43A1 VOICE-FREQUENCY CARRIER TELEGRAPH (VFCT) SYSTEM

(J70112-)

DESCRIPTION AND OPERATION

CONTENTS PAGE

1. GENERAL

1.01 This section provides physical and functional descriptions of the 43A1 voice-frequency carrier telegraph (VFCT) system arrangements, channel terminals, and associated equipment. It also includes the procedures for operating a 43A1 VFCT terminal.

1.02 This practice is reissued to:

(a) Delete obsolete information.

(b) Show the use of 262-type electronic switches in place of the 429A electron tubes.

(c) Include information pertaining to the use of the KS-type hybrid integrated networks (HINs) in place of the 407A and 408A electron tubes in the channel terminals.

(d) Change the format of the practice to conform to the standard BSP format specification.

Since this is a general revision, arrows normally used to indicate changes have been omitted.

A. Glossary of Terms

1.03 The following list of definitions are for terms relating to the 43A1 VFCT system as they will be used in this practice.

(a) ***Facility:*** A 2-wire or 4-wire transmission path (derived from physical lines or from a carrier telephone channel) which will pass the frequency bands transmitted by the 43A1 VFCT terminals. The facility provides both directions of transmission between 43A1 VFCT terminals.

(b) ***Channel Terminal:*** The basic unit of the 43A1 VFCT system. It includes the send and receive circuits for one end of a carrier telegraph circuit. There are four types of channel terminal; hub or neutral, each of which can be either single bandwidth (SW) or double bandwidth (DW).

(c) ***43A1 VFCT Terminal:*** One or more channel terminals using a common facility.

(d) ***43A1 VFCT System:*** Two or more 43A1 VFCT terminals connected by a facility.

B. Purpose of System

1.04 The 43A1 VFCT system provides half-duplex (HDX) or full-duplex (FDX) telegraph service between two or more terminals by means of frequency-shift carrier transmission over a 2- or 4-wire facility.

1.05 The 43A1 VFCT terminal may be used to terminate one end of a private line telegraph (PLT) channel of which the other end is terminated in another 43A1 VFCT terminal, a 43B1 voice-frequency carrier data (VFCD) terminal, 130-type subscriber set (subset), or a 1A data station. In addition, it may be used in a bridged system in which the various channels terminate at different locations in 1A data stations or 130-type subsets.

C. Transmission Scheme

1.06 In the 43A1 VFCT system, the mark and space signals from the telegraph terminal are transmitted over the facility as frequencies which are in the audio band. The channel terminals use frequency-shift keying to vary the signals transmitted from the mark to space frequency and vice versa. The channels are referred to by their midband frequencies. The midband frequencies are ***not*** transmitted over the facility as steady-state line signals.

D. System Arrangements

1.07 The sending and receiving frequencies of a 43A1 VFCT channel terminal are determined by the use of the 453- and 454-type networks, respectively. The networks are available to provide channels in two frequency band groups as follows:

(a) Up to seventeen SW channels using midband frequencies from 425 to 3145 Hz.

(b) Up to six DW channels using midband frequencies from 1360 to 3060 Hz.

READ ***The use of EAST and WEST in this practice is for descriptive purposes only.***

1.08 A typical system arrangement for the 43A1 VFCT system is given in Fig. 1. The system is not shown with channel branching on any of the channels. For a description of the various means of channel branching, refer to Part 3B.

Alarm Features

1.09 The A1 VFCT level variation detector is designed to monitor the total voiceband signal power present on the receive pair of a 4-wire facility. It is for use with 4-wire facilities only and not to be used with 2-wire applications. The A1 VFCT level variation detector will provide an alarm when the received power deviates plus or minus 8 dB from nominal. The gain of the level variation detector can be adjusted to a desired value, dependent on the nominal power of the received carrier signals. For a more complete description of the A1 VFCT level variation detector, refer to Section 312-700-101.

2. PHYSICAL DESCRIPTION

2.01 This part describes the physical appearance and electrical requirements of a 43A1 VFCT terminal and the various units which make up the 43A1 VFCT system.

A. Channel Terminals (Fig. 2)

2.02 The channel terminal is approximately 5-5/8 inches wide, 10-1/2 inches high, and 7-3/4 inches deep. When equipped with both the send (453-type) and receive (454-type) networks, it weighs approximately 12-1/2 pounds. The channel terminal is a plug-in unit which mounts in the J70112M or J70112N mounting unit (see Part 2B).

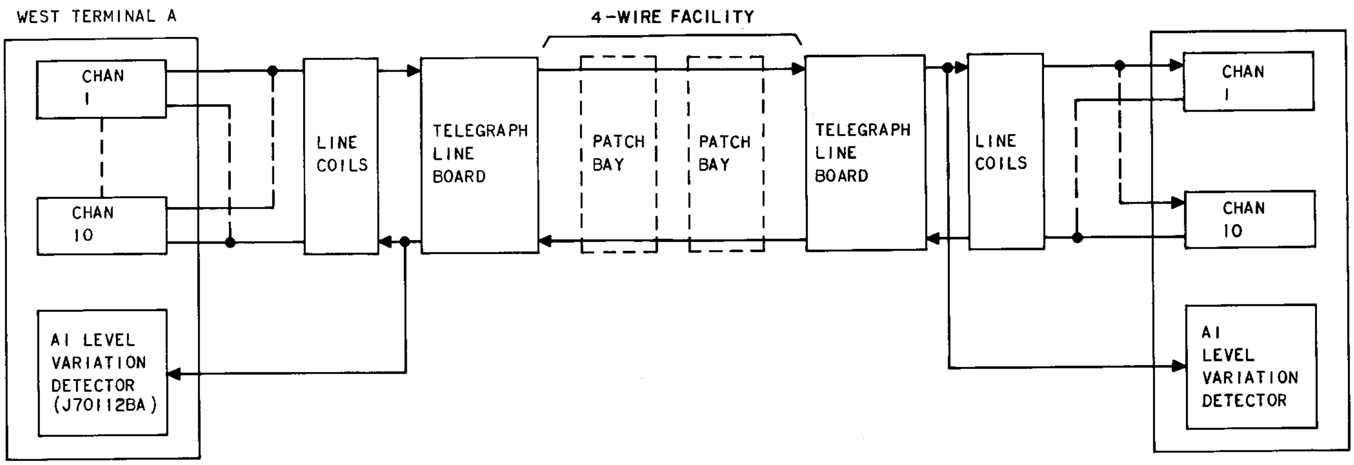


Fig. 1—Typical 43A1 VFCT System

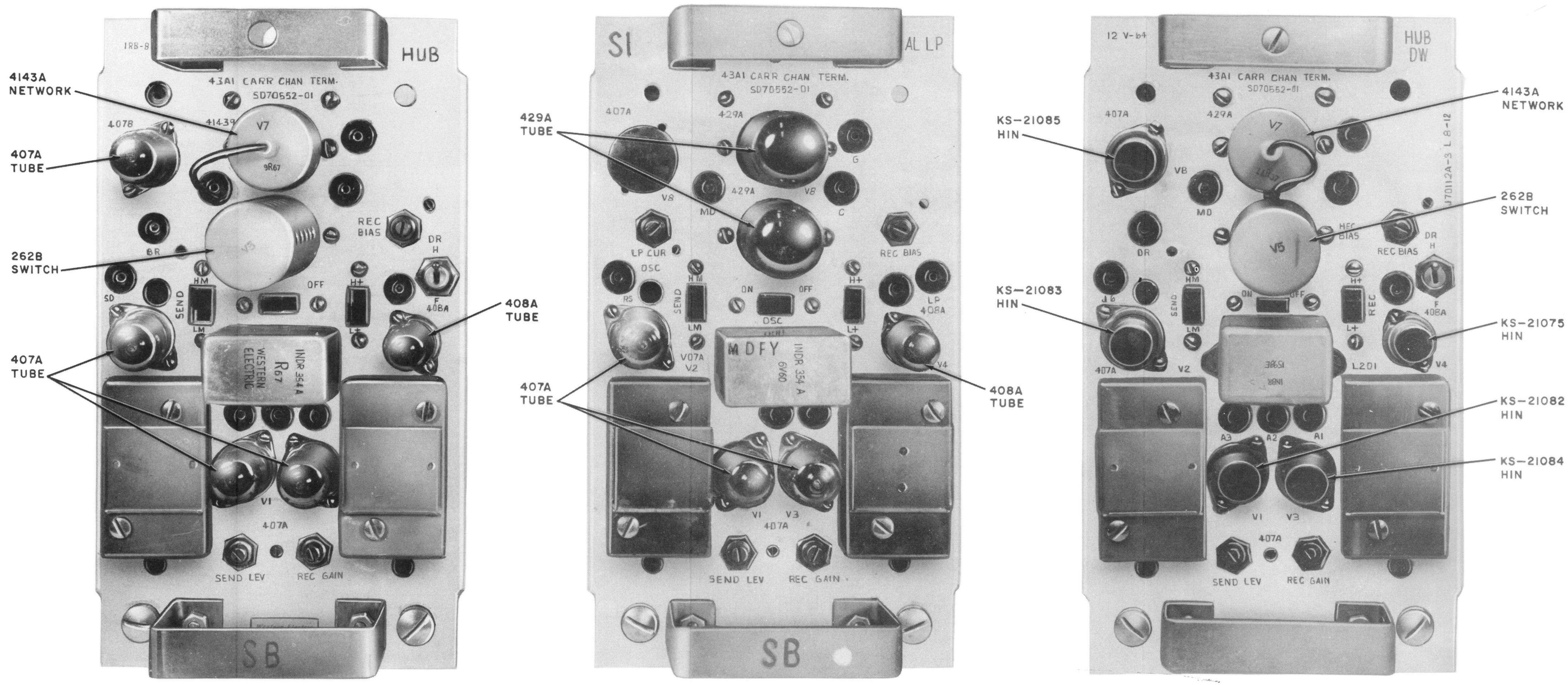
2.03 All power connections required by the channel terminal are provided through the mounting unit connector. The voltages required and the connector pin assignments for each are as follows:

(a) ***Filament Voltage***—20 volts dc on pins 5 and 8.

Note: As tubes are progressively replaced by the 262-type switch, 4143-type network, and KS-type HINs, the filament voltage may increase to up to −24 volts. In this case, readjust according to the common filament supply circuit schematic drawing (SD-70626-01).

(b) ***Plate Voltage***—+130 volts dc on pins 9 and 12.

(c) ***Positive Telegraph Battery***—+130 volts dc on pin 10 or ground on pin 15.



(A) HUB CHANNEL TERMINAL—SW EQUIPPED WITH 262B ELECTRONIC SWITCH AND 4143A NETWORK

(B) NEUTRAL CHANNEL TERMINAL—SW EQUIPPED WITH ELECTRON TUBES

(C) HUB CHANNEL TERMINAL—DW EQUIPPED WITH HINS, 262B SWITCH, AND 4143A NETWORK

Fig. 2—Channel Terminals

(d) ***Negative Telegraph Battery***—48 volts dc, −130 volts dc, or ground on pin 13.

2.04 The line connections required by the channel terminal are also provided through the mounting unit connector. The connector pin assignments for each line connection is as follows.

(a) ***Send Circuit***—Pins 14 and 17.

(b) ***Receive Circuit***—Pins 18 and 19.

2.05 The loop connections required by the channel terminal are also provided through the mounting unit connector. The connector pin assignment for each loop connection is as follows.

(a) ***Receive loop (R1 and R2)***—Pins 0 and 1.

(b) ***Send loop (S1 and S2)***—Pins 2 and 15.

2.06 Channel terminals are available in four types. Each type and the front panel markings that identify each type are as follows.

(a) ***Neutral SW***—BAL LP

(b) ***Neutral DW***—BAL LP DW

(c) ***Hub SW***—HUB

(d) ***Hub DW***—HUB DW.

B. J70112M- and N-Type Mounting Units

2.07 The J70112M-type (−24 volt filament battery offices) and J70112N-type (−48 volt filament battery offices) mounting units consist of the framework, assembly, equipment, and connectors (less wiring) for mounting up to three SW or DW channel terminals in a 19-inch relay rack bay. They are approximately 21 inches wide, 11 inches high, 1-1/2 inches deep, and 5 pounds in weight.

2.08 A partially equipped J70112M-1 mounting unit is shown in Fig. 3. In this arrangement (rated AT&T Standard), the filament voltage controls are located at the top of the bay and no duplex switches are required. In the arrangement shown in Fig. 4 (rated MD), the filament voltage controls and required duplex switches are located on a J70112B-2 panel which is located adjacent to the mounting unit.

2.09 Each mounting unit may be wired for either hub or neutral, HDX or FDX operation. In addition, neutral terminations may be arranged for 20-mA or 62.5-mA operation.

C. 453-Type (Send) and 454-Type (Receive) Networks (Fig. 5)

2.10 The send and receive networks are 7-7/8 inches high, 1-1/2 inches wide, and 5-1/2 inches deep. Both are plug-in units which mount (one of each) in the rear of the channel terminal. The networks are not supplied with the channel terminal and therefore, must be ordered separately.

2.11 The networks are available in SW and DW types and ***must*** be used in conjunction with the corresponding types of channel terminals.

2.12 The 453-type network consists of the oscillator tuning circuit and send bandpass filter that determine the send frequencies of the associated channel terminal. The 454-type network consists of the receive bandpass filter and discriminator tuning circuits that determine receive frequencies of the associated channel terminal. Networks are available for seventeen SW voiceband channels and six DW voiceband channels. The networks and their respective midband, high, and low frequencies are given in Table A.

D. Electron Tubes

2.13 The electron tubes used in the 43A1 VFCT channel terminals are the 407A, 408A, and 429A. Table B lists the tubes, their functions, and tube socket locations for each. A neutral channel terminal equipped with tubes is shown in Fig. 2B.

E. 262-Type Electronic Switches and 4143-Type Networks

2.14 The 429A tubes used in either the hub or neutral channel terminal may be replaced by the appropriate 262-type electronic switch and 4143-type network. The 262-type switches and 4143-type networks are shown in Fig. 6. A hub channel terminal, equipped with a 262-type switch, 4143-type network, 407A tubes, and 408A tubes is shown in Fig. 2A. The 429A tubes for each type of channel terminal and the type switch or network that replaces each are given in Table C.

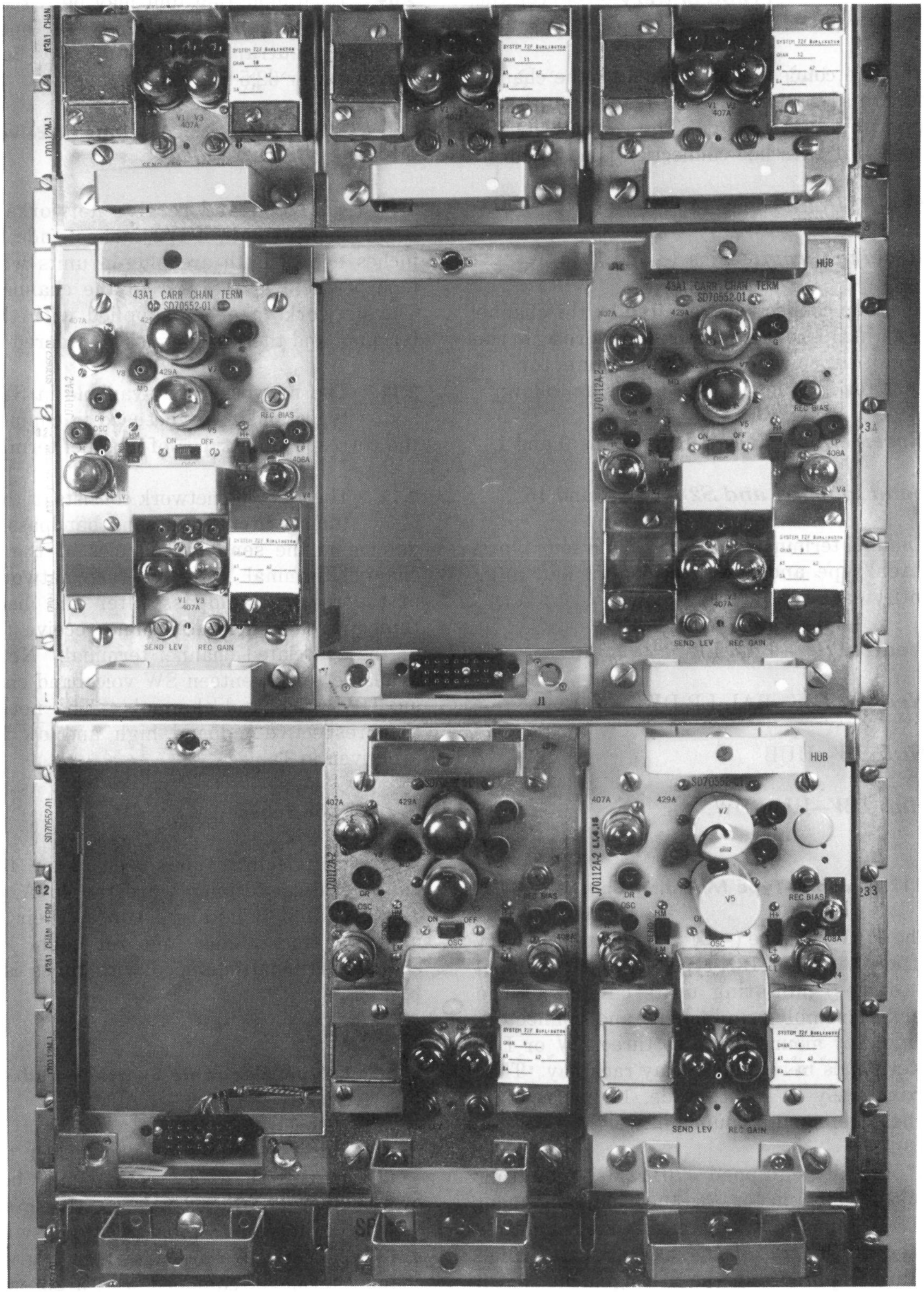


Fig. 3—Partially Equipped Channel Terminal Mounting Unit (AT&T Standard Arrangement)

