

43A1 CARRIER TELEGRAPH TERMINAL

CONTENTS	PAGE
1. GENERAL	1
2. TYPICAL BLOCK DIAGRAMS FOR A SYSTEM TERMINAL	2
3. FREQUENCY ALLOCATIONS AND CHANNEL NUMBERING	3
4. DESCRIPTION OF CHANNEL TERMINALS .	3
A. General	3
B. Sending Circuit	4
Sending Loop and Modulator	4
Oscillator	5
Sending Amplifier and Send Filter	5
C. Receiving Circuit	5
Receiving Filter and Amplifier Limiter	5
Discriminator, Rectifier, and DC Amplifier	6
D. Channel Terminal Controls	7
E. Filament Supply	8
5. DC LOOP CONNECTIONS TO CHANNEL TERMINALS	8
A. Loop Options (Tables A and B)	9-10
B. Full Duplex Operation	10
C. Half Duplex Operation	11
D. Back-to-Back Operation	11
E. One-way Multiple Loop Operation	13
F. Supervisory Signaling Circuit	13
G. Alarm Circuits	14
6. HUB CONNECTIONS TO CHANNEL TERMINALS	15
A. General	15
B. Directional Control Features for Half Duplex Operation (Table D)	15
C. Full Duplex Operation	17
D. Hit Indicator Connection	18
7. EQUIPMENT FEATURES	18
8. TESTING ARRANGEMENTS (TABLE C)	19
9. LIST OF DRAWINGS	21-22

1. GENERAL

1.01 This section gives the description and operating principles of the 43A1 carrier telegraph terminal. The 43A1 system provides in the voice-frequency range seventeen 2-way telegraph channels over a 4-wire circuit or eight 2-way plus one, one-way channels over a 2-wire circuit. In addition, it provides four 2-way channels in the above voice range; that is, for open-wire circuits, the portion of the frequency spectrum between the voice and the C-type carrier ranges or below OA-type carrier, and for H44 and H88 toll cables the portion above voice. One of the four high-frequency channels (3550 and 3750 cps) may also be used between voice and H-type carrier telephone circuits or above voice on H88 toll cables. On the dc side, options are provided for connection to various kinds of teletypewriter circuits for TWX and private-line service (PLS), including those at TWX switchboards, testboards and serviceboards, and at subscriber stations. An arrangement is also provided whereby two neutral type 43A1 channel terminals may be operated back-to-back; that is, with their dc loops directly interconnected to each other on a full duplex basis. No drop-off loop to a subscriber can be used, since the resulting transmission is unsatisfactory. Full duplex direct back-to-back connections are used to build up circuits on a carrier basis between offices where other carrier facilities are not available, to change transmission frequency, or to provide monitoring on a dc basis at an intermediate point.

1.02 This section is reissued to describe the following additional operating features for the 43A1 channel terminal.

- (a) A modification of the supervisory and alarm relay circuit to provide for no-carrier alarm with open loop PLS operation, and to permit the use of channel terminal circuits, equipped with a supervisory relay in TLX operation.

(b) An adjustable send bias control potentiometer for 20 ma subscriber loop operation.

(c) A method for operating a neutral loop channel terminal with a type 2 hub in testboard offices.

(d) A half duplex interconnecting network to permit back-to-back operation of neutral-type channel terminals with intermediate drop-off loops.

(e) Circuitry to permit one-way operation of a number of 43A1 carrier telegraph send-only channels from a 40C carrier telegraph channel, or a relay-type dc line repeater.

1.03 The system is a frequency shift system.

Mark and space signals are formed by shifting the carrier frequency between values which are 35, 40, 45, and 50 cycles, respectively, above and below the nominal midband frequency of a channel depending on the position of the channel frequency in the carrier frequency spectrum. Each channel terminal contains its own carrier-supply oscillator so that the terminal is adapted to small installations and for use on subscriber premises.

1.04 The ac circuits of the basic channel terminal unit are the same for all channels.

The equipment is entirely electronic. The operating frequencies of a particular channel terminal are determined by two plug-in frequency determining units, one for sending and one for receiving. In addition, the entire channel terminal is a plug-in unit and is thus conveniently replaced or removed for bench maintenance. Power supply and line and loop circuit connections are made externally through a socket mounted on a framework which in turn mounts on a 19-inch relay rack panel. The appearance of a channel terminal is shown in Fig. 1 and 2.

1.05 In providing service to outlying TLX subscribers, the 43A1 system has the advantage of providing three signaling conditions; mark, space, and no-carrier current. This allows supervision of the open-line type like that possible over dc polarized circuits and results in simplifications of the supervisory equipment at TWX switchboard offices.

1.06 Since the sending and receiving input circuits of the channel terminal are unbalanced, a line or line hybrid transformer is

always required between the terminal and the connected line.

1.07 The wiring of the plug-in unit is arranged at the factory for one or the other of two dc circuit options.

(a) Neutral loop operation.

(b) Type 2 hub operation.

The two basic types of terminals are not interchangeable and no provision is made for field conversion from one option to the other.

1.08 When the terminal is arranged for neutral operation, various external wiring arrangements provide for the connection of the terminal to testboards, to the TLX circuits of TWX switchboards, or, at a subscriber station, to the teletypewriter. The neutral loop arrangement is also used, with a 90A2 repeater, for connection to the type 1 hub of the No. 1 serviceboard. For connecting a neutral loop channel terminal to a type 2 hub at a testboard office, a 90C1 loop repeater and a 144A1 coupling unit are required.

1.09 When the channel terminal plug-in unit is arranged for type 2 hub operation, the external wiring connections are made to a No. 2 or 9B serviceboard or to a testboard.

1.10 Where desired, a universal wiring arrangement may be provided so that most of the external wiring plans can be obtained merely by changing straps on a terminal block.

2. TYPICAL BLOCK DIAGRAMS FOR A SYSTEM TERMINAL

2.01 A 43A1 system consists of one or more channel terminals located at each end of an interconnecting facility together with line filters and balancing networks, when required, to provide separation from other services utilizing the same facility.

2.02 A 43A1 system terminal is a group of one or more channel terminals which are connected in parallel to whatever line equipment is common to all, usually through a set of telegraph line jacks. Fig. 3 to 8, inclusive, are typical block diagrams, for illustrative purposes, of system terminals with various operating arrangements as stated in the titles of the figures.

3. FREQUENCY ALLOCATIONS AND CHANNEL NUMBERING

3.01 The allocation of frequencies, together with the method of numbering the channels, is indicated in Fig. 3 to 8, inclusive.

3.02 For 4-wire operation, all 17 channels may be used in each direction of transmission. It is generally desirable to operate 4-wire systems with the same channel frequency in both directions on each channel. In cases where objectionable interference between sending and receiving equipment is encountered, the frequency allocations shown in Fig. 3 may be used.

3.03 For 2-wire operation, it is necessary to use different frequencies for the two directions of transmission and only half the number of channels are available. For this type of operation, a typical channel grouping and frequency allocation are shown in Fig. 4. Since there is an odd number of channels in the system, one of the channels can only be used as a one-way channel in either direction. In Fig. 4 the 425-cycle channel is shown thus. This channel should be used to transmit or receive in the same direction as the 595-cycle channel. In cases where it is used in the opposite direction, the difference between send and receive channel levels measured at the line jack should not exceed 18 db. The channels in the above voice group (3550 to 4580 cycles) are usually operated on a 2- or 4-wire basis on cable. These channels have wider midband spacing than those in the voice range and should be arranged as shown in Fig. 5 and 6. When the single 3550- to 3750-cycle channel is used between voice and H-type carrier telephone facilities, it should be arranged as shown in Fig. 7 to secure the optimum frequency spacing with respect to the carrier frequencies of the H-type equipment.

3.04 It is sometimes desirable to shift from 4-wire to 2-wire operation at a point where a stem line separates into groups of branch lines. Fig. 8 shows a typical arrangement where all 17 channels on the 4-wire circuit are involved. Smaller numbers of channels may be used in the same pattern.

3.05 The nominal midband frequencies shown in Fig. 3 to 8 are not used for transmission. The transition from mark to space, or vice versa, is made in a shift of 70 to 100 cycles, depending on the channel, without phase discontinuity. In the voice-frequency band, the nominal midband channel frequencies, like those of the 40-type systems, are spaced 170 cycles apart, and the mark and space frequencies, 70 cycles apart in each channel as shown in Fig. 11. In the high-frequency band, the spacings between nominal midband channel frequencies and the amount of shift vary from channel to channel; the actual values used along with the filter characteristic curves are shown in Fig. 10.

3.06 Two control switches are mounted on the face panel of the 43A1 terminal, the SEND (HM or LM) and the REC (H+ or L+) switches. These switches make it possible to select either the higher or the lower frequency, as desired, for the marking frequency of the channel. The marking frequency referred to at this point is the frequency which will be produced by or cause the closure of the dc loop associated with the channel terminal. In the case of the voice-frequency channels, as indicated in the filter characteristics diagram of Fig. 11, the higher frequency is shown for the marking signal for all channels. For the channels in the above voice region there is an advantage in the selection shown in Fig. 10 which shows the channels in the upper part of the region using the higher frequency for marking and the channels in the lower part of the region using the lower frequency for marking. Under normal conditions in HDX operation where each channel is sending signals in one direction and receiving a steady marking signal in the other direction, the frequency of the steady marking condition is as far distant as possible from the signal frequencies in the sending direction. The possibility of cross-fire between the two directions of transmission in the same channel is thus minimized.

4. DESCRIPTION OF CHANNEL TERMINALS

A. General

4.01 In an AM telegraph carrier system, such as the 40 type, signals are formed by sending carrier current for marks and interrupting transmission entirely for spaces. In a frequency shift system, such as the 43A1, the marks con-

→sist of periods of carrier of one particular frequency and the spaces of periods of carrier of →another frequency. The voltage amplitude of →the carrier frequency on the carrier line is thus constant whether marking or spacing, and only →the carrier frequency changes. Signal transmission is accomplished by means of a modulator which shifts the frequency of the oscillator source up or down by an appreciable amount (70 to 100 cycles in the 43A1 system) at each signal transition. An oscillator is associated with each channel terminal. The desired frequency →shift is obtained by altering the capacity of the →oscillator tank circuit.

4.02 DC signals from the sending loop control an electronic modulator, which cuts in and out, by means of diodes, an additional capacitance in the tuned circuit of the oscillator and thus produces one frequency for a mark and another frequency, differing by 70 to 100 cycles, for a space. The marking or spacing frequencies are then amplified and passed through the SEND filter to the line.

4.03 Reception requires means sensitive to frequency changes to distinguish between the marking and spacing elements of the signals. This is provided by the "discriminator" which →functions essentially like two tuned circuits, one responsive to the marking frequency and the other to the spacing frequency. Each of these →tuned circuits is associated with a rectifier.

4.04 The principal features on the receiving side are the receiving filter, a 3-stage amplifier limiter, a discriminator, two varistor-type rectifiers with their outputs connected differentially, and a dc amplifier or receiving →output stage which acts as an electronic relay to control the current in the receiving loop.

4.05 The operation of the circuits of the channel terminal is described in detail below. For simplicity, the channel terminal shown in Fig. 12 is described on the assumption that it is connected for full duplex operation with ± 130 -volt (that is, 2 polarity) loops and is connected to a 4-wire facility. Under these conditions, the two directions of transmission are entirely separate from the sending keyboard at one end of the circuit to the receiving teletypewriter at the other. The duplex switch (DX) must be operated to full duplex (FDX) for this

case. Fig. 12 also shows, in parentheses, the loop voltage required when the loops are operated from positive 130 volts to ground and from positive 130 volts to negative 48 volts. Although not shown in this Fig., loops may also be operated from ground to negative 130 volts at the cathode →of the receiving tubes, which is known as →grounded loop operation.

B. Sending Circuit (Fig. 12)

Sending Loop and Modulator

4.06 In full duplex operation, when the sending teletypewriter is marking, a current of 62.5 ma flows from the +130-volt battery at the return end of the loop through R101 resistor and DX key contacts 3 and 1 to -130-volt battery. The voltage drop across R101 (about 80 volts with respect to the return voltage of the loop, in this case -130 volts) is divided by the 424-ohm and 856-ohm sections so that about 66 per cent of the total voltage drop or +53 volts is applied to the grid of V2 (b) tube. As the cathode is held at approximately +37 (in respect to -130 volt) volts by the R14, R15, and R16 potentiometers, the potential of the grid with respect to the cathode is approximately +16 volts assuming no grid current flows, and the tube will conduct. When the teletypewriter station is sending over a long loop, the signal wave appearing across R101 resistor will be rounded off due to cable capacity. Since the send control tube will conduct and send a mark when the signal wave has reached 66 per cent of its peak value, and the slope of the leading edge of the wave at this point is still vertical, the voltage division tends to compensate for the signal bias in long loops. Thus, conventional wave shaping, as specified in the loop loading practice, is not necessary and should not be used. In half duplex operation, the voltage divider is disconnected by the DX switch. The loop current flows through the plate and cathode circuit of the V5 and V6 receiving output tubes, and the internal impedance of these tubes takes the place of R101 resistor.

4.07 When the station teletypewriter is spacing, the loop is opened, thereby disconnecting the +130-volt battery. The grid of V2 (b) tube is held at -130 volts so that the potential of the grid with respect to the cathode is about -40 volts and the tube is cut off.

4.08 The V2 (b) tube is connected as one arm of a dc bridge (Fig. 13). With the tube *conducting* and the SEND switch in the LM position, the bridge is unbalanced and a current of 2.5 to 5.0 ma, depending upon the tube, flows through the CR1 to CR4 diodes in the forward direction of the arrows; that is, in the low impedance or conducting direction. With the tube *cut off*, the bridge is unbalanced in the opposite direction and 10 to 20 volts are applied to the diodes in the reverse or high-impedance direction.

Note: The V2 tube contains two independent triodes, one designated V2 (a) in the supervisory circuit and the other V2 (b) connected as the send control tube described above. The V1 and V3 tubes are similarly constructed. For simplicity, the triodes are shown as independent tubes in Fig. 12.

Oscillator

4.09 Both marking and spacing frequencies are produced by a single oscillator which consists of V1 (b) triode and an associated oscillating circuit. With the CR1 to CR4 diodes presenting a high impedance or practically non-conducting, the main tuned circuit of the oscillator consists of the primary winding of T1 transformer (terminals 5 and 7 of the send network) and CA and CB or CC tuning capacitors. Under this condition, the oscillator is tuned to the higher carrier frequency. The OSC potentiometer, together with RA resistor and CD capacitor, provides a fine tuning control. With this fine tuning, the frequency can be varied about 10 cycles in the voice range and 15 cycles in the higher-frequency range.

4.10 With the CR1 to CR4 varistors presenting a low impedance or conducting, the CG capacitor is effectively bridged to the oscillator-tuned circuit (coupled through T1 transformer) and the frequency is shifted to the lower value. The varistors function as a series switch under the control of the V2 (b) send control tube. No separate adjustment is provided for the lower carrier frequency since CG determines the amount of shift.

4.11 The switch designated SEND is a reversing switch for the diodes. When the SEND switch is operated to LM, the poling is such that a mark in the send loop will cause the V2 (b)

tube to conduct, which will cause the varistors to conduct, which in turn will connect the CG capacitor and cause the oscillator to generate the *lower frequency*. When the SEND switch is operated to HM, a mark in the send loop will cause the oscillator to generate the *higher frequency*.

4.12 The V1 (b) oscillator tube is operated with a plate potential of only about 60 volts, thus making the carrier voltages and currents applied to the varistors small in comparison with the dc control voltage and current. This insures that the varistors appear as a high or a low impedance over the whole cycle of the carrier frequency.

Sending Amplifier and Send Filter

4.13 The oscillator output power is adjusted by the SEND LEV potentiometer, amplified in the V1 (a) tube and passed through the send filter to the send bus and line. The output telegraph level may be varied from a maximum of +6 dbm to a minimum of practically no output.

4.14 Within the associated channel frequency band the send filter input impedance across terminals 1 and 3 is about 7500 ohms, but only 600 ohms between terminals 2 and 4, thus securing a satisfactory impedance match to both the plate circuit of V1 (a) and to the external circuit. Outside the associated channel frequency band the impedance between terminals 2 and 4 is sufficiently high as to be negligible.

C. Receiving Circuit (Fig. 12)

Receiving Filter and Amplifier Limiter

4.15 At the receiving end of the circuit, the carrier is selected by the appropriate receiving filter. Like the sending filter, this is an impedance transforming structure presenting 600 ohms toward the line within the associated channel frequency band, but about 140,000 ohms toward the grid cathode circuit of the first amplifier limiter stage V3 (a). The sensitivity of the receiver is such that it will operate with input carrier levels as low as -55 dbm on electrically quiet circuits. It will also operate on carrier levels as high as +6 dbm.

4.16 The carrier selected by the receiving filter is passed through a 3-stage resistance capacitance coupled amplifier limiter consisting of

V3 (a), V3 (b), and V4 tubes and associated circuits. Between the first and second stages the gain is adjusted by means of a REC GAIN potentiometer.

4.17 The purpose of the limiter is to keep the output of the V4 tube constant over a wide range of levels received from the line. When the carrier level is in the lowest portion of the range described in 4.15, practically no limiting takes place. As the receive level is increased V4 tube contributes most of the limiting action. The 1-megohm resistor in series with its grid prevents the grid from going positive and so confines swings in plate current to the range from 0 to about 10 ma, and the output is practically constant. When the input level is so high that grid current tends to flow in V3 (b) and V3 (a) tubes, these tubes also contribute to the limiting action due to the resistors in their grid circuits.

4.18 The grid of the V2 (a) supervisory tube is controlled by the rectified ac plate voltage of the V4 limiter tube. The function of this tube is to detect the presence and absence of carrier. When carrier is present V2 (a) tube is in its conducting condition whether the carrier frequency is marking or spacing. In the absence of carrier, the supervisory tube should become nonconducting. If the limiter tube is operating in a region where considerable limiting is taking place, loss of carrier may shift this tube to a region where very little limiting occurs. This will in effect increase the sensitivity of the supervisory circuit. For this reason, when the supervisory circuit is in use, it will be necessary to set the receive gain potentiometer for no higher gain than is necessary to secure satisfactory transmission, in order to prevent the occurrence of false supervisory signals resulting from line noise or cross channel interference in the absence of carrier. The method of doing this is described in detail in the operating practice.

Discriminator, Rectifier, and DC Amplifier

4.19 The output of the V4 limiter tube is passed on in two directions. A small part of the output is rectified and amplified in V2 (a) tube, providing about 10 ma dc for operating the supervisory relay as described later. The main output of V4 is passed through the primary side of the discriminator. This structure consists of two antiresonant circuits in series which

are tuned respectively to somewhat higher and lower frequencies than the high- and low-signal frequencies. When the lower frequency is received, the voltage across terminals 4 to 7 is, therefore, considerably higher than that across 7 to 10; conversely, when the higher frequency is received, the reverse is the case.

4.20 When the REC switch is operated to L+, connections are made as shown in Fig. 14. When the lower frequency is received, it is rectified chiefly by CR6, resulting in a direct current flowing in R32 in the direction of the arrow. The voltage at the D pin jack is, therefore, positive with respect to the voltage at the C pin jack, and V5 tube will conduct. This produces a marking current in the receiving loop.

4.21 When the higher frequency is received, it is rectified by CR7 resulting in a dc flowing in R33 in the direction of the arrow. The voltage at the D pin jack is, therefore, negative with respect to the voltage at the C pin jack, and the tube will be cut off. This produces an open or spacing condition in the receiving loop. For 62.5 ma loops, two tubes, V5 and V6, are connected in parallel to produce sufficient current. For 20 ma loops only V5 is used.

4.22 The REC switch is a reversing switch. When operated to L+, the circuit will operate as described in 4.20 and 4.21, so that the received *lower frequency* will produce a *mark*. When the switch is operated to H+, the circuit to the rectifiers is reversed so that a received *higher frequency* will cause a mark.

4.23 Capacitors bridged across R32 and R33 resistors bypass the carrier frequencies, and by lowering the impedance at these frequencies in the output circuit of V4 as compared with the impedance offered to the dot-cycle frequency, they tend to increase the relative voltage amplitude of the latter.

4.24 The importance of the limiter is now apparent, for since the discriminator would translate either changes in frequency or changes in magnitude appearing at its input into corresponding voltage variations across D and C jacks, it is necessary that magnitude changes be effectively eliminated by the limiting action of the preceding tube stages. With the arrangement employed, the V4 tube generates a plate-to-

cathode ac voltage which is relatively independent of signal amplitude or frequency. This voltage controls the action of the discriminator circuit as described in 4.19 through 4.23. Due to the limiting action, variations in level, which affect equally the marking and spacing frequencies, cause no signal distortion; in other words, frequency shift operation gives extremely effective level compensation. However, differences in level between the marking and spacing currents cause bias, therefore they should be kept to a minimum in a frequency shift system.

4.25 The rectified signals are passed through the low-pass filter (Fig. 12), consisting of L1 coil and C15 capacitor. This filter has a cutoff of about 40 cycles, or slightly above the dotting frequency of 100 words-per-minute signals. Its purpose is to discriminate against interfering frequencies exceeding about 40 cycles.

4.26 In the circuit shown in Fig. 14 the grid of V5 is unbiased with respect to its cathode. The received marking and spacing carrier current causes approximately equal positive and negative voltages, respectively, of about 50 volts on the tube grid circuit when the REC BIAS potentiometer is electrically centered. The grid cannot be appreciably positive because of the 1-megohm resistance in series with it. The tube cuts off with about 8 or 9 negative grid volts. The transition from marks to spaces, therefore, would occur while the grid potential is dropping from 0 to -9 volts. The resulting waveform of the signal in the loop is a close approximation of a square wave, but still contains some marking bias.

4.27 This marking bias could be compensated for by biasing the grid negatively about 5 volts. This effect is obtained by prebiasing the signals by means of the R42 resistance (Fig. 12), so that their mean value is -6 volts with respect to the cathodes of V5 and V6. In other words, the magnitude of the positive voltage is made 12 volts smaller than the magnitude of the negative voltage. The REC BIAS potentiometer provides means for additional bias compensations by the same method. This additional compensation is in the order of ± 10 to ± 15 per cent and is intended to take care of bias variations from other sources.

4.28 The V5 and V6 tubes act in parallel as an electronic switch which is closed by positive voltages across D and C jacks and which is opened by negative voltages across these same points. It should be noted that the actual circuit of an electronic loop is not opened and closed in a physical sense. The control of current is accomplished by the change of impedance in the plate-cathode circuit of the output tubes. When the receiving loop is closed (tube impedance low) current flows from the external loop battery through the loop and plate-cathode circuit of the output tubes to cathode battery. This current operates the receiving TTY to marking. When the loop is opened (tube impedance high) the current is effectively zero, and the TTY receives a spacing signal. Under the spacing condition negligible leakage currents in the order of 1 ma or less may continue to flow. If there is no incoming carrier current of either marking or spacing frequency the mean negative bias referred to in 4.27 will not be present. The grids of V5 and V6 will be at the same potential and a current slightly less than normal marking current will flow in the tubes and in the receiving loop. This current is in the order of 57 ma and will prevent the teletypewriter equipment in the loop from running "open." This is known as the "mark-hold" feature of 43A1 terminals.

4.29 Fig. 15 is based on Fig. 14 and shows the dc voltage output versus the frequency of the carrier input to the discriminator. When the carrier frequency is at the channel midband value, each of the tuned circuits of the discriminator is approximately at half response and equal amplitude voltages are delivered to the half-wave rectifiers. This results in zero net output across the series connected rectifier loads. For frequencies away from midband, the effect of working on opposite slopes of the two resonant circuits of the discriminator causes the output from one of the secondary windings to exceed that from the other and thus produces a net dc voltage from D jack to C jack. Typical values of D to C voltage are given in Table C. These values are not critical and may vary by several per cent from one channel terminal to another.

D. Channel Terminal Controls

4.30 The following elements in the circuit are adjustable and are classified as to whether

they are part of the plug-in terminal or external to the terminal.

(a) *Sending Circuit*

Mounted on Plug-in Terminal

- (1) A SEND switch for arranging the circuit to send either the higher or the lower of the two signaling frequencies for a marking signal.
- (2) An OSC potentiometer for making fine adjustments of the higher oscillator frequency.
- (3) An OSC switch for turning the oscillator on and off for testing purposes.
- (4) A SEND LEV potentiometer for setting the transmitting level.

Mounted External to Plug-in Terminal

- (5) A loop pad rheostat or fixed resistance to adjust the send loop resistance to the desired value.
- (6) A duplex switch (DX) as an option, when convenient switching between half and full duplex service is required.
- (7) A send bias adjustment potentiometer to adjust the voltage level at which the V2 (b) send control tube will conduct. This potentiometer is optional, and is used only for 20-ma loops of over 2-mile length.

(b) *Receiving Circuit*

Mounted on Plug-in Terminal

- (1) A REC GAIN potentiometer for adjusting the gain of the amplifier limiters.
- (2) A REC switch for arranging the circuit so that either the higher received carrier frequency or the lower will produce a mark in the receiving loop.
- (3) A REC BIAS potentiometer for adjusting the relative magnitude of the marking and spacing signals after rectification and hence the bias of the received signals.
- (4) A LP CUR potentiometer which controls the screen potential in the receiving output tubes.

Mounted External to Plug-in Terminal

- (5) A loop pad rheostat for adjusting the receiving loop resistance to the desired value.

E. Filament Supply

4.31 The heaters of all tubes are connected in parallel across pins 5 and 8 of the channel terminal connector. For a standard negative →24-volt power supply as shown in Fig. 20, pin 8 is connected externally to the -24-volt battery. Pin 5 is connected externally to a FIL ADJ rheostat, R102, to drop the 24-volt battery voltage to the required 20 volts for the tube heaters. In adjusting the setting of R102, a voltmeter may be connected between the FA and FB test points which are provided in the external circuit.

4.32 For TTY station sets using a KS-5663, List 6 rectifier for power supply, the tube heaters (pins 5 and 8) are connected directly to the 20-volt ac tap on the rectifier.

4.33 In cases where the only battery supply available for the heaters of the tubes is negative 48 volts, two options are provided. If the number of terminals is small (not over six) or if there is an odd number of terminals, the heaters of each channel terminal may be connected to the 48-volt supply through a series resistance which reduces the voltage to 20 volts. →This option, shown in Fig. 21, should be used as infrequently as possible. A second option, →shown in Fig. 22, is provided for 48-volt operation in which the heater circuits of two terminals are connected in series. If there is an odd number of terminals involved, one terminal must be →supplied by using the circuit of Fig. 21. A frame switch is provided for each terminal which automatically replaces the heater circuit with a dummy resistance when the plug-in unit is removed from the frame. When this option is used for terminal units which operate in 20-ma loops, the second receiving tube (V6) is not used, and its heater must be simulated by a dummy resistance plugged into the tube socket.

