165C1 TEST SET
FOR TESTING
43A1 CARRIER TELEGRAPH CHANNEL TERMINALS

CONTENTS

1. GENERAL

1.01 The 165C1 test set is a unit which may be used for testing and adjusting 43A1 carrier telegraph channel terminals, 453- and 454-type networks, and 407A, 408A, and 429A electron tubes.

1.02 This section is reissued to make minor changes in the description of operating features of the 165C1 test set and associated equipment required for making tests on 43A1 channel terminals. Since this is a general revision, the arrows ordinarily used to indicate changes have been omitted.

1.03 The test set may be used to test a channel terminal for the following functions:

(a) *AC Transmission Features*

(1) Operation with another channel terminal known to be in good condition on either a 2- or 4-wire basis.

(2) Operation with the sending and receiving sides of the channel terminal under test connected together.

(b) *DC Neutral Loop or Hub Features*

(1) Operation with neutral loop circuits on a half or a full duplex basis.

(2) Operation with type 2 hub circuits on a half or a full duplex basis. For this type of operation, suitable coupling units (144 type) must be furnished, see Paragraph 2.09.

1.04 The test set may be used for making frequency and voltage measurements on the 453-type send and the 454-type receive networks.

1.05 The test set may be used to test the electron tubes used in the 43A1 terminal for:

(a) Saturation current

(b) Cutoff current

(c) Internal grid-cathode and heater-cathode short circuits

2. DESCRIPTION OF CIRCUITS

A. General

2.01 The circuits of this test set consist of switches, coils, networks, jacks, keys, etc, by means of which the channel terminal under

test (called channel terminal A) and another channel terminal (called channel terminal B) may be connected in various testing hookups. A test milliammeter is provided as part of the set, for measuring current in dc circuits.

2.02 Four main control switches on the test set, designated CARRIER, DX A, LP A, and DX B, provide circuit arrangements as follows:

(a) The switch designated CARRIER has three positions which provide the following arrangements.

(1) Position 2W provides a simulated 2-wire transmission line between channel terminals A and B as shown in Fig. 10.

(2) Position 4W provides a simulated 4-wire transmission line between channel terminals A and B as shown in Fig. 11.

(3) Position LOC provides a simulated 2-wire transmission line over which channel terminal A may send signals to itself as shown in Fig. 12.

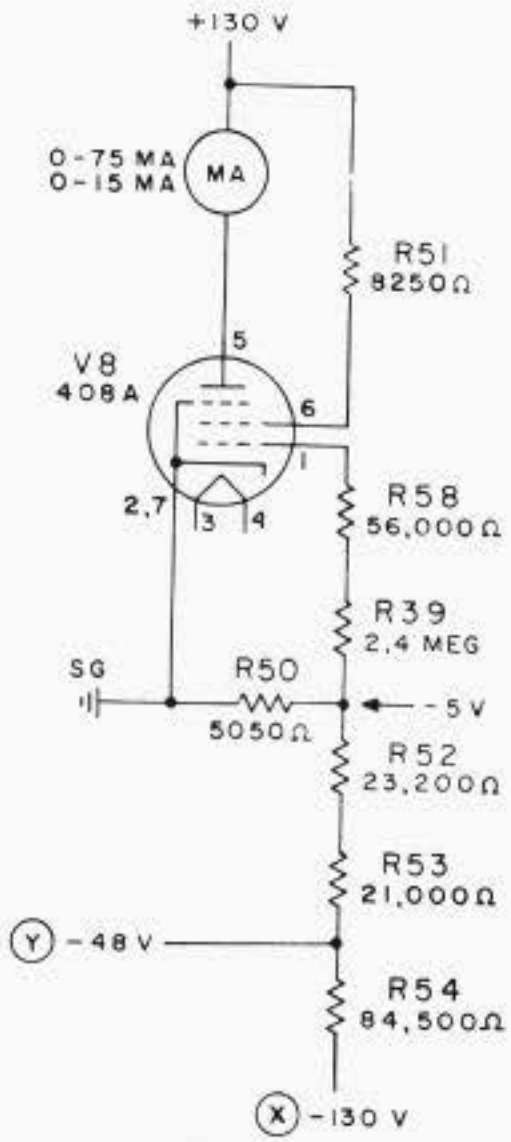

Fig. 2 – BIAS V7, V8 Key in CO Position for 408A Tube

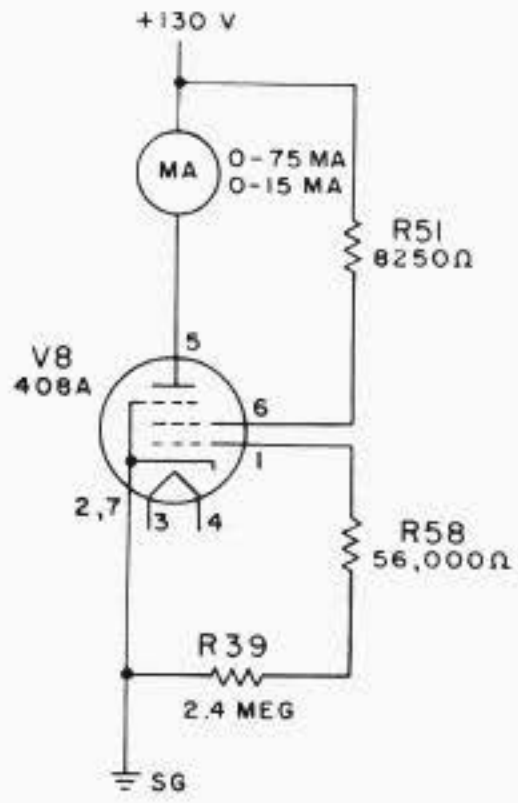

Fig. 1 – BIAS V7, V8 Key in C Position for 408A Tube

(b) The DX A switch has four positions which provide the following terminations for channel terminal A.

(1) A neutral loop full-duplex termination (NEUT FDX position) as shown in Figs. 13A, B, C, and D.

(2) A neutral loop half-duplex termination (NEUT HDX position) as shown in Figs. 14A, B, C, and D.

(3) A type 2 hub circuit full-duplex termination (HUB FDX position) as shown in Fig. 15.

(4) A type 2 hub circuit half-duplex termination (HUB HDX position) as shown in Fig. 16.

(c) The LP A switch has four positions which provide the following voltage and current arrangements for the various terminations of channel terminal A.

(1) A +130 volts to ground, 62.5-milliampere loop (+130-volt 62.5-milliampere position) as shown in Figs. 13A and 14A.

(2) A +130 volts to ground, 20-milliampere loop (+130-volt 20-milliampere position) as shown in Figs. 13B and 14B.

(3) A ±130 volts, 62.5-milliampere loop (±130-volt 62.5-milliampere position) as shown in Figs. 13C and 14C.

(4) A ±48 volts, 20-milliampere loop (+48-volt 20-milliampere position) as shown in Figs. 13D and 14D.

(d) The DX B switch has two positions which provide the following terminations for channel terminal B.

(1) A neutral loop full-duplex termination (FDX position) similar to Fig. 13A.

(2) A neutral loop half-duplex termination (HDX position) similar to Fig. 14A.

These loops are arranged for +130 volts to ground, 62.5-milliampere operation only.