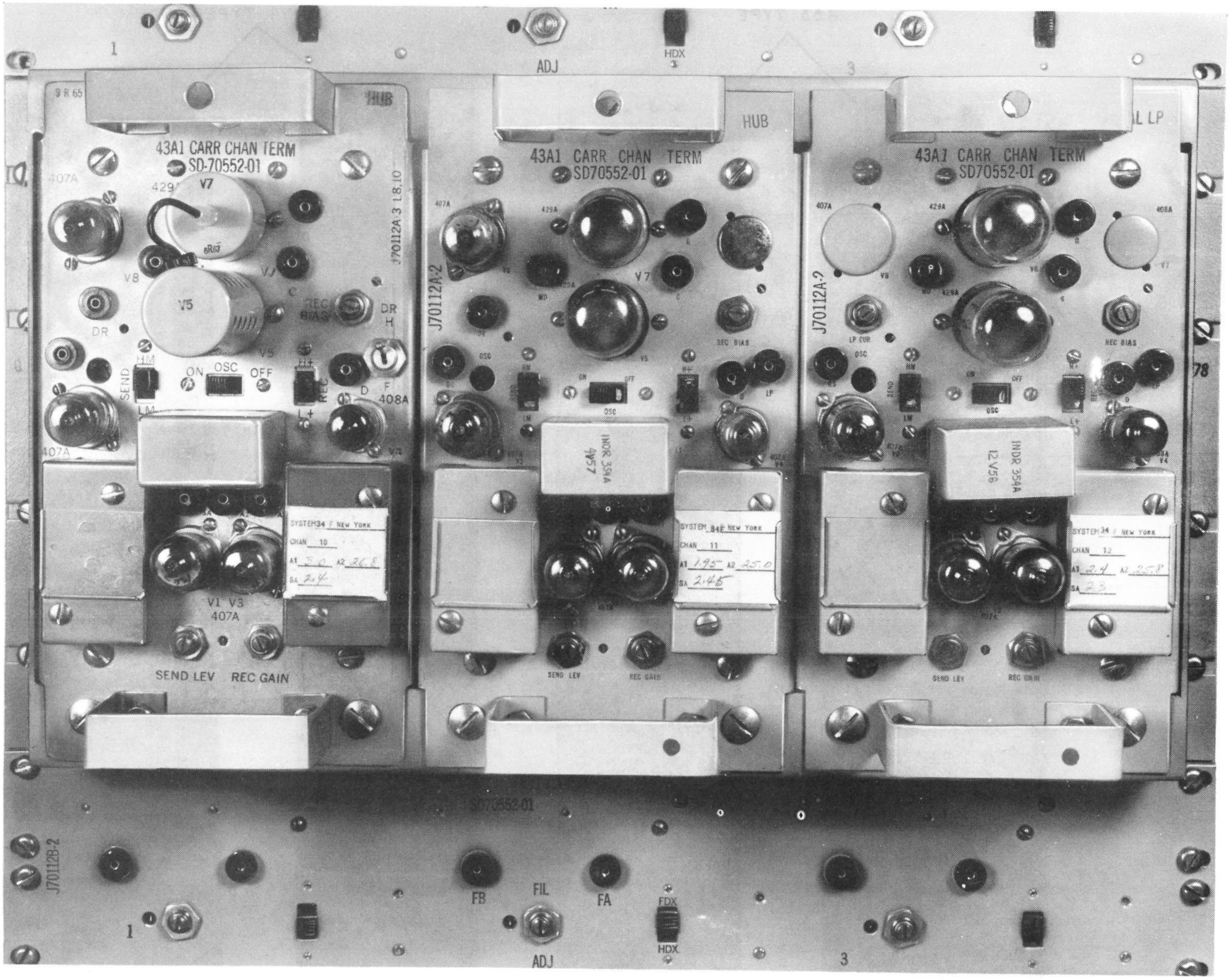


Fig. 4—Fully Equipped Channel Terminal Mounting Unit With J70112B-2 Filament Voltage Adjustment and Duplex Switch Panel (MD Arrangement)

F. Hybrid Integrated Networks (HINs)

2.15 The 407A and 408A tubes used in either the hub or neutral channel terminal may be replaced by the KS-type HINs (Fig. 7). A channel terminal equipped with the 262-type switch, 4143-type network, and KS-type HINs is shown in Fig. 2C. The 407A and 408A tubes for each type of channel terminal and the type HIN that replaces each are given in Table D.

3. FUNCTIONAL DESCRIPTION

3.01 This part functionally describes the operation of the various units which make up the 43A1 VFCT system.

A. General

3.02 To simplify the figures in this section, a single line is used where possible to represent a wire pair.

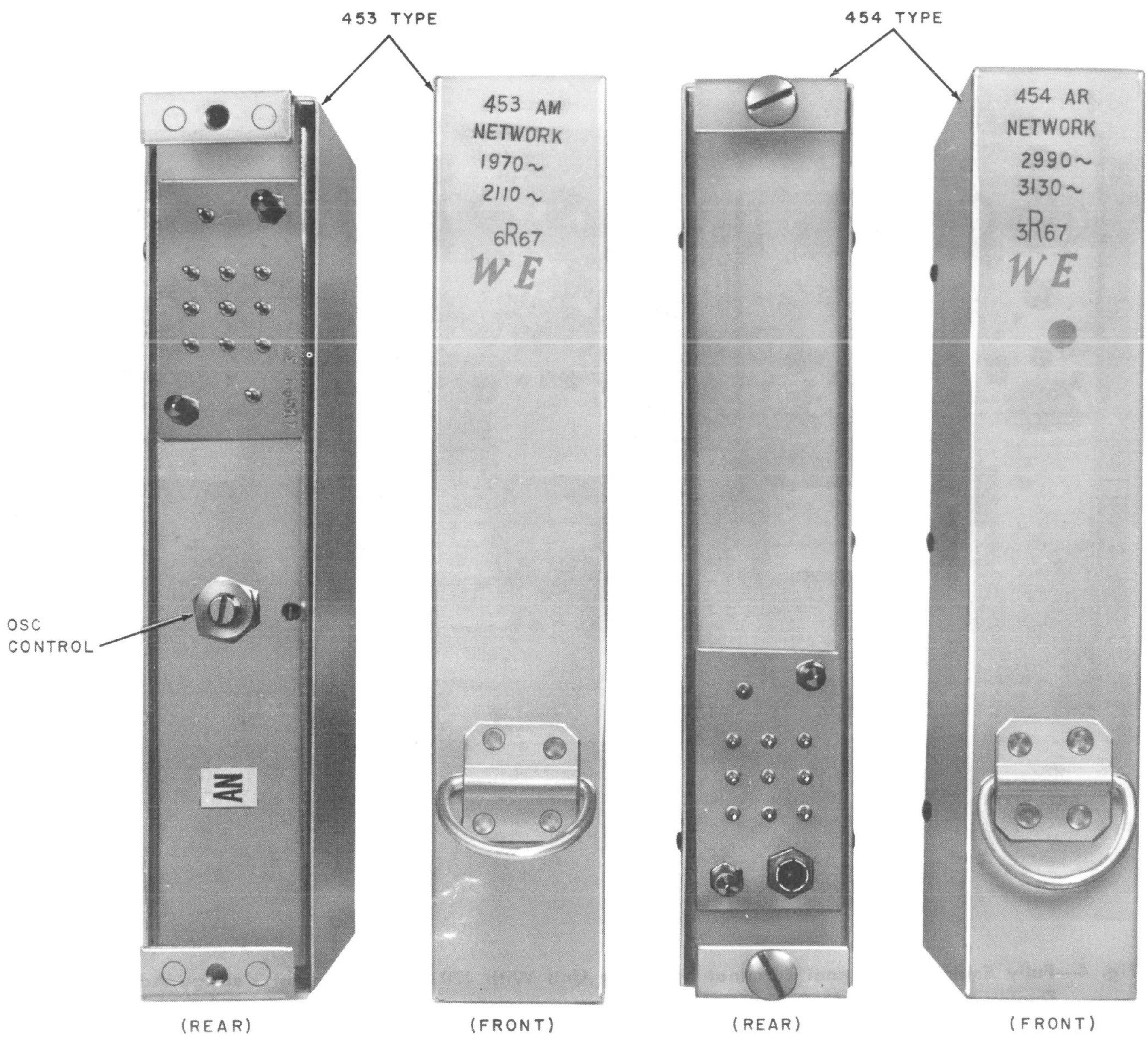


Fig. 5—453-Type (Send) and 454-Type (Receive) Networks

Line Coils and Hybrid Coils (Fig. 8)

3.03 The line sides of the send and receive networks used in 43A1 channel terminals are unbalanced. Also, both sides of 124-type (SW) and 686-type (DW) telegraph channel branching filters are unbalanced. In order to control noise in a carrier telegraph system, it is necessary to convert to balanced line transmission. In all cases, either line coils or hybrid coils should be connected between unbalanced equipment and the transmission facility.

3.04 For connections to voice-frequency facilities, line coils are used for 4-wire operation while line coils or hybrid coils are used for 2-wire operation. Block schematics of 4-wire and 2-wire telegraph systems are shown in Figures 8 and 9, respectively.

3.05 A 177D repeating coil may be connected as a line coil or as a hybrid coil for 4-wire and 2-wire line operations. The repeating coil has taps which permit matching various line impedances.

TABLE A

SEND AND RECEIVE NETWORKS

NETWORKS		CHANNEL FREQUENCIES (HZ)				CHANNEL NUMBERS
SEND	RECEIVE	MIDBAND	HIGH	LOW	SHIFT	
SW Voiceband Channels						
453AE	454AE	425	460	390	70	1
453A	454A	595	630	560		2
453B	454B	765	800	730		3
453C	454C	935	970	900		4
453D	454D	1105	1140	1070		5
453E	454E	1275	1310	1240		6
453F	454F	1445	1480	1410		7
453AA	454AA	1615	1650	1580		8
453G	454G	1785	1820	1750		9
453H	454H	1955	1990	1920		10
453J	454J	2125	2160	2090		11
453K	454K	2295	2330	2260		12
453L	454L	2465	2500	2430		13
453M	454M	2635	2670	2600		14
453AB	454AB	2805	2840	2770		15
453AC	454AC	2975	3010	2940		16
453AD	454AD	3145	3180	3110	70	17
DW Voiceband Channels						
453AK	454AK	1360	1430	1290	140	51
453AL	454AL	1700	1770	1630		52
453AM	454AM	2040	2110	1970		53
453AN	454AN	2380	2450	2310		54
453AP	454AP	2720	2790	2650		55
453AR	454AR	3060	3130	2990	140	56

This repeating coil is represented simply by a transformer symbol in the figures in this section.

3.06 Two-wire operation using line coils and hybrid coils is shown in Fig. 10. The hybrid arrangement is used for channels operating in opposite directions on adjacent frequencies.

3.07 In connecting 4-wire telegraph systems where the channel terminals are located in two bays, it may be desirable to provide two sets of line coils. The channels in one bay may be connected to one set of coils; channels in the other bay, to the other set. The line sides of both send line coils and the line sides of the receive line coils should be connected in parallel.

3.08 A terminal arranged for mixed operation of SW and DW channel terminals on a 2-wire facility is shown in Fig. 11. Connections to the impedance compensation network for mixed operation are shown.

Transmitting Pad (Fig. 8)

3.09 In order that the desired signal from each channel terminal on the line will be at the highest level relative to any unwanted signal which results from crosstalk, the channel terminal SEND LEV control is set for a channel terminal output of −6 dB for SW channels or −3 dB for DW channels. A transmitting pad is used to reduce the level to the standard telegraph line board value of −26 dB for SW channels or −23 dB for DW channels, taking into account the loss in the line coil and in the

TABLE B

CHANNEL TERMINAL TUBES

TYPE	DESIGNATION		FUNCTION
Tubes Used in Both Neutral and Hub Channel Terminals			
407A	V1		
		V1a	Send amplifier
		V1b	Oscillator
407A	V2		
		V2a	Supervisory amplifier
		V2b	Send control
407A	V3		
		V3a	1st amplifier-limiter
		V3b	2nd amplifier-limiter
408	V4		3rd amplifier-limiter
429A*	V5		Receive output
Tube Used in Neutral Channel Terminals, 62.5-mA Loops Only			
429A*	V6		Receive output
Tubes Used in Hub Channel Terminals Only			
429A*	V7		Directional control dc amplifier
407A	V8		
		V8a } V8b	Directional control flip-flop
*May be replaced by 262-type switch or 4143-type network (see Table C).			

Note: In hub channel terminals, tube V6 is omitted and tubes V7 and V8 are added. Tube V7 is mounted in the position occupied by tube V6 in neutral channel terminals, and tube V8 is mounted in a socket that is not provided in neutral channel terminals.

cabling. This procedure improves the signal-to-interference ratio.

3.10 The usual location of a transmitting pad is shown in Figures 8 and 11. The 20-dB pad shown in Fig. 8 is a nominal value that can be varied either up or down to compensate for cable variations such as tie cable, etc.

Impedance Compensation Network (Fig. 11)

3.11 Filter characteristics of the 43A1 send and receive networks are such that the adjacent channel filters present the proper impedance at the high and low frequencies of each channel.

3.12 For a SW channel terminal, the absence of a channel terminal at either side does not impair the performance at the baud rate for which it is designed. However, for a rate above 110 bauds, a DW channel terminal is adversely affected when it is installed with a SW or DW channel on one side and no channel on the other side.

3.13 To overcome this difficulty, a J70112AE impedance compensation network is connected to the drop side of the carrier telegraph system line coils as shown in Fig. 11. This network should be installed when the first DW channel is assigned to a system.

3.14 An impedance compensation network (Fig. 12) consists of a 4124A send equalizer and a

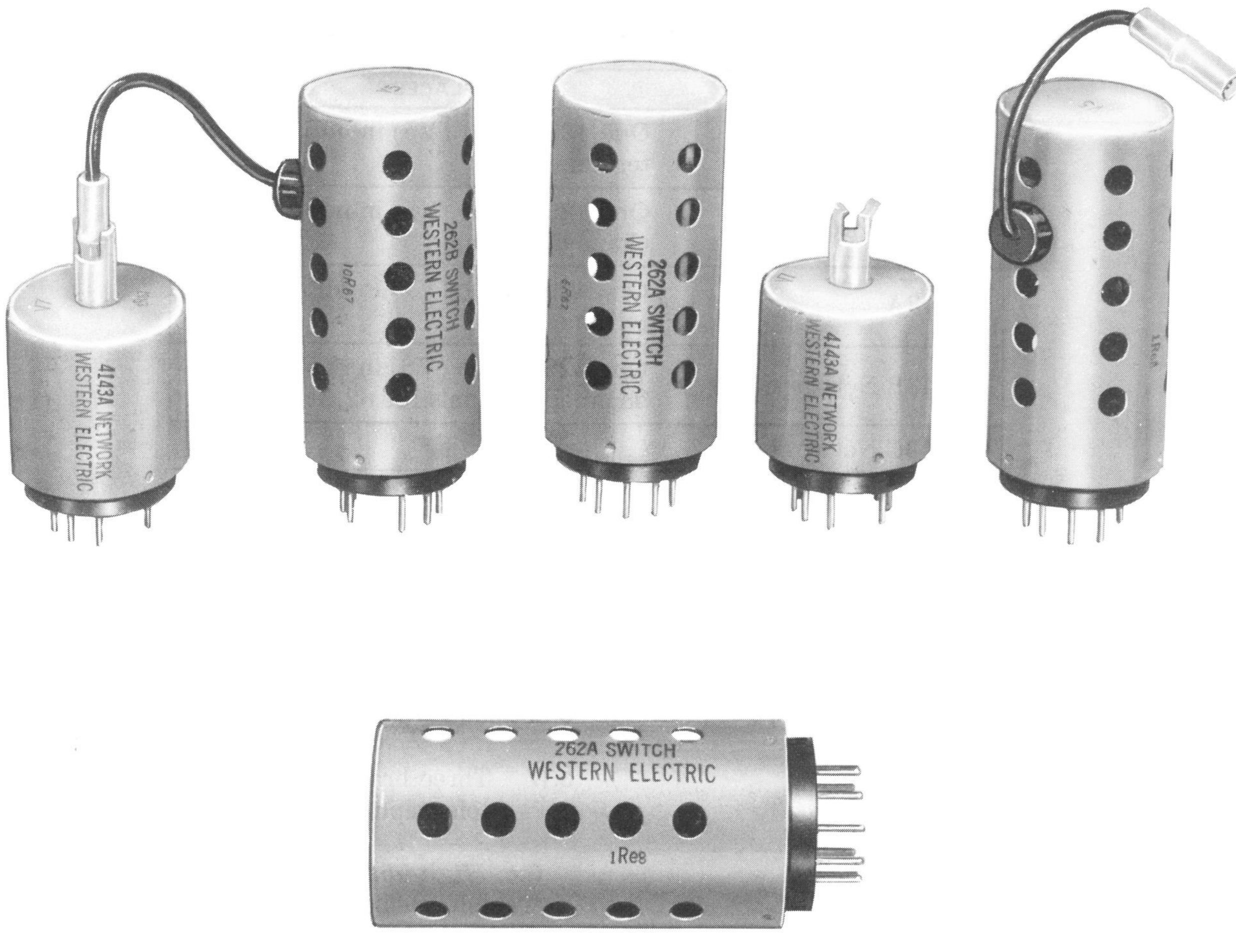


Fig. 6—262-Type Electronic Switches and 4143-Type Networks

4124B receiver equalizer which are connected in parallel with the corresponding channel terminal networks. Each equalizer contains six tuned circuits having impedances similar to the DW channel terminal networks. To improve the impedance of the telegraph terminal arrangement, the tuned circuits corresponding to the ***missing*** DW channel terminals are inserted by means of screw switches on the impedance compensation network. Also, SW channels should not be assigned between DW channels, in order to compensate for the impedance effect of a DW filter.

3.15 The low-frequency characteristic of this network is such that the 425-Hz channel cannot be used with it. Thus, a fully-loaded mixed voice-frequency system may employ the four SW and six DW channels using midband frequencies from 595 to 3060 Hz.

B. Branching

3.16 Branching permits increased flexibility of circuit layout and may be used at intermediate and terminal points of the 43A1 carrier telegraph system. By branching, one or more telegraph channels can be dropped or split at intermediate points, and service can be extended from terminal or intermediate points to several customers at separate locations. Branching is accomplished by means of branching networks or by channel filters.

TABLE C

262-TYPE SWITCH AND 4143-TYPE NETWORK USE

UNITS	REPLACES
262B Switch	One 429A tube (V5) in hub channel terminal.
262C Switch	One 429A tube (V5) in neutral channel terminal.
4143A	One 429A tube (V7) in hub channel terminal.
4143B Network	One 429A tube (V6) in neutral channel terminals for 62.5-mA loops.
4143C Network	*

* Neutral channel terminals for 20-mA loops do not use a tube in V6. However, when the tube in V5 is replaced by the 262C switch, a 4143C network *must* be installed in the socket V6.