5. DC LOOP CONNECTIONS TO CHANNEL TERMINALS

A. Loop Options (Tables A and B)

5.01 The types of dc connections which may be provided with the 43A1 terminal are summarized in Table A. So far as the plug-in channel terminal unit is concerned, two options are provided, one for neutral loop operation and one for type 2 hub operation. The units are wired in the factory for the option ordered, and they

TABLE A — DC LOOP CIRCUIT OPTIONS PROVIDED WITH 43A1 TERMINAL

TYPE OF TERMINAL (NOTE 1)	SERVICE (NOTE 2)	TYPE OF CIRCUIT	LOOP BATTERY	
			VOLTS	CUR. (MA)
Neutral Loop Type	Private Line (PLS) (Note 3)	TLT	± 130	62.5
		TLT	+130/Grd	62.5 or 20
Hub Type	TTY Exchange (TWX)	TLT	+130/-48	62.5 or 20
		TLT	Grd/-130	62.5 or 20
Hub Type	PLS or TWX Ringdown Trunks	Subscriber Station — 130B1, 130B2, 130C1 Subset	+130	62.5 or 20
		Ringdown Intertoll Trunks Toll 3A, 5 Swbds Sub. or TLT Open Line Loop	± 130	62.5
Hub Type	TTY Exchange (TWX)	Toll Sub. Line (TLX)	± 48	20
		Line Conc Units	± 130	20
Hub Type	PLS or TWX Ringdown Trunks	Intermediate Point	± 130	62.5
		Tandem FDX Sec.	± 130	62.5
Hub Type	TTY Exchange (TWX)	Substation — 130B1, 130B2, 130C1 Set	+130	20
		Type 1 Hub — No. 1 Service- board (Note 4)	± 48	20
Hub Type	TTY Exchange (TWX)	Type 2 Hub — No. 9 Testboard (Note 6)	Note 5	
		Type 2 Hub — No. 2 & 9B Serviceboards — No. 9 Testboard	Note 5	

Notes

1. Plug-in units manufactured for neutral loop operation are not interchangeable with those for type 2 hub operation.
2. An optional duplex switch is provided in the neutral loop when FDX operation is required.
3. All private line circuits in a particular office should operate with the same loop battery combination.
4. Terminal operation is neutral loop through 90A2 repeater to hub.
5. The type 2 hub operates HDX with +60 volts for mark and -30 volts for space. For FDX hub operation, the receiving leg (RL) of the channel terminal operates with -10 volts for mark and -60 volts for space.
6. Neutral type channel terminal operating through 90C1 loop repeater and 144A1 coupling unit to No. 2 hub.

cannot be converted by field modification. An external connection circuit can be provided so that either the hub-type or the neutral-loop type channel terminal can be installed in a given position on a relay rack bay. However, each channel terminal will still only operate according to the option for which it was ordered. For No. 1 serviceboard applications (type 1 hub) the neutral loop arrangement is used with the conversion to hub operation through the 90A2 repeater. If it is required to use a neutral-loop type channel terminal for No. 2 hub operation, conversion can be accomplished by means of a 90C1 loop repeater and a 144A1 coupling unit.

5.02 In addition to the external connection circuit covered in 5.01, other external connection circuits are provided to cover the optional arrangements shown in Table A. An optional universal wiring unit may be provided which makes it possible to obtain most of the desired dc options merely by changing strapings on a terminal strip. When a channel terminal is used at the subscriber station, the 130-type subset furnishes the socket and the external connections.

5.03 For TWX service, the external circuits also provide for the connection of the necessary supervisory leads. At the central office end, this is a connection to the supervisory relay in the TLX circuit which may be derived directly from the plate circuit of the supervisory tube or from a contact on the supervisory relay associated with the channel terminal. When the subscriber station includes a channel terminal, the plate battery supply of the oscillator tube in the channel terminal is controlled by a pair of contacts on the station power switch or the equivalent. Ringing equipment is provided which may be operated over the carrier channel from the central office switchboard.

5.04 Table B gives the maximum or limiting values of loop resistance external to the channel terminal for the various values of loop current and voltage. As indicated by Note 2 of the table, other considerations than resistance may determine limiting lengths of loop.

5.05 For 20-ma subscriber loops exceeding 2 miles in length, an external send bias control potentiometer circuit is provided, which is connected in parallel with R105 resistor as

TABLE B — LOOP CURRENT AND VOLTAGE

CURRENT (MA)	EXTERNAL BATTERY (VOLTS) (NOTE 1)	CHANNEL TERMINAL END OF LOOP (PIN 13, CATHODE) (VOLTS)	EXTERNAL LOOP RESISTANCE (OHMS) (NOTE 2)
20	+130	Grd	2500*
20	+130	-48	4900*
20	+ 48	-48	800
62.5	+130	Grd	800
62.5	+130	-48	1570
62.5	+130	-130	2880*
62.5	Grd	-130	800

Notes

- External battery is TLT battery or battery supplied through a connecting circuit such as TLX circuit. In all except the ± 130 -volt case, an additional +130-volt connection is made either directly or through 1500Ω to the terminal via pin 15. The resistance of the receive supervisory circuit (RS), connected to pin 6 of the channel terminal, should not exceed 2500 ohms.
- The starred values of resistance cannot be used for computing maximum permissible length of cable pairs due to resistance of equipment units at far end of loop and capacity effect.

shown in Fig. 19. This potentiometer permits adjustment of the amount of voltage swing applied to the grid of the V2 (b) send control tube to compensate for changes in wave form caused by the capacity of the loop cable. For 62.5-ma FDX loops, the fixed voltage division, obtained by the tapped R101 resistor, Fig. 12 as described in 4.06, is satisfactory.

B. Full Duplex Operation

5.06 For this case, the DX switch if provided is operated to FDX. When the DX switch is not provided as in direct leg serviceboard operation or some forms of testboard operation, some satisfactory substitute for R101 is required. The operation of this circuit is covered in Part 4 in connection with the description of the channel terminal.

C. Half Duplex Operation (Fig. 12)

5.07 The following description is based on ± 130 -volt loop operation. Figures in parentheses show loop battery voltage for other combinations.

5.08 With the DX switch operated to the HDX position, the receiving loop is disconnected, a connection is made between the output of the receiving circuit and the send loop so that this loop serves for both sending and receiving, and the connection to -130 -volt battery via terminal 1 of the switch is removed. An incoming marking signal from the carrier line causes V5 and V6 tubes to conduct. With an 80-volt drop through the tubes and a total loop resistance adjusted to 2880 ohms by means of the external loop rheostat, the loop current is 62.5 ma and the teletypewriter at the end of the loop is receiving a mark. The voltage to ground at the LP test jack of the channel terminal is -50 . As the cathode is held approximately at -93 volts, V2 (b) tube will conduct. The potential drop of 80 volts which was across R101 for the full duplex case has been replaced by a drop of 80 volts in the plate circuits of V5 and V6. Thus, sending from the loop is similar to that described for full duplex.

5.09 An incoming spacing signal from the carrier line makes V5 and V6 tubes non-conducting. The loop current drops practically to zero (approximately 1 ma for 260-volt operation, 0.5 ma for 130 volts), and the station teletypewriter receives a space. The potential on pin 0 of the channel terminal connecting jack is held positive in respect to the cathode of V2 (b) tube and a marking signal is transmitted back to the carrier line during both incoming marks and spaces from the carrier line.

5.10 To transmit a break signal the subscriber opens the loop circuit at the station teletypewriter, which sends a space to the carrier line regardless of any incoming signals. The break feature is provided automatically in this type of loop circuit because when the loop is opened by the station operator, it removes the $+130$ -volt battery at the end of the loop, and the -130 -volt supply at the cathodes of V5 and V6 tubes is applied through R65 and R12 resistors to the grid of V2 (b) tube. This makes the grid negative with respect to the cathode,

the tube is cut off, and a clean cut space is transmitted to the carrier line.

5.11 If a large leakage current exists across the loop conductors, the negative voltage supplied to grid 7 of V2 (b) via R65 might not be sufficient to hold the tube in a cut-off condition. In such a case, a break by the subscriber will result in the incoming transmission being reflected in an inverted condition to the distant carrier terminal. In this case, the distant sending subscriber would be broken by a "bust-up" of local copy or by operation of the keyboard break lock. This would normally be caused only by trouble in cable loops.

D. Back-to-Back Operation

Description of Function

5.12 It is frequently desirable to operate the dc loop of one neutral type 43A1 channel terminal directly into the dc loop of another. This is known as back-to-back operation and provides an intermediate point where one or more branches may be taken from a stem route, or monitoring functions can be performed. It also provides flexibility for establishing circuit routes.

5.13 Two types of back-to-back connections are available. In the first type, the dc sides of two channel terminals are interconnected directly on a full duplex basis as shown in Fig. 9. This system is used for through transmission when it is desired to change the transmission frequency between the incoming and the outgoing channels. No drop-off loops can be operated with this connection without serious distortion in transmission. However, monitoring can be performed by using two relay-operated teletypewriters. The second type of operation provides a half duplex circuit arrangement in which it is possible to interconnect two or three channel terminals with one or two relay-type loop repeaters on a back-to-back basis by means of an interconnecting network as shown in Fig. 23. Drop-off loops are connected to the loop repeaters at the intermediate point for dc loop operation. The ac outputs of the 43A1 channel terminals connected to the network will provide only carrier transmission. One or more of these outputs may be connected to subscriber loops which are equipped with 130-type sets.

Description of Operation

5.14 FDX Operation, Fig. 9: This figure provides for simultaneous transmission in both directions. A TLT jack circuit is provided for both channel terminals for monitoring and loop current adjustment purposes. A relay-operated teletypewriter in the WEST TLT-jack circuit will receive from the WEST terminal and send to the EAST terminal. Likewise, a teletypewriter in the EAST TLT-jack circuit will receive from the EAST terminal and send to the WEST terminal. In the idle condition, both the EAST and WEST terminals receive marking carrier current and each should cause its associated terminal to send marking carrier current. To accomplish this, the SEND and REC switches of both the associated terminals must be inverted; that is, if the SEND switch is at HM, the REC switch must be at L+ and if the SEND switch is at LM, the REC switch must be at H+. The SC ADJ rheostat and the LP CUR potentiometer are adjusted so that when a mark is received by one channel terminal the loop current through the TLT is 62.5 ma and the voltage drop across V5 and V6 tubes is 80 volts. This voltage, applied at the SL lead across the R110-R111 potentiometer is divided so that -110 volts are supplied to the grid of V2 (b) tube of the other channel terminal. Since the cathode is at -93 volts, V2 (b) tube is nonconducting but will send a mark due to the fact that the SEND switch is at the LM position. When a space is received 260 volts appear across the R110-R111 potentiometer and -65 volts at the junction point of R110-R111. The send control tube will conduct and send a spacing frequency to the distant terminal. The R110-R111 potentiometer values are adjusted for ± 130 -volt operation only. If the back-to-back circuit is part of a system where the lower frequency is being used for a marking signal, the send control switches of the associated terminals must be operated to the HM position. No-carrier supervision in both directions is repeated through the back-to-back connection by +130 volts from the supervisory relay of either terminal to the supervisory lead of the associated terminal.

5.15 HDX- Interconnecting Network, Fig. 23:

This arrangement is primarily intended for offices which are not equipped with a No. 2 and 9B serviceboard or other type 2 hub cir-

cuits. When available, the standard No. 2 type hub method of operation is preferable for HDX back-to-back services. The channel terminals are arranged for ± 130 -volts, inverse neutral, 62.5-ma operation with standard alignment, except that the SEND switches in all of the channel terminals connected to the network must be at HM and the REC switches of all of the channel terminals must be at L+. The interconnecting network actually is a special form of electronic hub circuit in which each send leg has in effect a hub of its own and is coupled by means of diodes to all receive legs except its own, thus eliminating the need for a directional control circuit.

5.16 Depending upon the required applications,

43A1 channel terminals may be used with various types of external connecting figures which are shown on the channel terminal circuit drawings. A typical B/B circuit arrangement for testboard operation of channel terminals is shown in Fig. 23. Since the loop terminating R101 resistor is associated with the channel terminal circuit but cannot be used when operation with the HDX interconnecting network is required, Fig. 23A, 23B, and 23C are furnished. When using Fig. 23A, the A and E leads of the channel terminal are wired directly to the LEGS jacks of the associated TLT-jack circuits. This option provides only limited flexibility, since if patching to spare channels is required each of the spares has to be arranged per Fig. 23A. To obtain complete patching flexibility, Fig. 23B must be used. The 3-position DX switch shown in Fig. 23B replaces the DX switch formerly used and permits the use of any channel terminal circuit for either FDX, HDX, or B/B-network operation. A typical circuit arrangement for HDX B/B operation for serviceboard offices or for testboard offices which will be converted to serviceboard operation is shown in Fig. 23 and 23C. The loop repeaters are connected to the interconnecting network by means of loop repeater patch jacks which are added for this purpose. The 90C1 loop repeaters shown in Fig. 23 are operated with the selector switch (OPN), on the repeater, operated to the STA position. The 0.13 megohm resistor on the S lead of the LP REP patch jack provides for a 1-ma current leak which will operate the repeater send relay to its spacing contacts in case the loop repeater should become disconnected from the

network termination. A channel terminal may be added or removed from the interconnecting network without affecting the operation of the other legs on the networks. When a loop repeater is removed from the interconnecting network, the send lead of the network must be grounded in order to maintain the correct current and voltage conditions in the network. This is done automatically by contacts on the loop repeater patch jack.

5.17 Each receive leg, R1 through R5, operates on an inverse neutral basis with current for space and no current for mark. The channel terminals are aligned for 62.5-ma loop current and 80V across the plate-cathode circuit of the receiving output tubes. When a space is received by one of the 43A1 terminals, a current of 62.5-ma flows in its receive leg. This current, drawn through the diodes connected to the SH junction points of the other four branches, is so divided that 10-ma flows from each of the voltage dividers associated with the other two channel terminal SH junctions, and 21-ma each from SH4 and SH5 junction. The combined resistances of these four branches result in a voltage of -50 volts at the SH junction and a drop of 80 volts across the receiving output tubes in the 43A1 terminal. With all receive legs marking each SH junction, SH1 through SH5 is at +50 volts. The ± 50 volts signal at SH4 and SH5 junctions results in a polar current of ± 6.5 -ma which flows through the windings of the S relay in the loop repeater to ground.

5.18 The interconnecting network can be arranged so that a space is transmitted to all legs associated with the network in case the carrier should fail in any of the 43A1 circuits. This is accomplished by means of the supervisory alarm relay (SA), and the no-carrier spacing relay (NCS) as shown in Fig. 24. If any one of the SA relays should release due to carrier failure, the +130-volt battery will be disconnected from the network. In the absence of positive battery, no current flows in the voltage divider circuits of the network and leads S1 to S3 have a potential of -130 volts and cause the send control tubes in the channel terminals to send a space to the lines. The loop repeaters are held spacing by a 1-ma current leak supplied by a 0.130 megohm resistor which is connected to negative battery in the patching jack circuit. When it is required to restore serv-

ice before the defective carrier leg is corrected, the emergency battery restore key (EBR) is operated. EBR lamp will light to indicate this operation.

E. One-way Multiple Loop Operation

5.19 A number of 43A1 channel terminals may be connected to a typical dc line repeater or a 40C carrier channel to provide one-way send only legs. This arrangement makes it possible to repeat telegraph signals received at an intermediate point over a 40C carrier channel or dc repeater over a maximum of ten 43A1 channel terminals as shown in Fig. 16a. Any polar sending dc repeater can be used if modified to send +130 volts for mark and -130 volts for space. Fig. 16b shows a terminating test circuit used for alignment purposes. The DROP 1 jack of the terminating circuit is patched to the DROP 1 jack of the TLT jack circuit associated with the repeater. Since the terminating circuit resistance is 1280 ohms, 80 volts will appear across it when the RL LP pad is adjusted for 62.5 ma. After removing the test terminating circuit and setting the adjustable loop pad to obtain a loop current of 62.5 ma, the correct send voltage of 80 volts will result at each S lead of the channel terminal legs. When a mark is received, current will flow and the V2 (b) send control tube will conduct since a potential of -77 volts (with respect to ground) appears at the grid of V2 (b) due to the voltage divider R12-R61. For a space, no current will flow because the repeater is terminated in a -130-volt battery. Thus, with -130 volts at the grid, the V2 (b) send control tube will be cut off, resulting in the transmission of a space.

F. Supervisory Signaling Circuit

Description of Function

5.20 For TWX service, the 43A1 terminals at TWX switchboard offices provide a supervisory circuit so that the subscriber can call the operator to initiate a call, recall the operator while a connection is up, or send a disconnect signal. (No special features in the 43A1 terminal are needed to allow the operator to ring the subscriber.) For these supervisory functions the frequency shift system provides, in addition to the two frequencies for the mark and space signals, a third condition of no carrier on the line.

Description of Operation

5.21 The circuit features at the subscriber station are covered in detail in the station practices. These do not involve the supervisory branch of the 43A1 terminal.

5.22 To call the operator in order to originate a call, the subscriber turns the power switch to ON on his teletypewriter set. One set of contacts on this switch closes the +130-volt connection to the plate circuit of the oscillator tube of the channel terminal. This sends carrier over the line to the switchboard office, and through a relay chain, lights the ANS lamp in front of the operator (see Section E45.155). To disconnect at the end of a call, the subscriber operates the power switch to OFF. This removes the plate voltage from the oscillator tube and the carrier stops. The operation of relays at the switchboard office lights the supervisory lamp in the operator cord circuit and notifies the operator that the subscriber is through so that she may take down the cord. To recall the operator during the course of a call, the subscriber first opens and then recloses his power switch. This causes the operator supervisory lamp to flash at a rate of 60 times per minute.

5.23 As long as carrier current (at either one of the two signal frequencies) enters the input of the carrier terminal at the switchboard office, the ac voltage on the plate of V4 tube, subject to half-wave rectification because of the presence of CR5 diode, is impressed on the grid of V2 (a) tube through the filter consisting of R30 and R31 resistors and C13 and C14 capacitors. The V2 (a) tube, conducting under this condition, acts as a dc amplifier and its plate circuit carries a current of about 10 ma, which operates the SU relay in the toll subscriber line circuit at the switchboard or the SA relay in the supervisory alarm relay circuit. Fig. 17 shows a simplified typical example of the circuit provided at the No. 3C switchboard. If the channel terminal circuit is not equipped with an SA relay, Y option as shown in Fig. 17 is used. The SU relay is operated directly by the plate current of V2 (a) tube which, in turn, causes the ANS lamp to light. For channel terminal circuits equipped with the SA relay, X option in Fig. 17 is used. The SA relay, operated by the plate current of the V2 (a) supervisory tube, operates the SU relay in the TLX circuit which

in turn causes the ANS lamp to light. When the operator answers by inserting a cord in the line jack, the ANS lamp goes out. Other operations of the toll subscriber line circuit are described in the practices covering TLX operation.

5.24 When the subscriber turns off his power switch, as for a disconnect, the flow of carrier current over the line stops. With no ac voltage on the plate of V4 tube, no rectified voltage gets to the grid of V2 (a), which goes to a potential of -24 volts as a result of the biasing battery connected to it. The V2 (a) tube then becomes nonconducting and the SU relay, in its plate circuit, releases, starting a chain of circumstances which lights the supervisory lamp in the operator cord circuit.

5.25 The filter, composed of R30 and R31 resistors and C13 and C14 capacitors removes the ac component of the rectified carrier. The C14 capacitor causes a delay of about 150 milliseconds in the buildup of the positive dc voltages on the grid of the V2 (a) tube. The purpose of this delay is to reduce the likelihood of false operation of the ANS lamp from short pulses of interference. When the supervisory feature is in use, the receiving gain of the channel terminal must be adjusted after test to give a 6-db margin against false operation by interference. This is done in accordance with directions contained in the operating practice.

5.26 When the flow of carrier current from the subscriber is interrupted, the time constants of the circuit are such that the V2 (a) tube becomes nonconducting in about 50 milliseconds.

G. Alarm Circuits

5.27 *No Carrier Alarm:* A chain circuit may be connected through a normally closed contact on the supervisory relay of selected channels in a system terminal. The presence of carrier current in any channel will keep the supervisory relay operated and the chain circuit open. Should all of the carrier currents in the system fail, the chain circuit will be closed to ground and will operate conventional alarm systems in the office as required. When required, a subscriber receiving loop may be connected through a set of contacts on the supervisory relay assigned to the associated channel terminal. In case of carrier failure on the associated

channel, the loop circuit opens and a space is transmitted to the subscriber whose loop would otherwise be kept closed by the mark-hold feature of the channel terminal.

6. HUB CONNECTIONS TO CHANNEL TERMINALS

A. General

6.01 The following discussion covers the dc circuits when the terminal is arranged for operation with the type 2 hub circuit of a No. 2 or 9B serviceboard. Two hub-type channel terminals may be operated back-to-back at an intermediate point for TLX applications. Supervision for this type of service is the same as the supervisory circuit for neutral-type channel terminals as shown in Fig. 9. Circuits for the hub portion are shown on drawings for the No. 2 and 9B serviceboard.

6.02 When connections are to be made to a type 2 hub circuit the V6 tube is omitted and V7 and V8 tubes are added to the channel terminal circuit as shown in Fig. 18.

6.03 To simplify the following description as well as the headings of Table D, the hub leg (including the SL lead for sending and the RL lead for receiving) which connects to the carrier channel terminal shown in Fig. 18 is called leg A. Any *other* leg which may be connected to this hub is referred to as leg B. A hub leg may represent a trunk circuit to distant office or a loop circuit to a PLS subscriber.

6.04 The V5 tube transmits incoming signals from the carrier channel to the receiving hub. The REC switch in the carrier terminal is operated to the position in which a mark will make the grid of V5 tube more negative than the cathode so that this tube is cut off during received marks. If the distant terminal is sending HM, the receive switch in the terminal connected to the hub should be in the L+ position. When a space is received from the carrier channel, the positive output from the detector causes the V5 tube to conduct.

6.05 For half duplex hub operation, the SL and RL leads of the channel terminal are connected to the send and receive hubs of the serviceboard, as indicated in Fig. 18. The send and receive hubs, in turn, are connected together either directly through a hub link or

through a regenerative repeater. They operate with +60 volts for mark and -30 volts for space. The functions of the directional control circuit for Fig. 18 are described in detail below.

6.06 For full duplex operation, the send and receive hubs operate entirely independently. The SL lead of the channel terminal is connected to the send hub, but between the RL lead and the receive hub a full duplex potentiometer and a 144C1 coupling unit are required. With this arrangement, the potentials of the RL lead of the channel terminal, connected to the so called full duplex hub, are -10 volts for mark and -60 volts for space. The -60 volts, which is the so called double-space voltage referred to later in the detailed discussion of half duplex operation, disables the directional control circuit, which has no function in full duplex operation.

6.07 The 144C1 coupling unit on the full duplex circuit converts the -10, -60 voltages on the RL lead and full duplex hub to the standard +60, -30 voltages on the receive hub of the serviceboard.

B. Directional Control Features for Half Duplex Operation (Table D)

6.08 The directional control circuit of Fig. 18 is required to provide the following features necessary for HDX operation.

(a) When leg A sends a space into the receiving hub, that space must not be sent back into the sending side of leg A, which must remain continuously marking.

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

(c) When any two legs, one of which may be leg A, are sending spaces simultaneously (double space) into the receiving hub, spaces must go out on all of the sending legs from the sending hub, including the legs of channels which are sending the spaces into the receiving hub.

6.09 The heart of the directional control circuit is the flip-flop V8 tube, the action of which, through the connecting resistors and diodes, automatically conditions the sending side

of leg A (through SL lead) so that it either can, or cannot as required, receive spaces from the hub. The condition (conducting or cutoff) of the left half of V8 tube is determined by its grid-to-cathode potential. Its cathode potential is controlled by the signal received from the channel terminal; as Fig. 18 shows, it is either +20 volts for a mark or -45 for a space. The potential of grid 3 of V8 tube is controlled by the potentials on the two sides of diode CR10 and whether they act in the forward or backward direction of the diode. The details of this action are given in the discussion below, the values of voltage for the various cases being summarized in Table D.

6.10 Table D also shows the condition of the left and right halves of V8 tube for various signal conditions. The flip-flop operation of V8 tube is such that whenever the left half conducts, the right half is cut off and vice versa. In summary, whenever the left half of V8 tube is cut off, the directional control circuit permits either marks or spaces to flow freely from the hub to leg A. When the left half of the tube conducts, the send side of leg A is held marking and cannot receive spaces from the hub.

6.11 With these general principles of circuit operation as a preliminary, the following paragraphs describe in detail the sequence of circuit operations for various assumed conditions of marks and spaces on the legs connected to the hub.

6.12 *A Mark From the Carrier Line (Leg A) and a Mark From Any Other Leg (Leg B)*
(Case A of Table D)

- (a) The V5 tube is cut off.
- (b) The hub voltage is +60 due to the hub potentiometer.
- (c) The V7 tube is cut off. Its grid and cathode are in parallel with the grid and cathode of V5 tube.
- (d) Cathode 2 of V8 tube is held at about +20 volts by means of the R38, R43, R58, and R59 potentiometer.
- (e) +130 volts is connected through R53 and R46 to the upper side of CR10 diode. The lower side of CR10 connects to the hub at +60 volts. This means that a voltage is

applied to CR10 in its forward direction so that its resistance is low. The actual voltage at the upper side of CR10 is about +60.

(f) The +60 volts acting on grid 3 of V8 tube through the R47 grid leak will cause the left side to conduct and in consequence the right side is cut off. Plate 6 of V8 tube is at a potential of about +130 volts.

(g) The net effect is to produce a potential at the junction of the R48 and R49 resistors of about +60 volts.

(h) The +60-volt potential at this junction acting through CR11 diode in its forward direction, together with the +60 volts of the hub, acting through CR12 in its forward direction (there being -130 volts on the other side of these diodes through R12 and R13), makes both of these diodes of low impedance. The net grid voltage on grid 7 of V2 (b) tube is about +40 volts. The tube conducts and transmits a marking signal to the carrier line.

