHz command carrier sent via a loopback circuit similar to that used at the far main station in two-section control.

4.25 A control center attendant can turn on any of the groups of monitoring oscillators in the sideleg route and can observe the signals received on the near-section lines. Monitoring oscillator signals on the far-section lines may be measured at the terminal main station.

5. CONTROL CENTER CIRCUITS

A. General

Sending

5.01 Control center sending circuits include ten audio oscillators, two command carrier oscillator-modulators, and dc logic arrangements.

5.02 The dc logic causes the proper audio command and command carrier signals to

be produced and establishes the signal paths required for the programs that are set up. The dc logic also prevents setting up a program that is not valid.

5.03 The ten audio oscillators produce frequencies from 607.5 to 982.5 Hz and the output of each audio oscillator is connected to a gate. Pushbuttons in the line selection, equalizer adjustment, and monitoring signal control circuits turn on the proper gates to produce the required command signals. For each command, one to three of the audio signals will be passed by the gates, as determined by the program that is set up. Commands control section selection, line selection, equalizer selection, equalizer test oscillators, equalizer adjustments, and monitoring oscillators.

5.04 Only one of the two command carrier oscillator-modulators will be in use at a time, according to the route selected. This oscillator-modulator will produce one of six command carrier frequencies, according to the remote location selected during programming. The 12 command carriers and their functions are listed in Table A.

Receiving

5.05 The control center receiving circuit includes amplifiers, filters, a spectrum analyzer for displaying monitoring oscillator signals, and meters used to determine relative amplitudes of equalizer test signals. The receiving circuit is connected to a receive line by route and line selection during programming.

B. Signal Paths

5.06 The principal signal paths in the control center and the connections to the transmit and receive lines in the routes served by a control center are shown in ▶Fig. 8.◀

5.07 Audio command signals are routed by the directing circuit, according to the program that is set up. If control is to be applied at the near main station where the control center is located, pushbuttons depressed will cause relay NM to operate and direct the audio command signals to the local A and B equalizers in the route selected.

5.08 Assume that the following pushbuttons are depressed during programming: route select 3, NEAR SECT, and line select 7. In this case, the A and B input paths to the local A and B equalizer route connection circuit are completed to the A and B equalizers in receive line 7 of route 3.

5.09 Relay AB will be operated when the program set up requires that audio command signals be sent to the local B equalizer in the receive line selected.

5.10 For transmission of commands to remote locations, the audio command signals modulate a command carrier assigned to the remote location selected. Audio command signals are directed to the W-E and to the E-W oscillator-modulators, only one of which will be in operation as determined by the route selected. Relay E-W is operated by a ground applied when the selected route requires the E-W command carrier frequencies, 412 to 492 kHz.

5.11 The command carrier signal path in the control center includes the following:

(a) A bandpass filter to block harmonics of the command carrier frequencies, which might interfere with other signals on the L4 lines

(b) A 15.4-dB pad which may be switched out when gross misalignment of the signal path to remote locations requires that the command carrier signals be sent at above-normal power

(c) Two jacks on the front panel for testing purposes.

5.12 When route select pushbutton 3 is depressed, the following actions occur:

(a) A relay operates in the ***transmitting*** route connection circuit to complete a path for command carrier signals to the first regular transmit line of route 3.

(b) A relay operates in the ***receiving*** route connection circuit to complete a path from the receiving line connection circuit for route 3 to the control center receiving circuit.

(c) The receiving line connection circuit for route 3 ***only*** is energized.