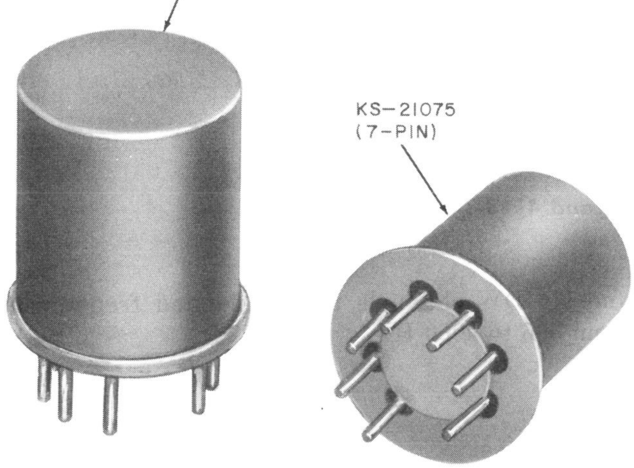


Fig. 7—Hybrid Integrated Networks

Branching Arrangements

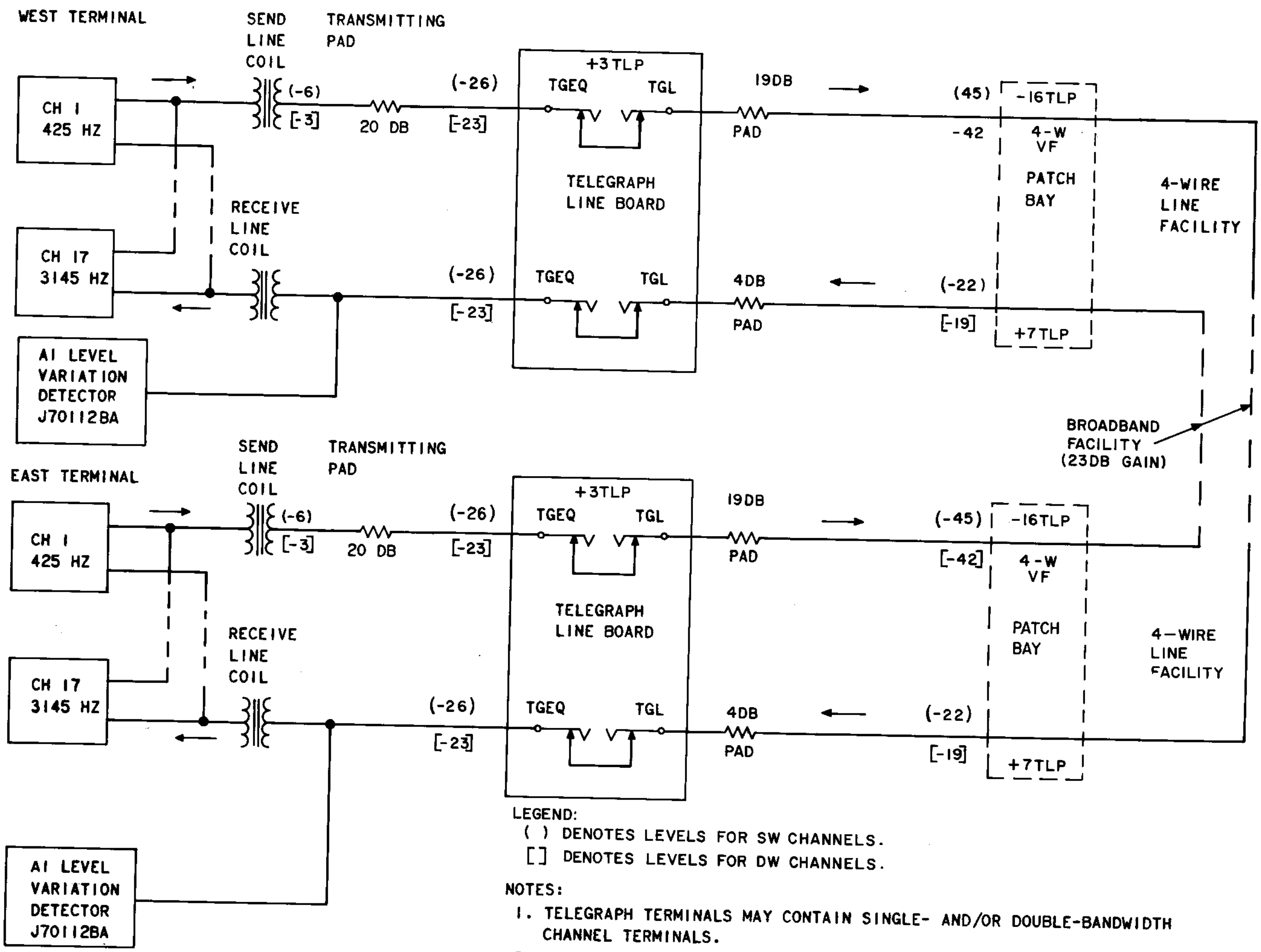
3.17 Three branching arrangements for the 43A1 telegraph system are shown in Fig. 13.

(a) ***High-impedance branching*** is used at an intermediate point and causes very little loss to the through signals. The loss to the through signals is about 0.3 dB and the loss to the branch is about 17 dB. This branching arrangement causes only a small reduction in return loss when used adjacent to a telephone repeater. Various line impedances may be matched by making different connections on the BDG (bridging) coil and by using different resistance values.

(b) The ***C2 bridge*** is an arrangement of six 100-ohm resistances which provides two branches. The loss from the line to each branch is 6 dB and the loss from each branch to the line is 6 dB. Two C2 bridges are used for

TABLE D
HIN USE

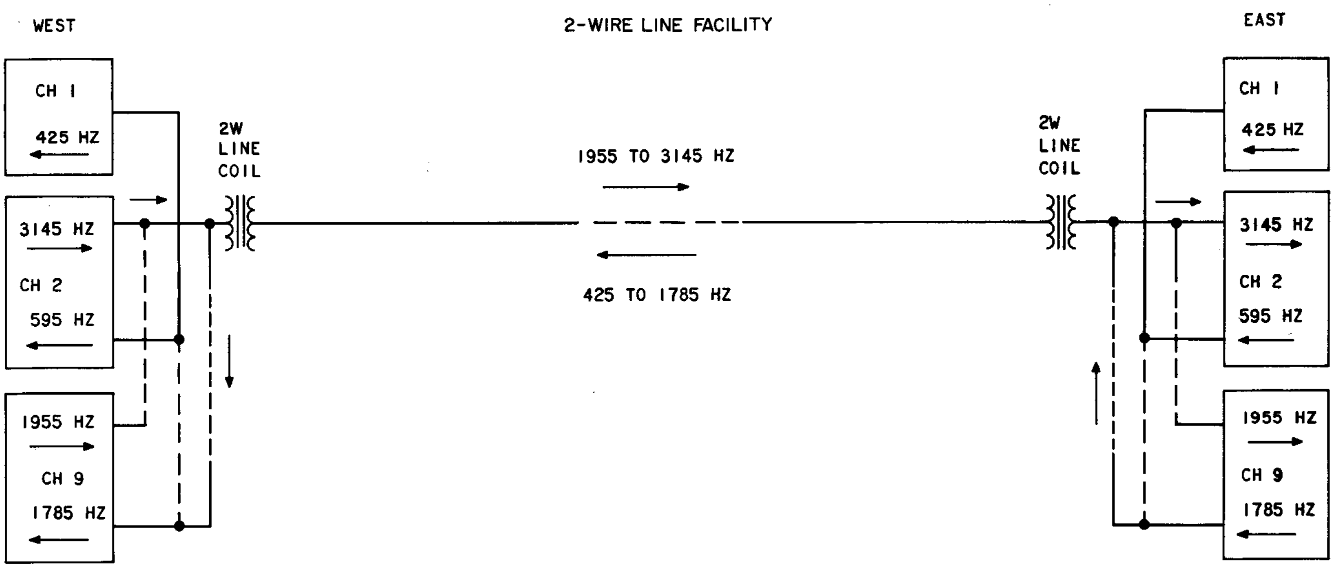
TYPE CHAN TERM.	SOCKET 407A	SOCKET 408A	REPLACED BY HIN
Hub and Neutral	V1	—	KS-21082
	V2	—	KS-21083
	V3	—	KS-21084
	—	V4	KS-21075
Hub	V8		KS-21085



LEGEND:
( ) DENOTES LEVELS FOR SW CHANNELS.
[ ] DENOTES LEVELS FOR DW CHANNELS.

NOTES:
1. TELEGRAPH TERMINALS MAY CONTAIN SINGLE- AND/OR DOUBLE-BANDWIDTH CHANNEL TERMINALS.
2. VALUES SHOWN IN PARENTHESES ARE SPECIFIC TELEGRAPH CARRIER POWERS (STL) IN DBM.
3. LINE FACILITY MAY BE ON PHYSICAL PAIRS OR MAY BE CHANNEL OF CARRIER TELEPHONE SYSTEM.

Fig. 8—Four-Wire Operation Using Line Coils



NOTES:
1. DIFFERENT FREQUENCIES MUST BE USED TO SEPARATE THE TWO DIRECTIONS OF TRANSMISSION. THE 425-HZ CHANNEL IS SHOWN PROVIDING ONE-WAY SERVICE.
2. WHEN DOUBLE-BANDWIDTH CHANNEL TERMINALS ARE OPERATED:
   (A) THE CORRESPONDING SINGLE-BANDWIDTH CHANNELS CANNOT BE OPERATED,
   (B) THE 4124A AND 4124B NETWORKS MUST BE PROVIDED, AND
   (C) THE 425-HZ CHANNEL CANNOT BE OPERATED BECAUSE OF THE 4124-TYPE NETWORKS.

Fig. 9—Two-Wire Operation Using Line Coils

connection of two 4-wire branches to a 4-wire line.

Note: Due to the high loss to the branching signals by the high-impedance branching arrangement [3.17 (a)], the C2 bridge [3.17 (b)] is the perferred arrangement.

(c) The ***2-wire branching network*** permits connection of as many as ten 2-wire branches at a terminal or intermediate point. Various line impedances may be matched by making the proper connections on the BL (branch line) coils, and different losses to the branches may be obtained by using different resistance values. This allows for a higher level in a long branch having more loss than the others. Each unused branch is terminated in a 600-ohm resistor which simulates branch impedance.

Channel Filters

3.18 Branching by means of low-loss 124-type SW and 686-type DW channel filters provides a way to drop one or more telegraph channels at an intermediate point or to extend channels to remote subscriber locations.

3.19 Telegraph channel filters of the 124-type are used for the 17 voice-frequency SW channels and the 686-type filters are used for six DW channels. Table E lists the channels, filters, their midband frequencies, and the mark and space insertion loss of each.

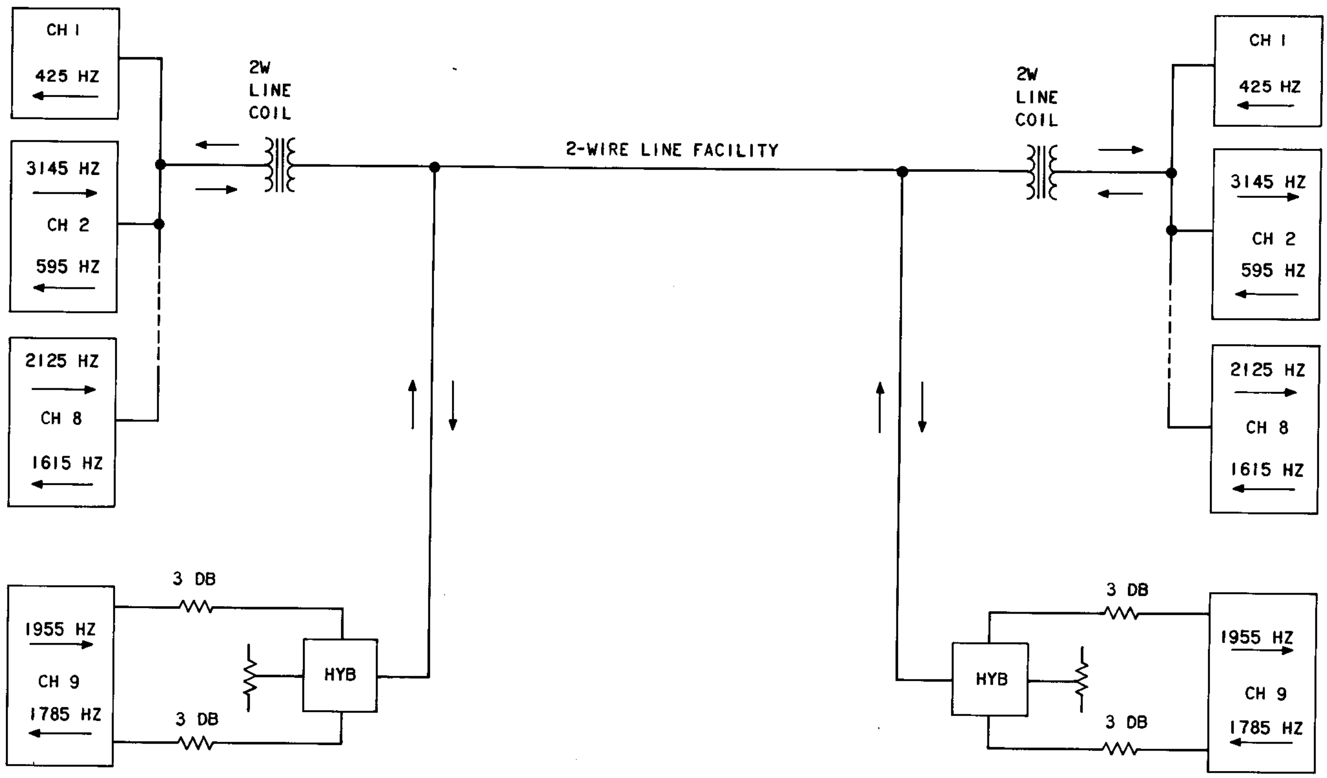
3.20 Channel filters make possible:

(a) Termination of a 4-wire line in 2-wire branches as shown in Fig. 14

(b) Conversion of a 4-wire line to a 2-wire line

(c) Connection of a 2-wire line to 2-wire branches

(d) Connection of 2-wire branches to a through 4-wire line as shown in Fig. 15.



NOTES:
1. SINGLE- AND/OR DOUBLE-BANDWIDTH CHANNELS MAY BE OPERATED IN THIS ARRANGEMENT.
2. 425-HZ CHANNEL, IF PROVIDED, MAY BE USED FOR ONE-WAY SERVICE IN EITHER DIRECTION BUT NORMALLY IS OPERATED IN THE SAME DIRECTION AS THE 595-HZ CHANNEL.
3. THE 3-DB PADS SHOWN ARE OPTIONAL AND ARE USED TO IMPROVE IMPEDANCE MATCH BETWEEN CHANNEL TERMINALS AND THE HYBRID COILS.
4. THE CHANNEL TERMINAL CONNECTED TO THE LINE CIRCUIT BY THE HYBRID ARRANGEMENT, CHANNEL 9 IN THIS CASE, MAY BE AT THE SAME LOCATION AS THE OTHER CHANNEL TERMINALS OR AT A REMOTE LOCATION.

Fig. 10—Two-Wire Operation Using Line Coils and Hybrid Coils

3.21 Channel filters permit splitting channels at an intermediate point as shown in Fig. 16. Splitting means that the same frequencies can be used in both directions from the intermediate point.

C. Voiceband Telegraph Applications

Telegraph Channels Operating with OA Carrier Telephone System

3.22 SW and/or DW telegraph channels having midband frequencies of 1785 Hz and below may be operated on the same line with an OA carrier telephone system. The OA carrier system operates on a 2-wire line and uses frequencies above 2 kHz. The 207F line filter was designed to make the frequency band below OA carrier line frequencies available for carrier telegraph or short-haul telephone order-wire use. This filter has a crossover region from approximately 1800 through 2300 Hz.

3.23 No intermediate amplification arrangement is provided for carrier telegraph operating below OA carrier telephone on a 2-wire line. When amplification is required, the carrier telegraph system must be operated on a 4-wire basis on two 2-wire lines. In this case, 207F filters separate the telegraph and OA carrier frequencies. Gain for the two directions of telegraph transmission is

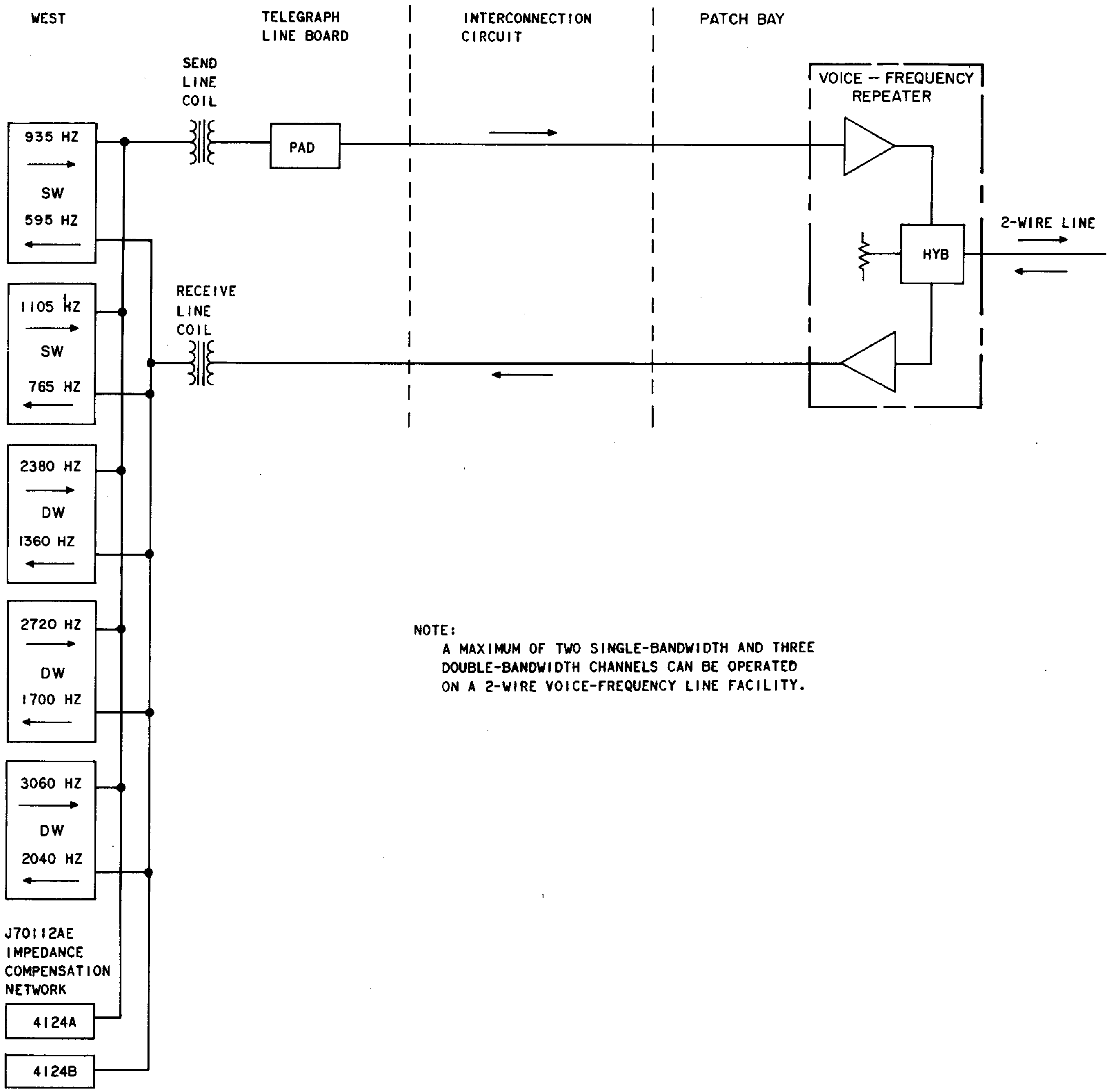


Fig. 11—Two-Wire Mixed SW and DW Operation

provided by V-type amplifiers connected between the low-pass sections of the filters.

Telegraph Channels Operating Over N, O, or ON Carrier Telephone Channels

3.24 Voice-frequency telegraph channels may be operated with or without compandors over N, O, or ON telephone carrier channels. On compandored channels, the steady telegraph signals cause the compandors to act as fixed-gain devices and the advantages of compandor operation are lost.