6.13 *A Space From the Carrier Line (Leg A) and a Mark From Any Other Leg (Leg B)*
(Case B of Table D)

- (a) V5 and V7 tubes are conducting, 30-ma plate current flows from the RL lead and the hub is at -30 volts which sends a space to leg B.
- (b) With V7 tube conducting, the potential of cathode 2 of V8 tube is about -45 volts.
- (c) The potential across CR10 is in its forward acting direction, its resistance is low, and the potential impressed on R47 and grid 3 of V8 tube is close to 30 volts.
- (d) Grid 3 of V8 is thus positive with respect to cathode 2 and the left side of V8 conducts.
- (e) The right side of V8 is cut off.
- (f) The +60-volt potential at the junction of R48 and R49 resistors acts through the forward direction resistance of CR11 so that the potential at the junction of CR11 and CR12 is approximately +60 volts. As a result, grid 7 of V2 (b) tube is at a potential of about +40 volts, the tube conducts and sends a mark into the carrier channel.

(g) The spacing voltage of -30 on the hub is prevented from getting through to the grid of V2 (b) tube by the high backward direction resistance of CR12.

(h) This illustrates how the directional control circuit maintains a "hold mark" condition on the sending side of leg A while there is a space from the receiving side of leg A.

6.14 A Mark From the Carrier Line (Leg A) and a Space From Another Leg (Leg B) (Case C of Table D)

(a) The hub potential is -30 volts because of the space from leg B.

(b) Since leg A is receiving a mark, tubes 5 and 7 are cut off.

(c) Cathode 2 of V8 is $+20$ volts.

(d) Grid 3 of V8 is at -30 volts, the hub potential.

(e) The left half of V8 tube is cut off and the right half conducts.

(f) The potential of plate 6 of V8 is about zero.

(g) The resulting potential at the junction of R48 and R49 resistors is about -30 volts.

(h) Now the potentials across both CR11 and CR12 are in their forward directions, having -30 volts on one side and -130 volts, through R12 and R13 resistors, on the other.

(i) Grid 7 of V2 (b) tube is at a potential of about -40 volts, the tube is cut off and sends a space to the carrier line of leg A.

6.15 A Mark From Leg A While Leg B Sends Marks and Spaces (Case D of Table D)

(a) For periods of transmission from leg B to the hub and thence to the sending side of leg A, the receiving side of leg A is continuously marking. The left half of V8 tube remains continuously in the cutoff condition and the directional control circuit permits the flow of either marks or spaces from the hub to the send side of leg A.

(b) Following the sequence of 6.14 (Case C, Table D) the next succeeding mark from leg B makes the hub potential $+60$ volts.

(c) With the right half of V8 tube conducting, the potential of plate 6 is near zero.

(d) The $+60$ volts and 0 volt are acting on CR10 diode in its backward direction so that its resistance is high.

(e) This prevents the $+60$ volts of the RL lead from getting to grid 3 of V8 tube which remains at about 0 volt.

(f) Since the voltage on cathode 2 is $+20$, the left half of the tube remains cut off.

(g) As in previously discussed cases, under this condition the voltage at the junction of R48 and R49 resistors is -30 and free transmission of either marks or spaces is permitted from the hub to the send side of leg A.

6.16 A Space From the Carrier Line (Leg A) and a Space From Any Other Leg (Leg B) (Case E of Table D)

(a) When any two legs send spaces to the hub at the same time, the hub voltage becomes -60 . This is known as the doublespace condition.

(b) With -60 volts on the RL lead, the potentials applied across CR10 are in its forward direction so that its resistance will be low. The voltage of grid 3 will be nearly that of the RL lead and will be negative with respect to the cathode.

(c) The left half of V8 tube will be cut off for either a mark or space coming in from the receiving side of the carrier channel.

(d) Therefore, the sending side of leg A will receive a space from the directional control circuit.

C. Full Duplex Operation

6.17 For full duplex operation, the send and receive hubs operate entirely independently of each other and, therefore, no directional control is required. As described below, the directional control circuit is automatically disabled so that it does not interfere with FDX transmission.

6.18 Because the RL lead is connected to a full duplex potentiometer, it takes voltages of -10 for an incoming mark and -60 for an incoming space. For both of these voltages, the potentials across CR10 are in its forward direction so that its resistance is low. Therefore, the potential of grid 3 of V8 tube is near the po-

arrangements on a 19-inch relay rack panel which may be mounted in a 28-type teletypewriter cabinet. A station rectifier is included to provide power requirements from the local 60-cycle supply. In addition, a 120C1 TTY subscriber set is required when furnishing unattended TWX service. The installation may be wired for attended or unattended service as required.

8. TESTING ARRANGEMENTS (Table C)

8.01 Pin jacks are provided at various points in the circuit for testing purposes. Table D lists these pin jacks and shows what observations may be made with them and some illustrative values of the various voltages measured.

(a) When loops of 43A1 terminals are connected to TLT circuits in testboards, provision is made for checking the values of loop current and LP/C voltage by means of various key and meter combinations which are conveniently located at the testboard or in the loop pad bay. These are shown in detail on the loop adjustment indicating circuits listed at the end of this section.

(b) Provision is also made, when 43A1 terminals are connected to TLT circuits, for substituting resistance terminations, having the correct value of resistance to match the power supply, in place of the actual operating loops. The terminating circuits are shown in detail on the testing and miscellaneous jack circuits listed at the end of this section.

TABLE C — LIST OF PIN JACKS FOR TESTING WITH ILLUSTRATIVE VOLTAGE READINGS

PIN JACK	TO MEASURE	AC OR DC	CARRIER LEVEL (dbm)	ILLUSTRATIVE VALUES OF MEASURED VOLTS	
				VAC TUBE VOLTMETER (VOLTS)	K5-14510 METER (VOLTS)
A1 to G	Received Input Level	AC	-25 -40	5.3 0.85	3.1 on 12 Scale 0.3 on 12 Scale
A2 to G	Received Input Level (REC GAIN at Max)	AC	-25 -40	30.0 15.5	28 on 60 Scale 13.4 on 60 Scale
D to C	Discriminator Rectifier Output	DC		Rec Mark +36 Rec Space -48	Rec Mark +34 Rec Space -46
LP to C (Note 1)	Plate — Cathode Voltage of Rec Out. tubes	DC		Send Mark and 80.0	Rec Mark 80
MD to C	Send Control Tube Plate	DC		Send Mark and Send Switch to 98.0	Rec Mark HM 98.0
RS to G	Receive Supervisory Tube Plate (Note 2)	DC	-25 -40 No. rec carrier	105.0 105.0 130.0	105.0 105.0 130.0
SA to G	Sending Output Level	AC	0 dbm send output -10 dbm send output	5.0 0.6	4.0 0.9
FA to FB	<u>Panel Portion of Terminal</u> Filament Supply Voltage	DC		20 ±0.5 Volts	

Notes

1. LP readings not available when the terminal is wired for type 2 hub operation.
2. Voltage is supplied to RS via a connection to a TLX relay circuit.

9. LIST OF CIRCUIT AND EQUIPMENT DRAWINGS

Channel Terminal, Loop, and Line Connection Circuits	CIRCUIT	EQUIPMENT
Interconnection Circuits for 40-type Carrier Telegraph (Applicable to 43A1)	SD-70515-01	ED-64004-01
43A1 Carrier Telegraph Channel Terminal	SD-70552-01	J70112A-()
Line Connection Circuits	SD-70553-01	ED-71148-01
Universal Wiring — Mounting Unit	—	ED-71142-01
Bay Layout and Associated Equipment	—	ED-71148-01
Line and Balancing Application Schematic — HF Range on Open Wire	SD-95692-02	ED-71148-01
TLT, Jack, and Testing Circuits		
TLT for No. 5 Toll Testboard	SD-62099-01	ED-63623-01
TLT for No. 5 Toll Testboard — Testboard Answering	SD-63099-02	Job Information
Four-jack TLT for No. 5, 16, and 18B Toll Testboard	SD-63107-01	ED-61624-01 (5) Job Information (16 and 18B)
TLT for No. 9 Telegraph Testboard	SD-63623-01	ED-63623-01
TLT for No. 9 Telegraph Testboard — Testboard Answering	SD-63623-02	ED-63623-01
Line and Misc Jack Circuits	SD-70358-01	ED-60206-03 ED-70968-01
90A 2-loop Repeater (No. 1 Serviceboard)	SD-70489-01	ED-70720-01
Loop Adjust Indicating — Simplified	SD-70566-01	ED-71148-01
Loop Adjust Indicating — Double Differential	SD-70568-01	ED-71148-01
Test and Miscellaneous Jack Circuits (With Loop Pads)	SD-70572-01	ED-71148-01
Application Schematic — DC Loops in Testboard Offices	SD-70573-01	—
Carrier Failure Alarm Circuit	SD-70744-01	—
Toll Subscriber Line Circuits for 43A1 Terminal		
No. 5 Switchboard	SD-70556-01	ED-71065-01
No. 3C Switchboard	SD-70557-01	ED-71097-01
Intermediate Point With Open Loop Subscriber Line	SD-70571-01	J70035C-()
Intermediate Toll Subscriber Line Test Circuit	SD-70571-01	J70035D-()
No. 3A Switchboard	SD-70582-01	ED-71098-01
No. 1 and 1A Switchboard — Attended Service	SD-70583-01	ED-71096-01
Line Concentrating Unit 101A and 102A	SD-70584-01	ED-70488-01 ED-70385-01
Hub Testing and Miscellaneous Jack Circuits No. 9 Testboard	SD-70564-01	—

SECTION E44.263

	CIRCUIT	EQUIPMENT
Application Schematic for Multiway Regeneration, No. 5 and 9 Testboards	SD-70565-01	—
No. 1 and 1A Switchboard — Unattended Service	SD-70680-01	ED-71133-01
No. 5 Toll Testboard, No. 9 Telegraph Testboard, No. 4 Morse Board — Open Loop Operation	SD-70681-01	J63511AA-()
Subscriber Station		
130B1 Subscriber Set	SD-70555-01	ED-71075-01
130B2 Subscriber Set	SD-70847-01 SD-70742-01 SD-70848-01	J70114B
130C1 Subscriber Set	SD-70847-01 SD-70735-01	J70127A
Station Connections — TWX	SD-70555-01	ED-71075-01
Station Connections — PLS	SD-70679-01	ED-71075-01
Subsets for Open Loop Operation From Intermediate Point Terminal		
Attended — 126A2 Subset	SD-70145-01	ED-70028-03 ED-70192-01
Unattended — 120C2 Subset	SD-70672-01	ED-71077-01
Package Arrangement for Temporary Emergency Service		
Cabinet Type 3 Channel 43A1 Carrier Telegraph System	SD-70844-01	J70112F-()

TABLE D — CONDITIONS IN DIRECTIONAL CONTROL CIRCUIT FOR HUB OPERATION

CARRIER LINE OF LEG A	INCOMING TELEGRAPH SIGNALS ON		V7 TUBE	CATHODE 2 OF V8	GRID 3 OF V8	LEFT HALF OF V8	RIGHT HALF OF V8	PLATE 6 VOLTAGE OF V8
	ANY OTHER LEG LEG B							
A Mark	Marking		Cut Off	+20	+60	Conducts	Cut Off	+130
B Space	Marking		Conducts	-45	-30	Conducts	Cut Off	+130
C Mark	Spacing		Cut Off	+20	-30	Cut Off	Conducts	0
D Mark	Spacing Followed by Marking		Cut Off	+20	0	Cut Off	Conducts	0
E Space	Spacing		Conducts	-45	-60	Cut Off	Conducts	0

Notes

1. These are the resistances of the diodes in the direction from the R48 to R49 junctions. They are low when the voltage applied (in the forward direction) is positive; high when it is negative.
2. Because of its own directional control, leg B will not send a space to itself.

DL CIRCUIT FOR HUB OPERATION (VOLTAGE VALUES FOR EXPLANATORY PURPOSES ONLY)

RIGHT HALF OF V8	PLATE 6 VOLTAGE OF V8	VOLTAGE JUNCTION R48 AND R49	HUB	CR11 RESISTANCE (NOTE 1)	CR12 RESISTANCE (NOTE 1)	OUTGOING TELEGRAPH SIGNALS ON	
						LEG A TO CARRIER LINE	ANY OTHER LEG LEG B
Cut Off	+130	+60	+60	Low	Low	Mark	Mark
Cut Off	+130	+60	-30	Low	High	Mark	Space
Conducts	0	-30	-30	Low	Low	Space	Mark (Note 2)
Conducts	0	-30	+60	High	Low	Mark	Mark
Conducts	0	-30	-60	Low	High	Space	Space

ion from the R48 to R49 junction or from the send hub toward the outgoing leg A. They
direction) is positive; high when it is negative.

it send a space to itself.

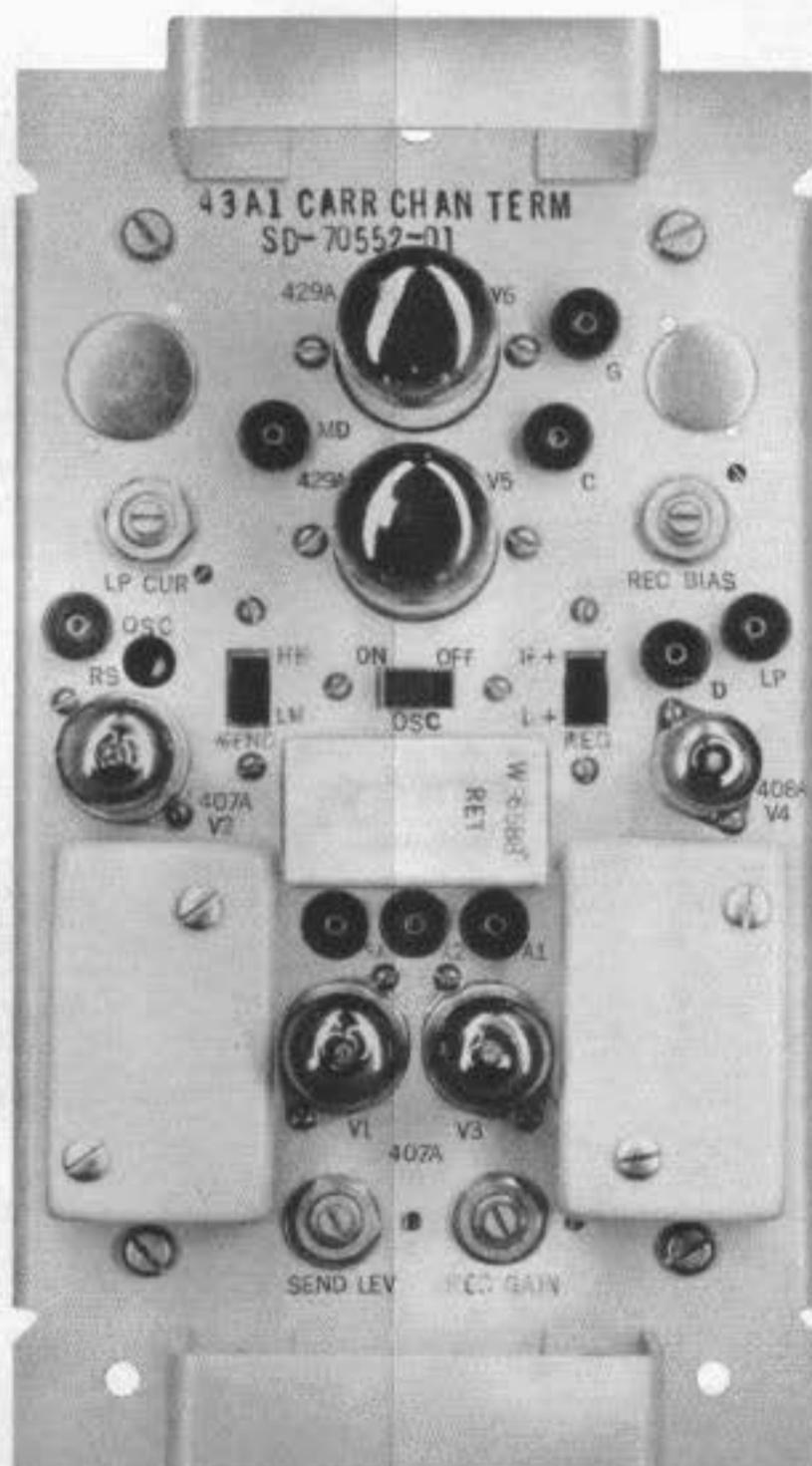


Fig. 1 - Channel Terminal - Front View

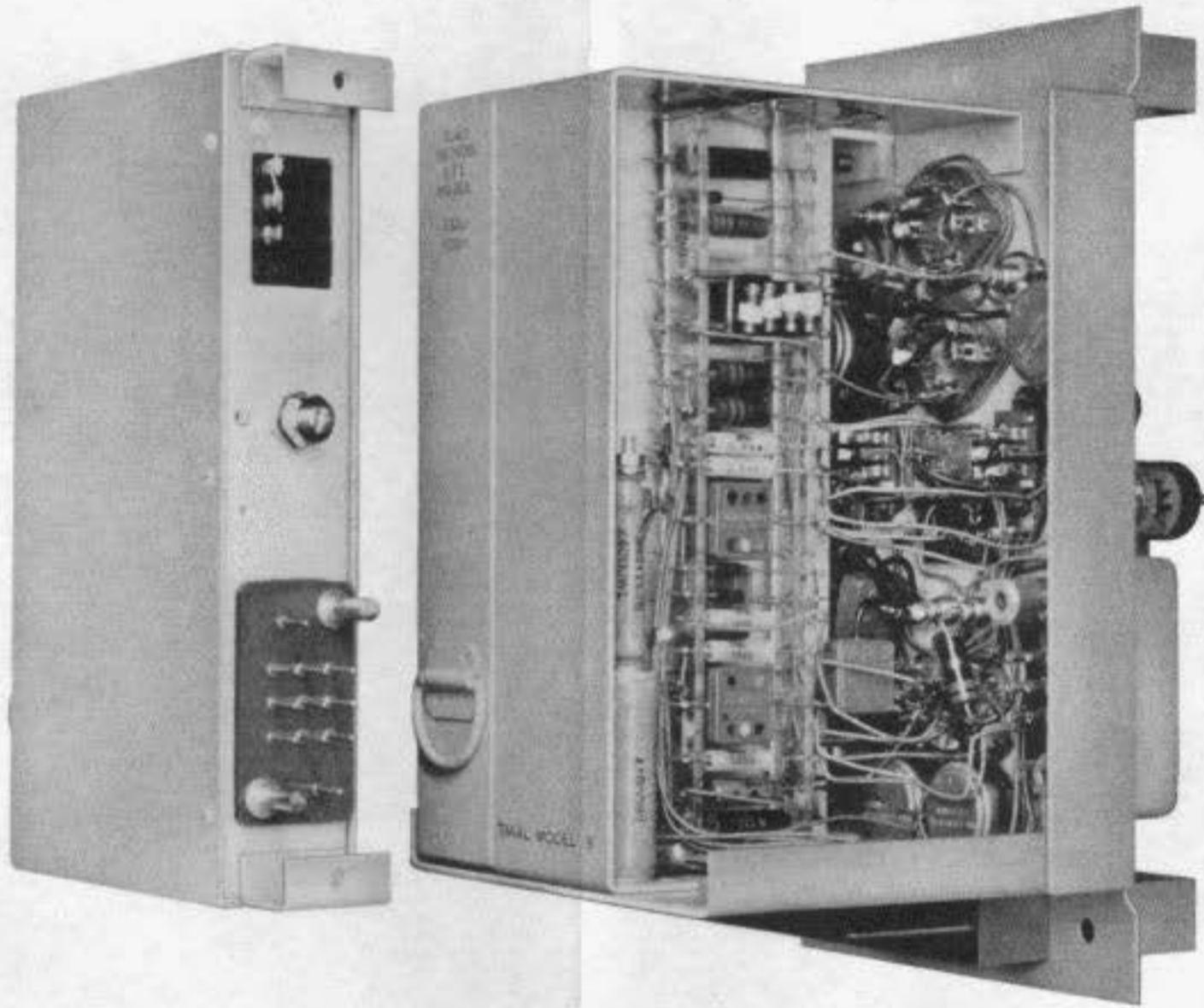
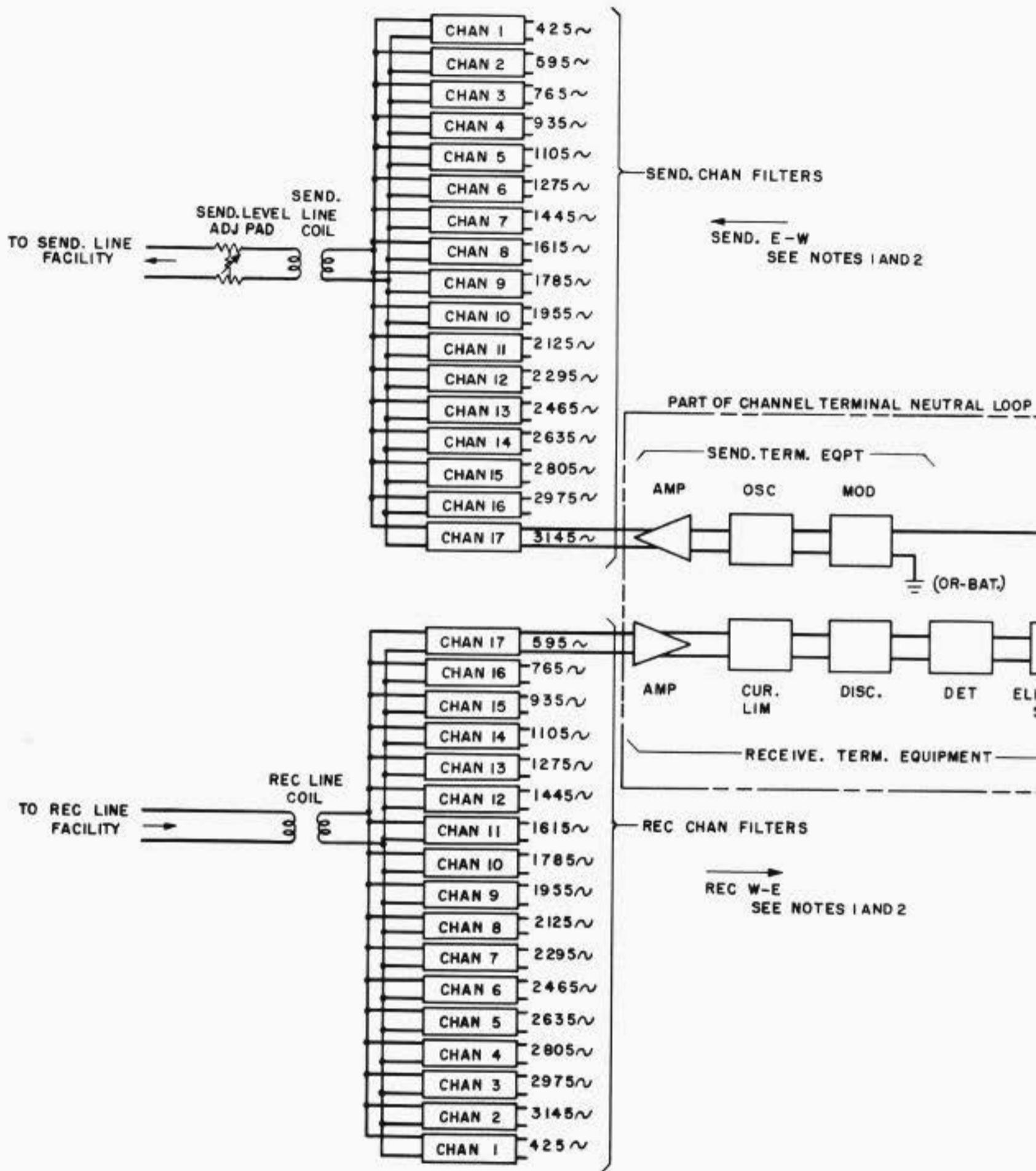


Fig. 2 — Channel Terminal — Oblique Rear View with 453 Send Network Removed



NOTES:

1. THE DIRECTIONS E-W AND W-E ARE ARBITRARY AND MAY BE REVERSED.
2. FOR NORMAL 4 WIRE OPERATION THE CHANNEL NUMBERS AND CORRESPONDING MID-BAND CHANNEL FREQUENCIES IN THE RECEIVING FACILITY SHOULD BE A DUPLICATE OF THOSE IN THE SENDING FACILITY. IN CASES WHERE OBJECTIONABLE INTERFERENCE BETWEEN SENDING AND RECEIVING EQUIPMENT IS ENCOUNTERED THE FREQUENCY ALLOCATION SHOWN IN THIS FIGURE MAY BE USED.