B. Electron Tube Test Circuits

2.03 The electron tube test circuits of the test set consist of electron tube sockets, resistors, power supplies, switching keys, and a meter by means of which the tests listed in Paragraph 1.04 may be made. The positions of the test keys and the requirements for tube testing are given in Table A. The plate voltage on the tubes during these tests must be 130 ±2 volts.

C. AC Transmission Test Circuits

2.04 The 2-wire setting (2W) of the CARRIER switch connects the sending and receiving filters together in both channel terminal A and channel terminal B, see Fig. 10. For testing under this condition, the midband frequency of the sending unit of channel terminal A must be the same as the midband frequency of the receiving unit of channel terminal B and vice versa. The frequencies in the two directions must differ by at least 170 cps. See Section AB83.047.02 for limitations on difference between send and receive levels. Simultaneous 2-way transmission may be carried on with this test setup. The carrier frequency and send level of either channel terminal may be measured at the adjacent EQPT jacks by instruments ex-

TABLE A

ELECTRON TUBE CODE NO.	TEST SET SOCKET DESIGN	FIG. NO.	PLT KEY POS V7	PLT KEY POS V9	BIAS KEY POS V7, V8	BIAS KEY POS V9	SHORT CKT KEY POS	ACCEPTABLE POS IN CHAN TERM	LIMITS CUR MA
407A	V7	7	SU	N	C	N	N	V1, V3	Min 7
407A	V7	7	SC	N	C	N	N	V1, V3	Min 7
407A	V7	7	SU	N	C	N	N	V2, V8	Min 8
407A	V7	7	SC	N	C	N	N	V2, V8	Min 8
407A	V7	8	SU	N	CO	N	N	V1, V2, V3	Max 0.4
407A	V7	8	SC	N	CO	N	N	V1, V2, V3	Max 0.4
407A	V7	9	N	N	N	N	SHORT	V1, V2, V3	0*
408A	V8	1	N	N	C	N	N	V4, V7	Min 9†
408A	V8	2	N	N	CO	N	N	V4, V7	Max 1.4
408A	V8	3	N	N	N	N	SHORT	V4, V7	0*
429A	V9	4	N	L	N	C	N	V5, V6	Min 32
429A	V9	4	N	H	N	C	N	V5, V6	Min 29
429A	V9	5	N	L	N	CO	N	V5, V6	Max 0.5
429A	V9	5	N	H	N	CO	N	V5, V6	Max 0.5
	V9	6	N	N	N	N	SHORT	V5, V6	0*

*Tapping tube lightly should not change meter reading of zero.
†Min. 10 Ma when tube is to be used to test 454 network.

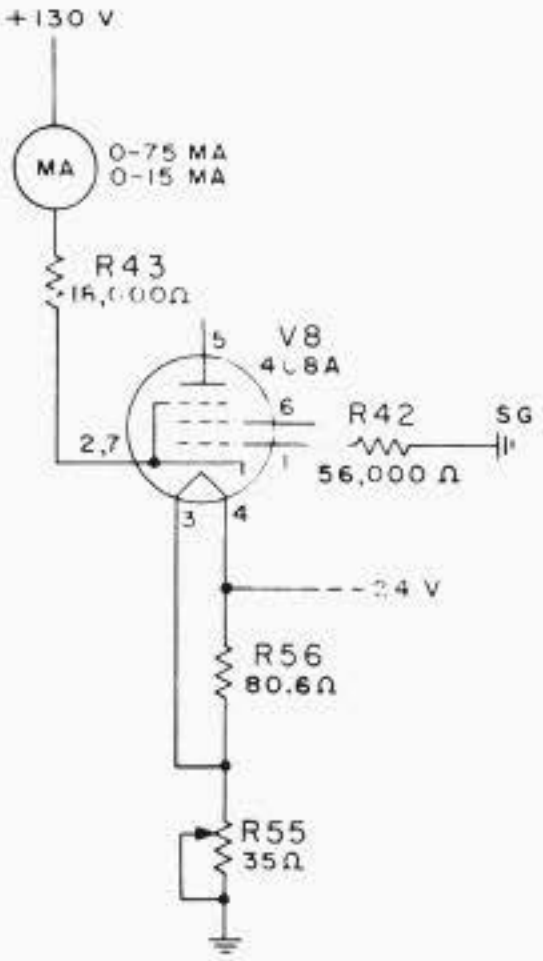

Fig. 3 — SHORT-CKT Key in SHORT Position for 408A Tube

ternal to the test set, see Part 4. A variable attenuator with 2 db steps, KS-14447, List 4, designated LINE 1, is included in this test circuit. An external carrier signal may be inserted into the LINE jacks in order to perform tests on either of the receiving circuits.

2.05 The 4-wire setting (4W) of the CARRIER switch connects the sending unit of channel terminal A to the receiving unit of channel terminal B and at the same time connects the receiving unit of channel terminal A to the sending unit of channel terminal B over a separate transmission path, see Fig. 11. The sending and receiving units of each channel terminal may have the same midband frequency, if desired, but when operating with maximum difference between send and receive levels, different frequencies for the two directions will give better results. See Section AB83.047.2 for detailed instructions. The EQPT and LINE jacks, A or B, may be used, respectively, as points for measuring the output of the sending channel terminal or for inserting a carrier signal into the receiving channel terminal in either direction. Each line is equipped with a variable attenuator with 2 db steps. The attenuators are designated LINE 1 and LINE 2.

2.06 The local setting (LOC) of the CARRIER switch permits channel terminal A to send signals to itself, see Fig. 12. In this arrangement, the sending and receiving units of the channel terminal must have the same midband frequency. The EQPT and LINE jacks may be used, respectively, as points for measuring the output of the sending circuit of the channel terminal or for inserting a carrier signal into the receiving circuit of the channel terminal. The line is equipped with a variable attenuator with 2 db steps designated LINE 1.

D. DC Neutral Loop and Type 2 Hub Test Circuits

2.07 Figs. 13A, 13B, 13C, and 13D show the circuit arrangements when the DX A switch is at the neutral loop full-duplex position (NEUT