5.13 When the NEAR SECT or FAR SECT pushbutton is depressed, the control center is arranged to produce the proper set of commands

TABLE A

COMMAND CARRIER SIGNALS

COMMAND CARRIER FREQ IN KHZ		LOCATION CONTROLLED (NOTE 3)	DIRECTED TO
W-E (NOTE 1)	E-W (NOTE 2)		
316	412	FAM1, FAM2, and FUM	Control command receiver:
—	412	SLJ and SLT	Selects line for connection of command carrier signals directed to equalizing repeaters.
			Establishes connections to selected equalizer in selected line at main station where loopback circuit is located.
			Controls relay AB in loopback circuits.
			Controls relay FM in loopback circuits at FUM and SLT locations.
			Controls connections to equalizers in far-section lines at SLJ location.
332	428	FAM1 and FUM	Equalizer command receiver:
—	428	SLT	Controls A and B equalizers in selected line at main station where loopback circuit is located
—	476	SLJ	Controls the group(s) of monitoring oscillators powered from the main repeater selected.
380	476	FAM2	
348	444	FE	Equalizing repeater command receiver:
364	460	NE	Controls A equalizer test oscillators.
			Controls A equalizer adjustments.
			Controls the two groups of monitoring oscillators powered from the equlaizing repeater selected.
396	492	Not assigned	Not assigned

Notes:

1. For one-section and two-section control, these frequencies are transmitted to the east and are looped back to lines transmitting to the west.
2. For one-section and two-section control, these frequencies are transmitted to the west and are looped back to lines transmitting to the east. For sideleg routes, these frequencies are assigned for either direction.
3. Location abbreviations:
   FAM1 — far main station in one-section control
   FAM2 — far main station in two-section control
   FUM — intermediate main station in two-section control
   SLJ — sideleg junction station in sideleg route
   SLT — sideleg terminal station in sideleg route
   FE — far equalizing repeater
   NE — near equalizing repeater

for line selection and equalizer connection at the distant main station(s).

5.14 When line select pushbutton 7 is depressed, the following actions occur:

(a) The command to select line 7 is sent to the loopback circuit at the distant main station(s).

(b) A relay operates in the receiving line connection circuit for route 3 to complete a path from receive line 7 in route 3 to the control center receiving circuit.

Signals received on this line now may be measured, adjusted, and observed at the control center.

C. Control Paths

5.15 The principal control paths and interlocks in the sending circuit of the control center are shown in ▶Fig. 9.◀ The control paths are discussed in the order in which the pushbuttons must be operated to set up a program.

5.16 With the control center arranged for the manual mode of operation, a ground path is completed from the power distribution circuit, through the OFF-MAN-AUTO switch, to terminal G on the route selection control circuit. Minus 25-volt power from the power distribution circuit connects to terminal -25 on the route selection control circuit. To set up a program, the attendant first depresses the ***line release*** pushbutton to complete the ground path that enables the route select pushbuttons.

5.17 The attendant next selects the route desired by depressing the proper one of the ten ***route select*** pushbuttons. Assume that route 3 is selected. Depressing route select pushbutton 3 causes the following ground and -25 volt paths to be completed.

(a) Ground is applied to terminal A on the line selection control circuit. This ground energizes the line selection control circuit.

(b) Ground is applied to terminal E3 on the transmitting route connection circuit, causing the relay for route 3 to operate. The control center sending circuit now is connected to a working transmit line in route 3.

(c) Ground is applied to terminal E3 on the receiving route connection circuit, causing the relay for route 3 to operate.

(d) Ground is applied to terminal C3 on the local A and B equalizer route connection circuit, causing the relay for route 3 to operate.

(e) Ground is applied via terminals TR3 and RS on the route selection control circuit to terminal RS on the directing circuit for command signals ***if*** the control center must transmit the E-W instead of the W-E command carrier frequencies for route 3. The E-W command carrier frequencies are transmitted for a sideleg route.

(f) Minus 25 volts is applied to terminal E11 on the receiving line connection circuit for route 3.

(g) Minus 25 volts is applied to terminal E1 on the local A and B equalizer line connection circuit for route 3.

5.18 The control center now is prepared for ***section selection.*** The attendant must depress the NEAR SECT or FAR SECT pushbutton. Section selection performs three functions:

(a) Enables the ten line select pushbuttons

(b) Conditions the control center to send the proper set of command signals for line selection at remote main repeater locations

(c) Conditions the loopback circuit at the intermediate main or sideleg terminal station for near-section or far-section control.