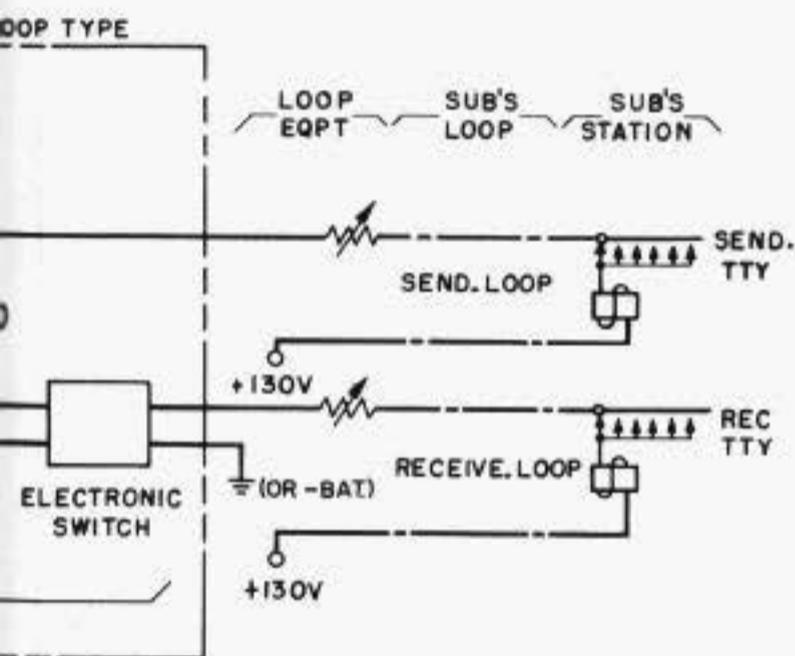
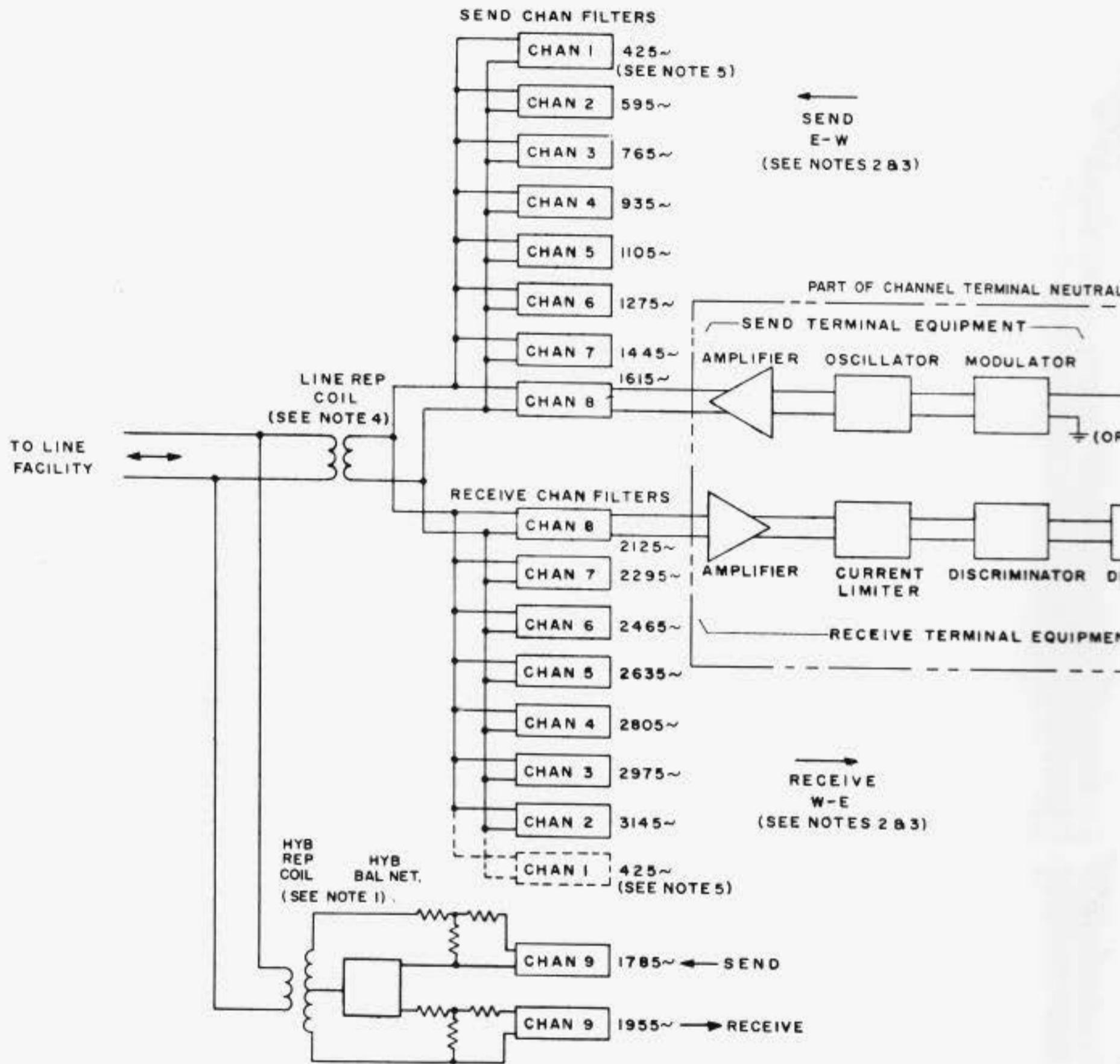
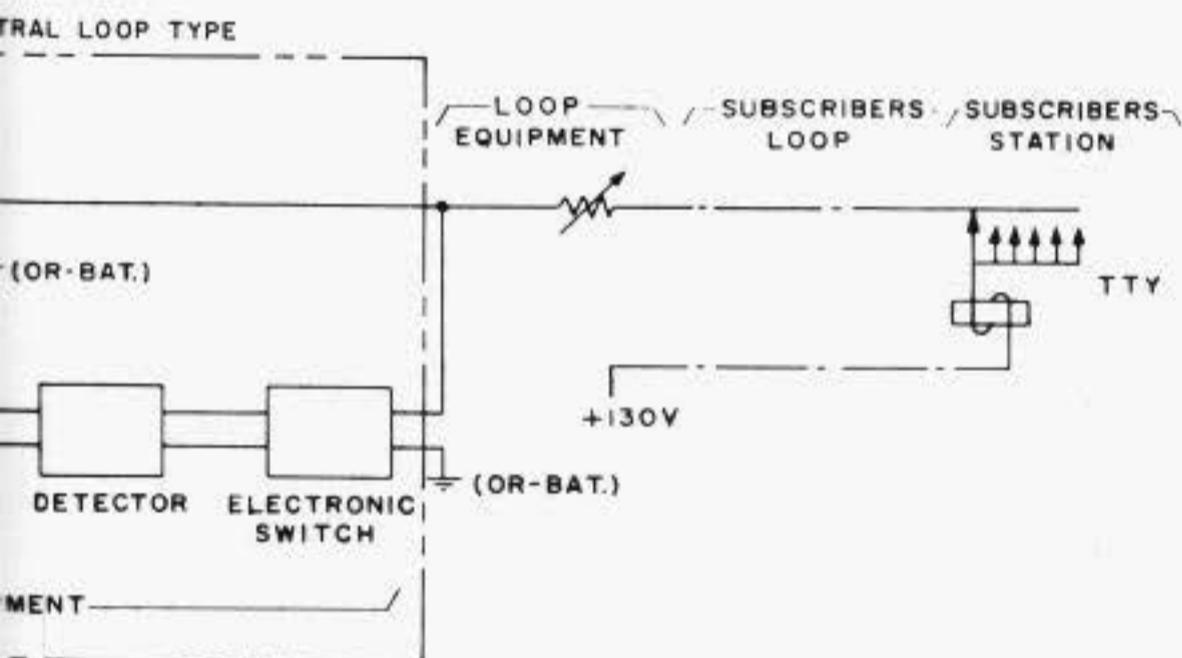


Fig. 3 - Typical Block Diagram of Carrier System on 4 Wire Circuit - With Full Duplex Loops

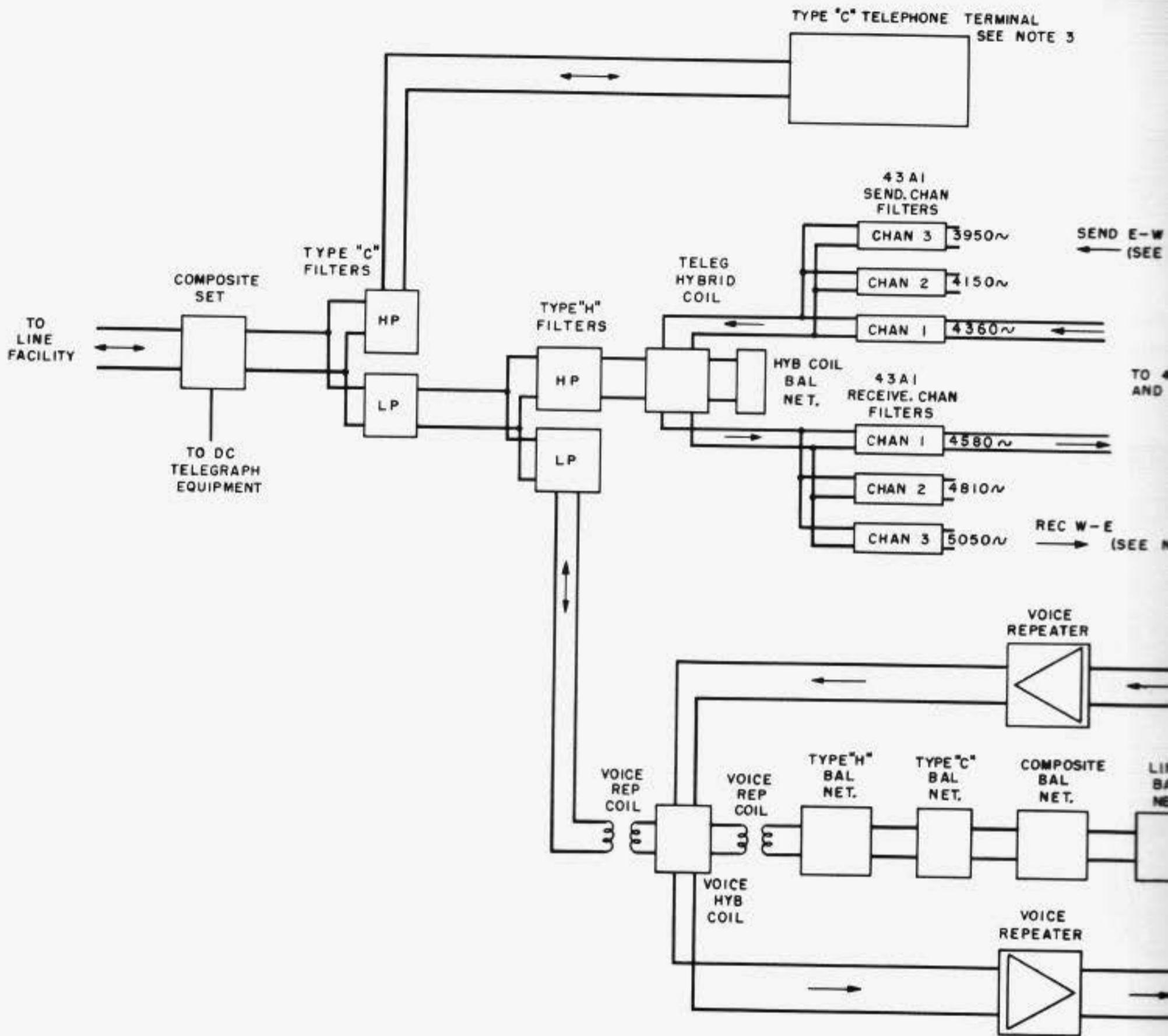


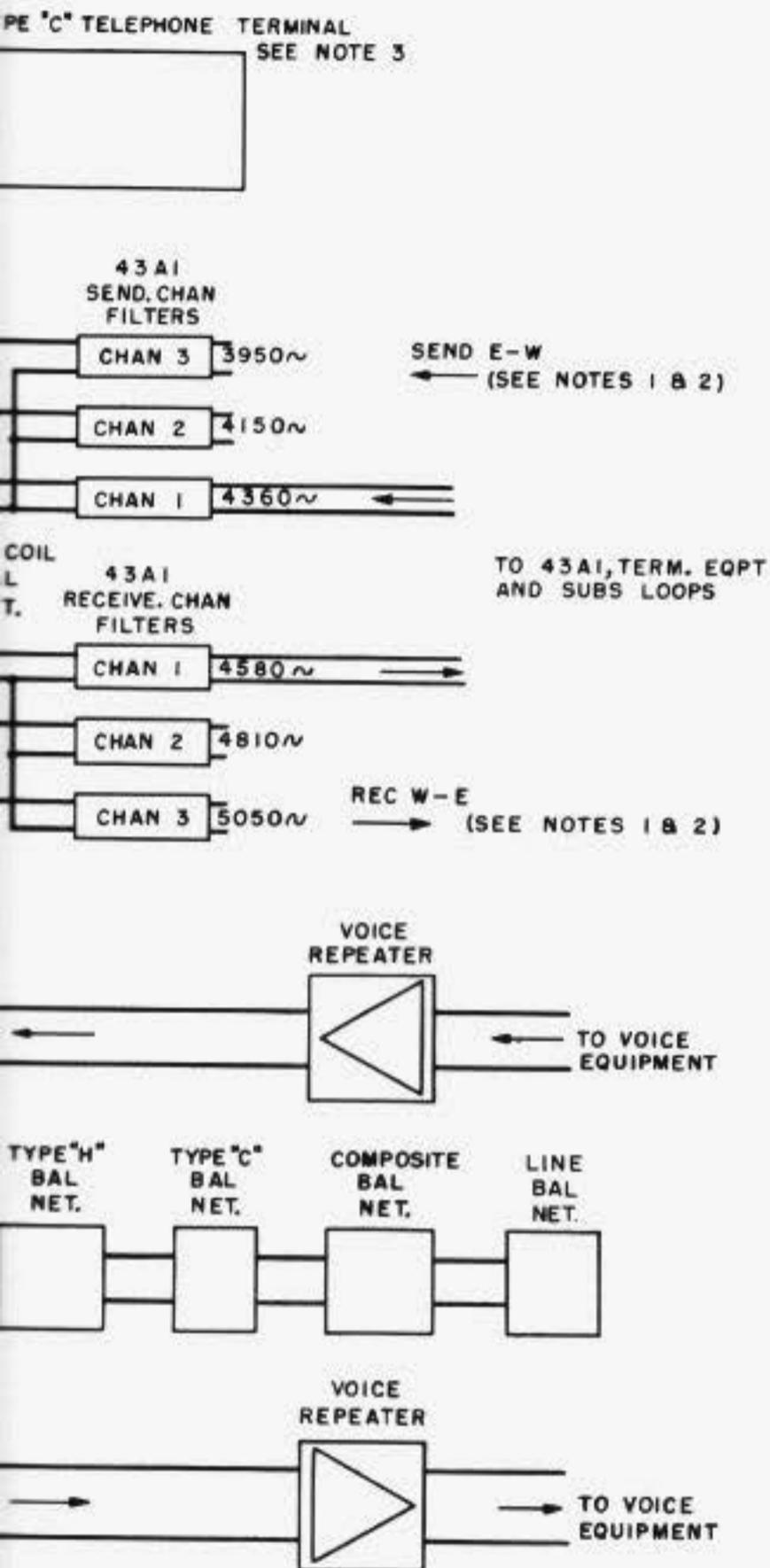


NOTES

1. IN SOME CASES, WHERE THE RATIO OF SEND TO RECEIVE LEVEL IS SMALL, THE HYBRID COIL AND BALANCING NETWORK MAY NOT BE REQUIRED.
2. THE DIRECTIONS E-W AND W-E ARE ARBITRARY AND MAY BE REVERSED, I.E., THE LOW FREQUENCY GROUP MAY BE USED FOR RECEIVING IF THE HIGH FREQUENCY GROUP IS USED FOR SENDING.
3. CHANNELS IN THE LOW FREQUENCY GROUP SEND LM AND RECEIVE H+. CHANNELS IN THE HIGH FREQUENCY GROUP SEND HM AND RECEIVE L+.
4. THE LINE REPEATING COIL MAY BE PHYSICAL OR PHANTOM. THE COIL SHOULD ALWAYS BE USED WITH TOLL LINES BUT MAY BE OMITTED ON EXCHANGE AREA CABLES.
5. IN THIS ARRANGEMENT, THE 425 ω CHANNEL MAY BE USED ONLY AS A ONE WAY CHANNEL EITHER SENDING OR RECEIVING. IT SHOULD NORMALLY BE USED TO TRANSMIT OR RECEIVE IN THE SAME DIRECTION AS THE 595 ω CHANNEL. WHEN USED IN THE OPPOSITE DIRECTION THE DIFFERENCE BETWEEN SEND AND RECEIVE LEVELS SHOULD BE LIMITED TO 18 DB.

Fig. 4 – Typical Block Diagram of Carrier System on 2 Wire Circuit — With Half Duplex Loops

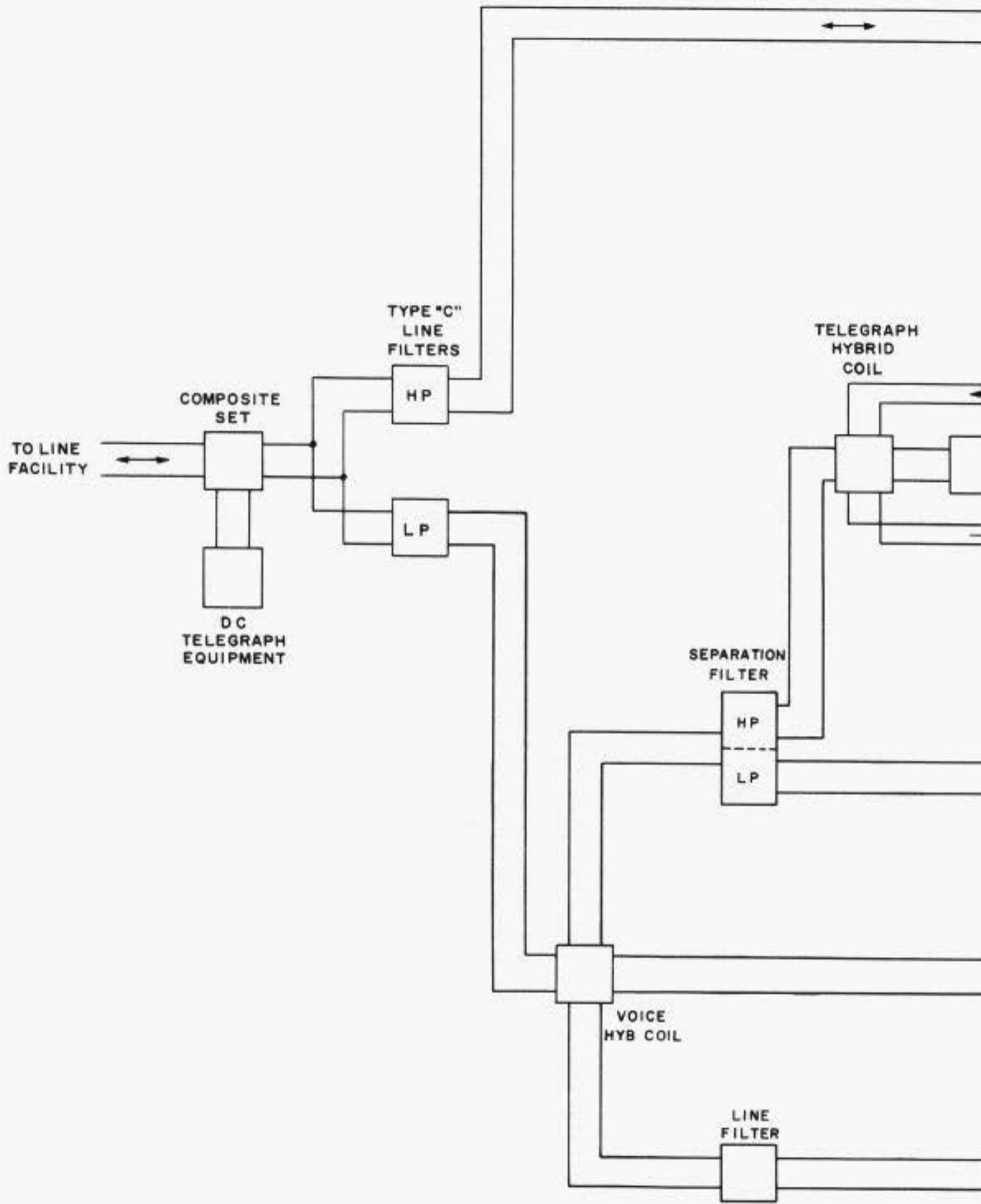


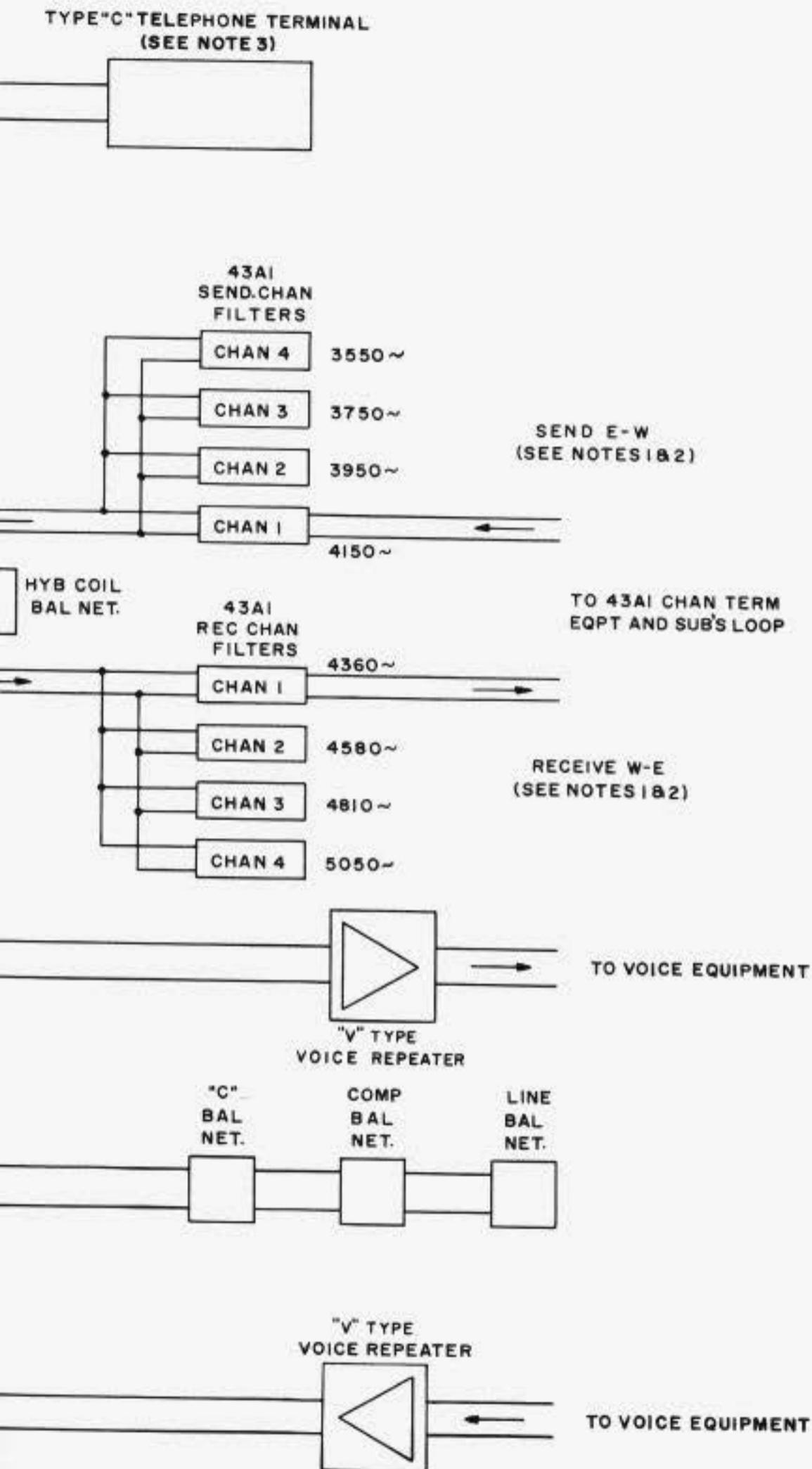


NOTES:

1. THE E-W AND W-E DIRECTIONS ARE ARBITRARY AND MAY BE REVERSED, I.E. THE LOW FREQUENCY GROUP MAY BE USED FOR RECEIVING IF THE HIGH FREQUENCY GROUP IS USED FOR SENDING.
2. FOR THIS APPLICATION EACH OF THE 43A1 CHANNELS SHOWN IN THIS FIGURE SHOULD BE ARRANGED TO SEND THE LOWER FREQUENCY FOR A MARKING SIGNAL, I.E. THE SEND SWITCH ON LM. AT THE DISTANT TERMINAL, THE SEND SWITCH SHOULD BE ON HM, THIS PROVIDES THE MAXIMUM SEPARATION BETWEEN THE "C" VOICE AND 43A1 CARRIER FREQUENCIES.
3. THIS ARRANGEMENT MAY ALSO BE USED ON CABLE CIRCUITS WHERE THE TYPE "C" CARRIER TELEPHONE EQUIPMENT IS NOT PRESENT.