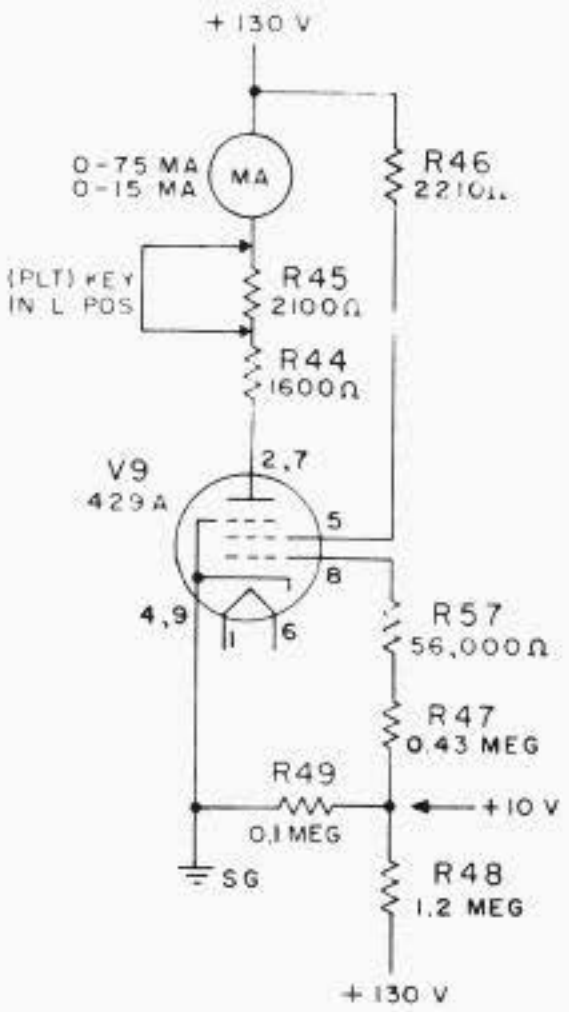

Fig. 4 — V9 BIAS Key in C Position for 429A Tube

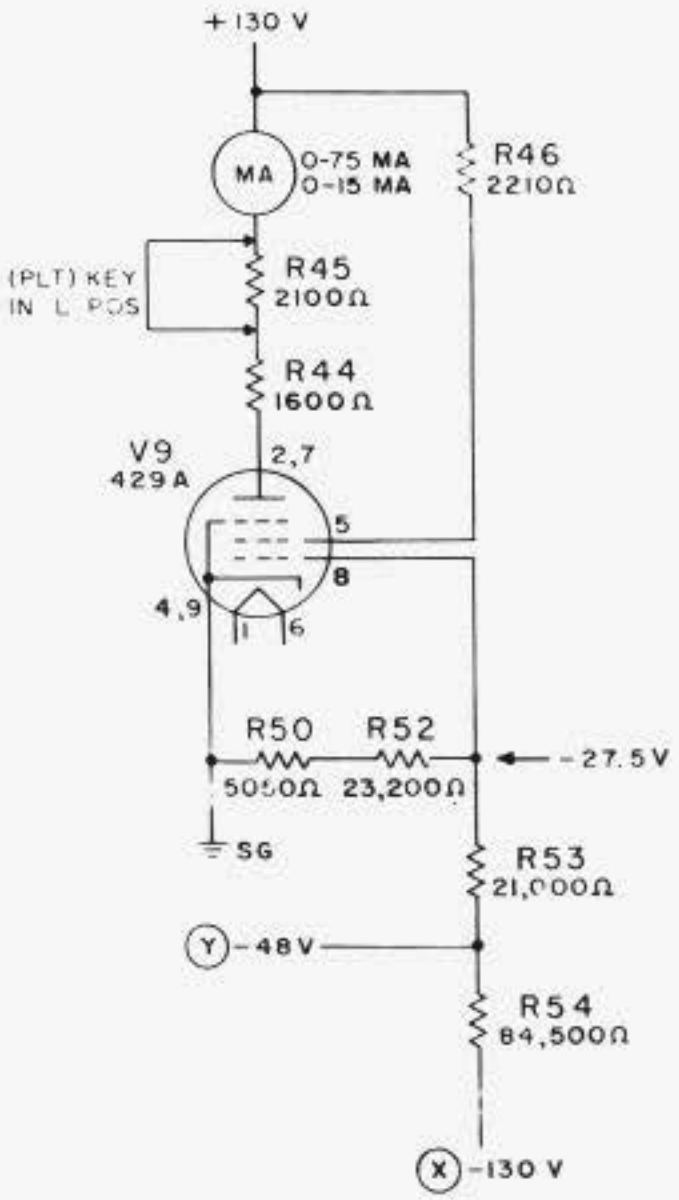

Fig. 5 — V9 BIAS Key in CO Position for 429A Tube

FDX), and the LP A switch is set to operate with various arrangements of loop battery supply as noted in the title of each figure. When tests are made with 20-milliampere loops, the V6 tube should be removed from its socket on channel terminal A. Direct current in the send or receive loops may be read by connecting the dc milliammeter to the SL CUR jacks or the RL CUR jacks, respectively. Bias and distortion measurements may be made in the send or receive loops by connecting the appearance circuit of a 118C3 transmission measuring set to the SL TMS jack or the RL TMS jack, respectively. A source of teletypewriter set signals must be connected to the SL CUR jack in order to make transmission measurements. The SEND key in the test set circuit may be used to produce either a steady marking or a steady spacing signal. In the normal position, a marking signal is sent.

2.08 Figs. 14A, 14B, 14C, and 14D show the circuit arrangements when the DX A switch is at the neutral loop half-duplex position (NEUT HDX), and the LP A switch is set to operate with various arrangements of loop battery supply as noted in the title of each figure. Tests may be made in the same manner as for the full-duplex termination.

2.09 Fig. 15 shows the circuit arrangement when the DX A switch is at the hub circuit full-duplex position (HUB FDX). The voltages for the operation of the hub-terminated channel terminal A may be measured at the SEND HP, the REC HP, and the FDX HP jacks. The volt-

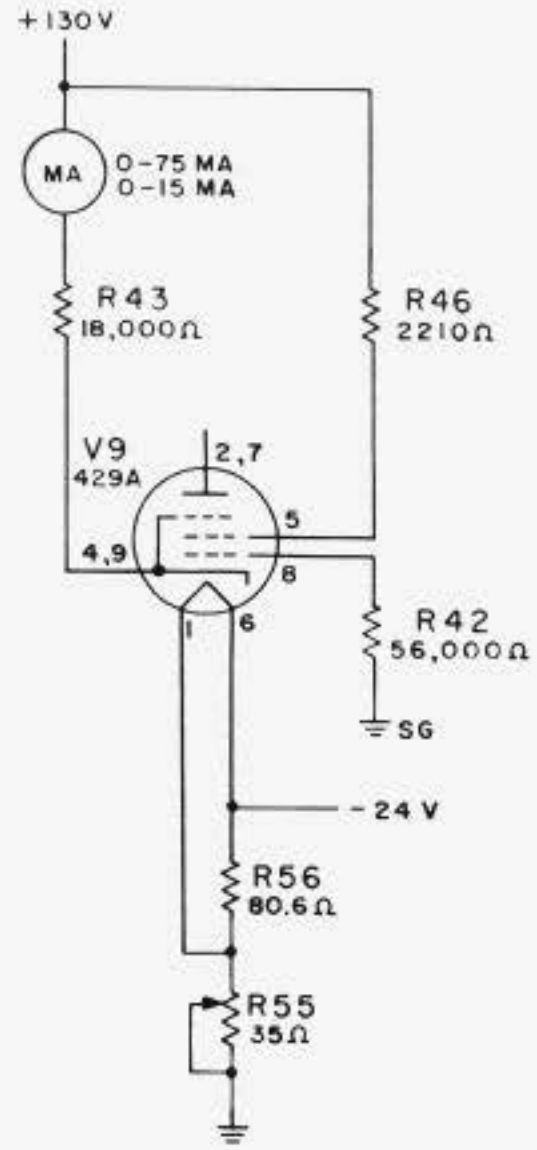

Fig. 6 — SHORT-CKT Key in SHORT Position for 429A Tube

ages at the SEND HP and REC HP jacks are +60 ±3 volts for a mark and —30 ±2 volts for a space. The voltages at the FDX HP jack are —10 ±2 volts for a mark and —60 ±3 volts for a space. The 144B and 144C coupling units shown in Fig. 15 provide a neutral loop termination which permits current and distortion measurements to be made. The coupling units are not furnished as part of the test set. Receive loop current may be read at the RL CUR jack. The HIT INDICATOR lamp is lighted when the channel terminal is receiving a spacing signal. A source of hub test signals must be connected to the SEND HUB jack when it is desired to make transmission tests. In order to check the double-space condition at channel terminal A, the SEND key may be used to send a second spacing signal into the hub circuit when it is already spacing. Hub-type channel terminals may be per Fig. B or Fig. W of the channel terminal circuit. Either may be tested per Fig. 15 or 16 of this section.