3.25 Two types of noncompandored N carrier channel units are available: the through

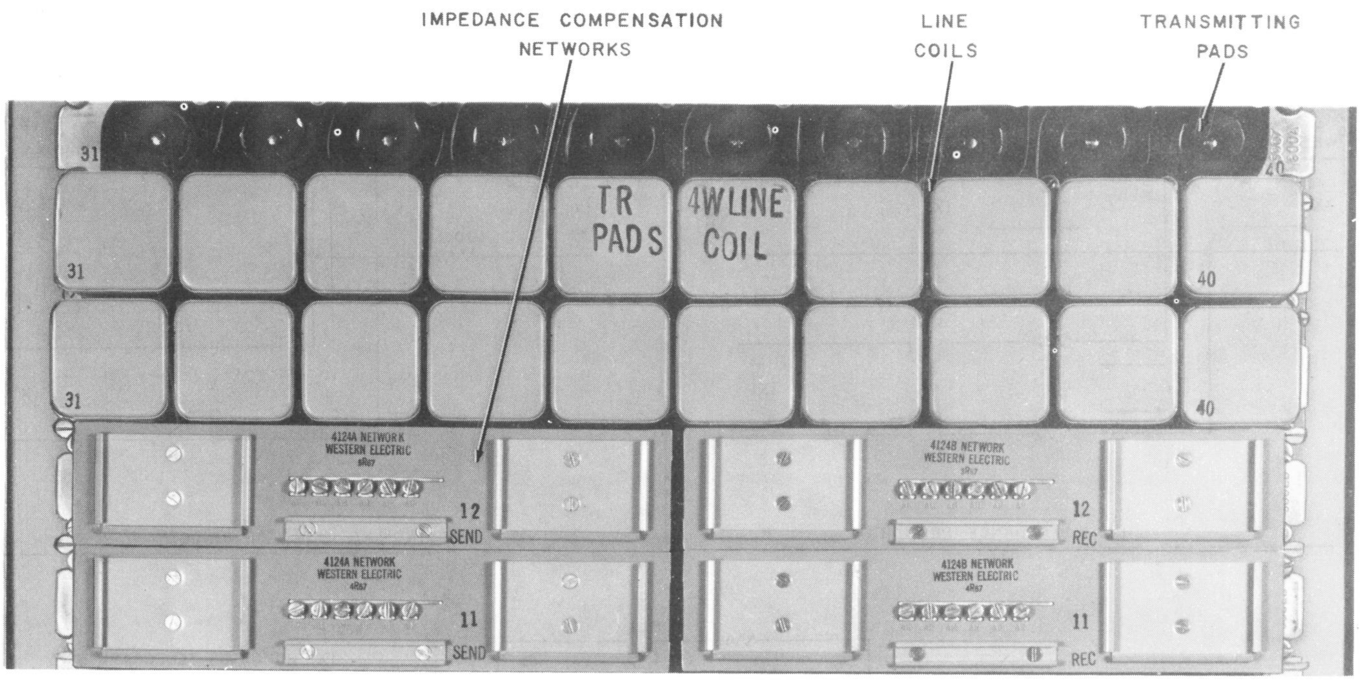


Fig. 12—43A1 VFCT System Units

unit J98703H and the special services unit J98703AM. The main difference between the two is that the through unit is arranged for input and output powers between ±1.5 dBm (telephone level) since it is intended for back-to-back connections, while the special services unit is arranged for standard office levels. When more than 15 channels are used with N1, O, or ON telephone carrier channels, use of the special services unit is required.

D. Channel Terminals—General

Types of Channel Terminals

3.26 Channel terminals are of four types, which are designed for two types of dc operation and for two bandwidths of carrier operation.

(a) The two dc arrangements are:

(1) Neutral—signals are current/no-current pulses. Marking signals are 20 mA or 62.5 mA and spacing signals are 0 mA.

(2) Hub—signals are voltage levels. Marking signals on half-duplex hubs are +60 volts and spacing signals are −30 volts. Hub signals are used only within a central office.

(b) The two bandwidth arrangements are:

(1) Single bandwidth (SW)—permits maximum keying speed of 75 baud

(2) Double bandwidth (DW)—permits maximum keying speed of 150 baud.

3.27 Each channel terminal contains its own oscillator and, therefore, is adaptable to small installations for use with 130-type subsets at subscriber locations. List numbers of the various channel terminals are given in Table F.

Channel Terminal Send and Receive Filters

3.28 Filter characteristics of the send and receive networks are such that the adjacent channel filters present the proper impedances at the upper and lower frequencies of the channel. For SW channels, absence of a channel at either side does not impair its performance at the maximum baud rate for which it is designed. In the case of DW channels, an impedance compensation network is used, as explained in 3.11 through 3.15.

3.29 Typical loss-frequency characteristics of SW voiceband channel filters are shown in Fig. 17.

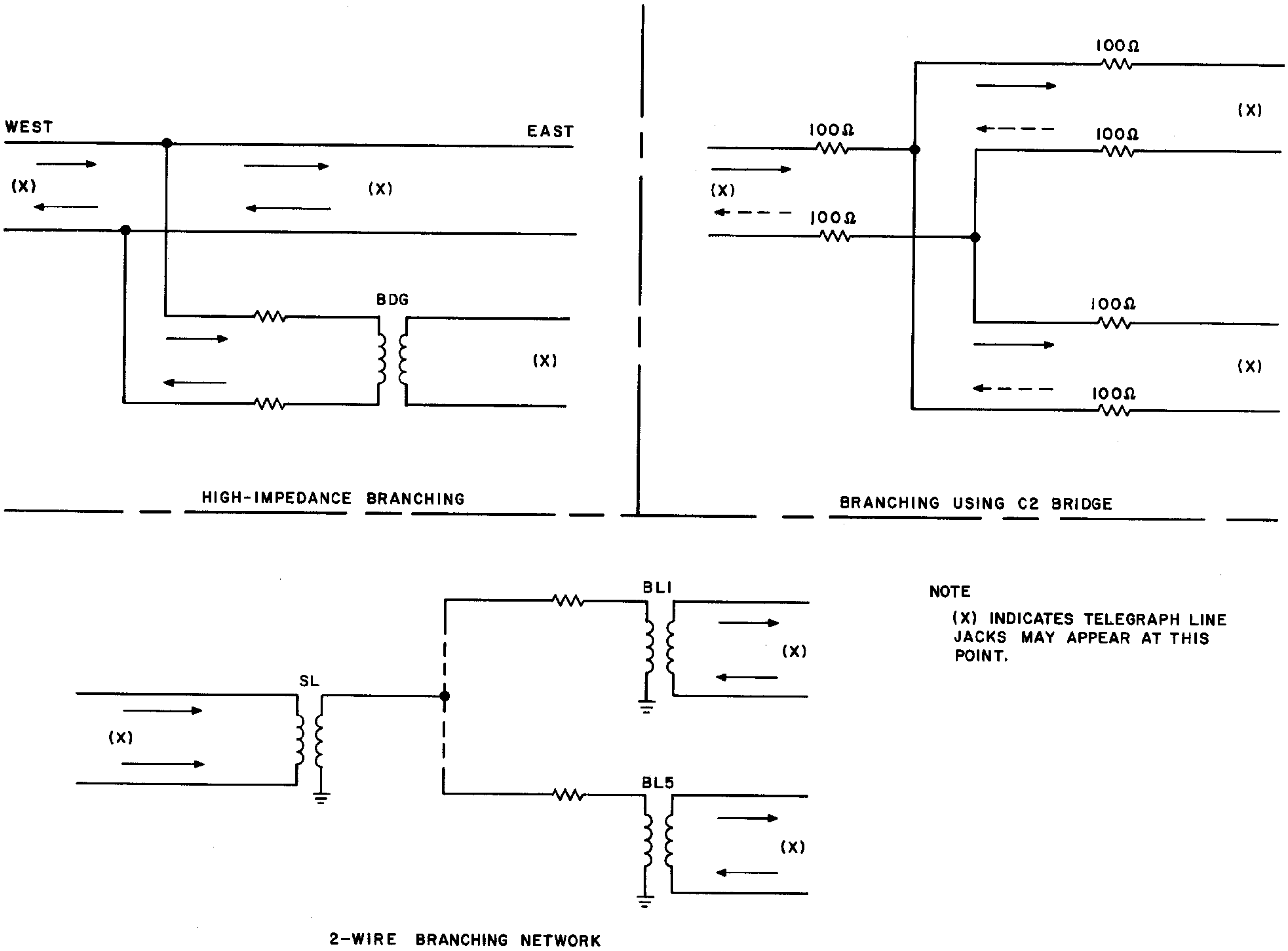


Fig. 13—Branching Arrangements

DW channel filters have similar but wider loss-frequency characteristics.

E. Channel Terminals—Detailed

3.30 A 43A1 channel terminal converts dc mark and space signals to ac frequency-shift signals for transmission over a facility. The mark, space, and midband frequencies of each channel terminal are listed in Table A.

3.31 A block diagram of a channel terminal is shown in Fig. 18. Mark and space signals in the send termination are applied to a modulator, which causes the channel terminal oscillator to shift from one to the other of the two frequencies assigned to that channel. Channel carrier signals are sent over the facility to the distant receiving channel terminal. Received carrier signals are amplified, limited, and detected in the channel terminal to control the current (neutral) or voltage (hub) in the receive termination.

Sending Circuit

3.32 A channel terminal sending circuit includes a modulator, an oscillator, a send amplifier, and a send filter. Figure 19 is a diagram of the sending circuit.

3.33 Each channel terminal contains its own oscillator. Channel oscillator frequencies and the amount of frequency shift are determined by the send network used in the channel terminal.

TABLE E

124-TYPE (SW) AND 686-TYPE (DW)
CHANNEL BRANCHING FILTER NETWORKS

SW CHANNEL NUMBER	MIDBAND FREQUENCY (HZ)	NETWORK CODE	INSERTION LOSS (dB)		DW CHANNEL NUMBER	MIDBAND FREQUENCY (HZ)	NETWORK CODE	INSERTION LOSS (dB)	
			S	M				S	M
1	425	124A	3.5	3.5					
2	595	124B	3.5	3.5					
3	765	124C	3.7	3.5					
4	935	124D	4.0	3.5					
5	1105	124E	3.6	4.3					
6	1275	124F	4.5	4.5					
7	1445	124G	4.0	4.1	51	1360	686A	2.2	2.2
8	1615	124H	5.2	5.2					
9	1785	124J	6.0	5.5	52	1700	686B	2.1	2.4
10	1955	124K	6.0	5.0					
11	2125	124L	6.5	6.0	53	2040	686C	2.1	2.4
12	2295	124M	6.5	6.5					
13	2465	124N	6.5	7.0	54	2380	686D	2.0	2.7
14	2635	124P	7.0	6.5					
15	2805	124R	6.5	7.0	55	2720	686E	2.1	2.6
16	2975	124S	7.0	6.5					
17	3145	124T	6.0	6.5	56	3060	686F	1.7	3.9

A ***modulator*** shifts the oscillator frequency 70 to 140 Hz, depending upon the channel frequency and bandwidth, as indicated in Table A. The modulator circuits used in hub and neutral channel terminals are shown in Fig. 19.

3.34 Associated with the modulator is the SEND switch, which may be operated to determine whether a ***mark*** in the send loop causes the high- (HM) or the low- (LM) channel frequency to be produced. In Bell System service it is conventional to use the high frequency for mark. When a circuit operates between a 43A1 and a 43B1 channel terminal, the 43A1 channel terminal must transmit the high-channel carrier frequency for mark (HM).

3.35 The oscillator tuning circuit contains a capacitor (CG) which is inserted or removed under control of the modulator. When the capacitor is inserted, the low channel carrier frequency is produced. The levels of the high- and low-frequency carrier signals are approximately the same. Channel oscillator frequency should be adjusted with the aid of properly calibrated test equipment.

(a) Coarse oscillator tuning is accomplished on some SW send networks by changing the strapping of three terminals on the send network with the OSC control centered.

(b) Fine oscillator tuning is accomplished by adjusting the OSC potentiometer, which is part of the send network. The OSC control (Fig. 5) is accessible through a hole in the faceplate of all channel terminals.

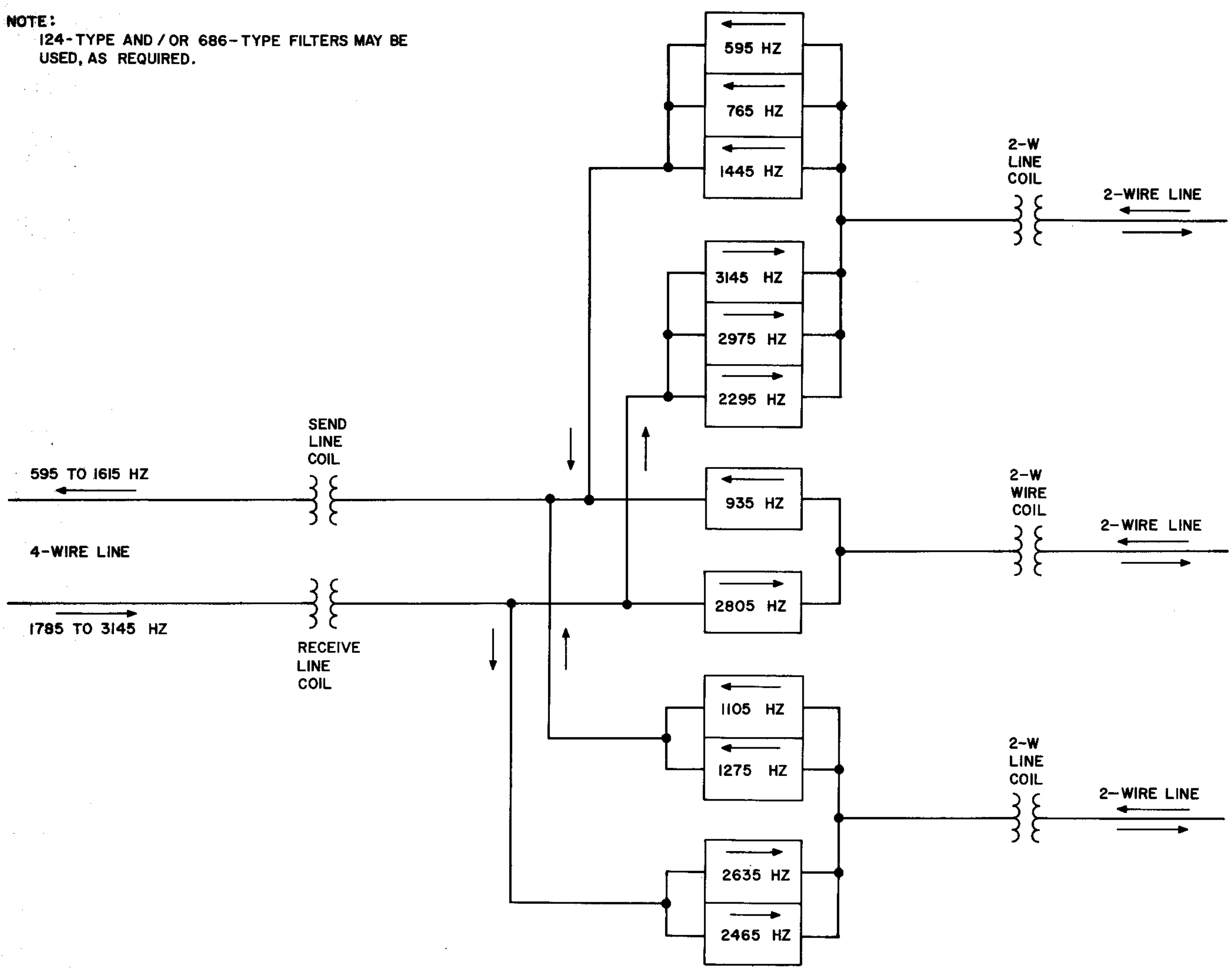


Fig. 14—Two-Wire Branches Connected Via Filters

3.36 Oscillator signal input to the send amplifier may be adjusted by the send level (SEND LEV) control. Send amplifier output is applied to the send bus and line circuit via a send filter, which is part of the send network.

3.37 Telegraph carrier output power of a channel terminal to the line circuit may be varied by the SEND LEV control from no output to a approximately +4 dBm.

Line Circuit (Figures 8 and 10)

3.38 The line circuit may include:

(a) A line coil and a transmitting pad if it is a 4-wire line circuit (Fig. 8)

(b) A transmitting pad and a hybrid coil if it is a 2-wire line circuit (Fig. 10).

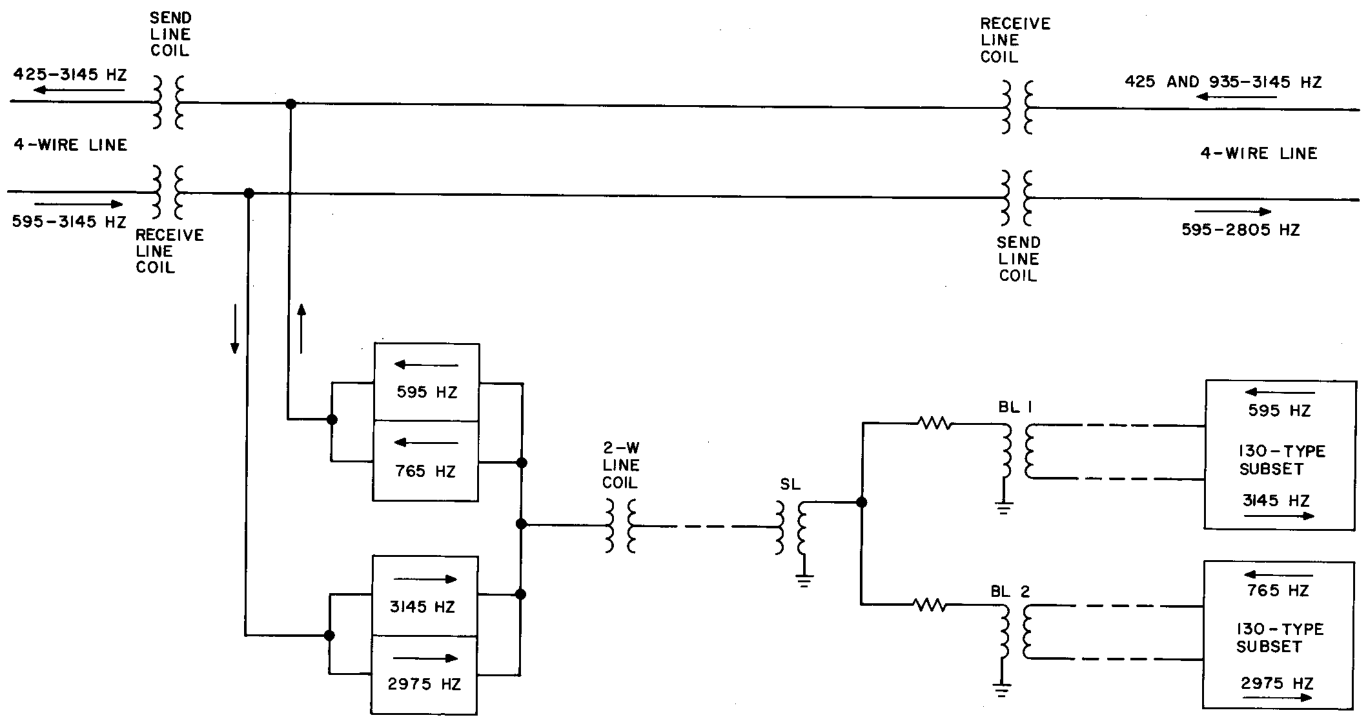


Fig. 15—Two-Wire Subscriber Stations Connected Via Filters

3.39 The transmitting pad controls the combined telegraph carrier signal power applied to the line circuit. Sending level at the voice-frequency telegraph line jacks is normally adjusted to −26 (SW) or −23 (DW) dBm for the 43A1 system. Specific telegraph level (STL) is the amount of carrier power expressed in dB from one carrier telegraph channel at 0 transmission level point (TLP).