Fig. 5 - Typical Block Diagram of Three HF Channels Applied Between Voice and Type C Carrier Telephone

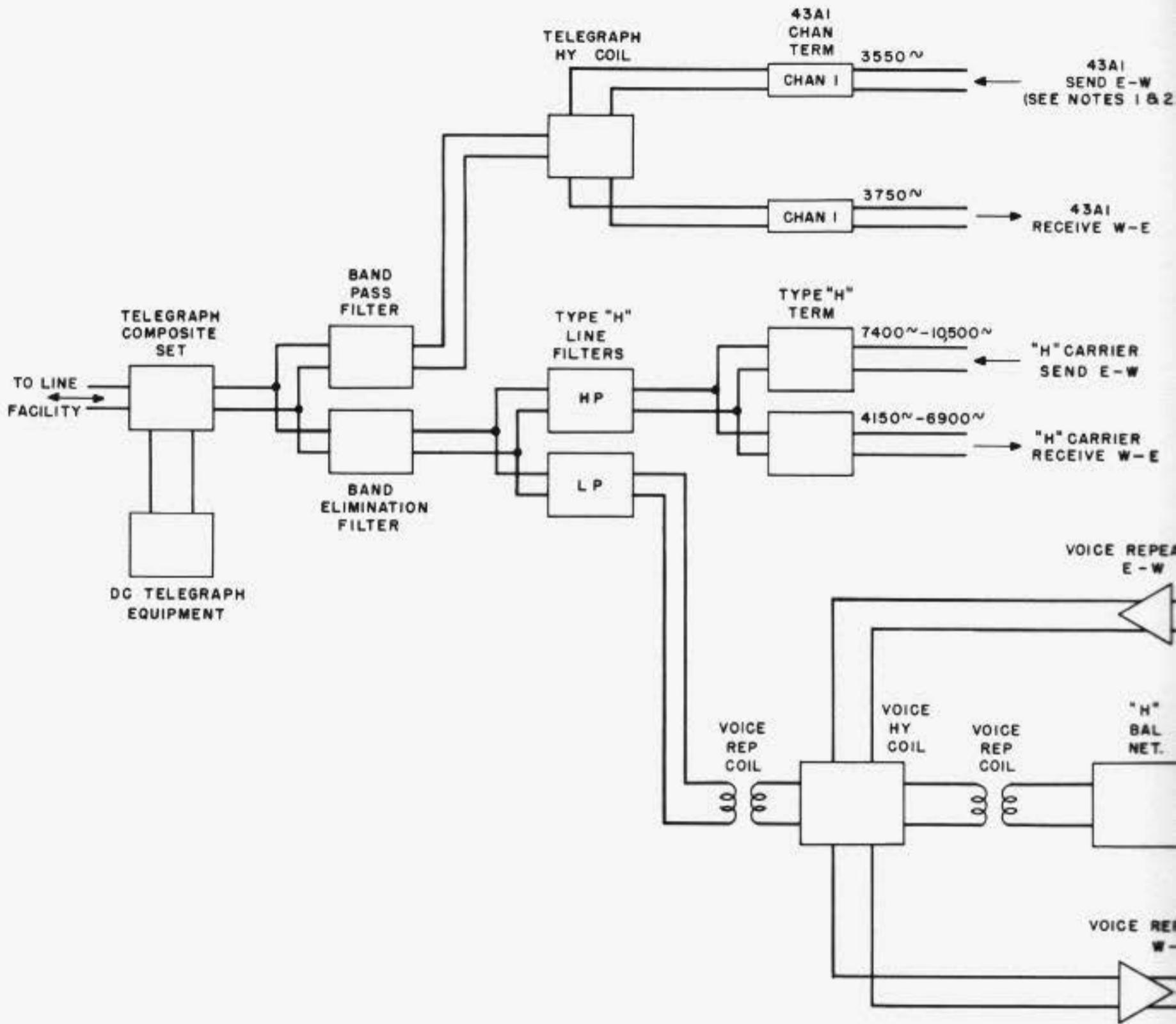




NOTES:

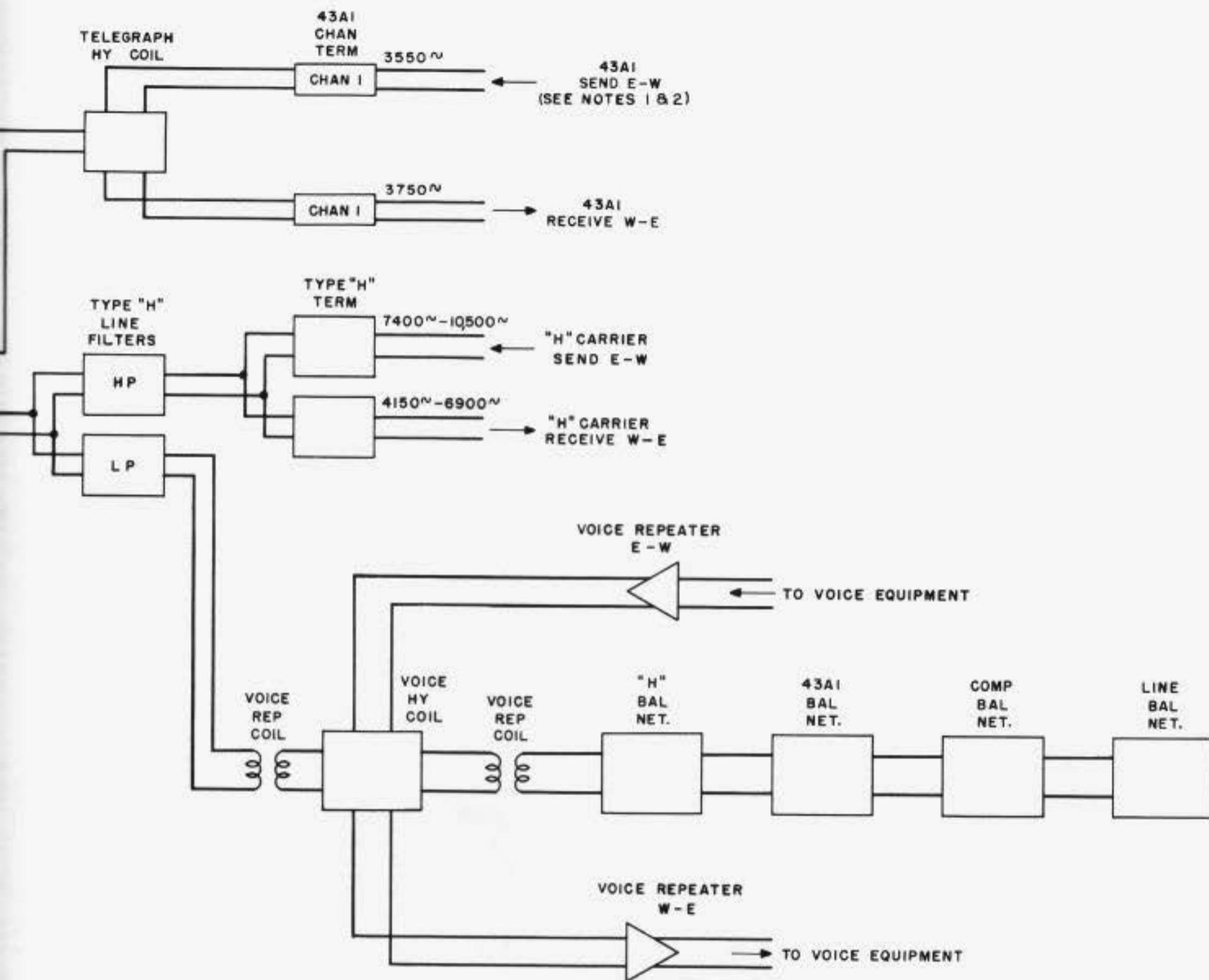
1. THE E-W AND W-E DIRECTIONS ARE ARBITRARY AND MAY BE REVERSED, IE, THE LOW FREQUENCY GROUP MAY BE USED FOR RECEIVING, IF THE HIGH FREQUENCY GROUP IS USED FOR SENDING.
2. FOR THIS APPLICATION EACH OF THE 43AI CHANNELS SHOWN IN THIS FIGURE SHOULD BE ARRANGED TO SEND THE LOWER FREQUENCY FOR A MARKING SIGNAL, IE, SEND SWITCH, LM. AT THE DISTANT TERMINAL THE SEND SWITCH SHOULD BE ON HM. THIS PROVIDES THE MAXIMUM SEPARATION BETWEEN THE "C" VOICE AND 43AI CARRIER FREQUENCIES.
3. THIS ARRANGEMENT MAY ALSO BE USED OMITTING THE TYPE "C" CARRIER TELEPHONE EQUIPMENT. IN THAT CASE THE "C" BALANCING NETWORK IS OMITTED.
4. FIG. 6 MAY ALSO BE USED AS AN ALTERNATE FOR FIG. 5 FOR ONE TO THREE CHANNELS OF 43AI.

Fig. 6 - Typical Block Diagram of Four HF Channels Applied Between Voice and Type C Carrier Telephone



NOTES:

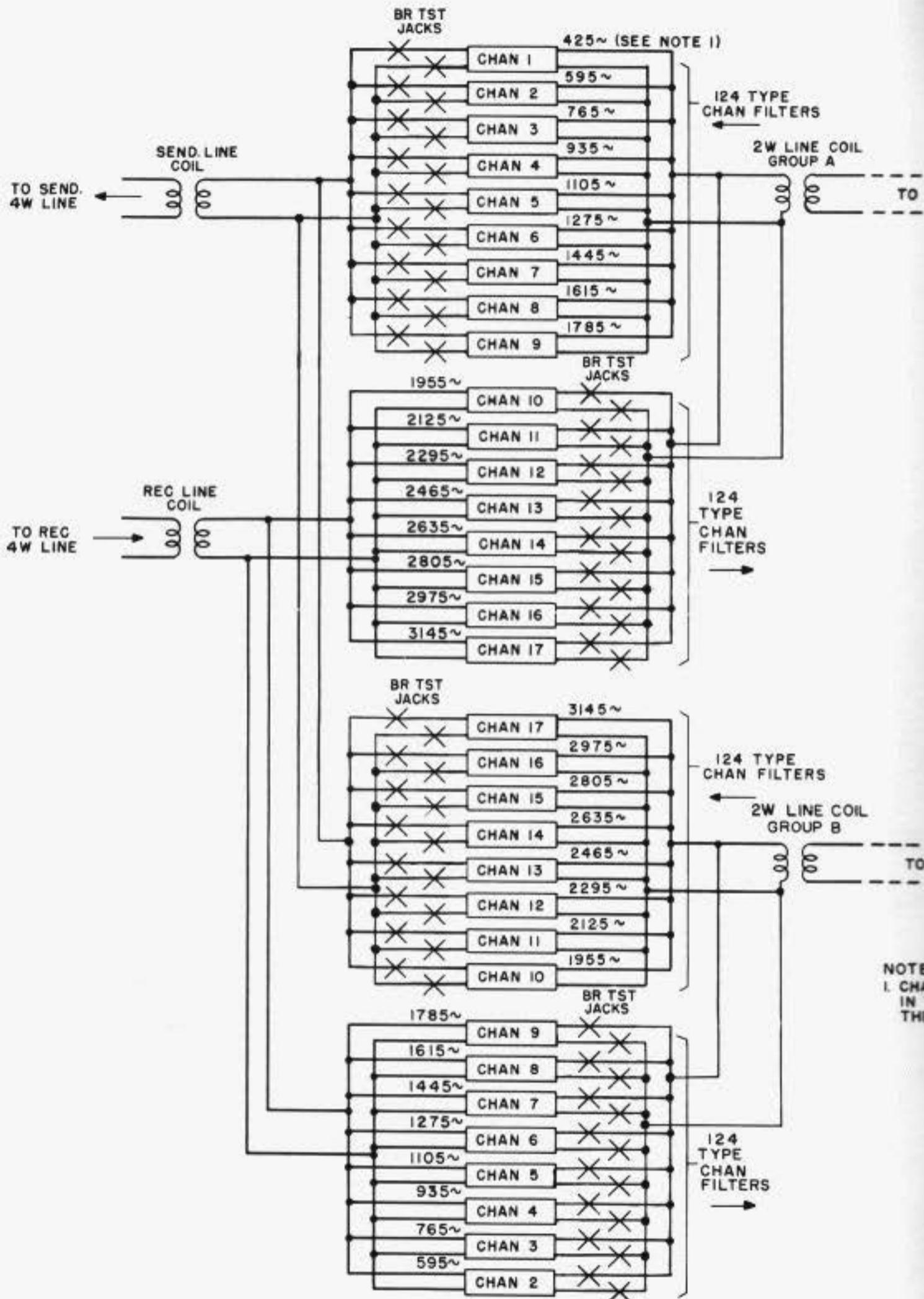
1. THE CHANNEL FREQUENCY RELATIONSHIP BETWEEN 43AI AND H CARRIER TELEPHONE CHANNELS MUST BE AS SHOWN.
2. THE 43AI TERMINAL SHOWN IN THIS FIGURE SHOULD BE ARRANGED TO SEND THE LOWER FREQUENCY FOR A MARKING SIGNAL & SEND SWITCH AT LM. THE DISTANT TERMINAL SHOULD BE ARRANGED TO SEND THE HIGHER FREQUENCY FOR A MARKING SIGNAL & SEND SWITCH AT HM. THE RECEIVE SWITCHES SHOULD BE ARRANGED ACCORDINGLY.



CHANNEL FREQUENCY RELATIONSHIP BETWEEN 43AI AND CARRIER TELEPHONE CHANNELS MUST BE AS SHOWN.

43AI TERMINAL SHOWN IN THIS FIGURE SHOULD BE ARRANGED TO SEND THE LOWER FREQUENCY FOR A MARKING SIGNAL & SEND SWITCH AT LM. THE DISTANT TERMINAL SHOULD BE ARRANGED TO SEND THE HIGHER FREQUENCY FOR MARKING SIGNAL & SEND SWITCH AT HM. THE RECEIVE SWITCHES SHOULD BE ARRANGED ACCORDINGLY.

Fig. 7 - Typical Block Diagram of Single HF Channel Applied Between Voice and Type H Carrier Telephone



NOTE
1. CHA
IN T
THE

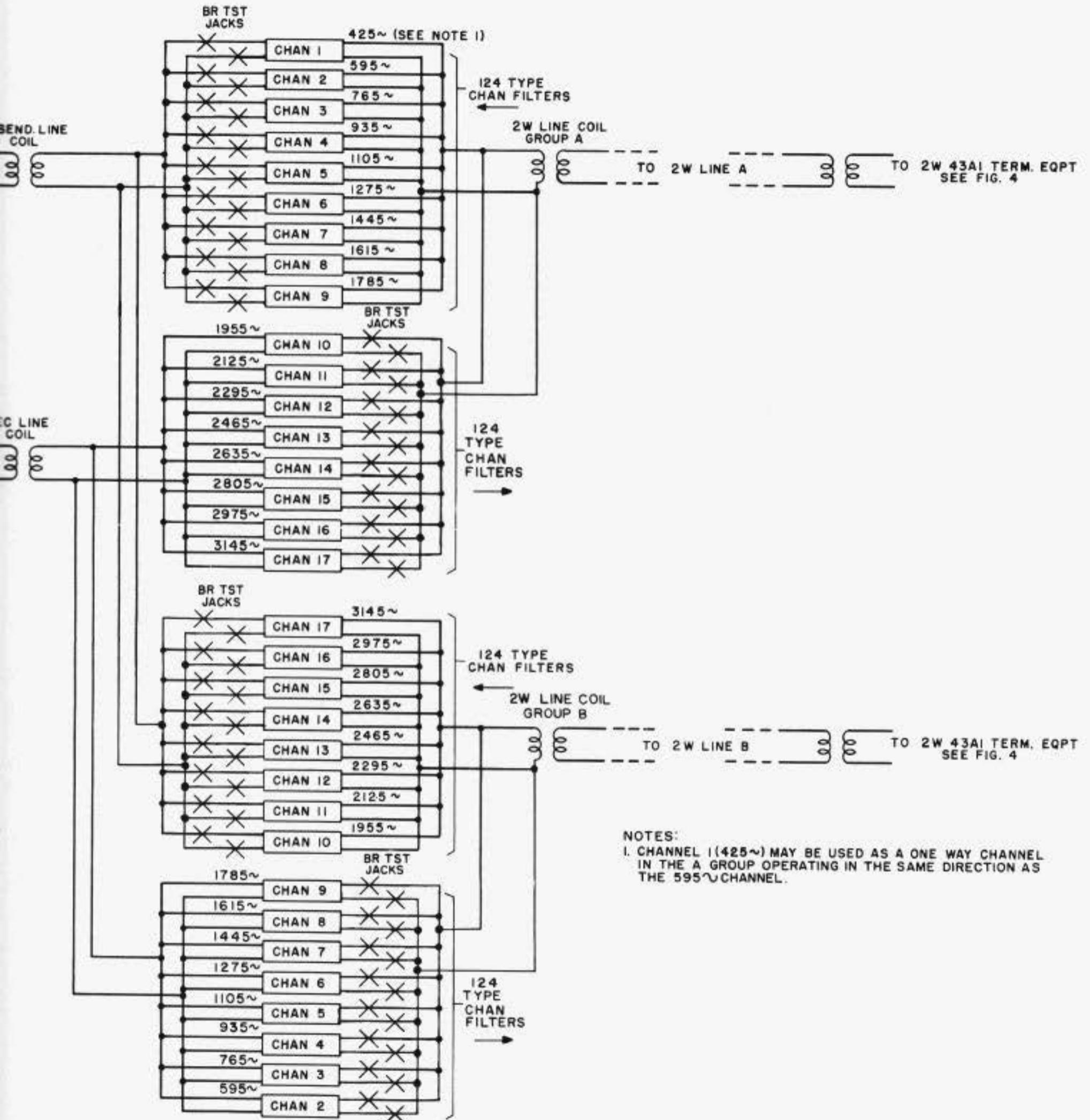
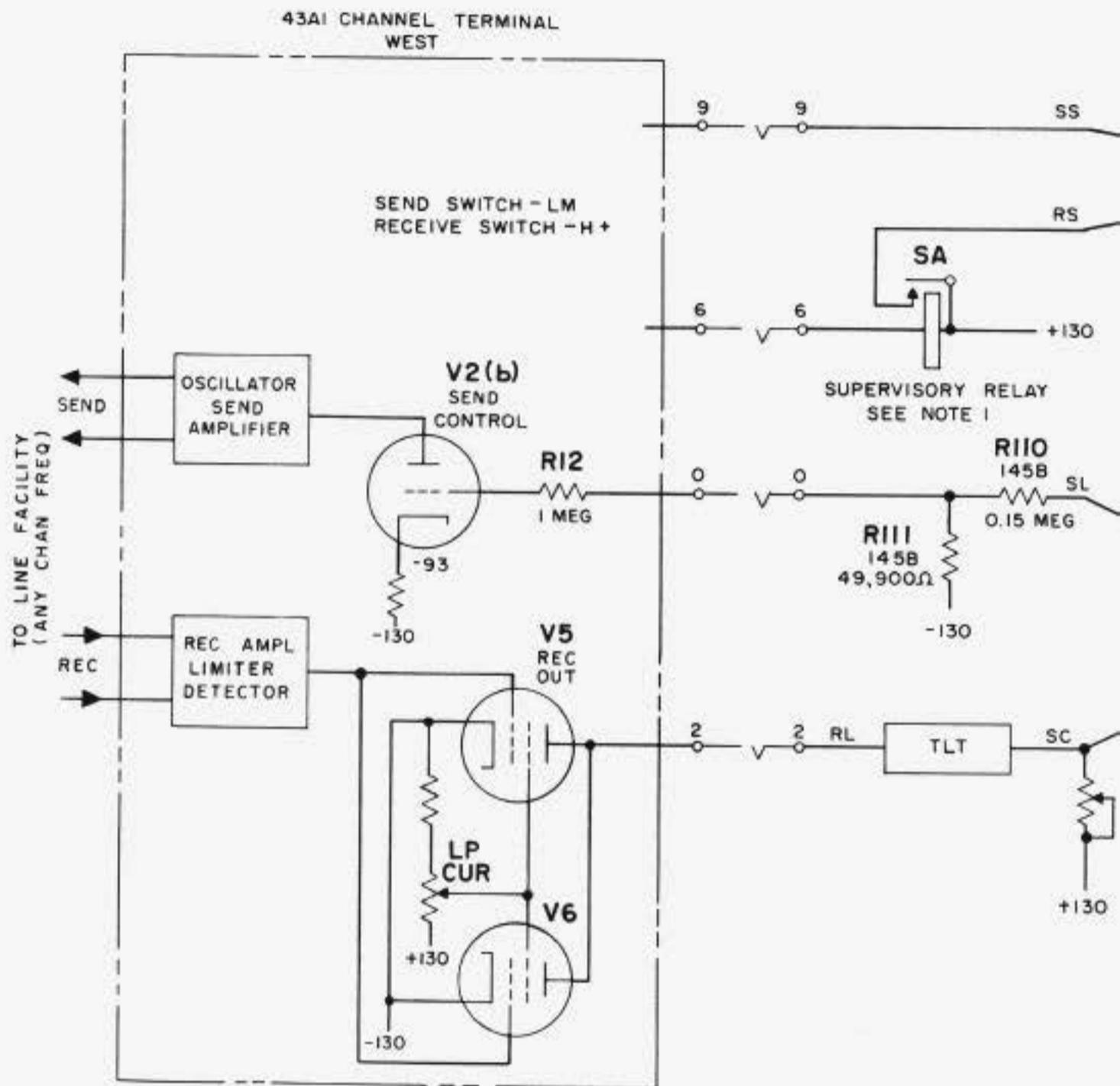


Fig. 8 - Typical Block Diagram of 2- to 4-Wire Intermediate Point



NOTES:

1. THE "RS" AND "SS" LEADS AND THE SUPERVISORY RELAYS MAY BE OMITTED WHEN SUPERVISION IS NOT REQUIRED. WHEN THIS IS DONE, +130V BATTERY MUST BE CONNECTED TO PIN 9 ON BOTH CHANNEL TERMINALS.

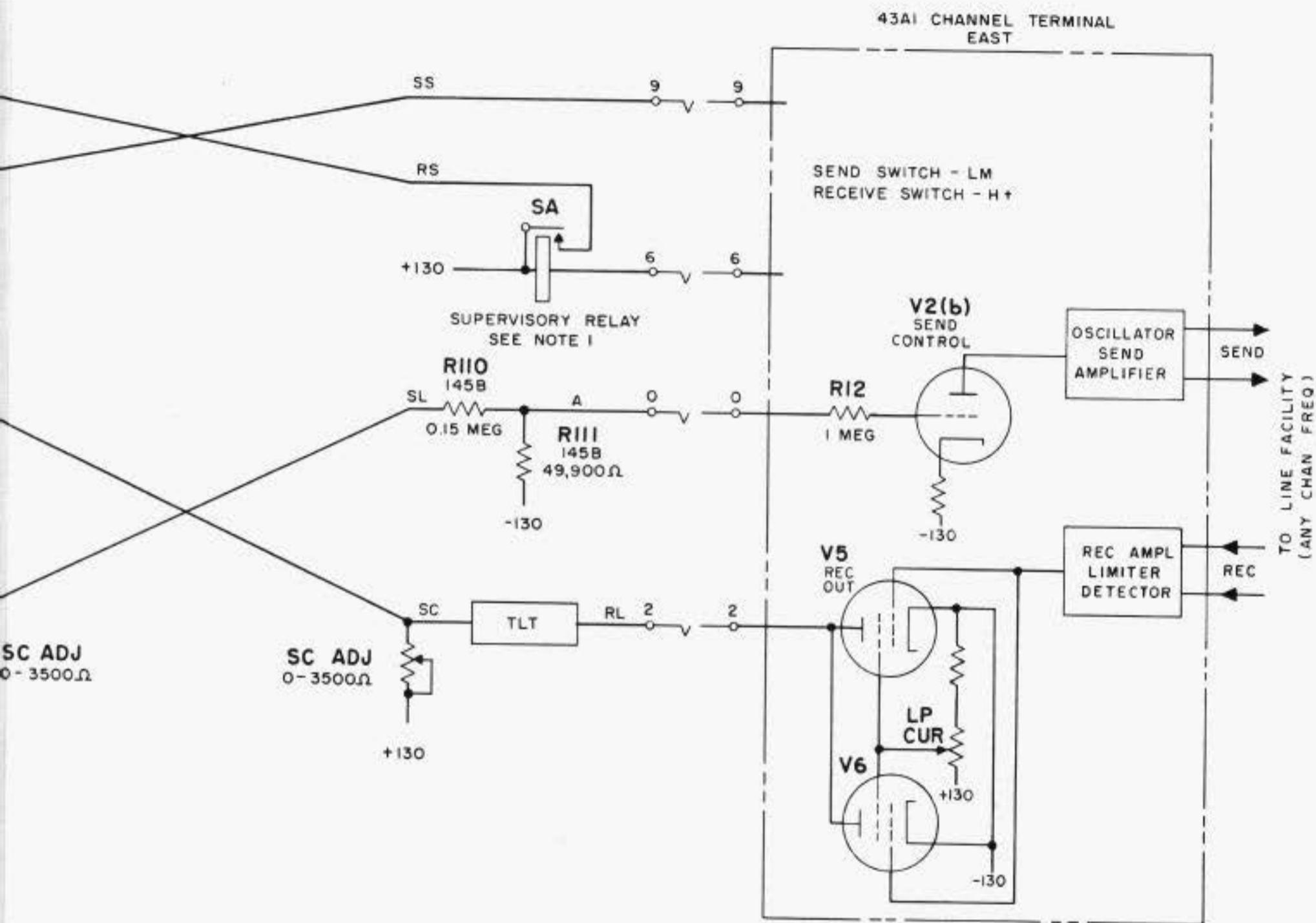
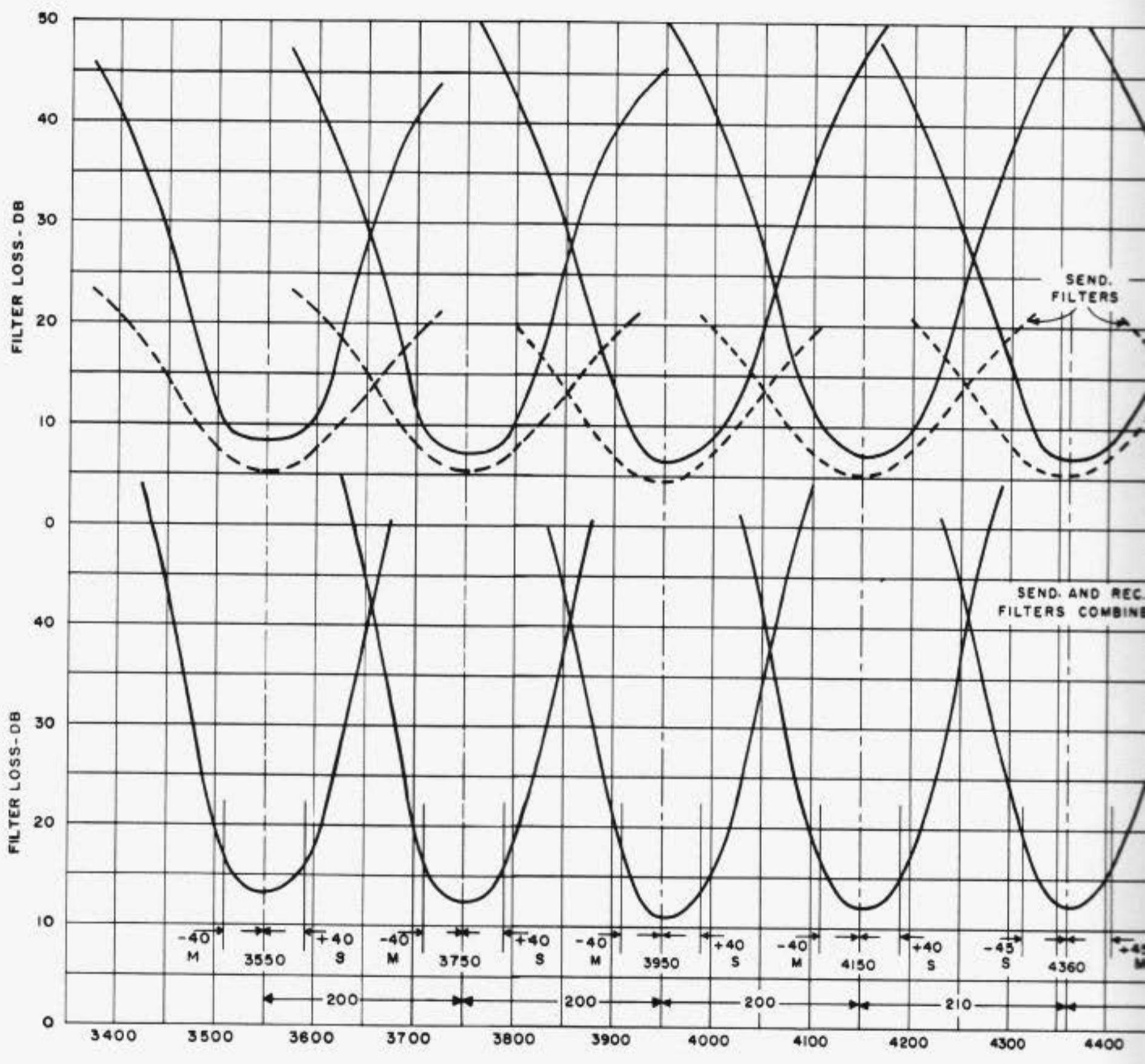


Fig. 9 - Typical Diagram of Two 43A1 Channel Terminals Arranged for FDX Back-to-Back Operation