2.10 Fig. 16 shows the circuit arrangement when the DX A switch is at the hub circuit half-duplex position. This circuit differs from that of Fig. 15 chiefly by the omission of the receiving hub potentiometer, the FDX HUB potentiometer and the 144C coupling unit. Measurements are made in a manner similar to that described under the full-duplex hub circuit termination.

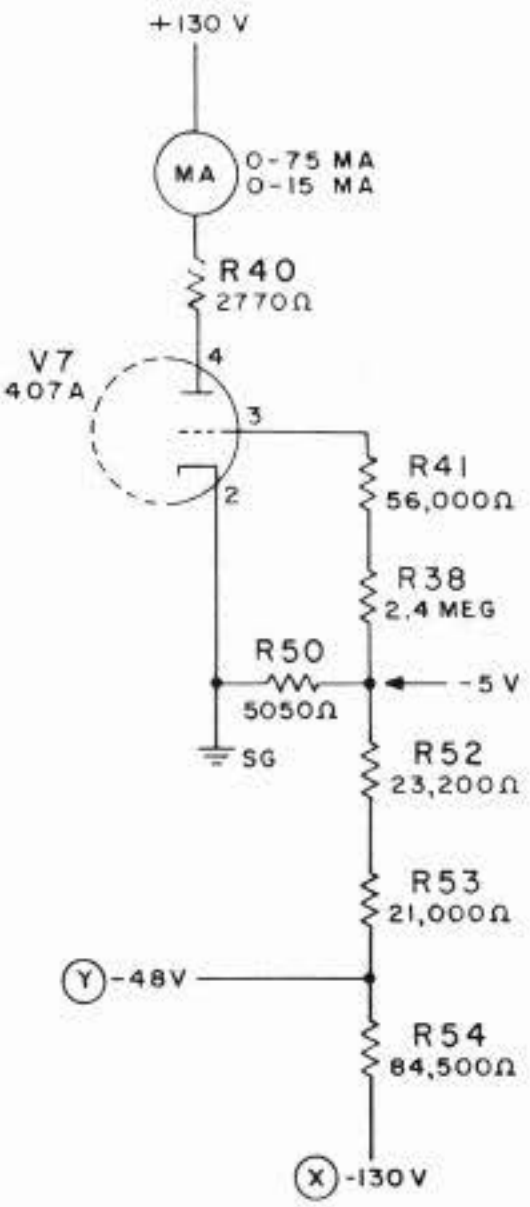

Fig. 8 — BIAS V7, V8 Key in CO Position for 407A Tube

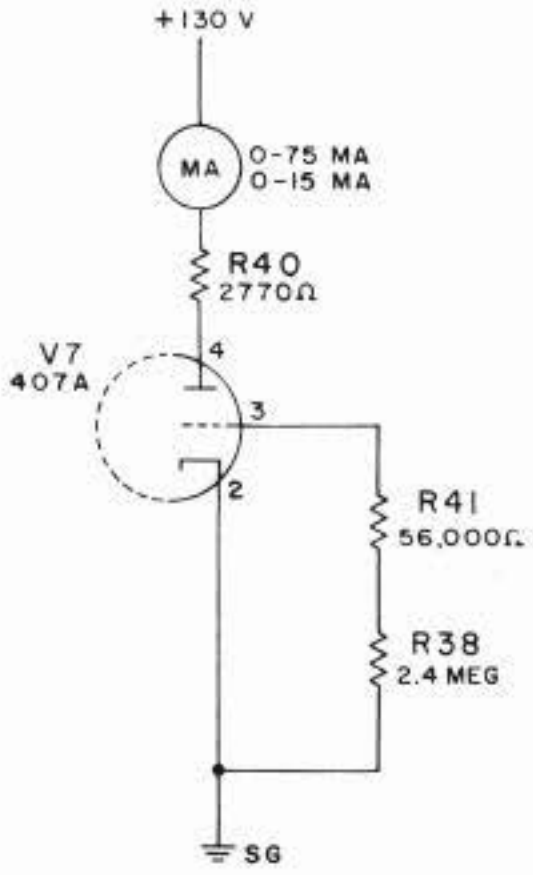

Fig. 7 — BIAS V7, V8 Key in C Position for 407A Tube

E. Supervisory Test Circuit

2.11 The circuit to test the receiving supervisory control feature of channel terminal A appears in Fig. 17. When the channel terminal receives a carrier signal of sufficient level, SU relay is operated and the RS (green) lamp is lit. The operating current for the relay may be measured at the RS CUR jack. Supervisory carrier-on and carrier-off signals may be obtained by operating the B CARR key to the ON and OFF positions, respectively.

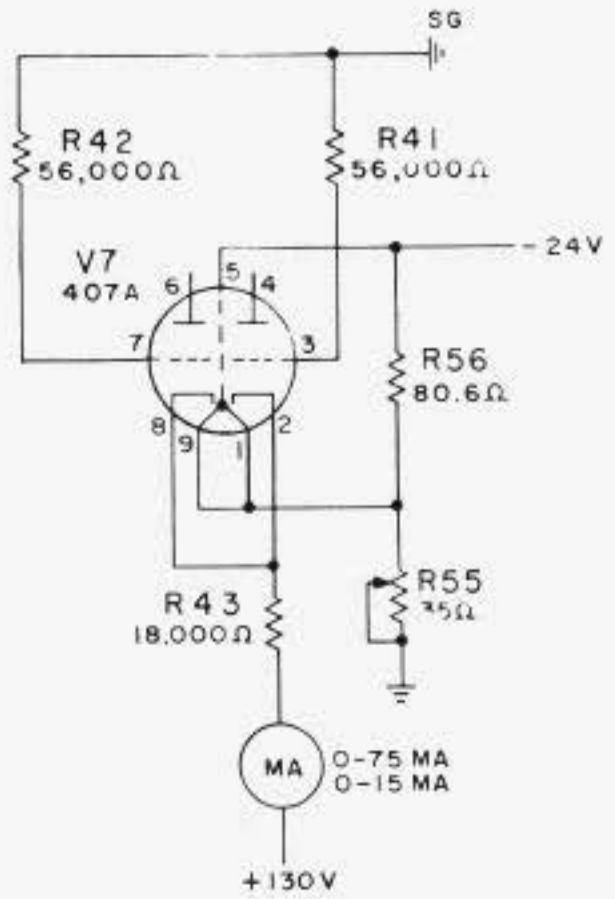

Fig. 9 — SHORT-CKT Key in SHORT Position for 407A Tube

3. DESCRIPTION OF EQUIPMENT

A. General

3.01 The test set consists of a basic unit which mounts the apparatus and circuitry required to provide the interconnection and switching functions of the test set. It may be mounted on a 19-inch relay rack mounting panel which is 21 inches high. The set will protrude approximately 4-3/8 inches in front of the mounting panel. Its over-all depth is approximately 8-7/8 inches. The test set weighs approximately 35 pounds. When equipped with two 43A1 channel terminals, it weighs approximately 60 pounds.

B. Basic Unit

3.02 The basic unit, see Fig. 18, consists essentially of the following five panels.

Jack panel
Meter and control panel
Component panel
Transmission measuring set appearance panel
Tube test panel

3.03 The jack panel and the meter and control panel occupy the lower third of the panel area of the test set. They contain the jacks, keys, signal lamps, and switches which control the test set. In addition, they contain the two line attenuators and the milliammeter.