5.19 Next, the attendant selects the line desired by depressing the proper one of the ten ***line select*** pushbuttons. Assume that line 7 is selected. Depressing line select pushbutton 7 completes the following ground paths:

(a) To terminal C7 on each local A and B equalizer line connection circuit

(b) To terminal E7 on each receiving line connection circuit.

5.20 The local A and B equalizer line connection circuit for route 3 and the receiving line

connection circuit for route 3 are the only ones receiving -25 volts from the route selection control circuit.

5.21 The ground and -25 volt paths now completed cause the following actions:

(a) The relay for line 7 operates in the line connection circuit for local A and B equalizers for route 3 and completes paths for audio command signals to the local A and B equalizers in line 7 of route 3.

(b) The relay for line 7 operates in the receiving line connection circuit for route 3 and completes a path from receive line 7 of route 3 to the control center receiving circuit.

5.22 In addition, the following ground paths now are complete:

(a) From terminal MS4 of the line selection control circuit to the first loopback circuit and relay contacts therein that are associated with control on lines 7 and 8

(b) To the location select pushbuttons of the originating control circuit for equalizer adjustment

(c) To the monitoring signal control pushbuttons of the originating control circuit for monitoring signals.

5.23 After route selection, section selection, and line selection have been completed, the attendant may program for equalizer test and adjustment ***or*** may turn on any group of monitoring oscillators powered by the main and equalizing repeaters in the selected line.

D. Interlocks

5.24 Several interlocks, shown in ▶Fig. 9,◀ are included in the control paths to assure that programming is performed in desired sequences. These sequences are intended to prevent sending false or ambiguous commands and to prevent leaving undesired lockups in loopback circuits. These interlocks have functions, as follows:

(a) An interlock between the line selection control circuit and the route selection control circuit prevents selection of a route until the line release pushbutton is operated. When a line has previously been selected, this assures that a line-release command has been sent to the loopback circuits at the remote main stations before a different route is selected. If this command were not sent before a different route was selected, an equalizer connection relay and a line connection relay could be left locked up in a loopback circuit.

(b) An interlock within the line selection control circuit prevents selecting a line until section selection has been made. Section selection arranges the control center to send the desired set of line selection commands.

(c) Interlocks between the equalizer adjustment and the monitoring signal control circuits permit use of only one of these circuits at a time.

(d) An interlock between the equalizer adjustment and line selection control circuits prevents selection of a different line until the location selection portion of the equalizer adjustment circuit is released.

(e) Interlocks between the loopback circuits and the monitoring signal control circuit prevent the control center attendant from turning on a group of monitoring oscillators in a line in which the distant control center attendant on that route has already turned on monitoring oscillators.

E. Overrides

5.25 Several overrides are provided which increase the usefulness of the control center.

5.26 A ***receive override*** circuit, enabled upon route selection, permits an attendant to connect the control center receiving circuit to any receive line in the selected route. There are ten receive override line select pushbuttons on the route and line select panel.

5.27 Some uses of the receive override feature are as follows:

(a) ***All Control Arrangements:*** When trouble locating through use of the monitoring oscillator signals, monitoring oscillator signals are applied to four lines at a time, two in each direction. If a line trouble prevents turning on

monitoring oscillators by blocking command signals sent to that line, monitoring oscillator signals may be applied to that line by sending commands to the other line of the pair. The receive override circuit is used then to connect the control center receiving circuit to the line in trouble so that the received monitoring oscillator signals may be examined to locate the trouble.

(b) ***Two-Section Control:*** When line switching has occurred in the far section, equalizer test signals and monitoring oscillator signals turned on in a failed far-section line will appear on the near-section protection line as long as it is in a maintenance condition. The control center receiving circuit can be connected to the near-section protection line through use of the receive override feature. ▶To provide continuity through an intermediate office which is a power feed station equipped with protection line termination, the transmitting and receiving switches must be operated at the intermediate office (Fig. 4).◀

(c) ***Sideleg Route Control:*** When equalizing far-section lines, equalizer test signals turned on in any far-section line are looped back to the near-section protection line by the loopback circuit at the sideleg terminal station. To measure these equalizer test signals, the control center receiving circuit can be connected to the near-section protection line through use of the receive override feature.