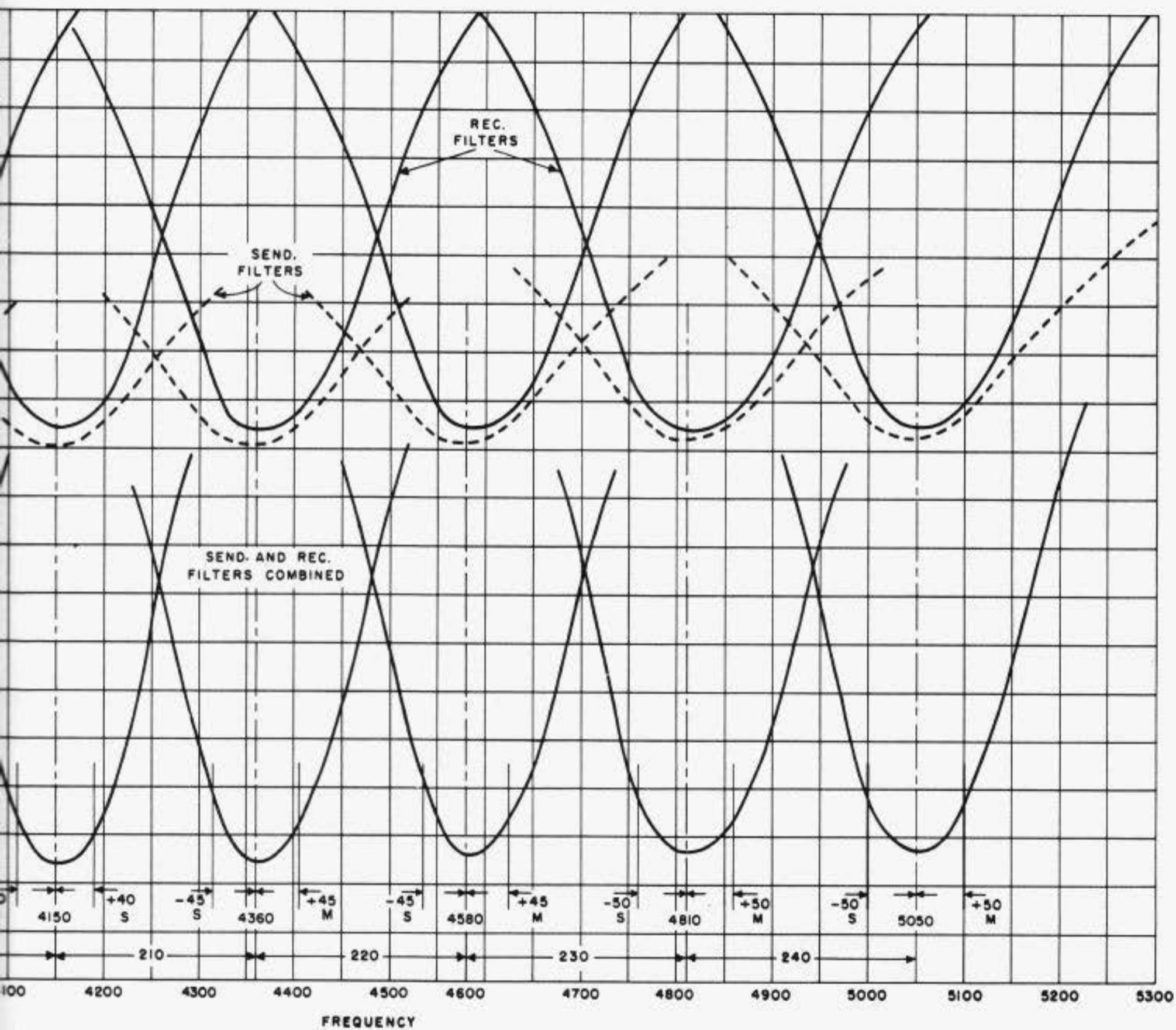
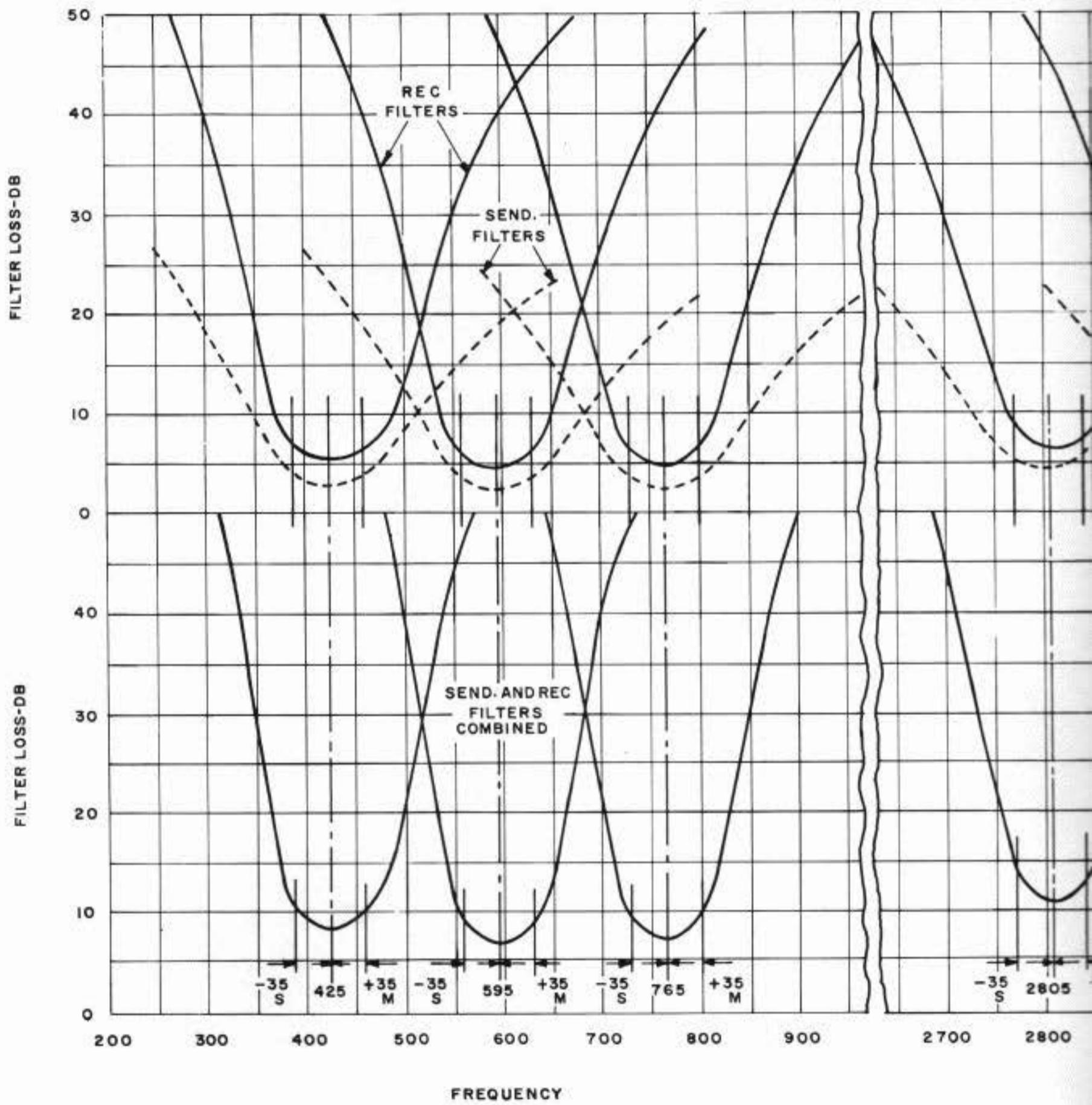


Fig. 10 – Characteristic Curves of Sending and Receiving Filters of High-frequency Channels



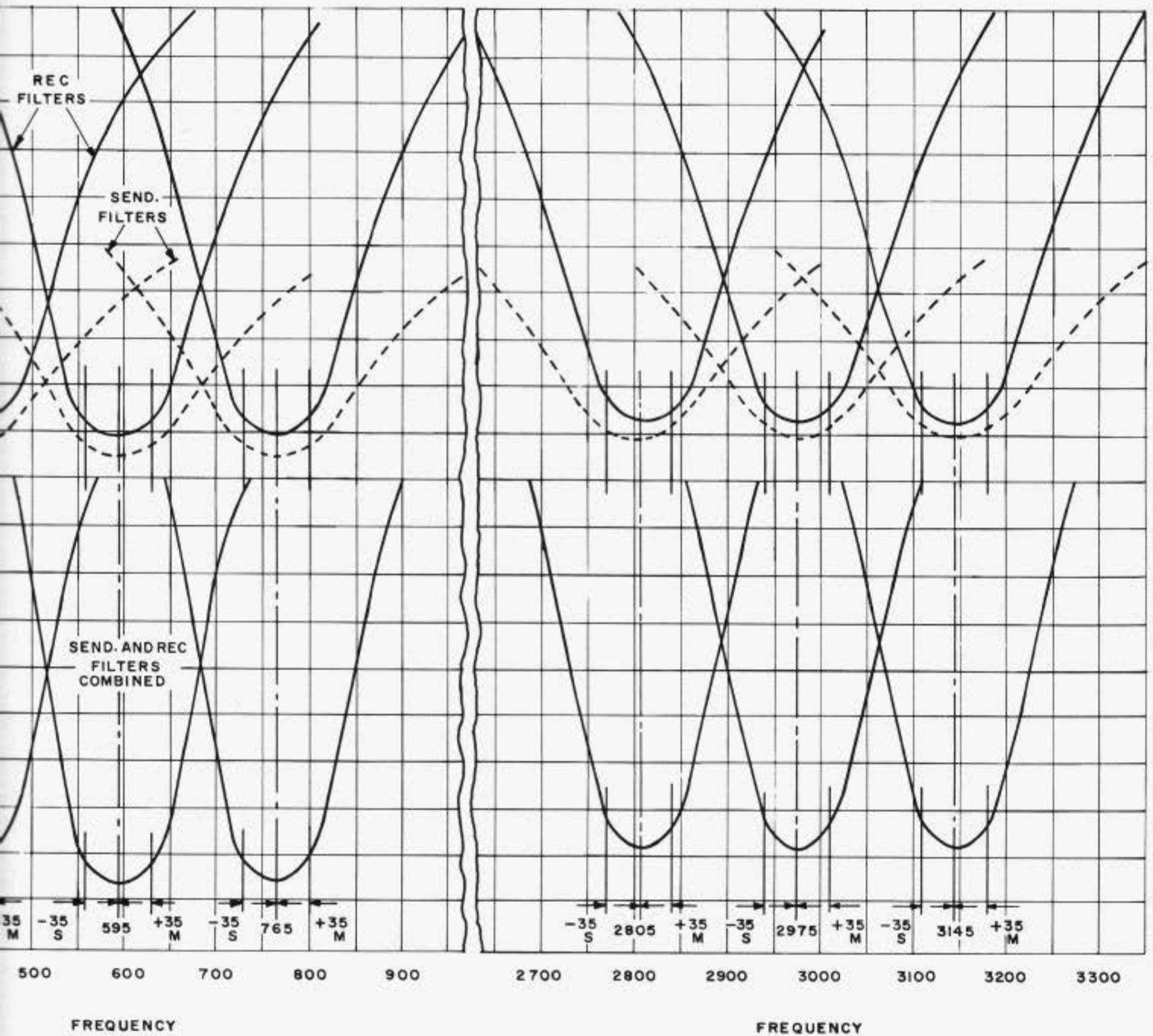
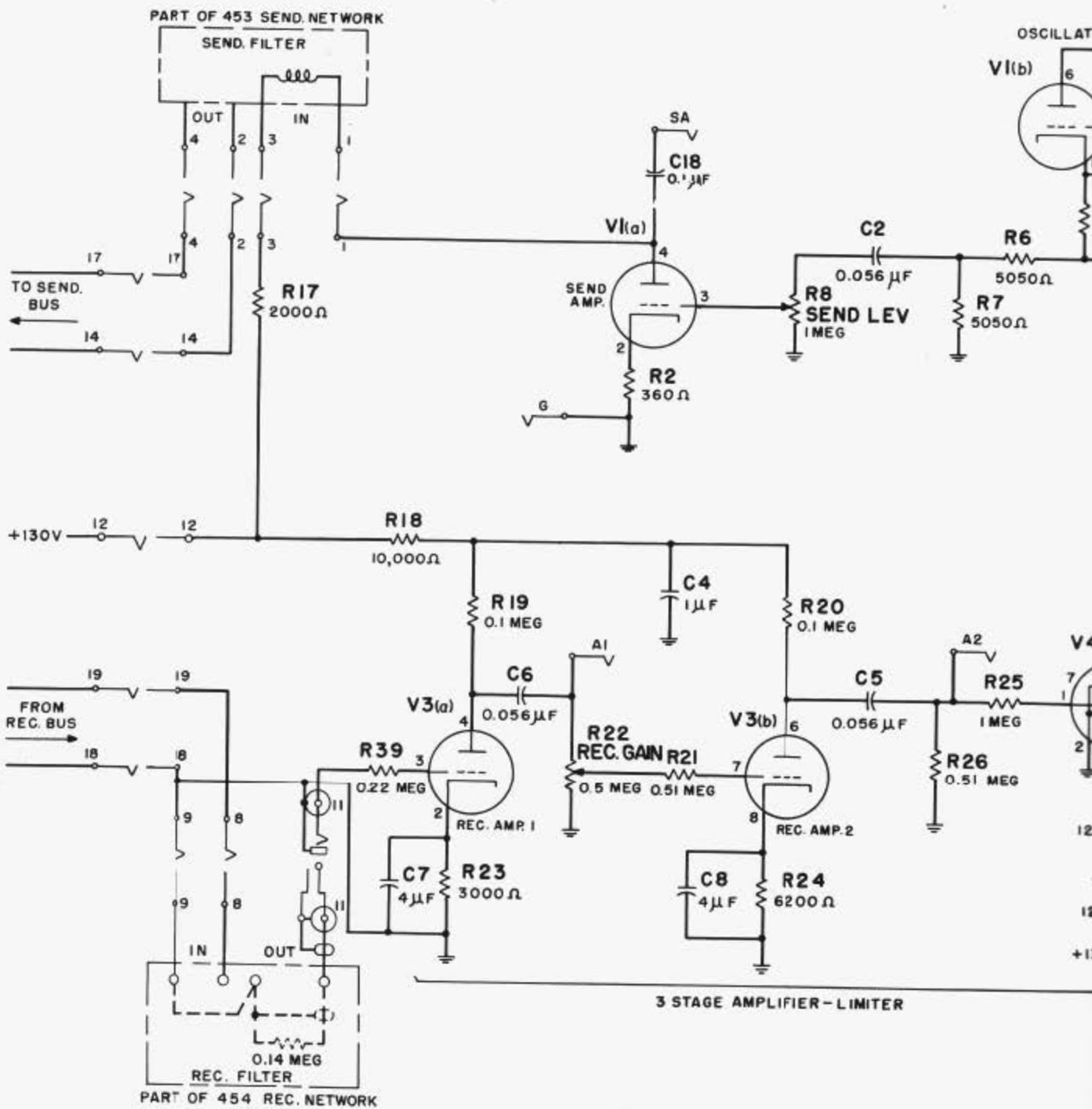
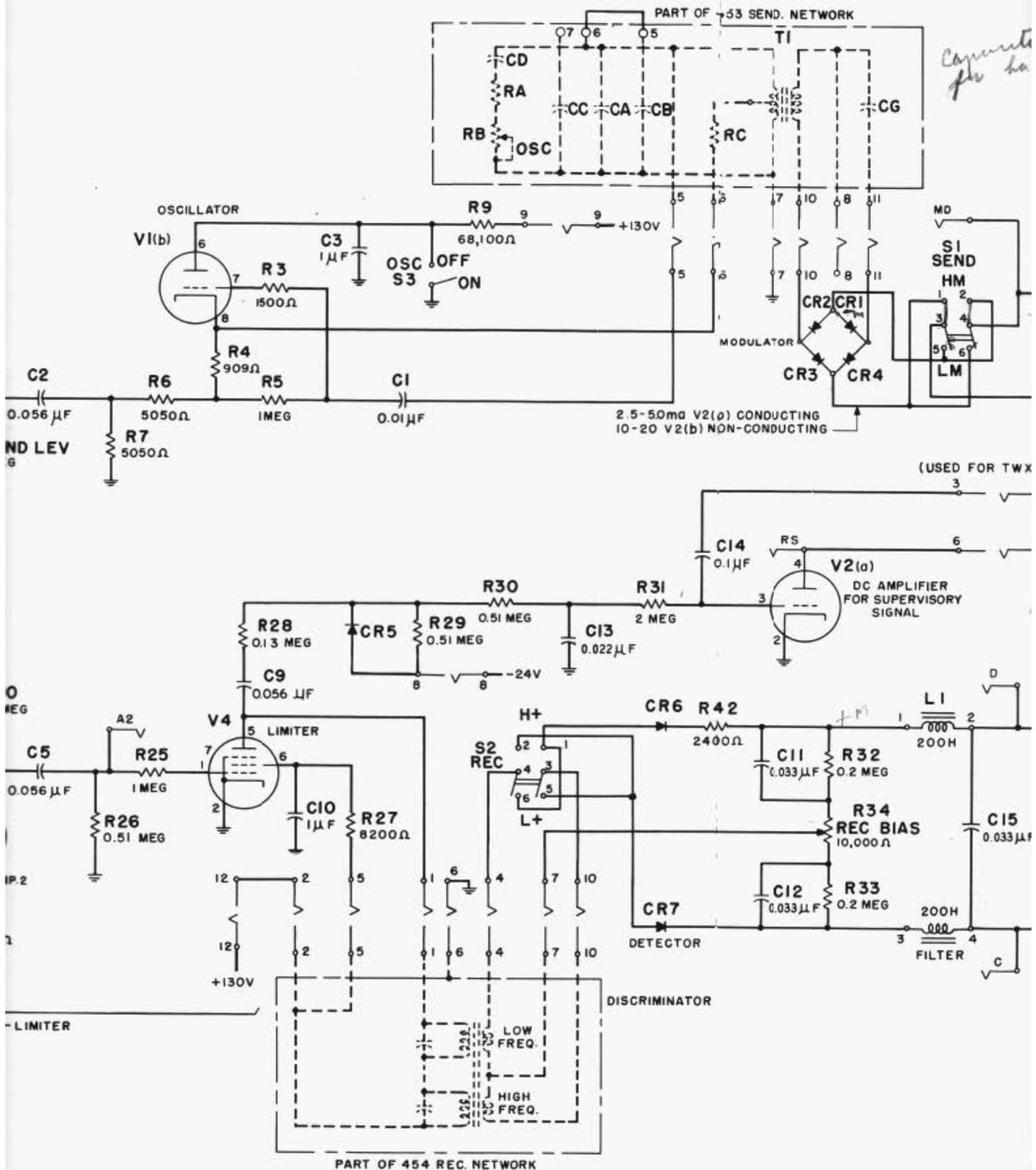
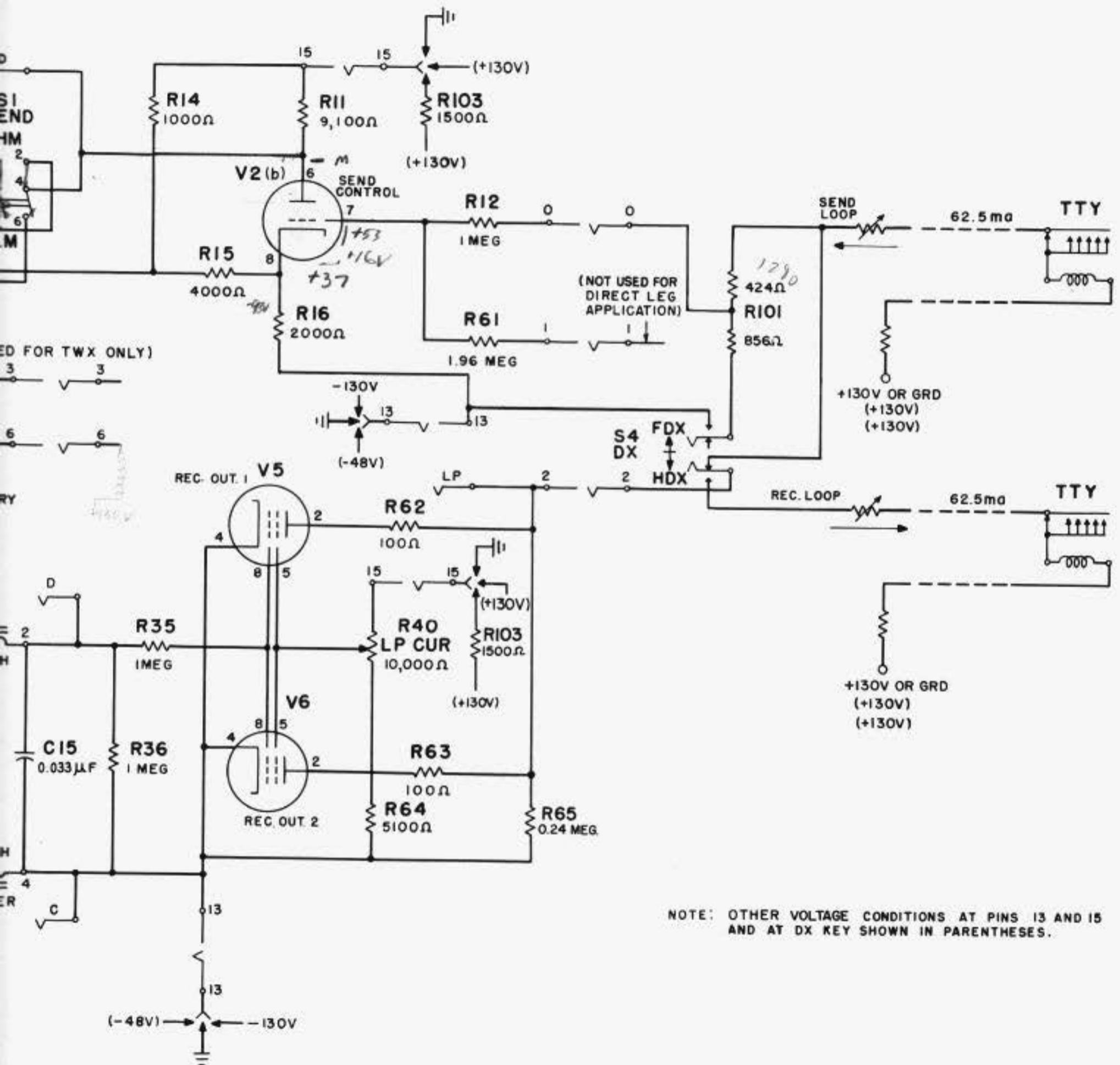


Fig. 11 – Characteristic Curves of Sending and Receiving Filters in the Voice Range





Capacitor shunted out for the marks



NOTE: OTHER VOLTAGE CONDITIONS AT PINS 13 AND 15 AND AT DX KEY SHOWN IN PARENTHESES.

Fig. 12 - Schematic of Channel Terminal Shown with One or Two Polarity, 62.5 MA Loops

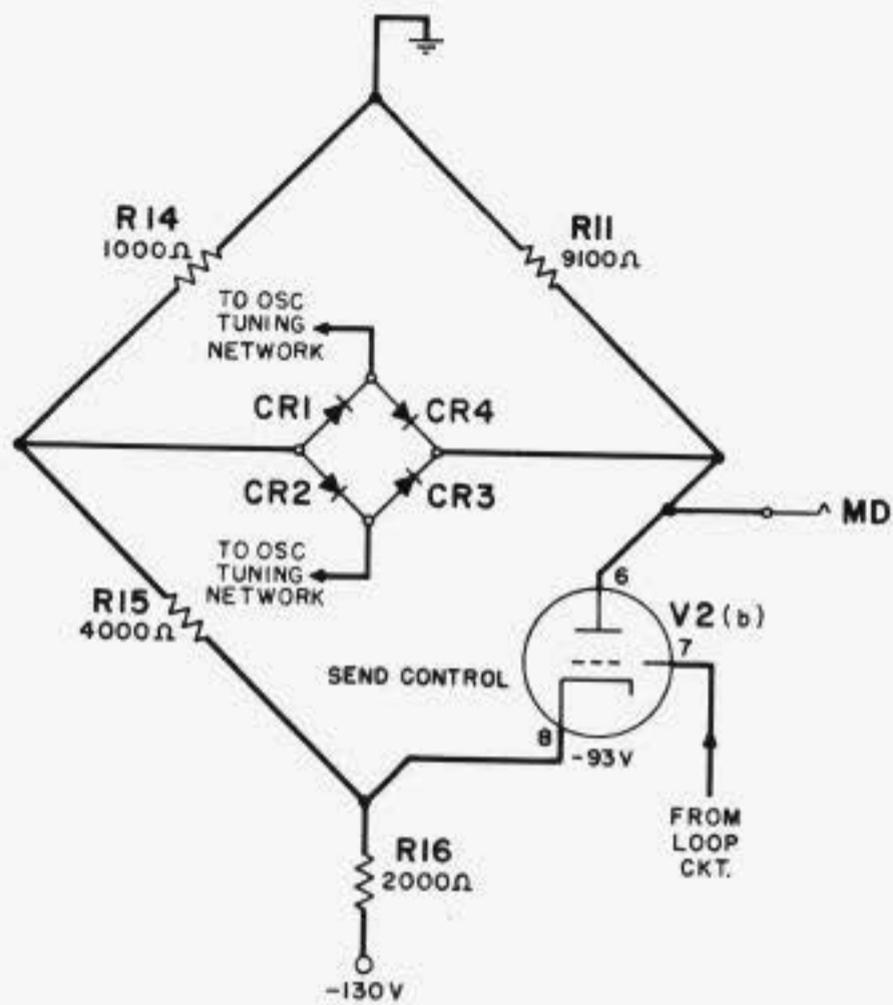


Fig. 13 - Bridge Circuit Containing Send Control Tube V2 (b)