3.04 The component panel occupies the rear of the top sixth of the panel area of the test set. It is directly behind the tube test panel. It contains the supervisory relay, repeating coils, resistors, varistors, and terminal strips.

3.05 The transmission measuring set appearance panel is located between the meter and control panel and the tube test panel. This panel mounts a standard appearance circuit for the 118C3 or 118C4 transmission measuring set. It contains the adjusting rheostats for the filament voltage supply for channel terminals A and B. The two channel terminals are mounted on brackets which are built into the test set. These brackets appear on the test set to the right and to the left of the measuring set panel.

3.06 The tube test panel occupies the front of the top sixth of the panel area of the test set. It contains one socket each for the 407A, 408A, and 429A electron tubes. It contains the T FIL rheostat which adjusts the filament voltage for the tube under test. It also contains most of the resistors associated with the vacuum tube test circuit.

C. Arrangements of Channel Terminals

3.07 The channel terminal under test (channel terminal A) must be mounted at the left of the measuring set panel (front view). Channel terminal B is generally mounted at the right of the measuring set panel. These channel terminals are inserted from the front of the test set and connect with the multicontact KS-14173 jacks which are permanently wired to the test set.

3.08 In order to gain access to the interior of channel terminal A, it may be placed on a bench or a table and connected to the jack on the test set by means of a P20E patch cord. When so arranged, the send and receive networks of the channel terminal may be connected to it through adapters, see Fig. 19.

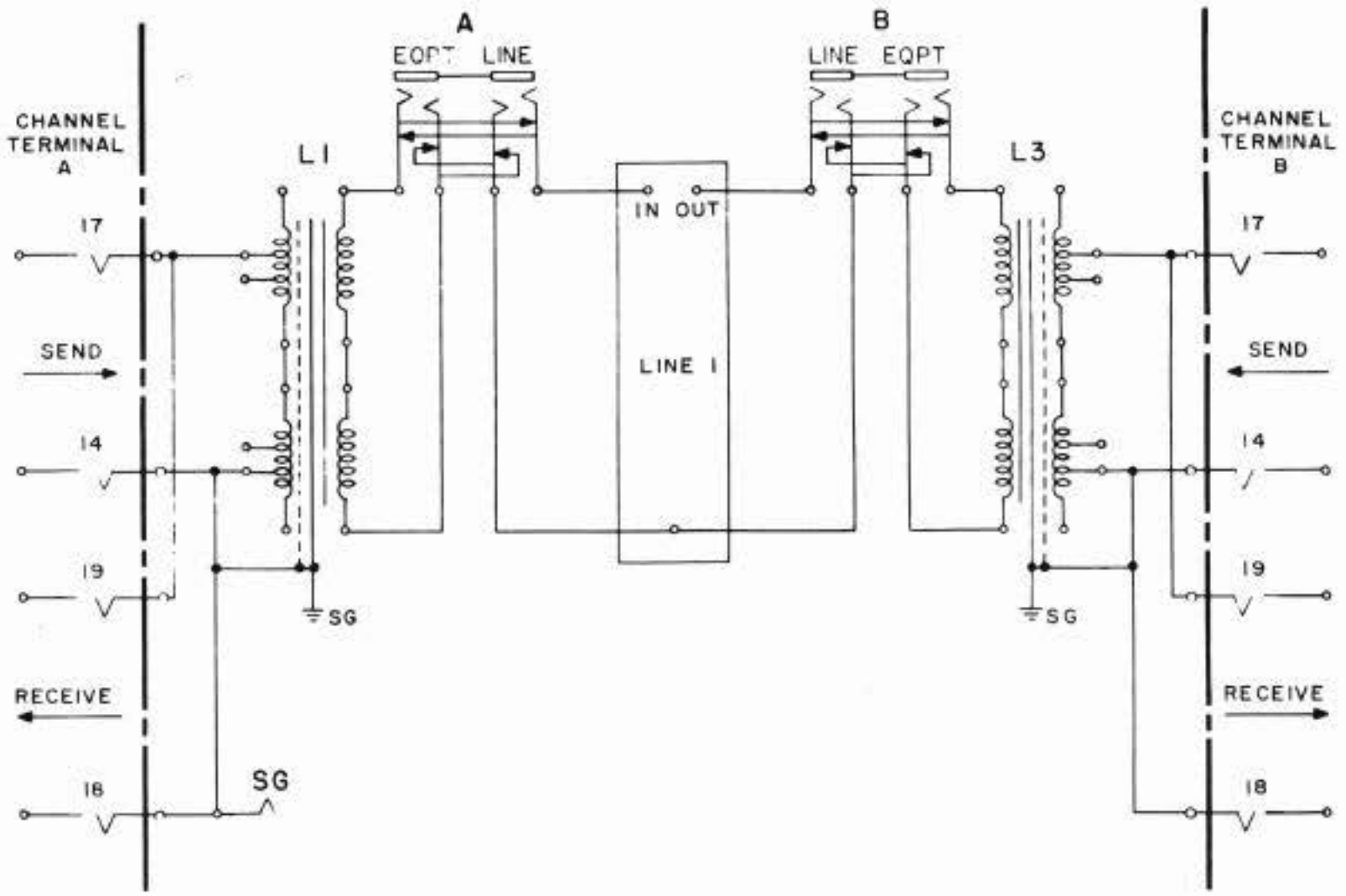

Fig. 10 — 2-wire Line

D. Associated Equipment

3.09 In order to properly test the 43A1 channel terminal, the following equipment is needed in addition to the test set.

(a) A high-impedance multiscale volt-ohmmeter suitable for measuring dc voltages from 3 to 300 volts with an accuracy of at least 2 per cent of the full-scale value, and ac voltages from 3 to 60 volts with an accuracy of at least 5 per cent of the full-scale value. The dc impedance of the meter should be 20,000 ohms per volt, while the ac impedance should be 3000 ohms per volt (the KS-14510 meter is adequate).

(b) A source of open and close as well as type 2 Hub test signals (the 110C multiple sender may be used).

(c) A 118C3 or 118C4, or a 164C1 transmission measuring set.

(d) A level measuring device with a 600-ohm input impedance. (The 13A transmission measuring set may be used. If a vacuum tube voltmeter with a db scale is used, a separate 600-ohm termination must be provided to use with it.)

(e) A frequency source and a frequency measuring device accurate to ±1 cps within the range 300 to 6000 cps.

(f) One 144B and one 144C coupling unit to be known as "reference coupling units." These coupling units must ***not*** have legs relay circuits cabled to them.

(g) Two 43A1 channel terminals equipped for 62.5-milliampere neutral loop operation which are to be used as "reference units."