Receiving Circuit

3.40 The minimum recommended receive level for channels using the supervisory circuit is −26 dBm per channel. The receive level per channel is normally adjusted to −26 dBm (SW) or −23 dBm (DW) at the telegraph line jacks and amplified to −17 dBm (SW) or −14 dBm (DW) at the receiver input by use of the 227-type amplifier. Channel terminals equipped with the KS-type HINs in place of the 407A and 408A tubes may be operated at a receive level of −26 dBm (SW) or −23 dBm (DW) STL without the need for a 227A amplifier.

3.41 A channel terminal circuit includes a receiver filter, three amplifier-limiter stages, a discriminator, a detector, and a receive output circuit. A second output of the amplifier limiter circuit connects to the supervisory circuit. A simplified schematic of a DW channel terminal receiving circuit is given in Fig. 20.

3.42 At the receive end of the facility, the mark and space carrier signals of a given channel are selected by the receive filter which is part of the receive network. The channel carrier signals then pass through three amplifier-limiter stages which maintain an essentially constant output to the discriminator.

3.43 One output of the amplifier-limiters is applied to the discriminator transformer primary windings which are connected in series. The discriminator consists of two parallel tuned circuits which are part of the receive network. The discriminator is tuned to frequencies somewhat higher and lower than the high- and low-carrier frequencies of the channel.

3.44 For the following explanation, assume the distant channel terminal SEND switch is on HM so that the channel high-carrier frequency

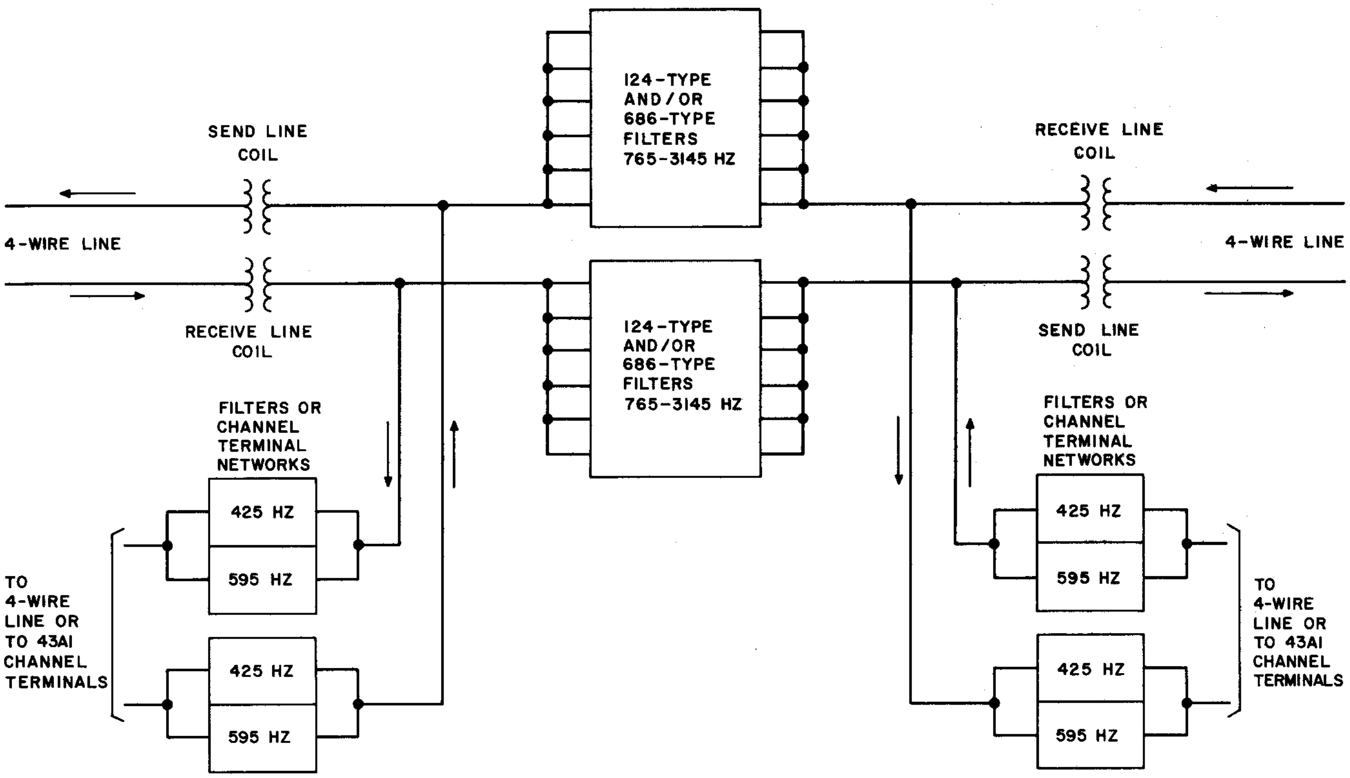


Fig. 16—Splitting Channels at Intermediate Point Via Filters

represents a marking signal. When the REC switch on a neutral channel terminal is operated to H+ (Fig. 20), connections are arranged to produce a mark in the receive loop when the high-carrier frequency is received.

3.45 When a high-carrier frequency is received at the discriminator, the voltage across the high-frequency tuned circuit is much greater than that across the low-frequency tune circuit. Similarly, receipt of a spacing signal causes the voltage across the low-frequency tuned circuit to be much greater than that across the high-frequency tuned circuit.

3.46 Voltages across the discriminator secondary tuned circuits are rectified and applied to a resistor-capacitor peak detector circuit. Marking and spacing carrier signals cause direct currents in opposite directions through the peak detector and produce voltages of opposite polarities between pin jacks C and D.

3.47 When the REC switch is on H+ and the high-carrier frequency is received, voltage across the discriminator high-frequency tuned circuit is rectified and the resulting direct current produces a positive voltage at pin jack D with respect to pin jack C. In this case, the input to the 262-type switch is positive, causing the switch to conduct. A spacing signal produces reversed voltage between pin jacks C and D, and the switch does not conduct. With no received carrier signals, the input to the 262-type switch will be at the same potential, causing the switch to conduct. This provides the mark-hold feature, which keeps current in the receiving loop when the carrier fails.

3.48 A typical frequency versus dc-voltage characteristic of the discriminator-detector circuit is shown in Fig. 21.

3.49 Voltages applied to the 262-type switch (V5) control the current in the receive loop. Transitions between marking and spacing signals occur when pin 8 is at approximately −4 volts with respect to the cathode. This inherent marking bias is compensated for by a resistor that prebiases the detector signals and makes the mark and space

TABLE F

43A1 VFCT CHANNEL TERMINALS

EQUIPMENT AND RATING	DESCRIPTION	EQUIPMENT STAMPING	EQUIVALENT EQUIPMENT	REMARKS
J70112 A-1 and A-2				
List 1 MD	Basic unit			
2	Neutral SW			
3	Hub SW			
4	Hub SW			
5	Hub SW	L3, 5	L4	Convert L3 to L4
6	Hub SW	L2, 6	L4	Convert L2 to L4
7 MD	Cover*			
J70112 A-3				
List 8 MD	Basic unit			
9	Neutral SW			Improvement and SH.
10	Hub SW			L9 plus return space directional control
11				(RSDC)
12 MD	Neutral DW			
	Hub DW			
J70112 A-1 and A-2				
List 13 A&M	Neutral DW	L2, 13	L11	Changed SW to DW
14	Hub DW	L2, 14	L12	Changed SW to DW
15	Hub DW	L4, 5, 15	L12	Changed SW to DW
16	Hub SW	L4, 5, 16	L10	Improved supervisory circuit
17	Neutral SW	L2, 17	L9	Improved supervisory circuit
18 A&M	Hub SW	L2, 18	L10	Changed Neutral SW to Hub SW
J70112 A-4				
List 19 Std	Basic unit			
20	Neutral SW			Overcome rec net drift and improve EH
21				2, 3, and 4 up to 75 baud.
22	Hub SW			L20 plus reduce distortion on first
23				character after change in direction of
24 Std				transmission
	Neutral DW			
	Hub DW			
	Cover*			
J70112 A-4				
List 25 A&M	Neutral SW	L2, 17, 25		Improved transmission
26 A&M	Hub SW	L4, 16, 26		Improved transmission and directional control

* Cover is used when a send or receive network is omitted, as in one-way service.

TABLE F (CONT)

43A1 VFCT CHANNEL TERMINALS

EQUIPMENT AND RATING	DESCRIPTION	EQUIPMENT STAMPING	EQUIVALENT EQUIPMENT	REMARKS
J70112 A-4 List 27 A&M	Neutral SW	L9, 27		Improved transmission
J70112 A-4 List 28 A&M	Hub SW	L18, 28		Improved transmission and directional control
29 A&M	Hub SW & DW	L10, 29; L12, 29; L14, 15, 29; or L16, 18, 29	L21 L23 L23 L21	Improved directional control Improved directional control
J70112 A-4 List 30 A&M	Hub & Neutral SW & DW	L30		Protective ground
J70112 A-4 List 31 STD	Hub & Neutral SW & DW	L31		Resistor required for channel terminals equipped with HINs

signals in the receive loop nearly equal in length. Any residual bias on the loop signals can be compensated for by adjusting the REC BIAS control until unbiased signals are produced in the receive loop. The REC BIAS control permits varying bias approximately ±10 percent.

3.50 In the case of 62.5-mA neutral loops where 429A tubes are used, tube V6 is operated in parallel with tube V5 to provide the loop current. In hub and 20-mA neutral loops, only tube V5 is used to provide the receive output.

Supervisory Circuit (Neutral Channel Terminal)

3.51 The supervisory circuit detects the loss of received carrier signals or a drop below a predetermined level. The REC GAIN control may be adjusted so that the supervisory circuit will indicate when the received carrier signals of a channel drop a predetermined amount below normal power.

3.52 An example of supervisory circuit connections to provide carrier failure alarm and space-hold features are shown in Fig. 22.

3.53 Rectified carrier signal from the amplifier-limiter (V3b) maintains V2a in a conducting condition as long as received carrier signals are above the predetermined power. The output current of V2a holds the associated SA relay operated.

3.54 When received carrier signals drop below a predetermined minimum, V2a cuts off and relay SA releases, activating the appropriate alarm(s).

3.55 Proper setting of the REC GAIN control provides a margin so that false supervisory signals will not result from line noise or interchannel interference during periods when no carrier is received for a given channel.

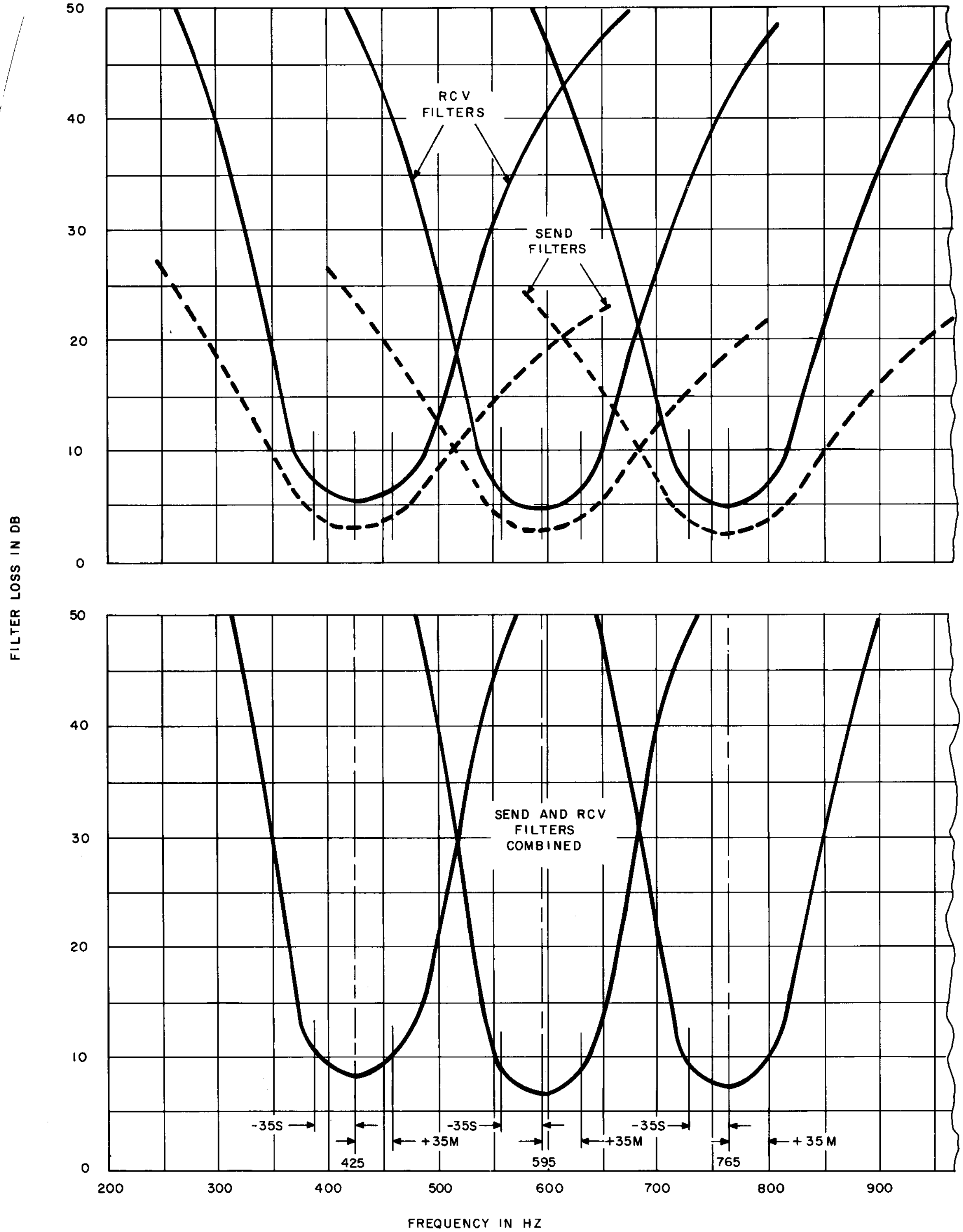


Fig. 17—Typical Loss-Frequency Characteristics of SW Voiceband Filters

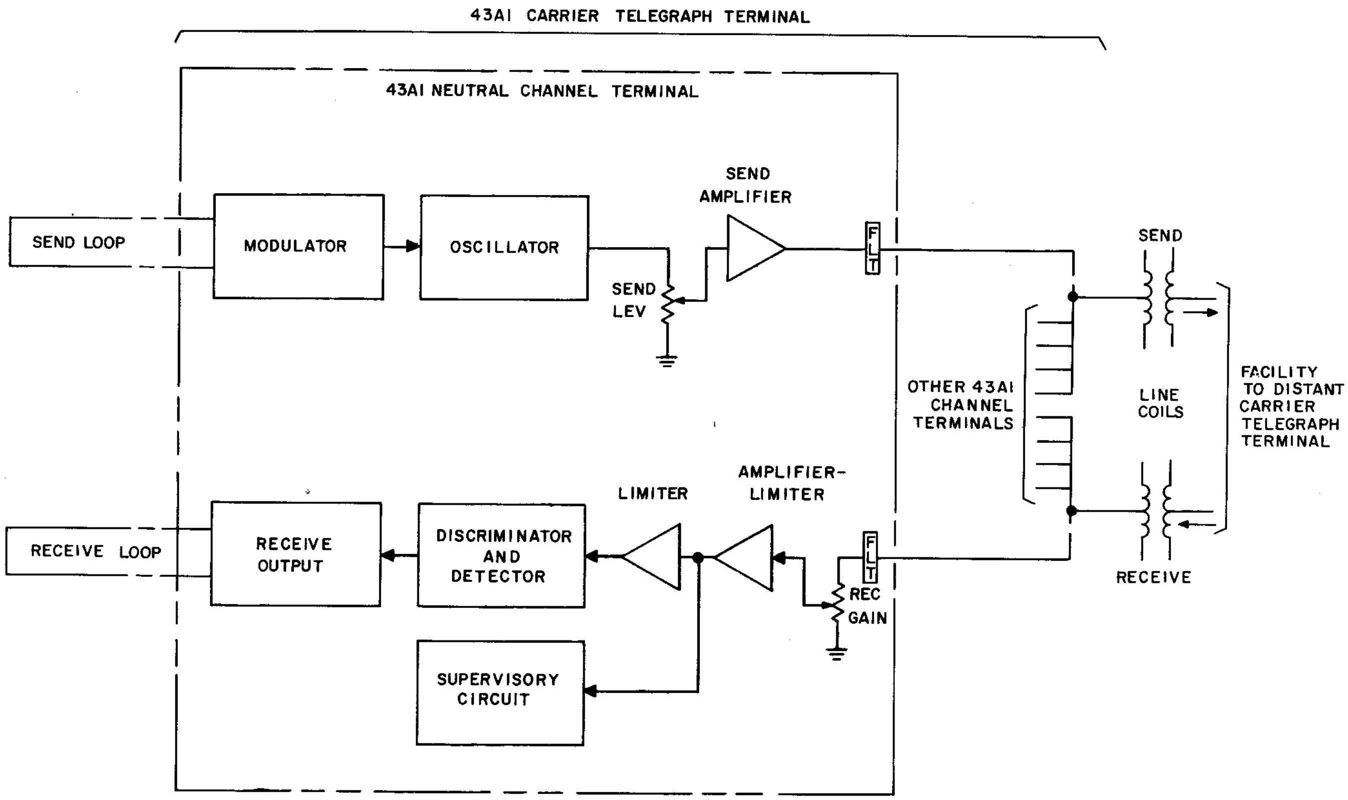


Fig. 18—Neutral Channel Terminal With FDX Connections

F. Termination Circuits

General

3.56 Channel terminals are manufactured for hub or for neutral loop operation. Both SW and DW, hub and neutral channel terminals may operate on either a full-duplex or a half-duplex basis.

> *Note:* Full-duplex circuits provide independent send and receive paths; thus, transmission can take place in both directions simultaneously. Half-duplex circuits permit the subscriber to send and to receive, but transmission can take place in only one direction at a time.

3.57 Figure 23 is a complete schematic of the neutral channel terminals and Fig. 24 is a schematic of the hub channel terminals. The hub channel terminal arrangement shown in Fig. 24 includes the newer directional control (DR) switch and improved space-hold feature.