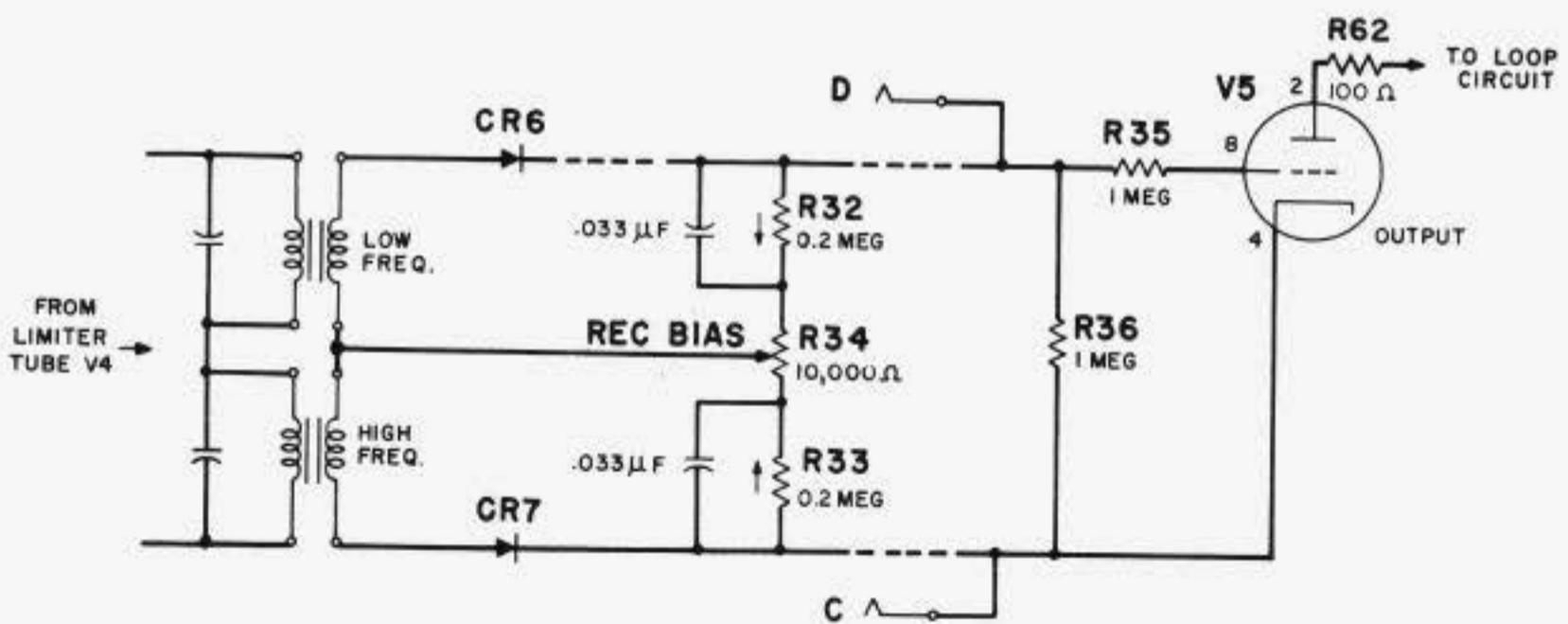


Fig. 14 - Simplified Schematic of Discriminator, Rectifier, and Output Tube

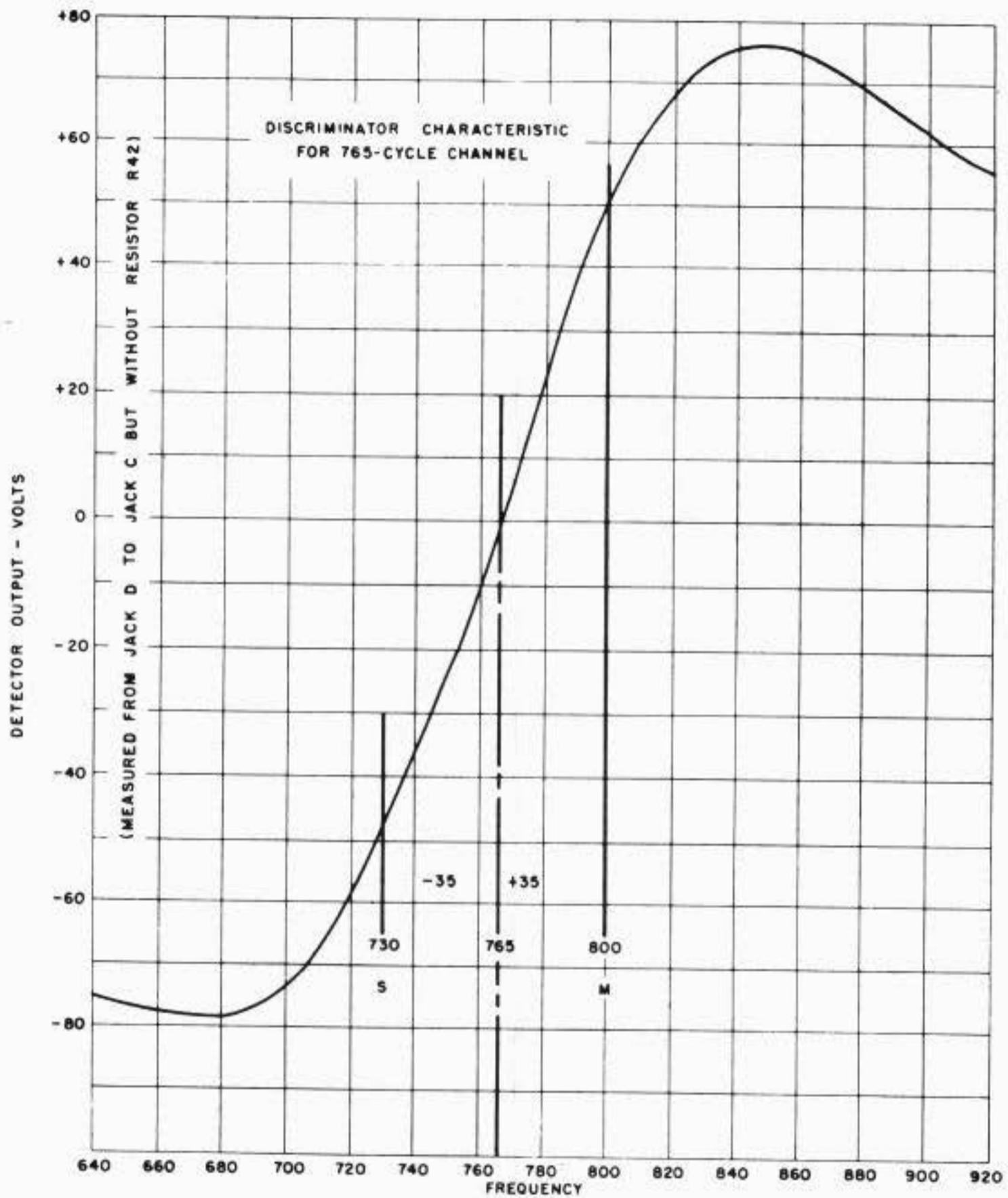


Fig. 15 - Measured Characteristic Curve of
Discriminator Output Versus
Frequency

TYPICAL TELEGRAPH LOOP TERMINAL

MULTI-SEND LEGS JACK AND TERMINATING RESISTOR

SEND-ONLY LEGS JACK

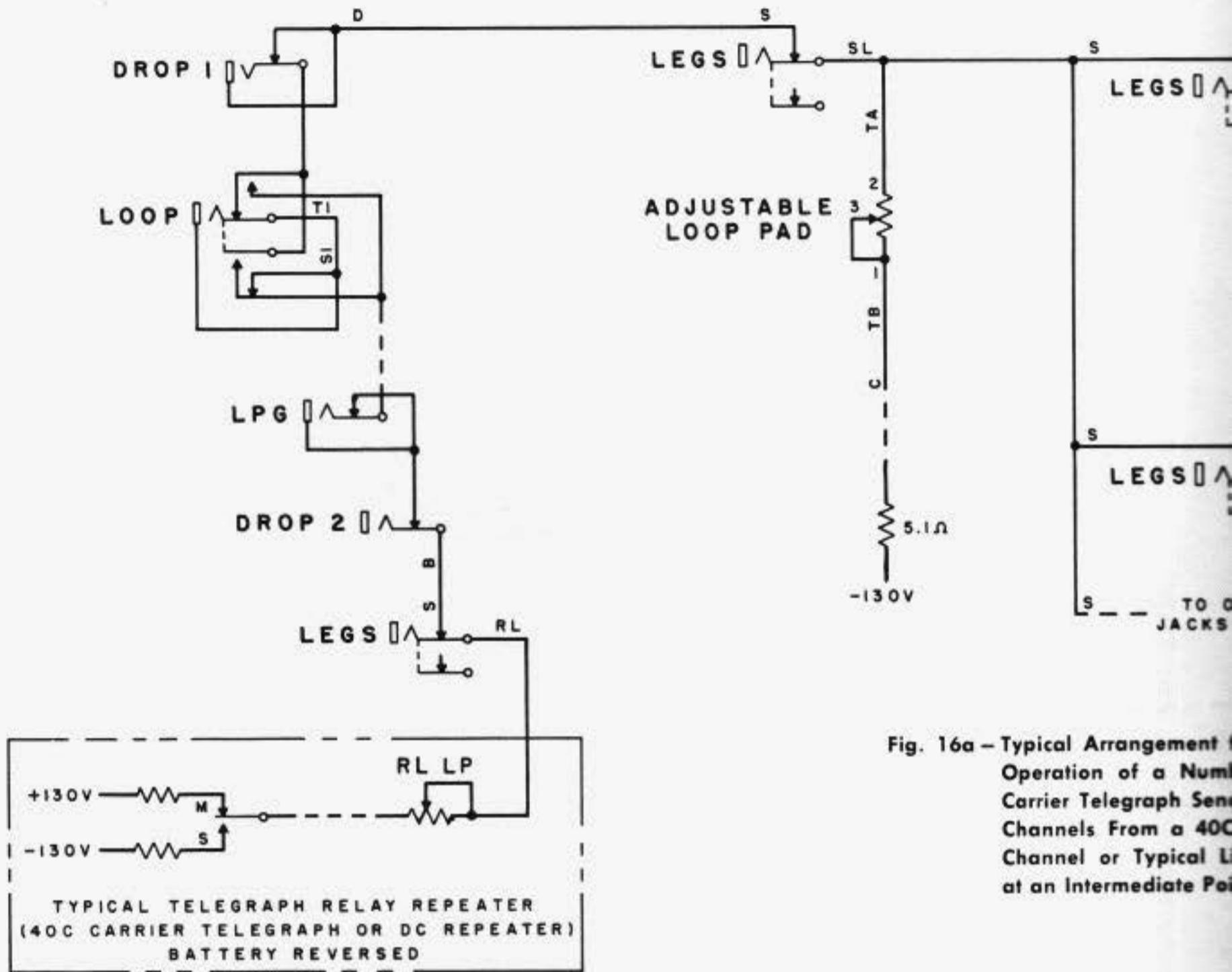


Fig. 16a - Typical Arrangement for the Operation of a Number of Carrier Telegraph Send Channels From a 40C Channel or Typical Loop Channel at an Intermediate Point

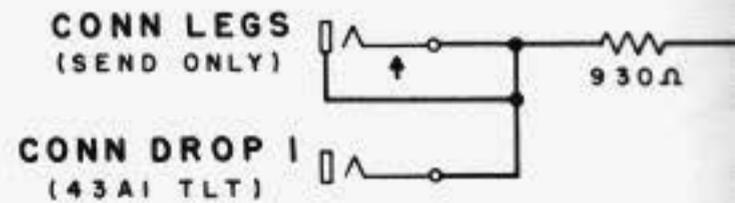


Fig. 16b - Test Jack Circuit for the Alignment of Send-only Channel Terminal Circuits

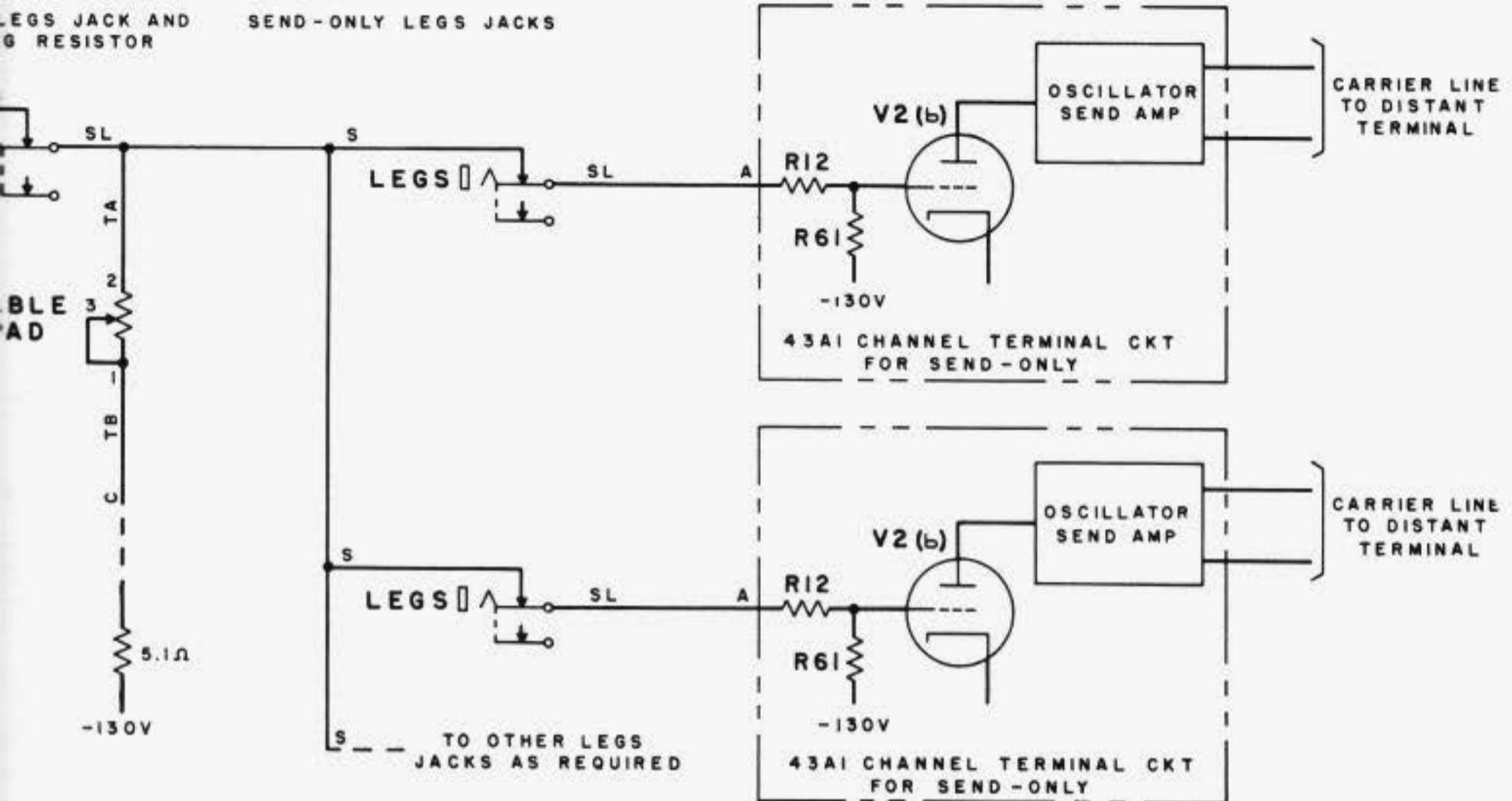


Fig. 16a - Typical Arrangement for One-way Operation of a Number of 43A1 Carrier Telegraph Send-only Channels From a 40C Carrier Channel or Typical Line Repeater at an Intermediate Point

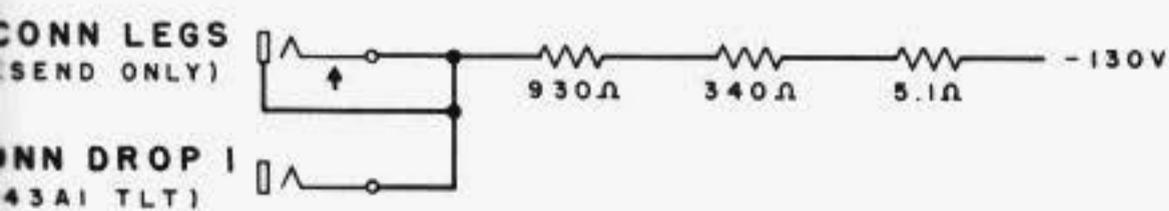
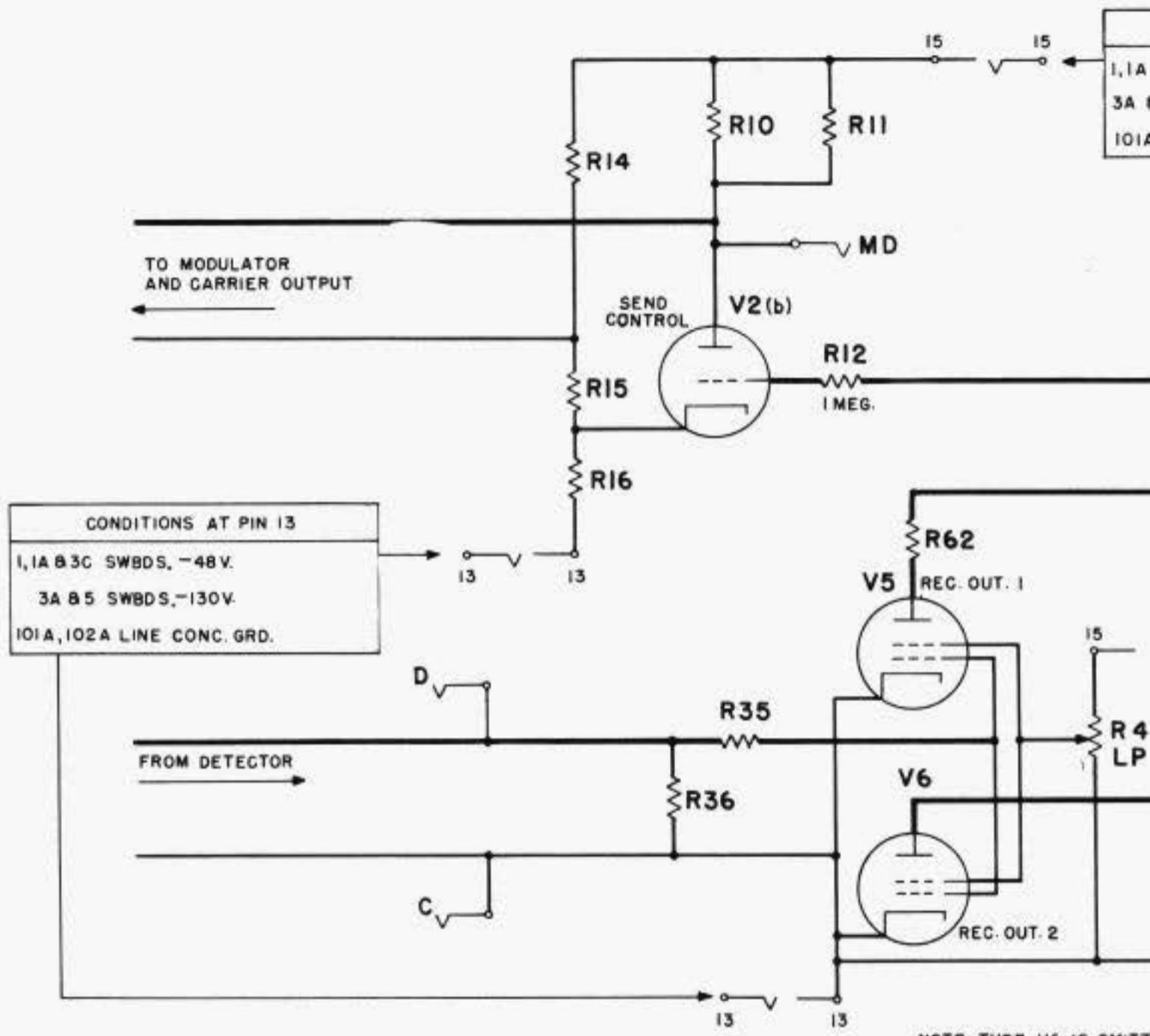


Fig. 16b - Test Jack Circuit for Terminating and Alignment of Send-only 43A1 Channel Terminal Circuit

Fig. 16 (a) & (b)



NOTE: TUBE V6 IS OMITTED
SUPERVISORY SIGNAL

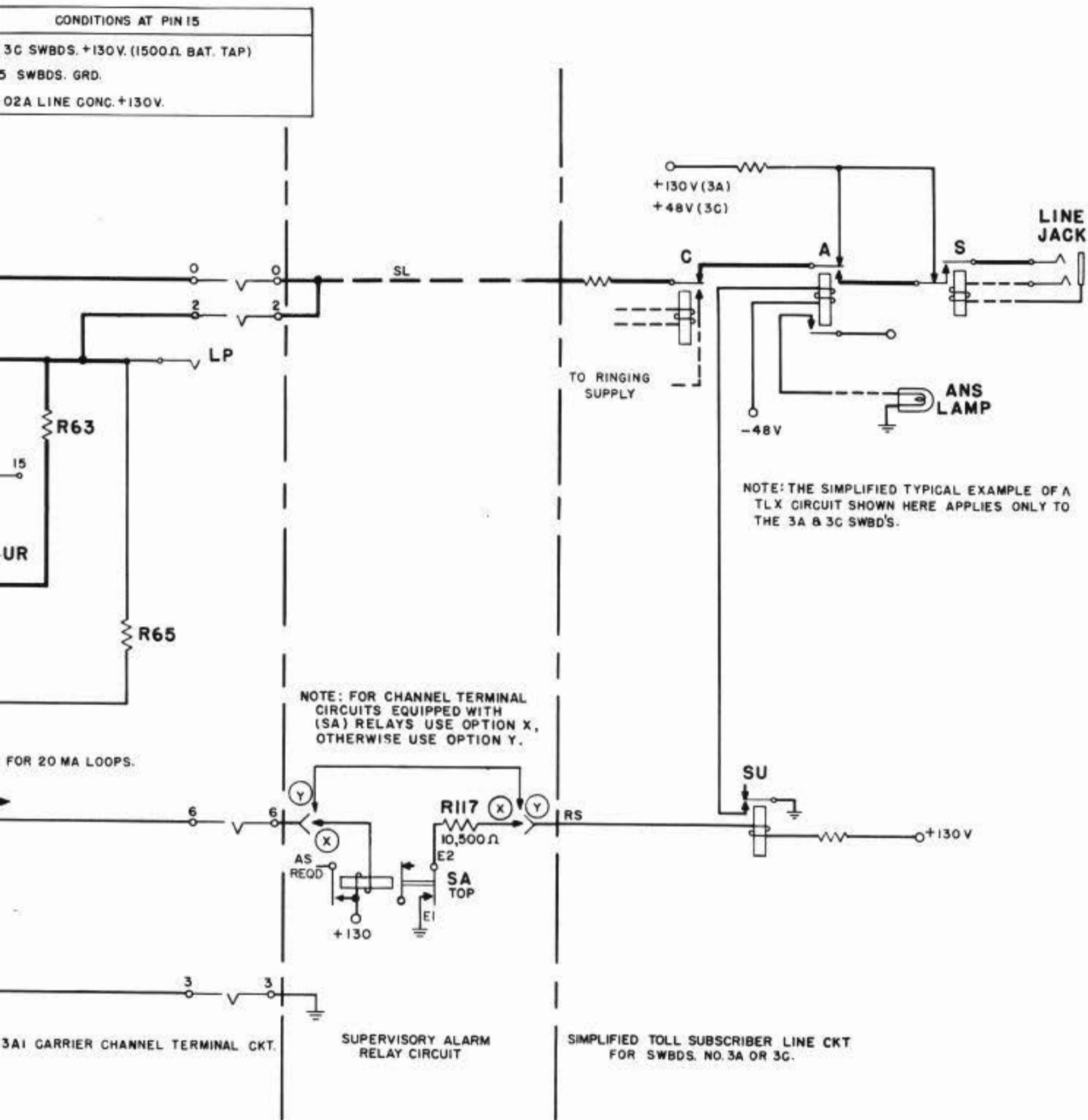
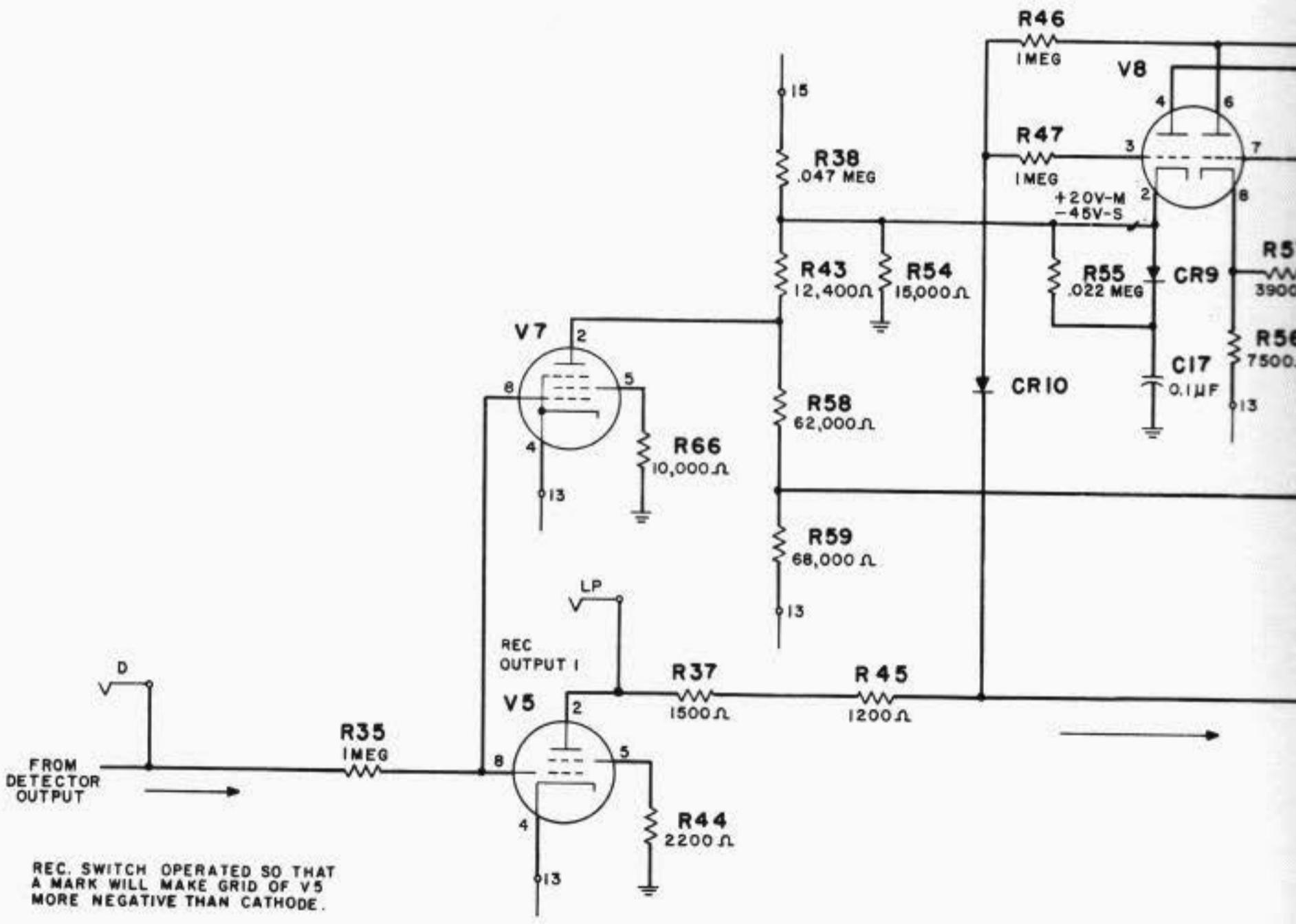
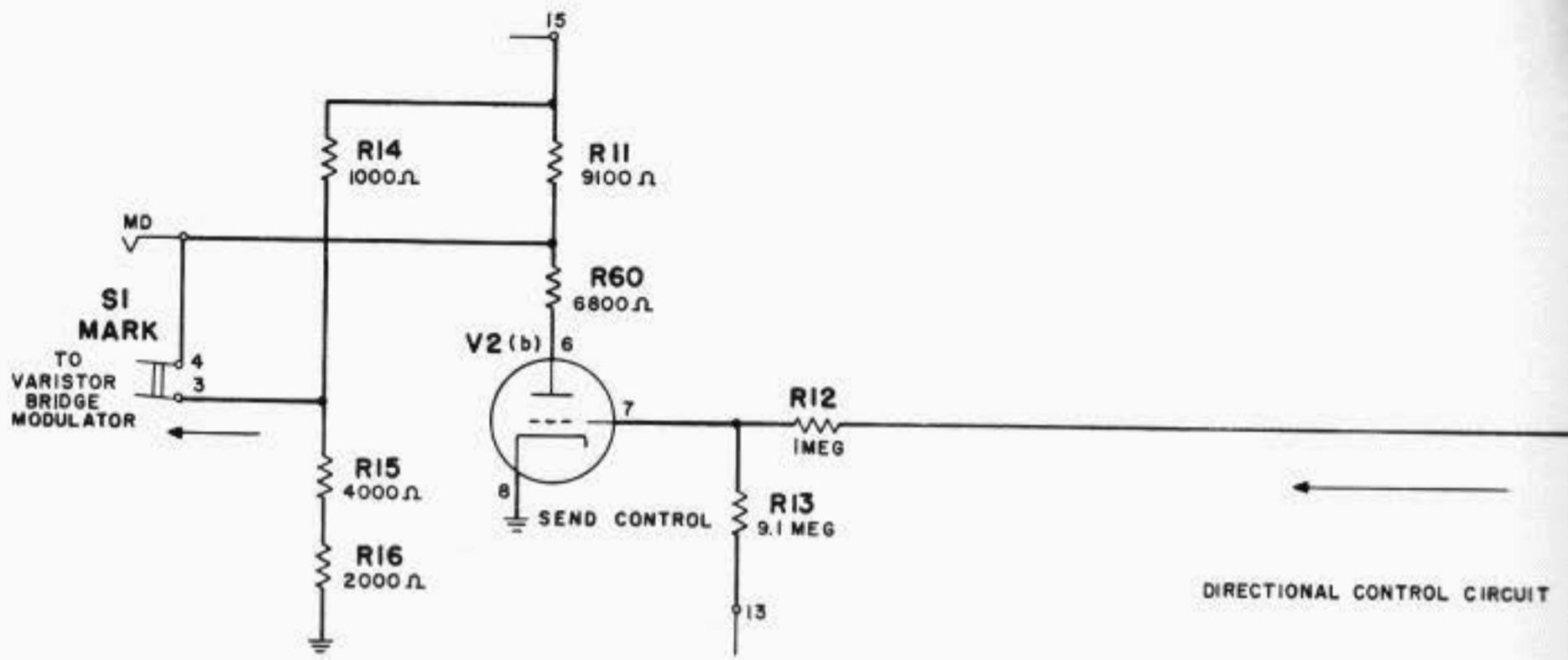


Fig. 17 - Typical TWX Switchboard Termination of TLX Lines



REC. SWITCH OPERATED SO THAT A MARK WILL MAKE GRID OF V5 MORE NEGATIVE THAN CATHODE.