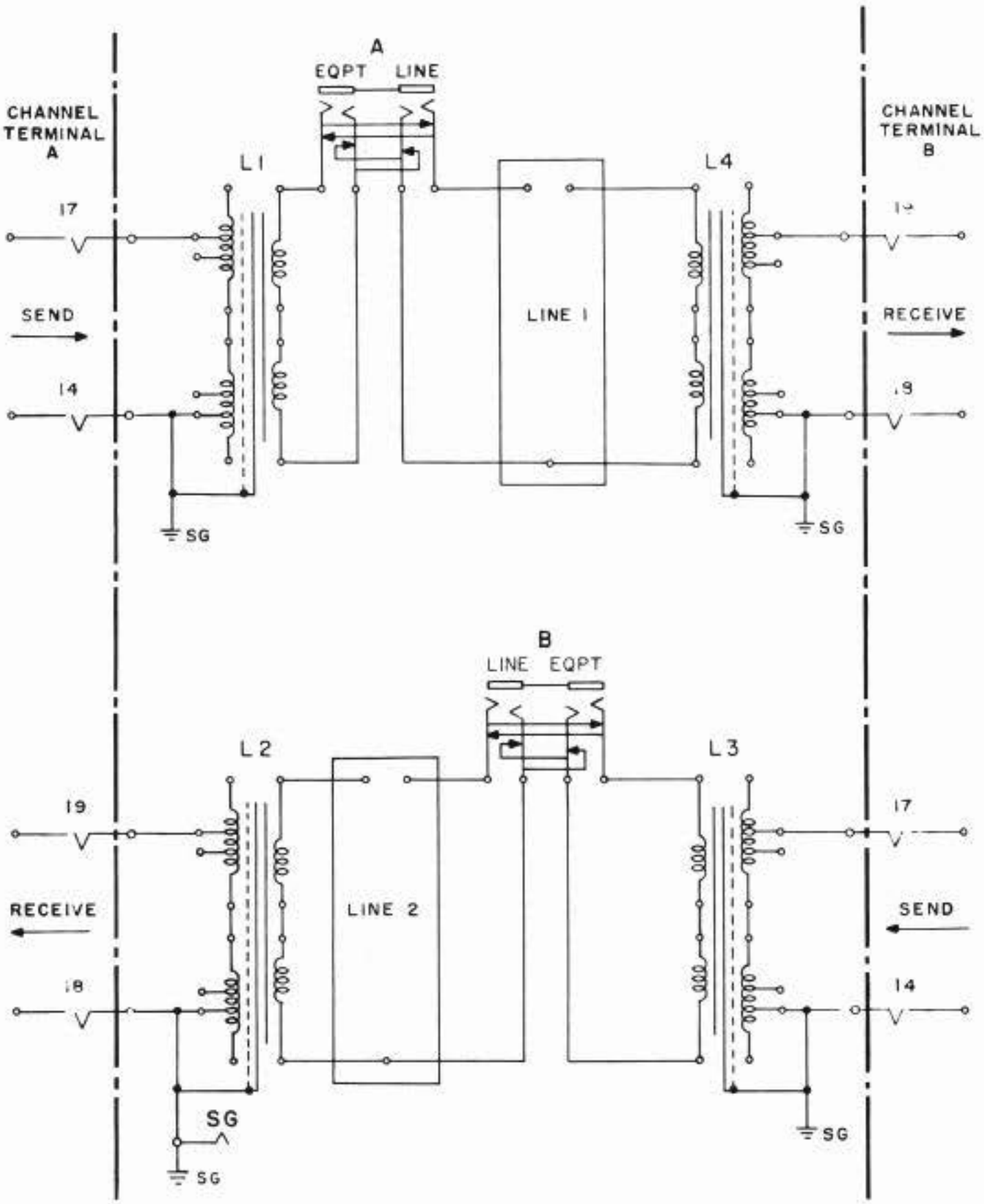

Fig. 11 — 4-wire Line

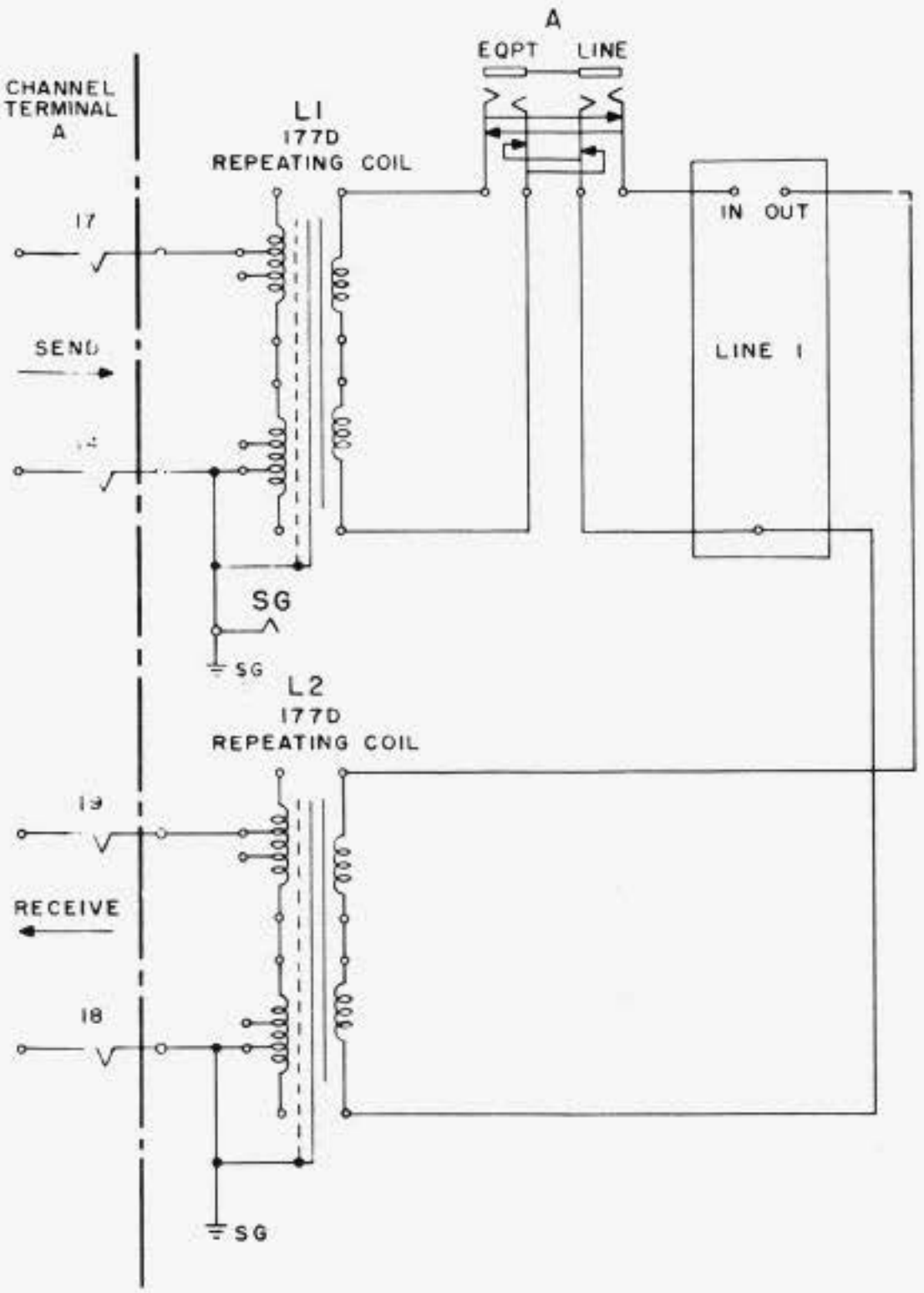

Fig. 12 – Channel Terminal A Sending to Itself

(h) A full complement of 453- and 454-type networks which meet the test requirements for these networks in Section E35.437 plus an additional 453U and 454U network. The two pairs of "U" networks are to be used as "reference networks" in the "reference units."