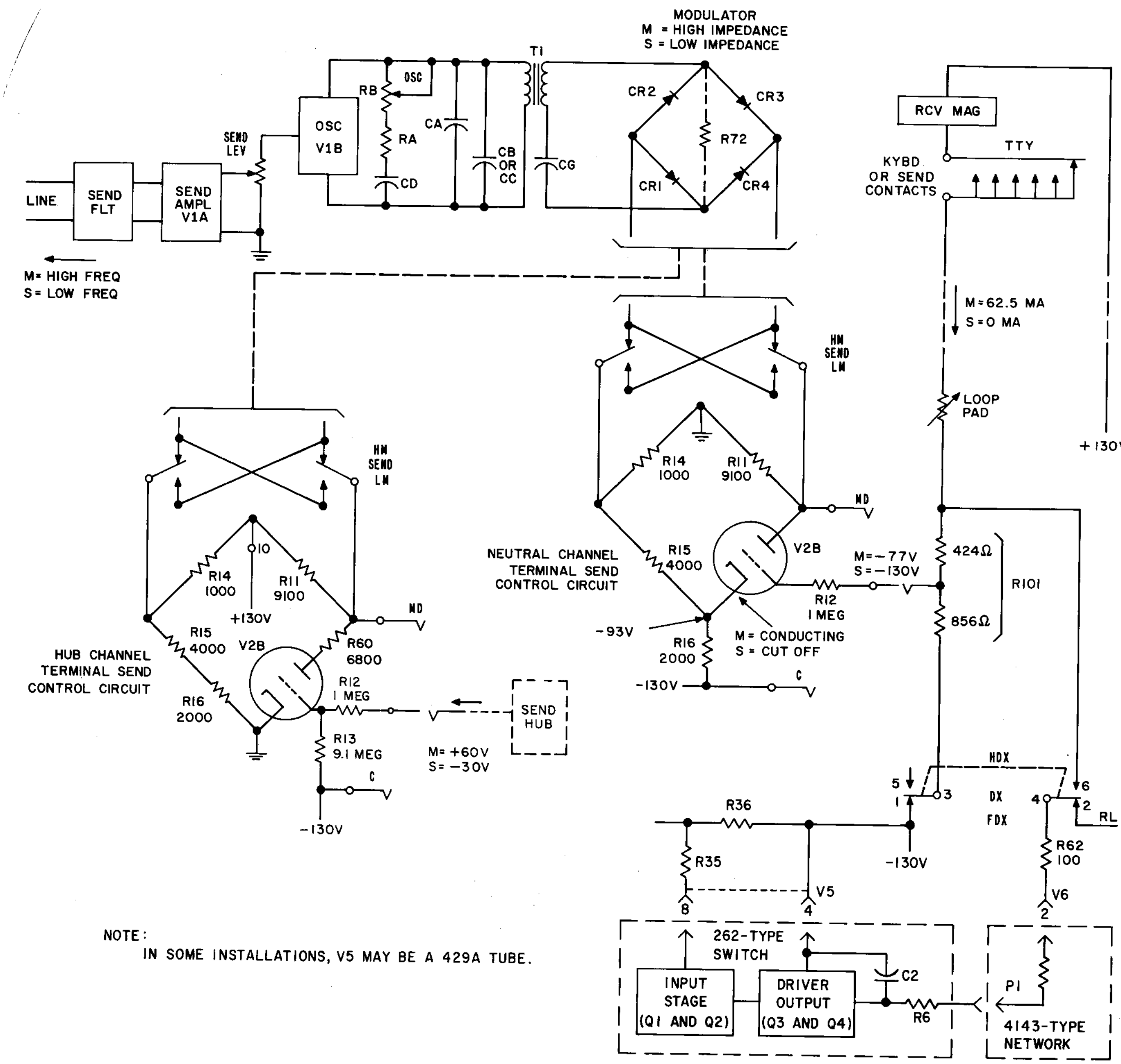
3.58 For neutral channel terminals, the duplexing is done on the IDF and testboard or service board. For hub channel terminals, the DR switch may be operated to select half- or full-duplex operation in conjunction with the serviceboard duplexing circuits.

3.59 Circuits may be extended through two or more carrier telegraph systems in tandem.

Neutral Channel Terminals

3.60 The station equipment at a subscriber location is connected in the dc loop circuit of a neutral channel terminal, which may be located in the telegraph office or at the subscriber location. Loop resistance and distortion of the dc signal pulses limit the length of dc loops over which satisfactory transmission may be obtained.

3.61 With a neutral channel terminal located at a subscriber location, transmission to the telegraph office is by means of the channel carrier signals. The distance between the telegraph office



NOTE:
IN SOME INSTALLATIONS, V5 MAY BE A 429A TUBE.

Fig. 19—Sending Circuit

and the subscriber location is of minor importance in this case. The channel carrier signals can be amplified and distortion, which is the major problem in dc loops, is low.

3.62 For long 20-mA subscriber loops, an external send bias control should be provided. This send bias control permits adjustment of the amount of voltage swing applied to the input of send control (V2b), to compensate for waveform changes caused by capacitance in the loop circuit.

Neutral FDX Operation (Fig. 25 and Fig. 26)

3.63 Figures 25 and 26 are simplified schematics of both the 20-mA and 62.5-mA FDX loop connections to a neutral channel terminal.

3.64 Letters ***a*** through ***c*** in Fig. 25 and Fig. 26 indicate loop voltage combinations that can be used in neutral loops.

3.65 When a send station equipment is marking, current in the send loop is 20 or 62.5 mA. When the send station equipment is spacing, the loop is open at the send contacts and the loop current is 0 mA. The control voltages applied to V2b cause the modulator to shift the channel oscillator between the low- and the high-channel carrier frequencies.

3.66 Received carrier signals produce dc voltages at pin 8 of the 262-type switch, causing the switch to conduct or cut off. The 262-type switch and 4143-type network control the receive loop current, which is 20 or 62.5 mA for marks and 0 mA for spaces.

Neutral HDX Operation (Fig. 27 and Fig. 28)

3.67 Figures 27 and 28 are simplified schematics of both the 20-mA and 62.5-mA HDX loop connections to a neutral channel terminal.

3.68 With the channel terminal loop connections arranged for HDX operation, a connection is made between the receive output and the send loop, which serves for both sending and receiving. In neutral HDX operation, the channel terminal must be receiving a steady mark from the distant terminal while the loop subscriber is sending. When the loop subscriber is receiving, the send control output must be a steady mark to the distant terminal.

3.69 An incoming ***mark*** from the carrier line causes the 262-type switch to conduct, and the station equipment in the loop circuit receives a mark. The voltage drop across resistor R101 in FDX operation has been replaced by the voltage drop of the 262-type switch and 4143-type network. Thus, sending from the station equipment is similar to that discussed for FDX operation.

3.70 An incoming ***space*** from the carrier line causes the 262-type switch to cut off.

(a) Loop current drops to zero.

(b) The station equipment in the loop circuit receives a space signal.

(c) Pin 7 of V2b is positive with respect to pin 8 because of the voltage drop across resistor R65. V2b continues to conduct, causing the channel terminal to continue to transmit a steady mark to the carrier line circuit.

3.71 To transmit a ***break*** signal, the subscriber opens the loop at the station equipment to send a long space. If desired, a break signal may be transmitted automatically when no carrier is received if the loop circuit is connected through contacts of relay SA, which is controlled by received carrier.

(a) The break feature is provided automatically in HDX circuits because, when the loop is opened at the teletypewriter, the potential at the end of the loop is removed.

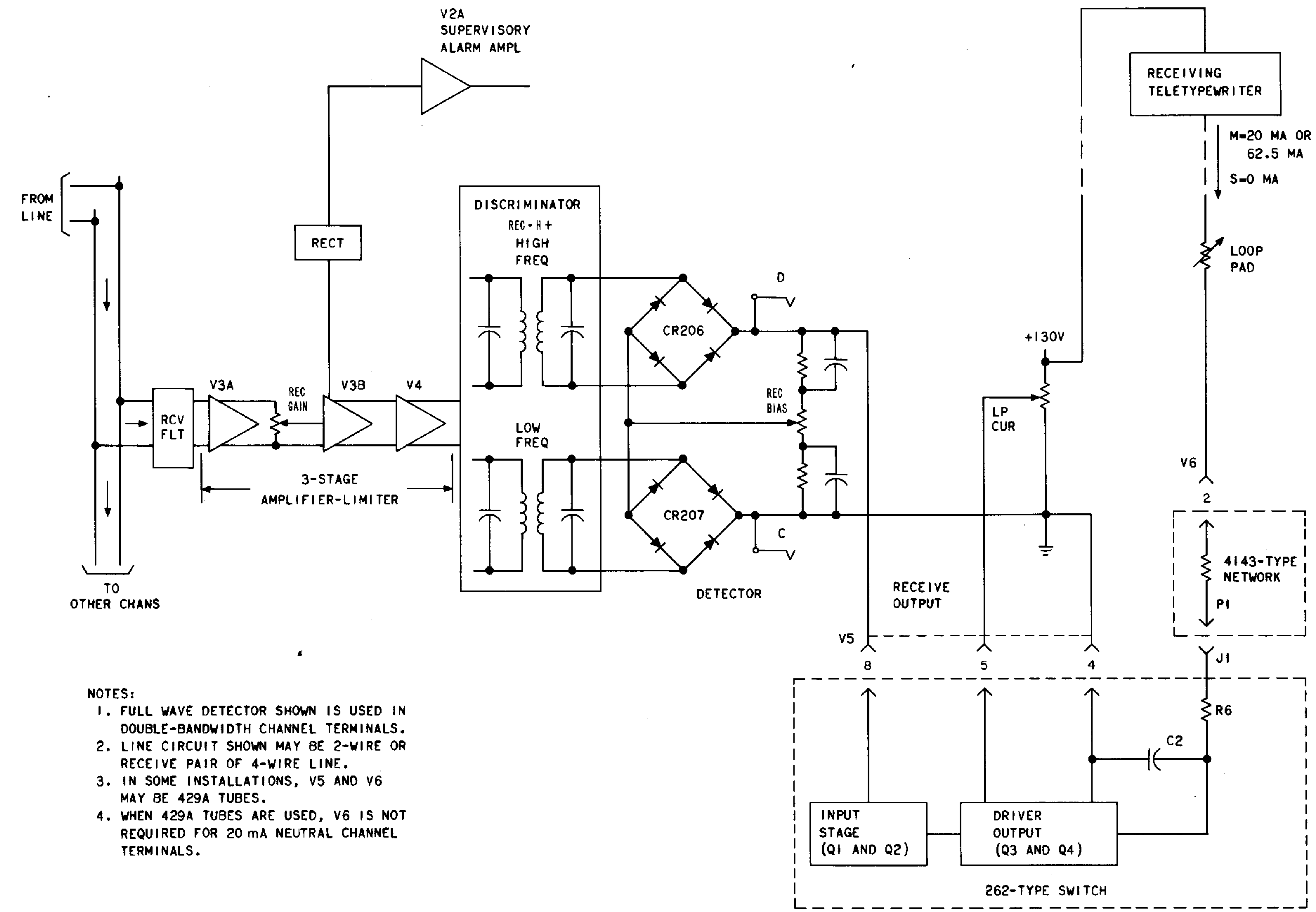
(b) The potential at pin 4 of the 262-type switch is applied to pin 7 of V2b through resistors R65, part of R101, and R12. This makes pin 7 of V2b negative with respect to the pin 8, V2b is cut off, and a steady space is transmitted to the carrier line. This steady space is transmitted regardless of any incoming signals from the distant terminal.

Neutral Back-to-Back Operation

3.72 A circuit may be extended through two or more carrier telegraph systems by means of back-to-back (B/B) connections from a channel terminal of one system to a channel terminal of another system. By B/B connections, telegraph circuits can be provided between points where there is no direct carrier telegraph system. This increases the flexibility of circuit layouts.

3.73 B/B circuits are established by connecting the dc loop of one neutral channel terminal directly to the dc loop of another neutral channel terminal on a full-duplex basis. This provides an intermediate point where one or more branches may be taken from a main route and where monitoring and testing can be performed.

3.74 In neutral FDX B/B connections (Fig. 29), the receive loop of each channel terminal is connected to the send loop of the other channel terminal. This arrangement is used for through transmission regardless of whether the subscriber stations are operating FDX or HDX. No drop-off loops can be operated at the B/B point without



NOTES:
1. FULL WAVE DETECTOR SHOWN IS USED IN DOUBLE-BANDWIDTH CHANNEL TERMINALS.
2. LINE CIRCUIT SHOWN MAY BE 2-WIRE OR RECEIVE PAIR OF 4-WIRE LINE.
3. IN SOME INSTALLATIONS, V5 AND V6 MAY BE 429A TUBES.
4. WHEN 429A TUBES ARE USED, V6 IS NOT REQUIRED FOR 20 mA NEUTRAL CHANNEL TERMINALS.

Fig. 20—Receiving Circuit

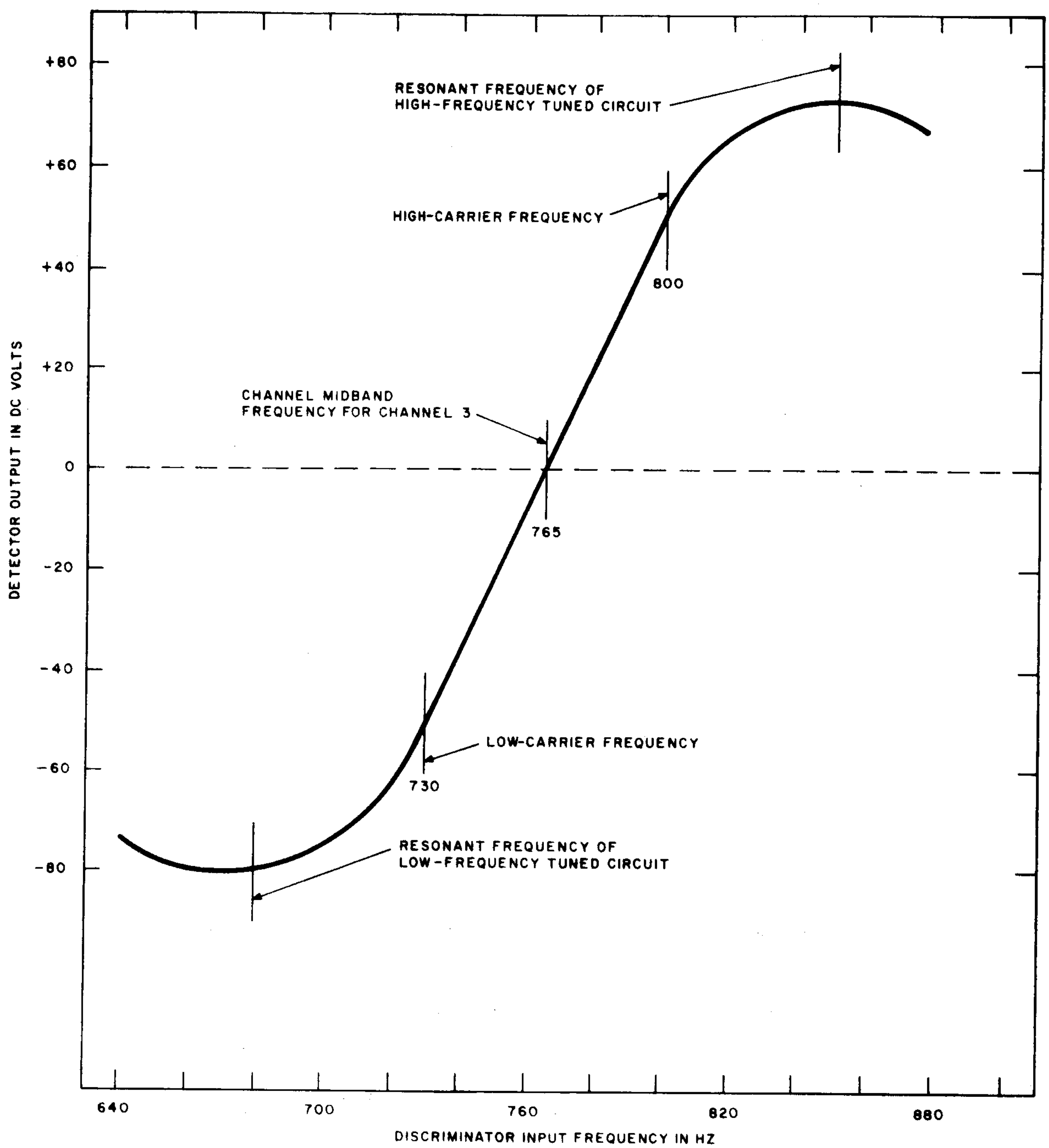


Fig. 21—DC Voltage/Frequency Characteristics of the Discriminator-Detector

serious distortion being introduced to the through transmission. However, monitoring can be performed by using a relay-operated teletypewriter in the direction of transmission which is to be monitored.

3.75 It is possible to interconnect two or three channel terminals with one or two relay-type loop repeaters on a B/B basis by means of an interconnecting network. Drop-off loops are connected to the loop repeaters at the intermediate point for dc loop operation.