5.28 A and B equalizer test signals turned on at any location go down the line to the next main station at which equalizer test signal blocking is provided. Thus, equalizer test signals may pass through several control sections. A ***detector override*** circuit, enabled upon route selection, permits an attendant to power the detector circuits so that equalizer test signals turned on by an upstream control center attendant may be measured.

5.29 The ***B signals receive override*** circuit, enabled upon route selection, permits an attendant to arrange the control center receiving circuit to accept the B equalizer test signals. This override is used when B equalizer test signals are turned on upstream and the local control center attendant wishes to measure these test signals. The detector override circuit must be used at the same time to power the detector circuits.

6. EQUIPMENT DESCRIPTION

A. Control Center

6.01 A control center is a console 6 feet wide by 6 feet high by 2 feet deep with an 18-inch writing shelf across the whole front, as shown in Fig. 2.

6.02 Equalizer adjust meters, pushbuttons, switches, indicating lamps, and a spectrum analyzer are mounted on the front of the control center which is divided vertically into three parts.

6.03 Route select and line select pushbuttons are located on the lower left of the front panel. Equalizer adjust meters and associated controls are located on the left and center parts. Equalizer control pushbuttons are located on the lower center part. Monitoring oscillator control pushbuttons and a spectrum analyzer are located on the right part. All controls can be reached by an attendant seated in front of the control center.

6.04 There are three removable doors at the rear, which provide access to the control center sending and receiving circuits. Dc-to-dc converters and a fuse panel are mounted at the rear top of the console.

6.05 Louvers on the doors, sides, and top provide ventilation. Shock mount springs are used to cushion the entire console at hardened installations. Wiring enters through a hole in the top.

B. Loopback Circuits

6.06 A loopback circuit occupies three shelves mounted in the control connecting bay for the route served.

6.07 Mounting and wiring are from the rear of the bay. Access to an individual shelf is obtained by unfastening the mounting screws and withdrawing that shelf. Cabling has slack loops to permit withdrawing the shelves.

6.08 Test points and controls for command receiver gain adjustments appear at the front of the bay and loopback circuit amplifier adjustments are made from the rear.