(i) A vacuum tube voltmeter suitable for measurement of ac voltages as low as 0.1 volt with an accuracy of at least 5 per cent of the full-scale value. It should have a scale reading directly in decibels. The Hewlett-Packard 400A or 400C vacuum-tube voltmeter may be used.

E. Miscellaneous Connections

3.10 The following items may be connected as shown on SD-70696-01 to terminals of the test set as required, on either a permanent or temporary basis.

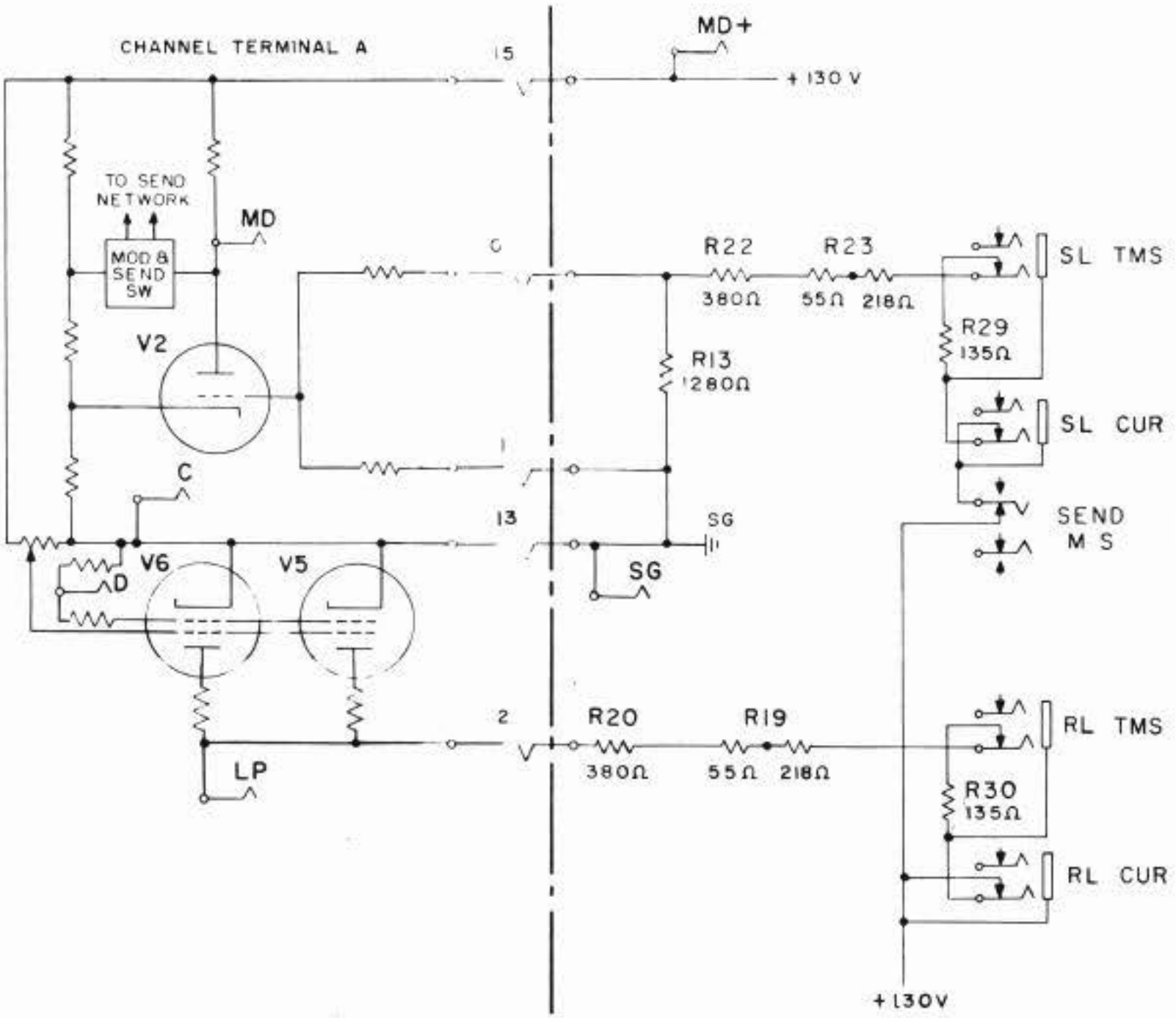

Fig. 13A – Full Duplex Neutral Loop Termination 130 Volts and Ground, 62.5 Milliamperes

A 110C multiple sender

Six trunk connections

One 144B and one 144C coupling unit

A 118C3 transmission measuring set appearance circuit

DC power supply

3.11 DC power for the test set must be obtained from the dc power supplies in the area where the set is to be used. The power should be supplied to the set through suitable office fusing.

4. DESCRIPTION OF OPERATING FEATURES

4.01 Loop current measurements may be made with a 2-scale milliammeter which is built into the test set. Current may be read on the 0- to 75-milliampere scale by patching from the DC MA jack to the SL CUR or the RL CUR jacks of channel terminal A or B or to the RS CUR jack or the TUB CUR jack. If the reading is less than 15 milliamperes, the SENS key may be depressed and the current may be read on the 0- to 15-milliampere scale, see Fig. 20.