BATTERY CONNECTIONS

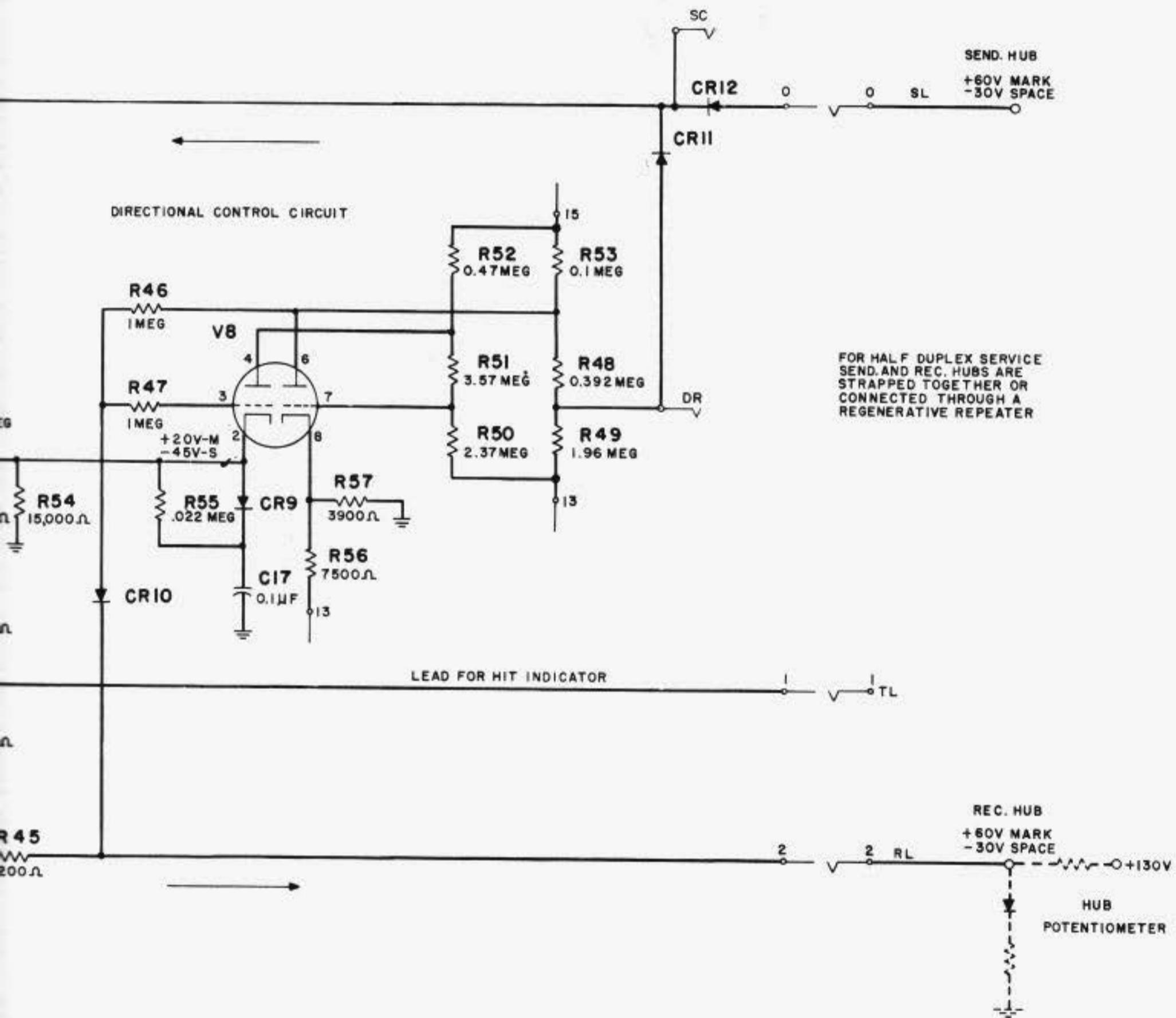
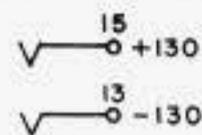
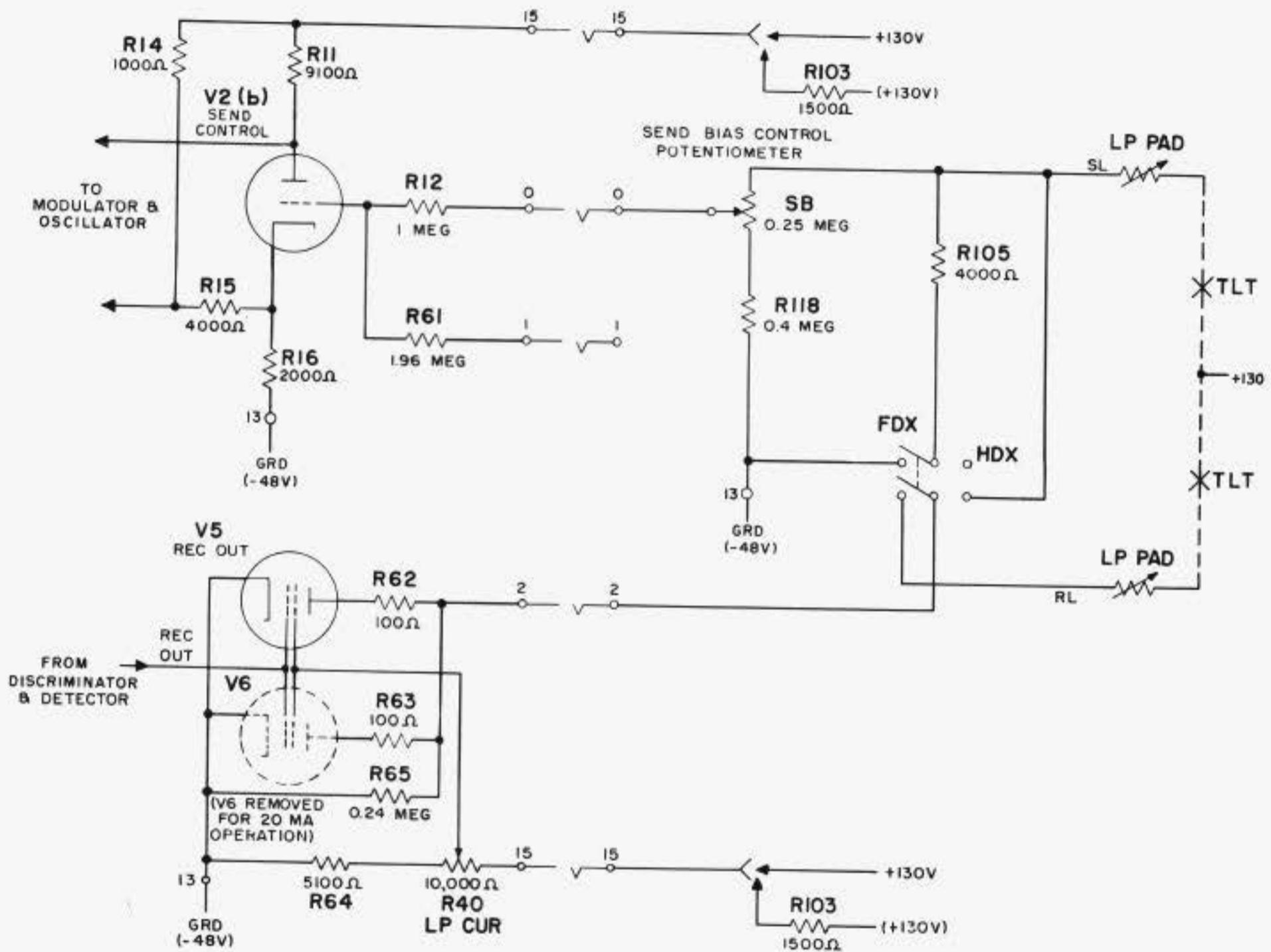


Fig. 18 - Part of Channel Terminal Circuit for Type 2 Hub Operation



PG 10

Fig. 19 - Send Bias Adjustment Potentiometer Shown for 20 MA Loops

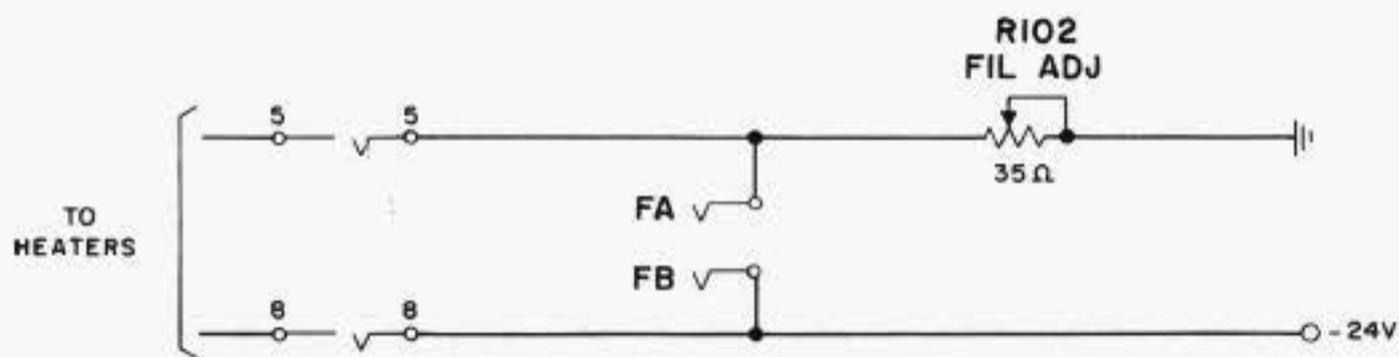


Fig. 20 – Channel Terminal Connection to -24 Volt Battery for Heater Supply

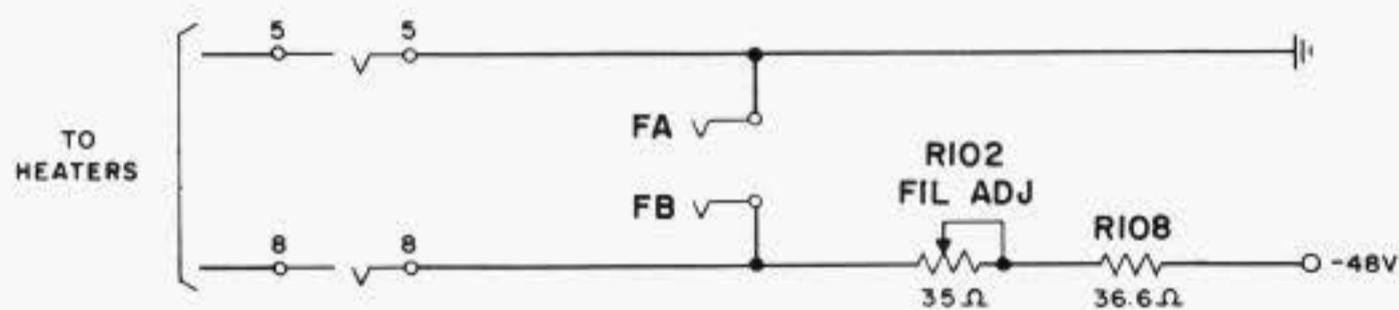


Fig. 21 – Channel Terminal Connection to -48 Volt Battery for Heater Supply

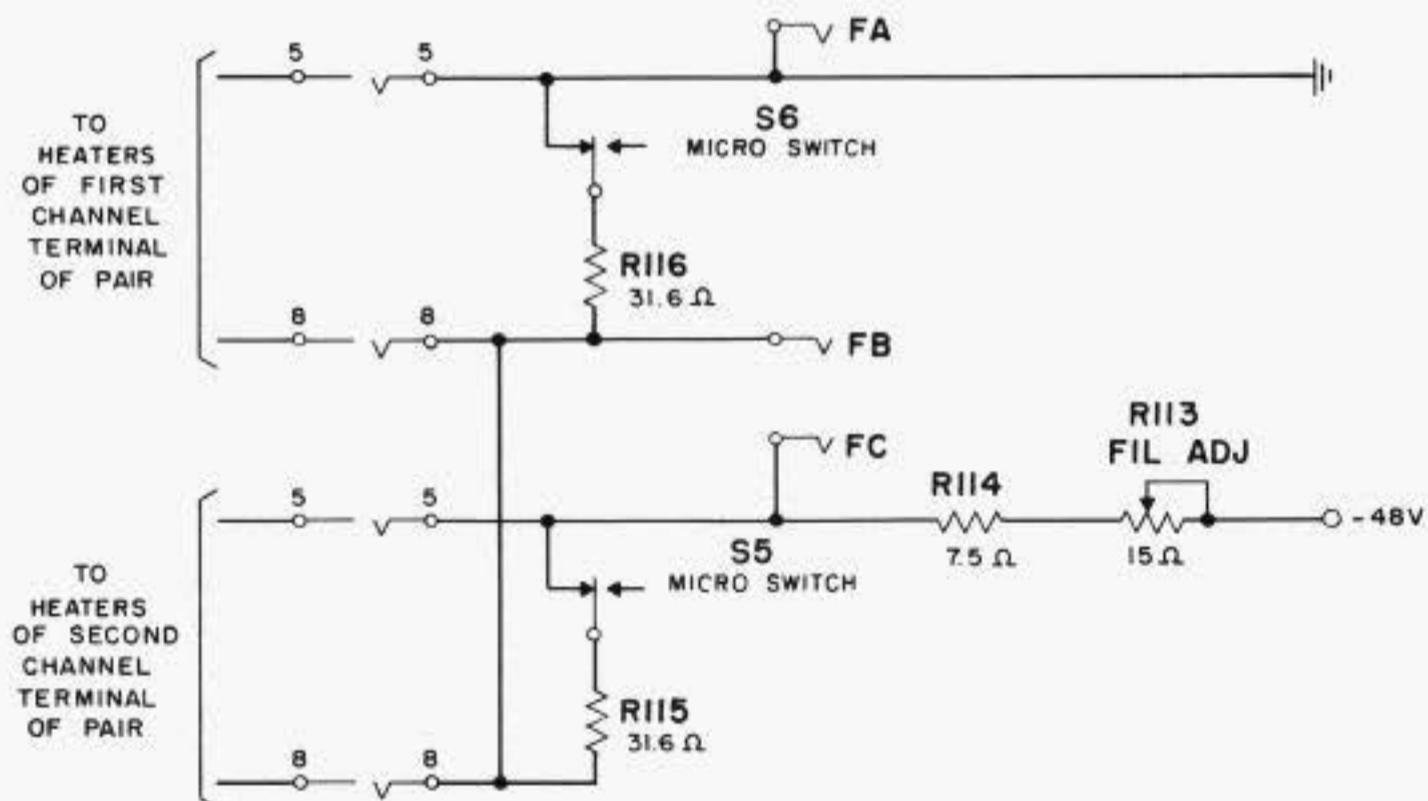
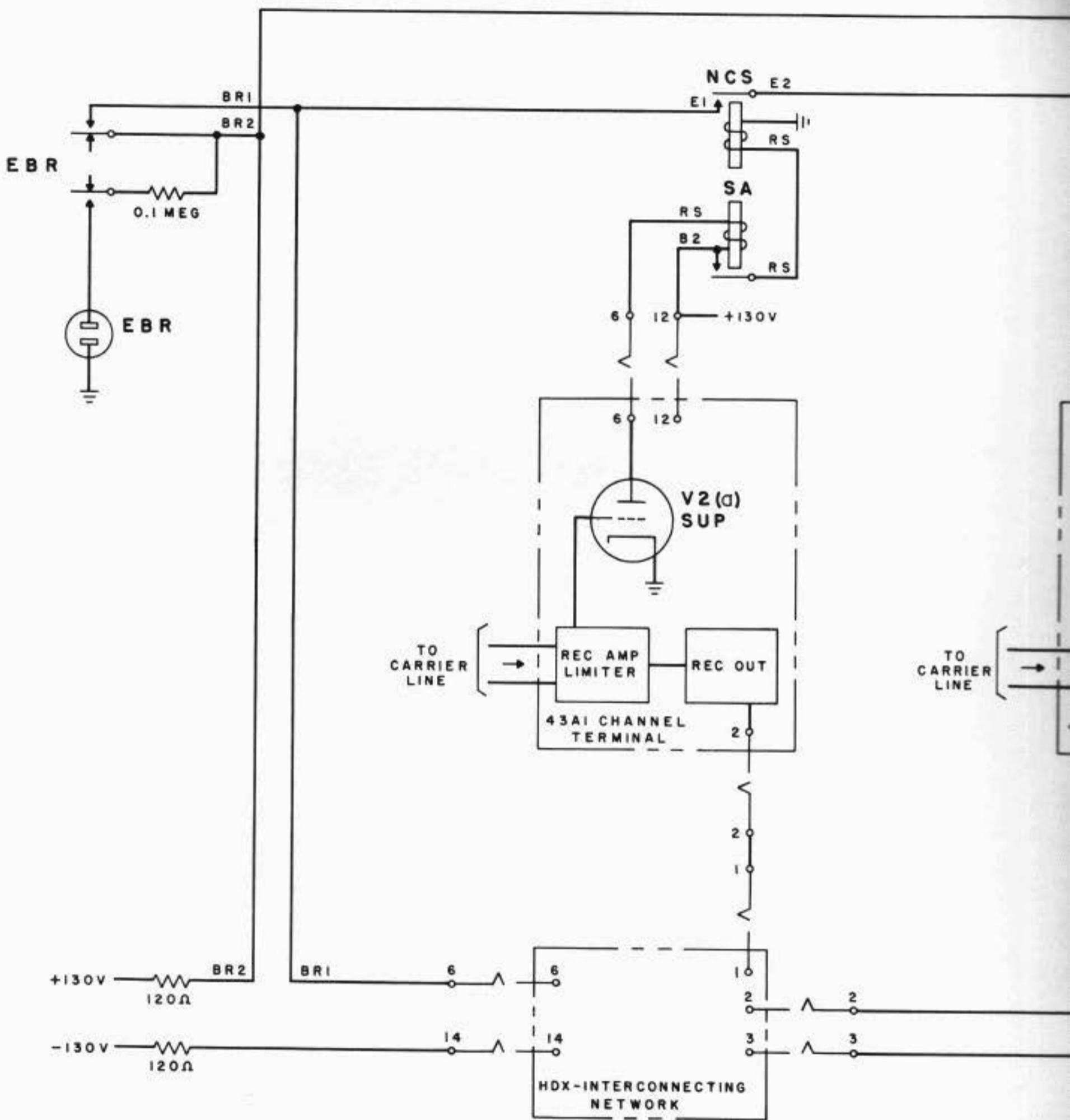


Fig. 22 – Channel Terminal Connection to -48 Volt Battery for Heater Supply for a Pair of Channel Terminals

BATTERY RESTORE
KEY AND LAMP
CIRCUIT

FIRST 43AI CHANNEL
TERMINAL CIRCUIT



SECOND 43AI CHANNEL
TERMINAL CIRCUIT

THIRD 43AI CHANNEL
TERMINAL CIRCUIT
(AS REQUIRED)

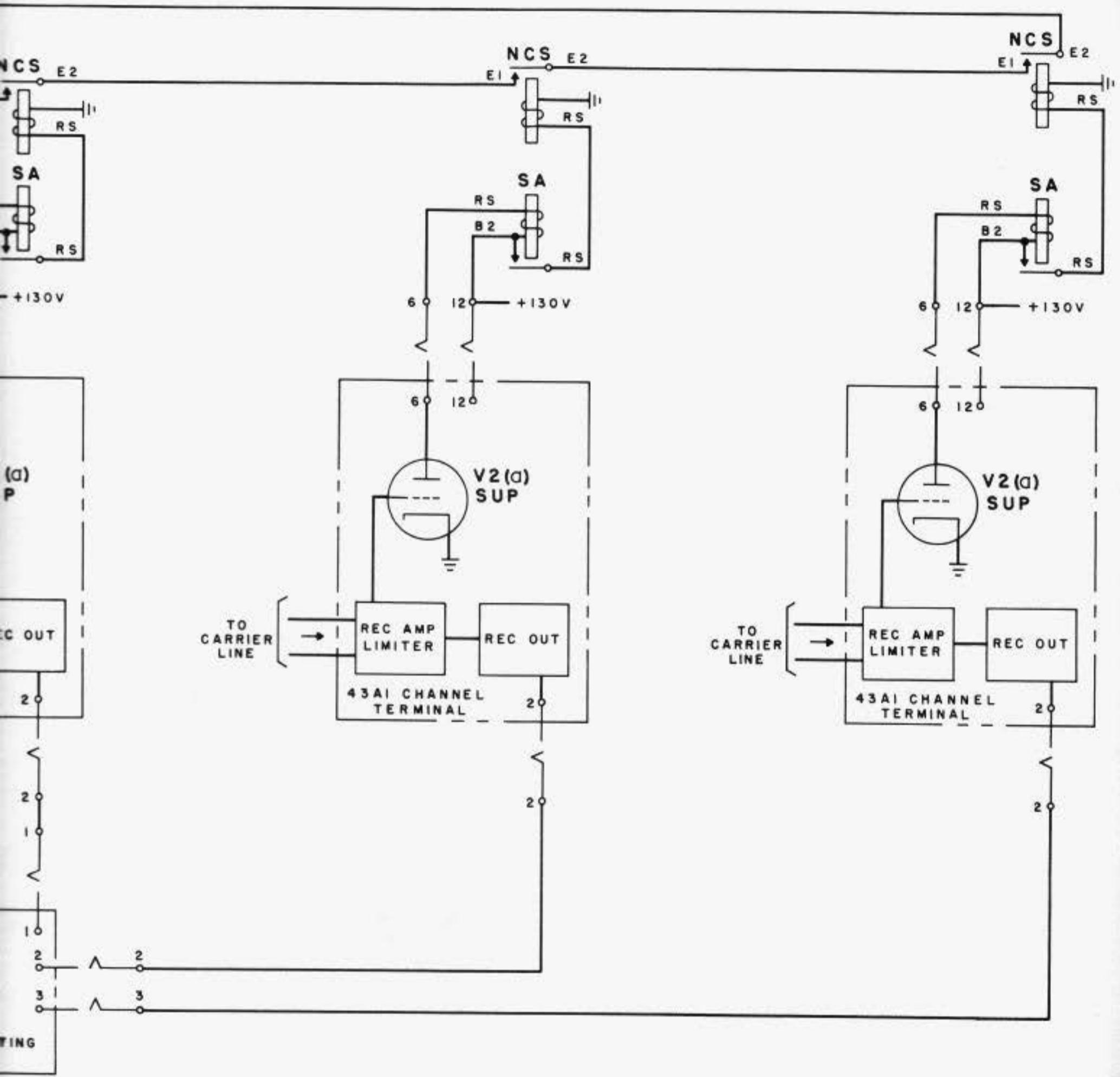


Fig. 24 – Typical Circuit Arrangement for Obtaining No-carrier Indication for Channel Terminals Associated with the HDX-interconnecting Network