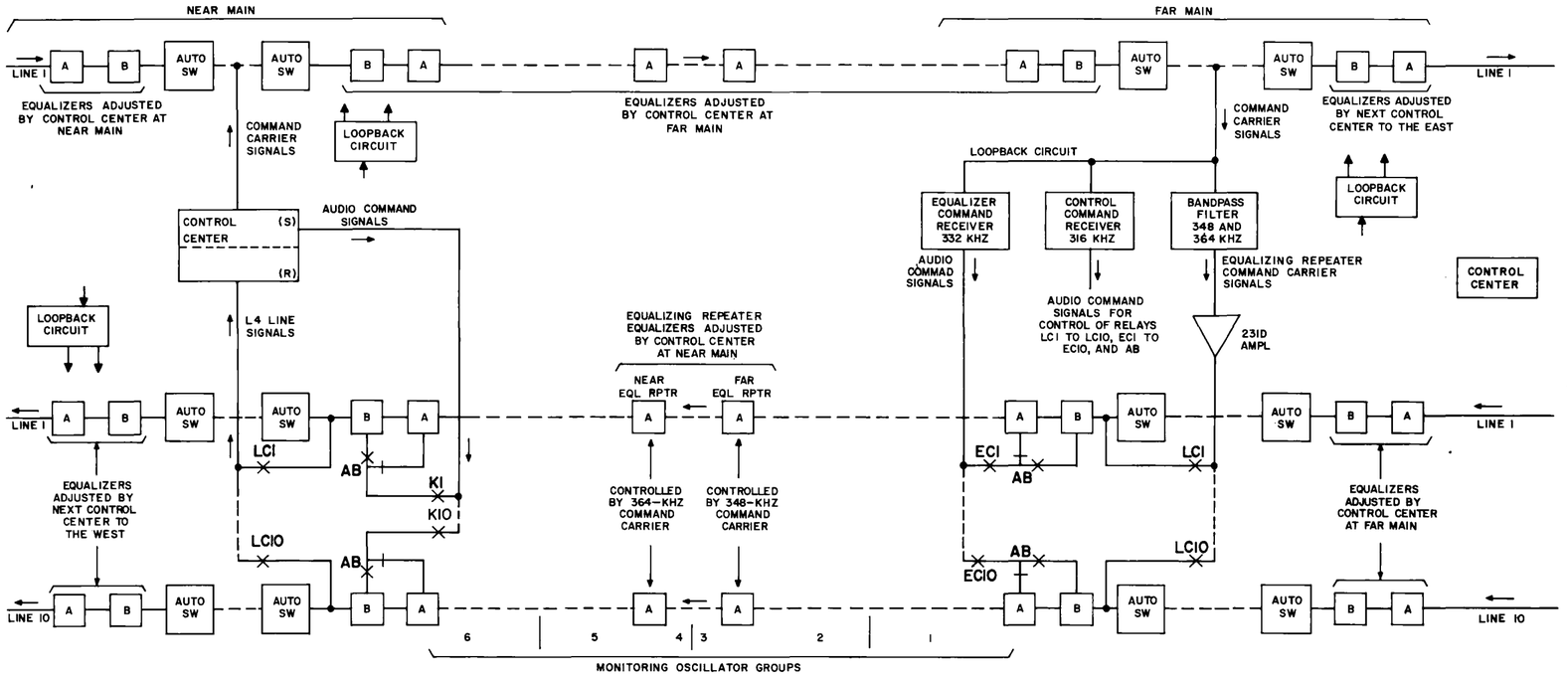
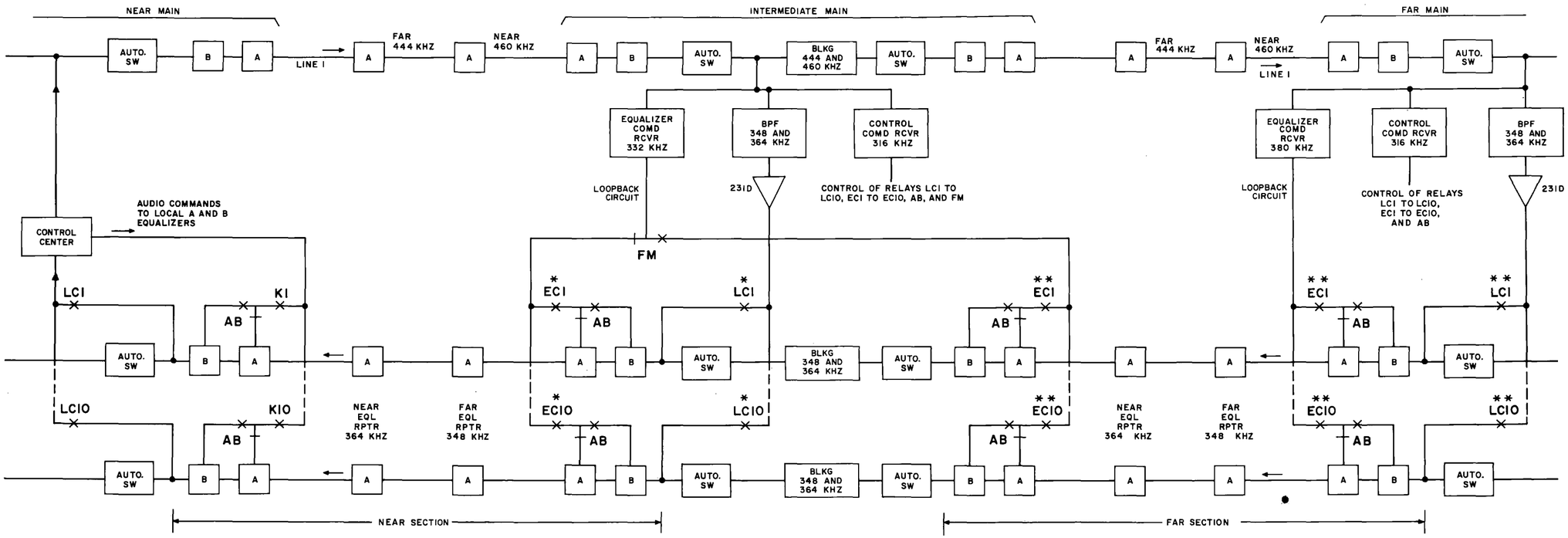