3.76 A B/B arrangement providing simultaneous transmission in both directions is shown in

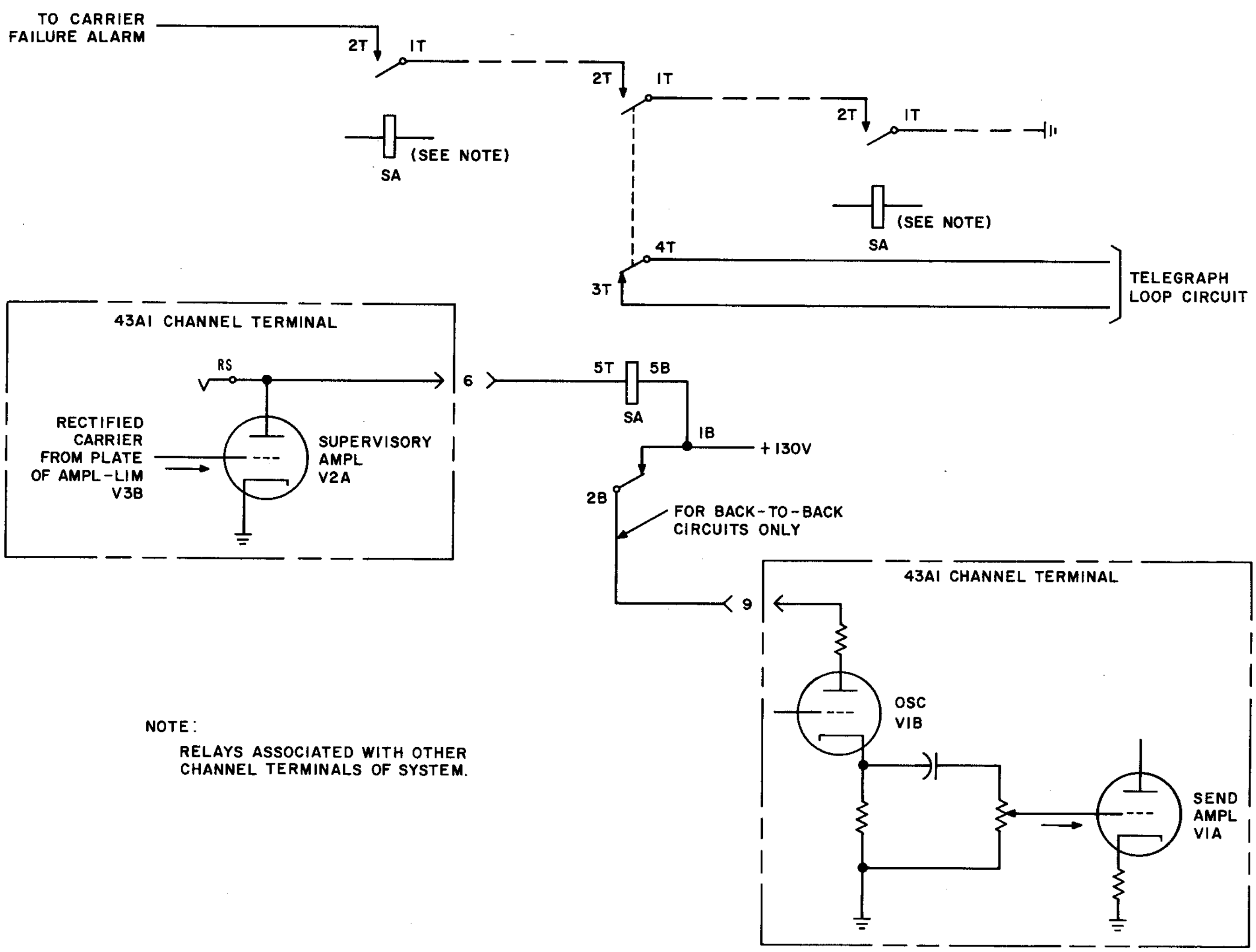


Fig. 22—Example of Supervisory Circuit Arrangement for Neutral Channel Terminals

Fig. 30. A telegraph loop termination (TLT) jack circuit is provided for both channel terminals for monitoring and loop-current adjusting purposes. A relay-operated teletypewriter in the west TLT jack circuit will receive signals from the west channel terminal and may send signals to the east channel terminal. Likewise, a teletypewriter in the east TLT jack circuit will receive signals from the east channel terminal and may send signals to the west channel terminal.

3.77 In the idle condition, both channel terminals receive steady mark carrier current from their distant channel terminals, and it is necessary that both channels transmit mark carrier current to their distant channel terminals. To accomplish this, the SEND and REC switches of the channel terminals connected B/B should be set as shown in Fig. 29.

3.78 The B/B connection inverts the mark and space signals. By setting one SEND (or REC) switch at the B/B point to the position opposite the setting of the REC (or SEND) switch at the distant terminal, the mark and space signals are inverted again and are thereby restored to their normal condition. Thus, the mark and space signals arriving at the receiving station are the same as those transmitted by the sending station.

3.79 As long as carrier current at either of the two signal frequencies enters the receive circuit of a channel terminal, the signal from the output of V3b is rectified and applied to pin 3 of

Fig. 23—Neutral Channel Terminal—Schematic

NOTE:
THE 429A TUBES PREVIOUSLY USED IN V5 AND V6 HAVE BEEN REPLACED BY THE 262B SWITCH AND 4143A NETWORK.

Fig. 24—Hub Channel Terminal—Schematic

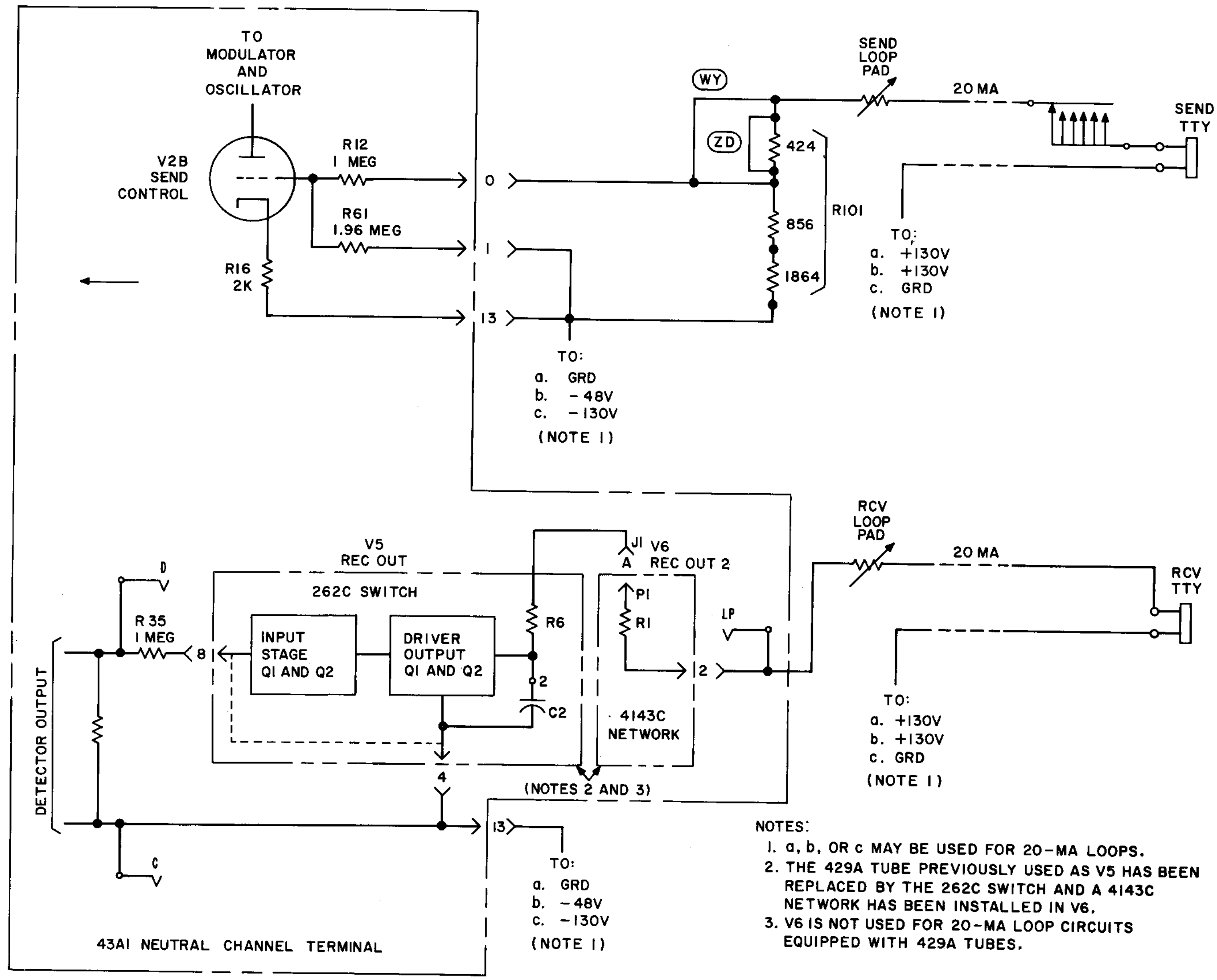


Fig. 25—20-mA Neutral FDX Loop Connections

the supervisory alarm (V2a). The output current of V2a operates supervisory alarm relay SA (Fig. 30).

3.80 Three functions are provided by relay SA.

(a) Contacts 1T and 2T of all SA relays associated with the channel terminals of a given system are wired in series. Ground is on contact 1T of the first SA relay, and contact 2T of the last SA relay connects to the carrier failure alarm circuit for the system. When carrier fails on ***all*** channels of the system, all SA relays release and a no-carrier alarm results.

(b) Contacts 3T and 4T of relay SA are used to open the loop in HDX or to open the receive loop in FDX operation.

(c) Contacts 1B and 2B of relay SA may be used in B/B operation to cut off the oscillator of the associated channel terminal in order to cause relay SA at the distant terminal to release and open the loop.

Hub Channel Terminals

3.81 A hub channel terminal connects through a No. 2, 9B, or DOTC serviceboard to a hub potentiometer circuit.

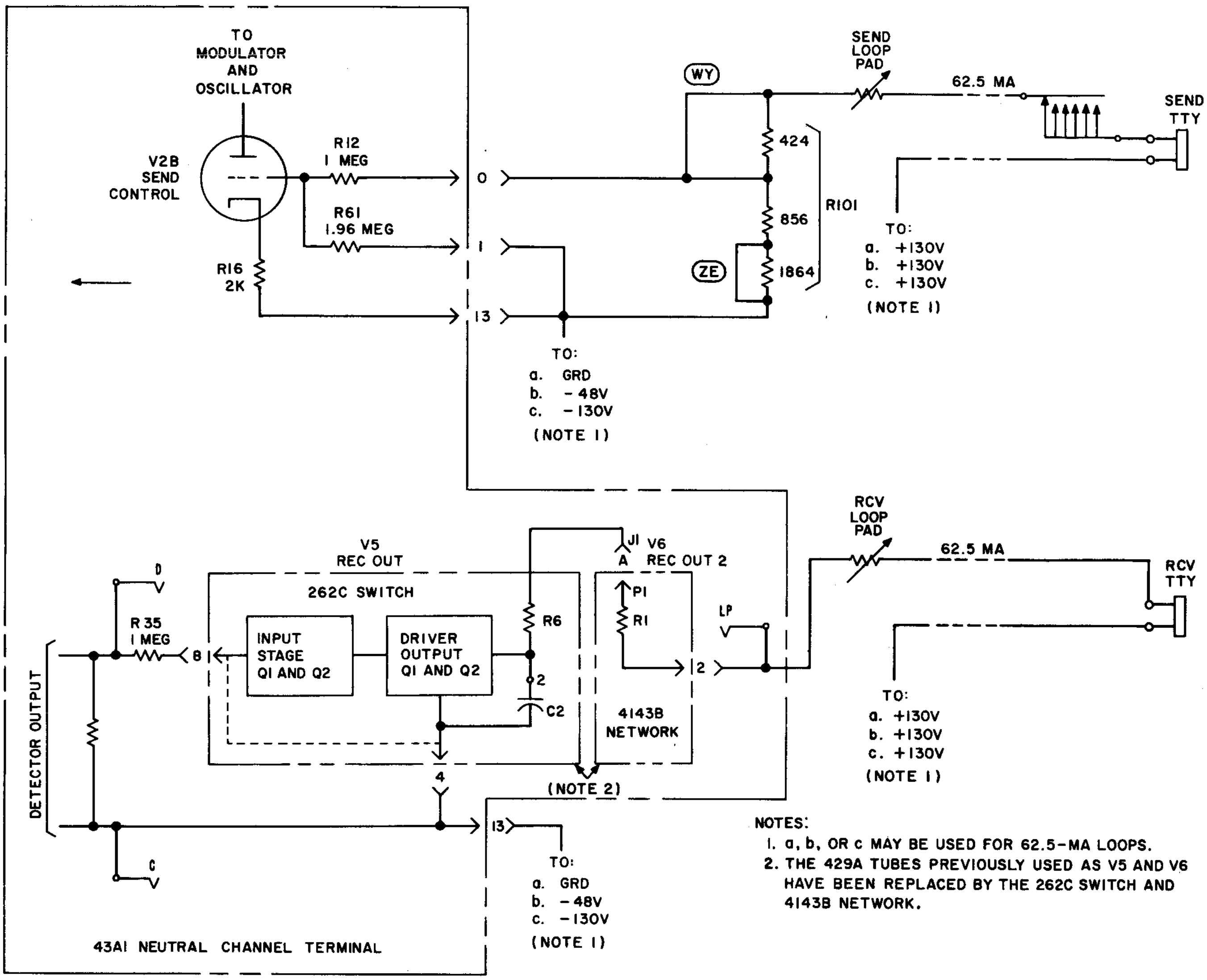


Fig. 26—62.5-mA Neutral FDX Connections

Hub FDX Operation

3.82 For hub FDX operation, switch DR on the channel terminal is operated to F and the send and receive hub circuits operate entirely independent of each other. The SL lead of the channel terminal is connected directly to the send hub, and the RL lead is connected directly to the receive hub.

Hub HDX Operation

3.83 For hub HDX operation, switch DR is operated to H. The SL and RL leads of the channel terminal are connected to a common type-2 hub, either directly or through a regenerative repeater. A hub leg may be a trunk circuit to a distant office or a loop circit to a subscriber.

3.84 With the send and receive hubs connected, either directly or through a regenerative repeater, it is necessary to prevent incoming line signals from reaching the send control circuit and being sent back to the originating terminal. This is accomplished by the directional control circuit, which maintains a mark-hold condition on send control (V2b) while signals are being received by the channel terminal.

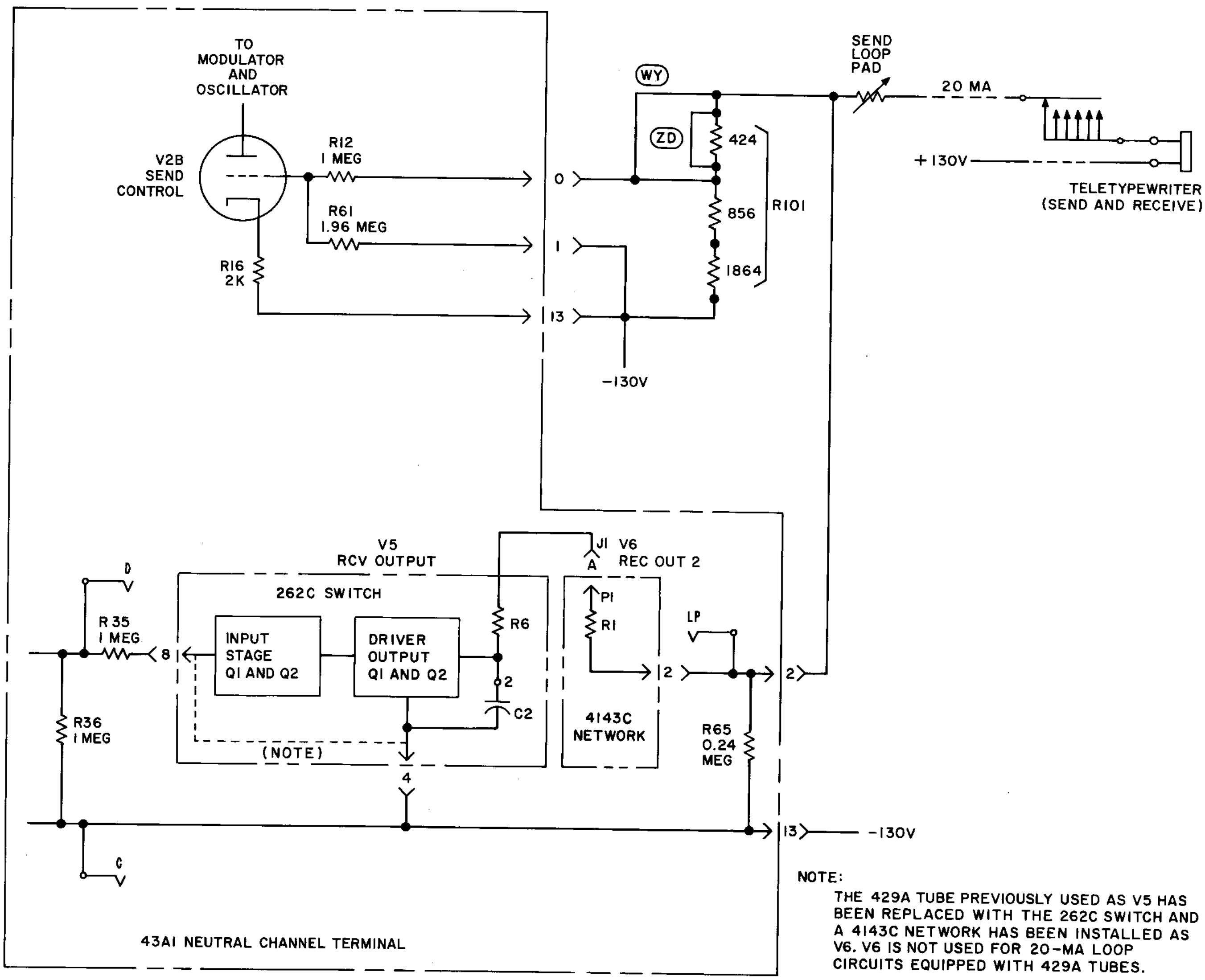


Fig. 27—20-mA Neutral HDX Loop Connections

3.85 Receive output 262-type switch controls signals from the hub channel terminal to the receive hub circuit. The REC switch in the channel terminal must be operated to the L+ position.

(a) When the 262-type switch is cut off, the voltage on the RL hub is at the marking potential of +60 volts.

(b) When a space is received from the distant terminal, the positive voltage output of the detector causes the 262-type switch to conduct, and the RL hub is at the spacing potential of −30 volts.

3.86 All units connected to the hub circuit are electronic devices. The voltage on the SL lead from the hub is +60 volts for mark and −30 volts for space. The send hub mark and space voltages are supplied either by the output side of a regenerative repeater or by the receive hub through a hub link.