Fig. 6—One-Section Control—Block Diagram



LEGEND:

* LINE CONNECTION AND EQUALIZER CONNECTION RELAYS CONTROLLED BY NEAR-SECTION SET OF AUDIO COMMANDS ON 316-KHZ COMMAND CARRIER.

** LINE CONNECTION AND EQUALIZER CONNECTION RELAYS CONTROLLED BY FAR-SECTION SET OF AUDIO COMMANDS ON 316-KHZ COMMAND CARRIER.

Fig. 7—Two-Section Control—Block Diagram

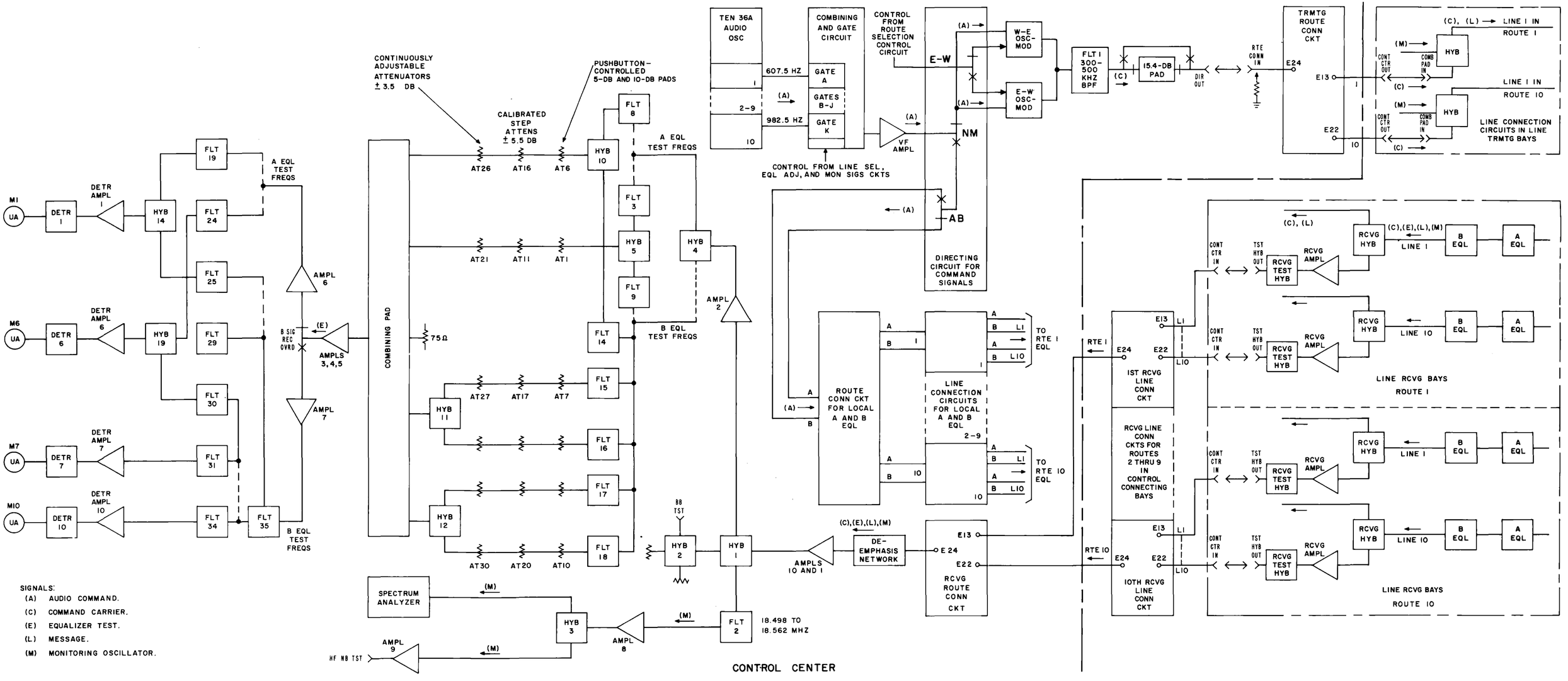


Fig. 8—Control Center—Signal Paths

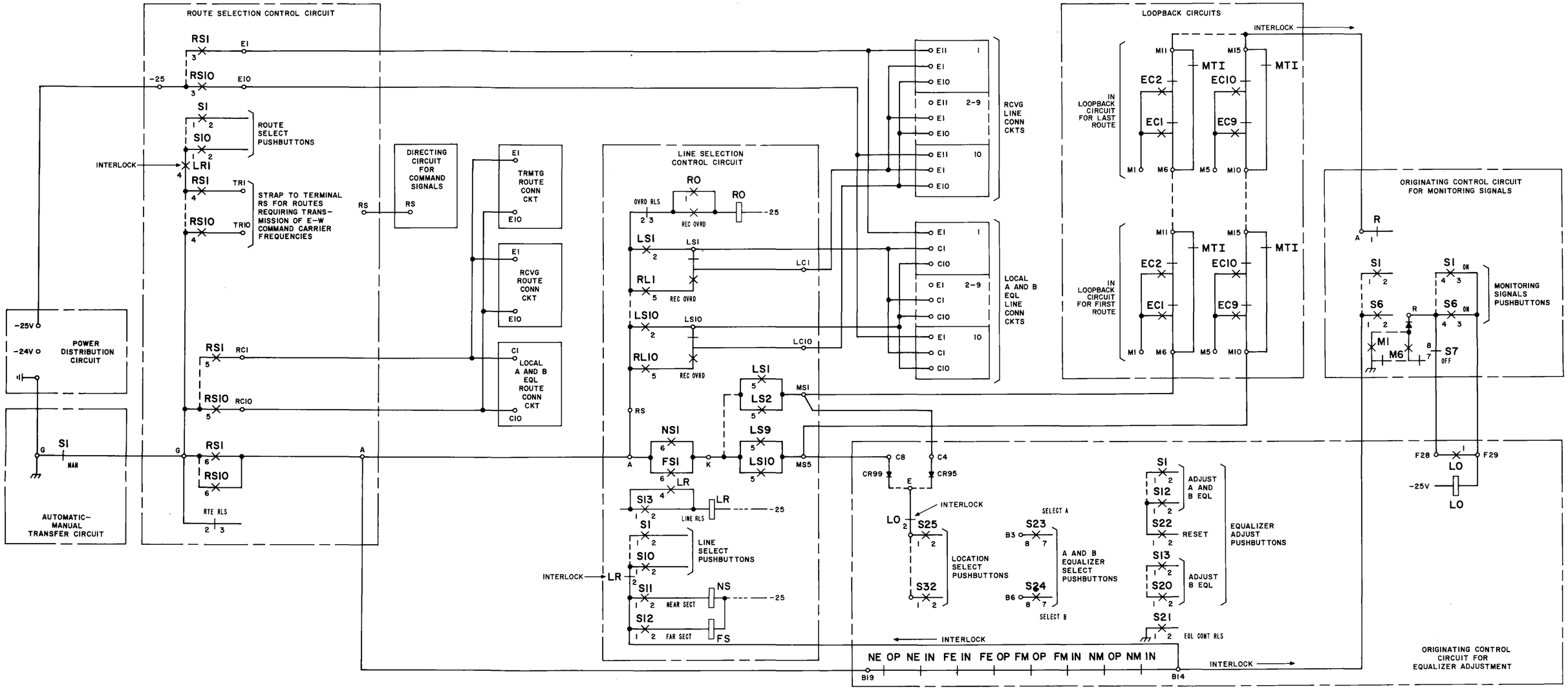


Fig. 9—Control Center—Control Paths