3.87 To simplify the explanation of the directional control circuit shown in Fig. 24, the hub leg that connects to the channel terminal under consideration will be called ***leg A.*** Any other leg that may be connected to this hub will be referred to as ***leg B.*** The directional control circuit is

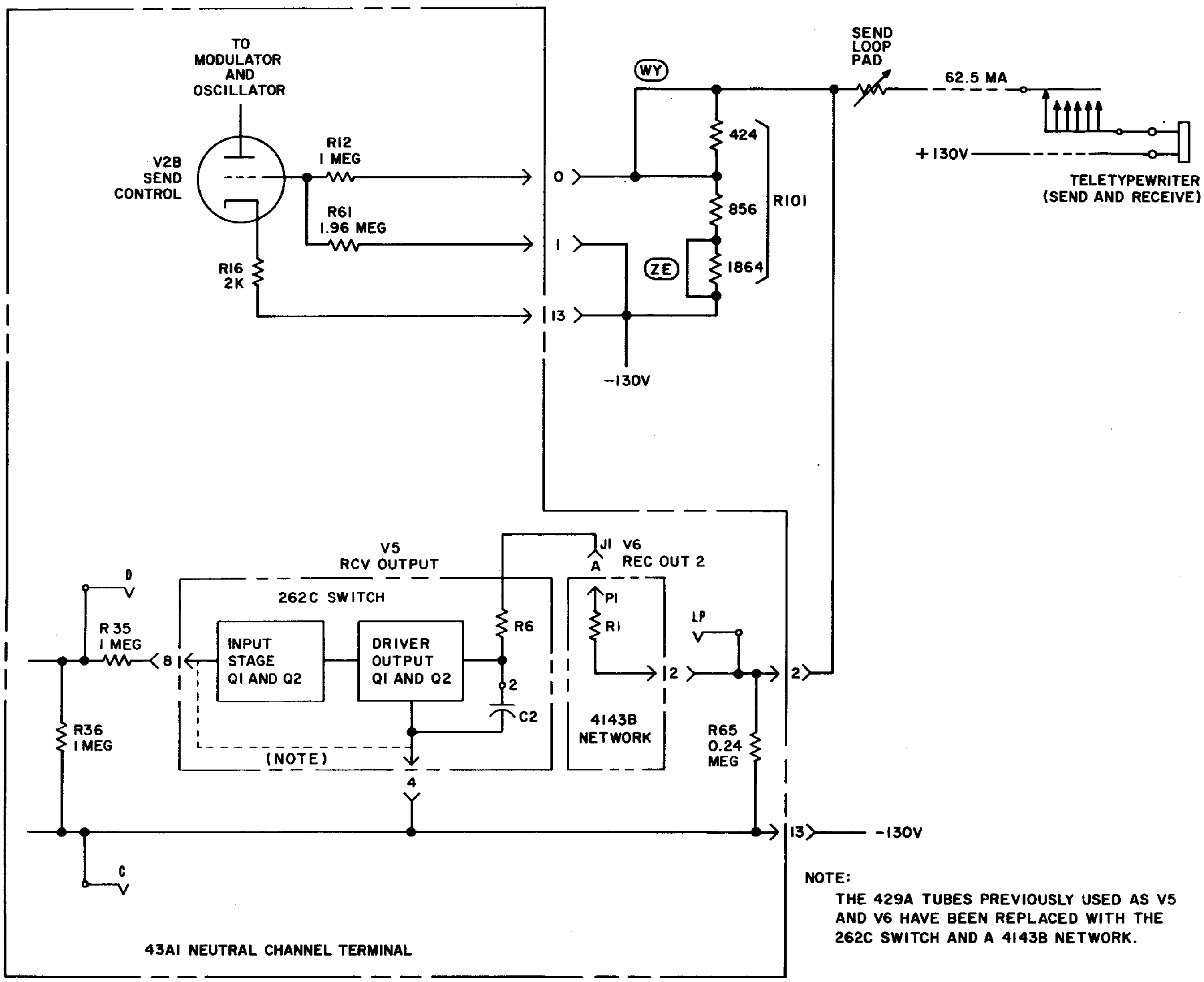


Fig. 28—62.5-mA Neutral HDX Loop Connections

required to provide the following features necessary for HDX hub operation.

(a) When leg A sends a space into the receive hub, that space must ***not*** be sent back into the send side of leg A. The channel terminal must send a steady mark to the line.

(b) When any other leg, such as leg B, sends a space into the hub, that space must go through to the send side of leg A.

(c) When any ***two*** legs, one of which may be leg A, are sending a space simultaneously (double space) into the receive hub, spaces must go out on all of the send legs from the send hub, including the legs of channels that are sending the spaces into the receive hub. The circuit from the output of V2a to pin 3 of V8b, when provided, causes a steady space to be sent back to the distant terminal when no carrier is received. This break signal interrupts sending by the distant subscriber until the carrier circuit is restored to normal.

3.88 Directional control (V8) is connected as a flip-flop, which conditions the send side of leg A so that it either can or cannot, as required,

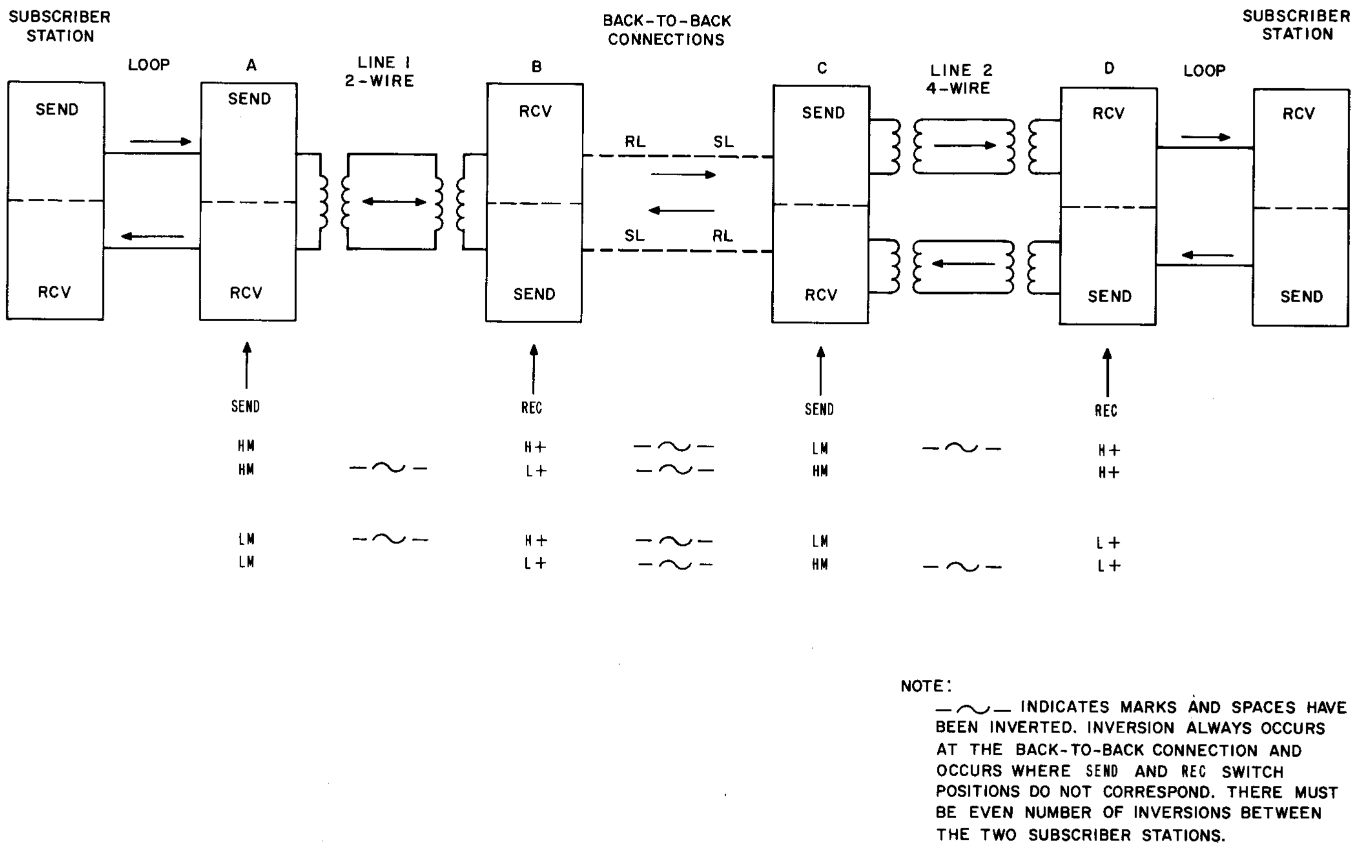


Fig. 29—Neutral Back-to-Back Connections

receive space signals from the hub. V8a conducts or cuts off as determined by its pin 3 to pin 2 voltage. The pin 2 potential is controlled by the signal from the receive channel terminal, which is applied to pin 8 of V7. Pin 2 of V8a is at +20 volts for received mark signals and at −45 volts for spaces. The pin 3 potential of V8a is controlled by the potentials applied to diode CR10.

3.89 Flip-flop action is such that when V8a conducts, V8b is cut off, and vice versa.

(a) When V8a is cut off, directional control action permits marks and spaces to pass freely from the hub to the send side of leg A.

(b) When V8a conducts, the send side of leg A is held on steady mark and cannot pass spaces from the hub.

3.90 Table G gives voltages and conditions of V7, V8a, and V8b for various signals in the hub circuits and for the no-carrier condition.

Hit Indicator Connection

3.91 Lead TL (Fig. 24) is provided to give an indication at the service position of the presence of an incoming space. Open-circuit voltages on the TL lead of approximately −50 volts for mark and −125 volts for space are provided for lighting TL indicator lamps.

4. METHOD OF OPERATION

4.01 This part describes the switches and controls that are provided on the neutral and hub channel terminals.

4.02 The locations and functions of switches and controls for the carrier telegraph system are as follows:

(a) Send circuit controls mounted on channel terminal

- The SEND (HM or LM) switch arranges the circuit to send the high- (HM) or low- (LM) channel carrier frequency for mark. HM is the usual position of the SEND switch.

- The OSC (ON or OFF) switch permits turning the oscillator on and off for testing purposes.

- The SEND LEV potentiometer permits adjusting the level of channel carrier signals transmitted to the line.

(b) Send circuit control mounted on send networks

- The OSC potentiometer permits fine adjustment of the channel terminal oscillator frequency.

(c) Receive circuit controls mounted on channel terminal

- The REC GAIN potentiometer permits adjusting the overall gain of the amplifier-limiter stages.

- The REC (H+ or L+) switch permits arranging the circuit so that either the high- (H+) or low- (L+) channel carrier frequency will produce a positive voltage at the detector output.

- The REC BIAS potentiometer permits adjusting the relative dc voltage output of the mark and space signals from the discriminator-detector and, hence, the bias on the received signals.

- The LP CUR potentiometer (only in neutral channel terminals) permits adjusting the potential on the screen grid of the 429A tube in socket V5 to obtain the proper loop current. The LP CUR control is adjusted fully clockwise when the 262C switch is used in V5.

- The DR (F or H) switch (only in hub channel terminals) permits connecting directional control circuit output to the SL lead for HDX hub operation.

(d) Controls mounted external to channel terminal

- Loop potentiometer or fixed resistance permits obtaining the proper loop resistance (neutral channel terminals only).

- The duplex (DX) switch (MFR DISC) is provided as an option when switching between HDX and FDX neutral operation is required.

- The SEND BIAS potentiometer permits adjusting the voltage at which the send control tube will conduct. This potentiometer is optional and is used only for long 20-mA loops.

- The transmitting pad permits adjusting the power of the combined carrier telegraph signals sent to the facility.

- The FIL ADJ rheostat permits adjusting the filament dc voltage to the proper value.

4.03 It is recommended that channel terminal SEND and REC switches be set in accordance with Table H.

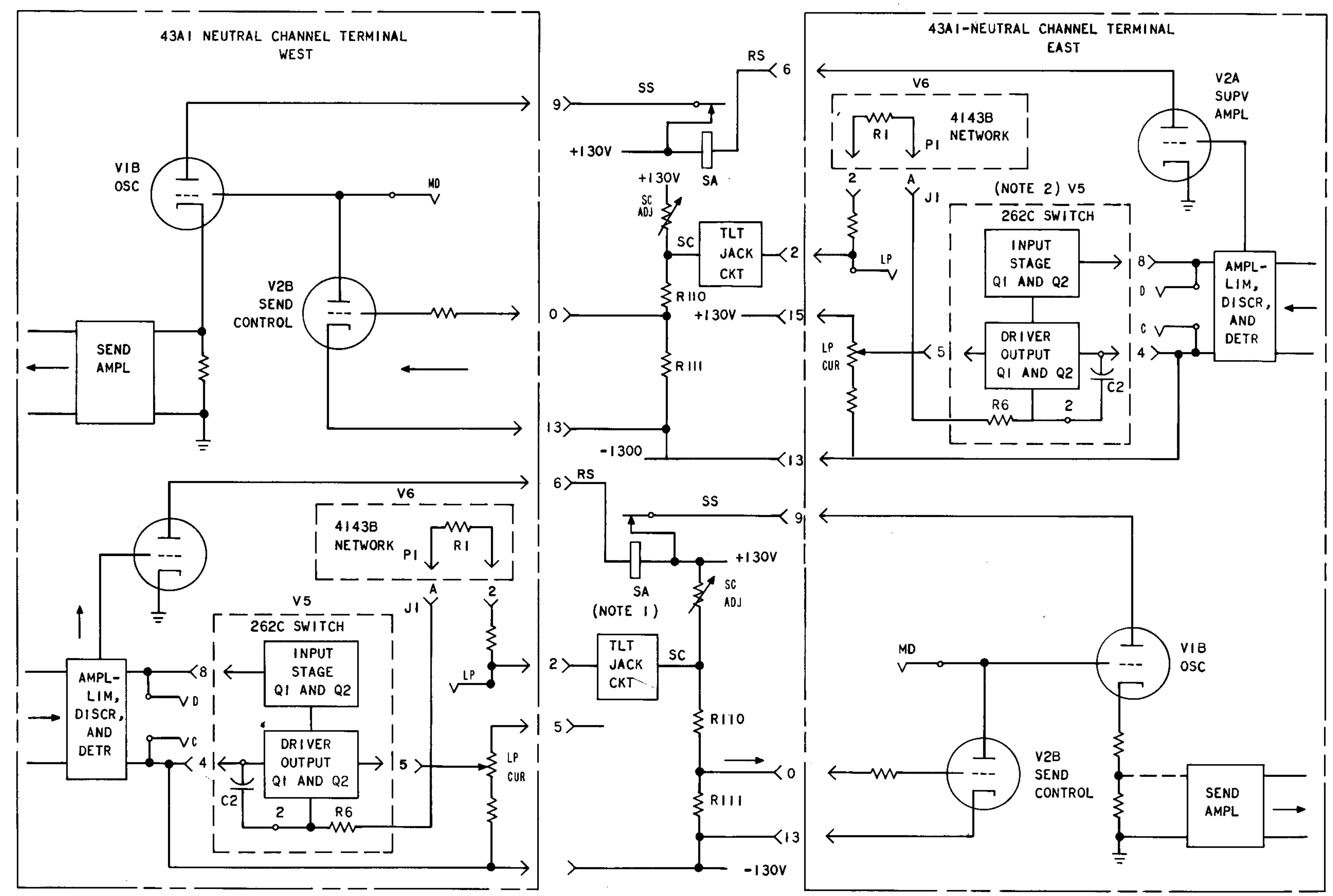
5. TESTING

5.01 Pin jacks are provided for making tests at various points in the channel terminal circuits.

Caution: Voltmeter probes should not be inserted in tube sockets.

5.02 When 43A1 channel terminals are connected to TLT jack circuits in testboards, provision is made for loop current and voltage measurements by means of various key and meter combinations, which are located at the testboard or in the loop pad bay. Provision is made also for substituting resistance terminations of the proper value in place of actual loop circuits.

5.03 The 165C1 test set, described in Section 103-824-102, is designed for making bench tests and alignments of the 43A1 channel terminals.



NOTE:

(1) THE SA RELAYS AND ASSOCIATED RS AND SS LEADS MAY BE OMITTED WHEN SUPERVISION IS NOT REQUIRED. IN THIS CASE, +130 VOLTS MUST BE CONNECTED TO PIN 9 ON EACH CHANNEL TERMINAL.

(2) THE 429A TUBES PREVIOUSLY USED IN V5 AND V6 HAVE BEEN REPLACED BY THE 262C SWITCH AND 4143B NETWORK.

Fig. 30—Neutral FDX Back-to-Back Operation

TABLE G

CONDITIONS IN DIRECTIONAL CONTROL CIRCUIT FOR HDX HUB OPERATION

INCOMING TELEGRAPH SIGNALS ON:			V7	PIN 2 OF V8A	PIN 3 OF V8A	PIN 6 V8A	V8B	PLATE OF V8B	DR PIN JACK	HUB	RESISTANCE *(Note 1)*		OUTGOING TELEGRAPH SIGNALS ON:	
	CARRIER LINE OF LEG A	ANY OTHER LEG (LEG B)									CR11	CR12	LEG A TO CARRIER LINE	ANY OTHER LEG (LEG B)
A	Mark	Mark	Cutoff	+20	+60	Conducts	Cutoff	+130	+60	+60	Low	Low	Mark	Mark
B	Space	Mark	Conducts	—45	—30	Conducts	Cutoff	+130	+60	—30	Low	High	Mark	Space
C	Mark	Space	Cutoff	+20	—30	Cutoff	Conducts	0	—30	—30	Low	Low	Space	Mark *(Note 2)*
D	Mark	Marks and Spaces	Cutoff	+20	0	Cutoff	Conducts	0	—30	+60 and —30	High	Low	Marks and Spaces	Mark
E	Space	Space	Conducts	—45	—60	Cutoff	Conducts	0	—30	—60	Low	High	Space	Space
F	No Carrier	Mark	Conducts	—45	—30	Conducts	Conducts *(Note 3)*	0	—30	—30	Low	Low	Space	Space

Note 1: These are the resistances of the diodes in the direction from pin jack DR or from the send hub toward send leg A. Diode resistance is low when the voltage applied is positive; high when the voltage is negative.

Note 2: Because of its own directional control, leg B will not send a space to itself.

Note 3: V8b conducts because of positive voltage applied from pin 4 of V2a through zener diode CR16.

TABLE H

CHANNEL TERMINAL SEND AND REC SWITCH POSITIONS

TYPE OF LINE OPERATION	TERMINAL	SWITCH	TYPE OF OPERATION			
			HUB	NEUTRAL	INVERSE NEUTRAL	BACK-TO-BACK NEUTRAL FDX
4-Wire, Voice Frequency	East and West	SEND	HM	HM	HM	LM
		REC	L+	H+	L+	H+
2-Wire, Voice Frequency	East	SEND	HM	HM	LM	HM
		REC	L+	H+	L+	H+
	West	SEND	HM	HM	HM	LM
		REC	L+	H+	H+	L+

Test Points

5.04 Listed below are the pin jack test points, their locations, and functions.

(a) Pin jacks that appear on both neutral and hub channel terminals:

- C—Pin 4 of V5 and V6 (receive output circuits)
- G—Channel terminal chassis ground
- MD to C—Output voltage swing of send control circuit (indicates modulator drive)
- SA to G—Signal level at output of send amplifier
- A1 to G—Signal level at output of first receive amplifier-limiter stage
- A2 to G—Signal level at output of second receive amplifier-limiter stage
- D to C—Polarity and amount of detector-filter output voltage

(b) Pin jacks that appear on neutral channel terminals only:

- RS to G—Receive supervisory dc amplifier output
- LP to C—Pin 2 to pin 4 voltage of receive output circuits

(c) Pin jacks that appear on hub channel terminals only:

- SC to G—Send control voltage at junction of diode gate CR11 and CR12

(d) Pin jacks that are mounted in the external circuit:

- FA to FB, FB to FC, or FA to FC—Channel terminal filament voltage.

6. REFERENCES

6.01 The following Bell System Practices (BSPs) pertain to the 43A1 VFCT system.

312-700-200—43A1 Voice-Frequency Carrier Telegraph (VFCT) System—(J70112-)—Installation and Connections

312-700-300—43A1 Voice-Frequency Carrier Telegraph (VFCT) System—(J70112-)—Maintenance Procedures

312-700-500—43A1 Voice-Frequency Carrier Telegraph (VFCT) System—(J70112-)—Test Procedures

312-700-201—A1 Level Variation Detector

103-824-102—43A1 Carrier Telegraph System—165C1 Test Set—Description

103-824-502—43A1 Channel Terminals Maintenance Center Tests—Using 165C1 Telegraph

Test Set
103-825-100—KS-19935 Telegraph Test Set

6.02 Circuit description (CD) and schematic drawing (SD) 70552-01 pertains to the 43A1 VFCT system channel terminals. For the CDs and SDs pertaining to the line circuits, loop terminal circuits, serviceboards, TTY subscriber stations, and miscellaneous circuits used with the 43A1 VFCT system, refer to Part 4 of CD-70552-01.