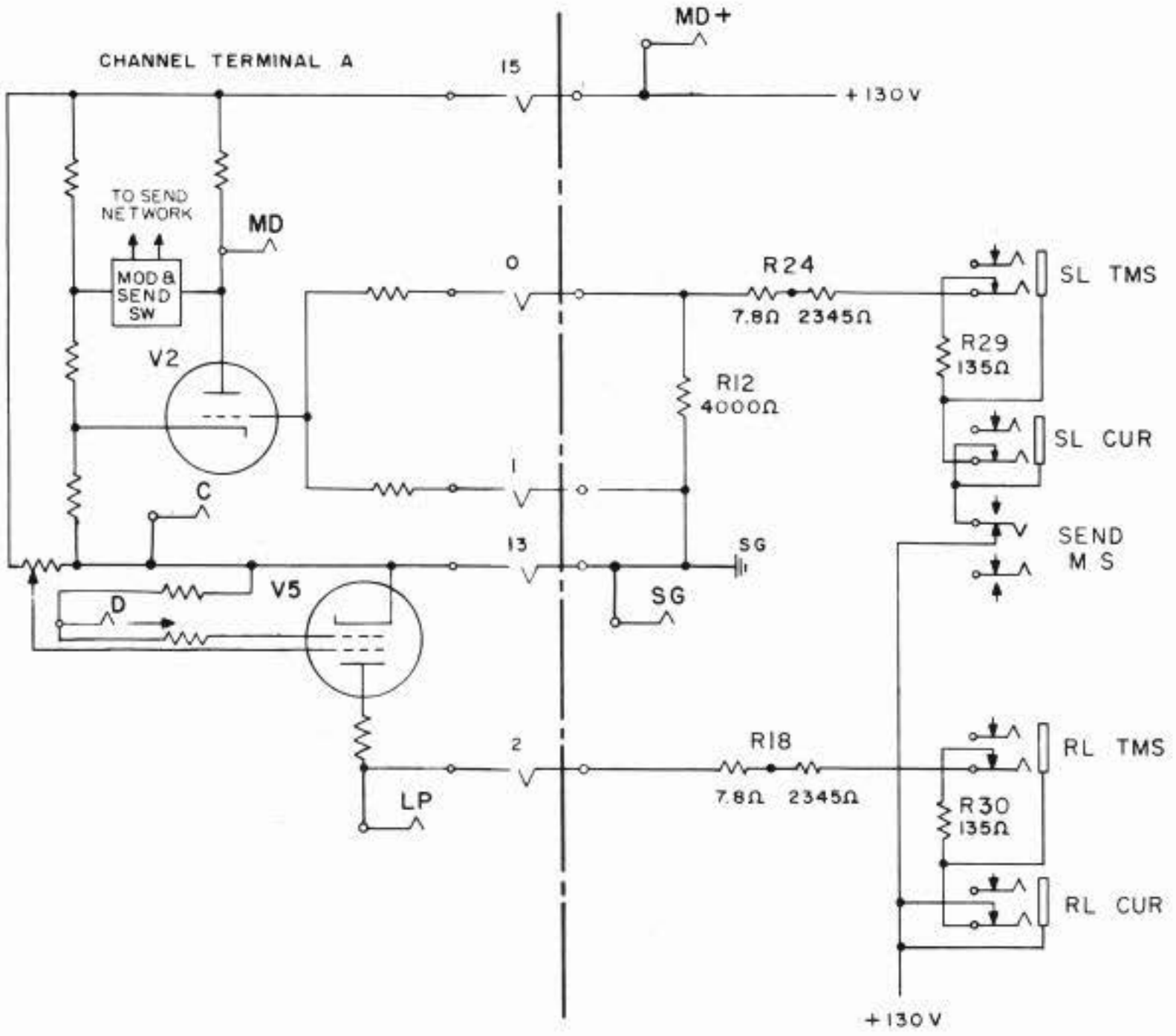

Fig. 13B — Full Duplex Neutral Loop Termination 130 Volts and Ground, 20 Milliamperes

4.02 If an appearance of the 118C3 or 118C4 transmission measuring set is furnished, bias and total distortion measurements may be made by patching from the TMS IN jack to either the RL TMS or the SL TMS jacks. Through the operation of control keys of the 118C appearance circuit measurements can be made on loops of various types and signalling speeds. For a description of the operation of the 118C3 set see Bell System Practice Section E45.428.

4.03 Test signals for transmission measurements may be introduced into either channel terminal send loop by patching from the 110C SIGS NEUT jack to the SL CUR jacks. For terminals arranged for hub operation, the 110C HUB SIGS jack should be patched to the SEND HUB jack.

4.04 Filament voltages of channel terminals A and B may be measured by connecting a voltmeter across the F+ and F— pin jacks. There is a separate set of these jacks for each channel terminal. The voltage may be adjusted to the required 20 volts, by adjusting the A FIL or the B FIL rheostats, respectively. These rheostats are located on the transmission measuring

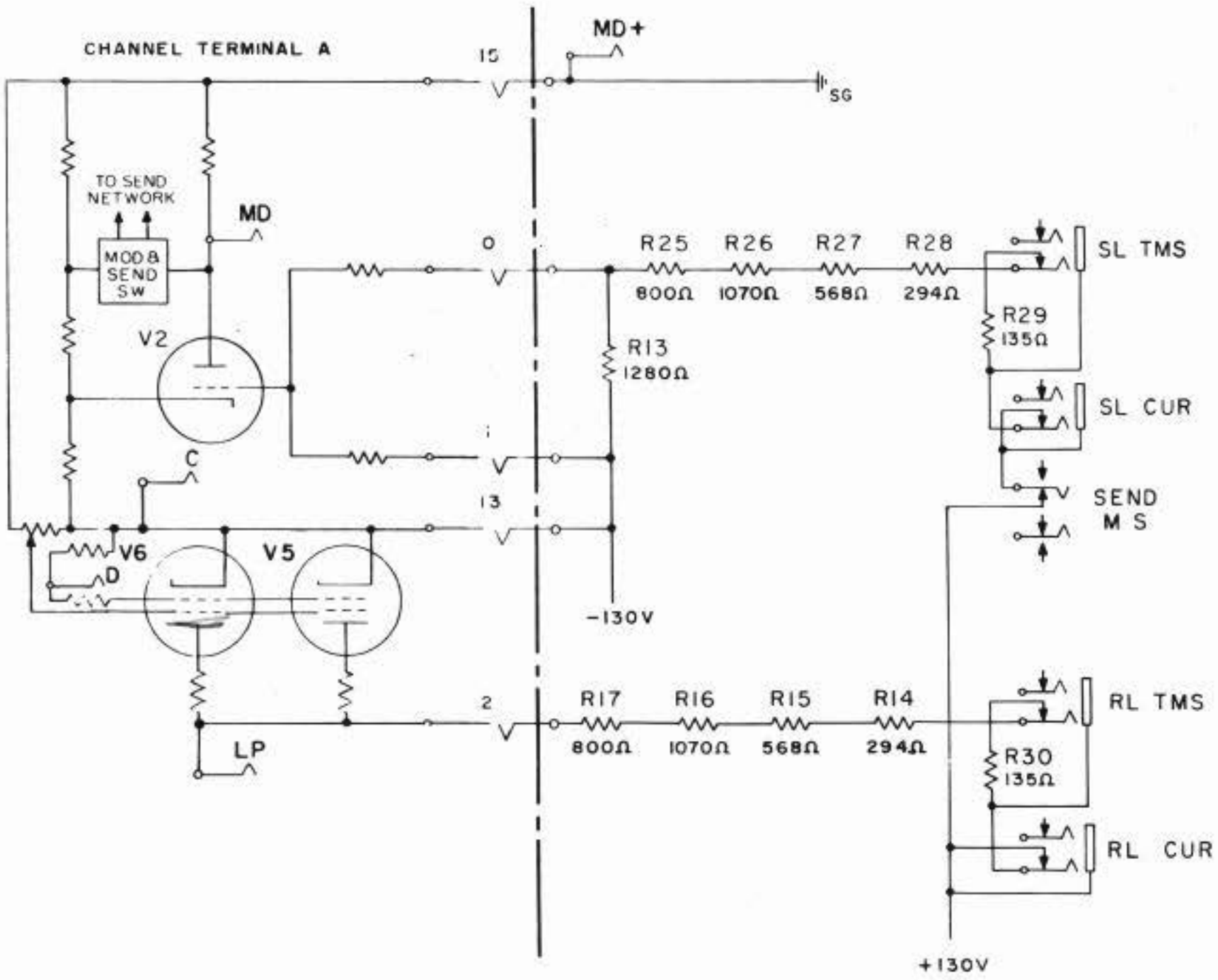

Fig. 13C — Full Duplex Neutral Loop Termination ±130 Volts, 62.5 Milliamperes

set panel. Voltage measurements, described in Section E44.263 of Bell System Practices on the 43A1 channel terminal, may be made at the pin jacks on the channel terminal.

4.05 A static measurement of the carrier signals send level can be made by transmitting a steady mark and patching from a 13A transmission measuring set to the EQPT jack adjacent to the sending channel terminal. See Figs. 1, 2, and 3. A static measurement of the SEND frequency may be made by patching from a frequency meter to the same jack.

4.06 If apparatus to be connected at the LINE or EQPT jacks requires connections other than the tip-ring jacks provided, the CARRIER JACK CONVERSION jack circuit may be used, see Fig. 21. In this case, the required LINE or EQPT jack should be patched to the appropriate jack or jacks in the group, and the external apparatus should be patched to another jack in the same group. Similarly, the DC JACK CON-

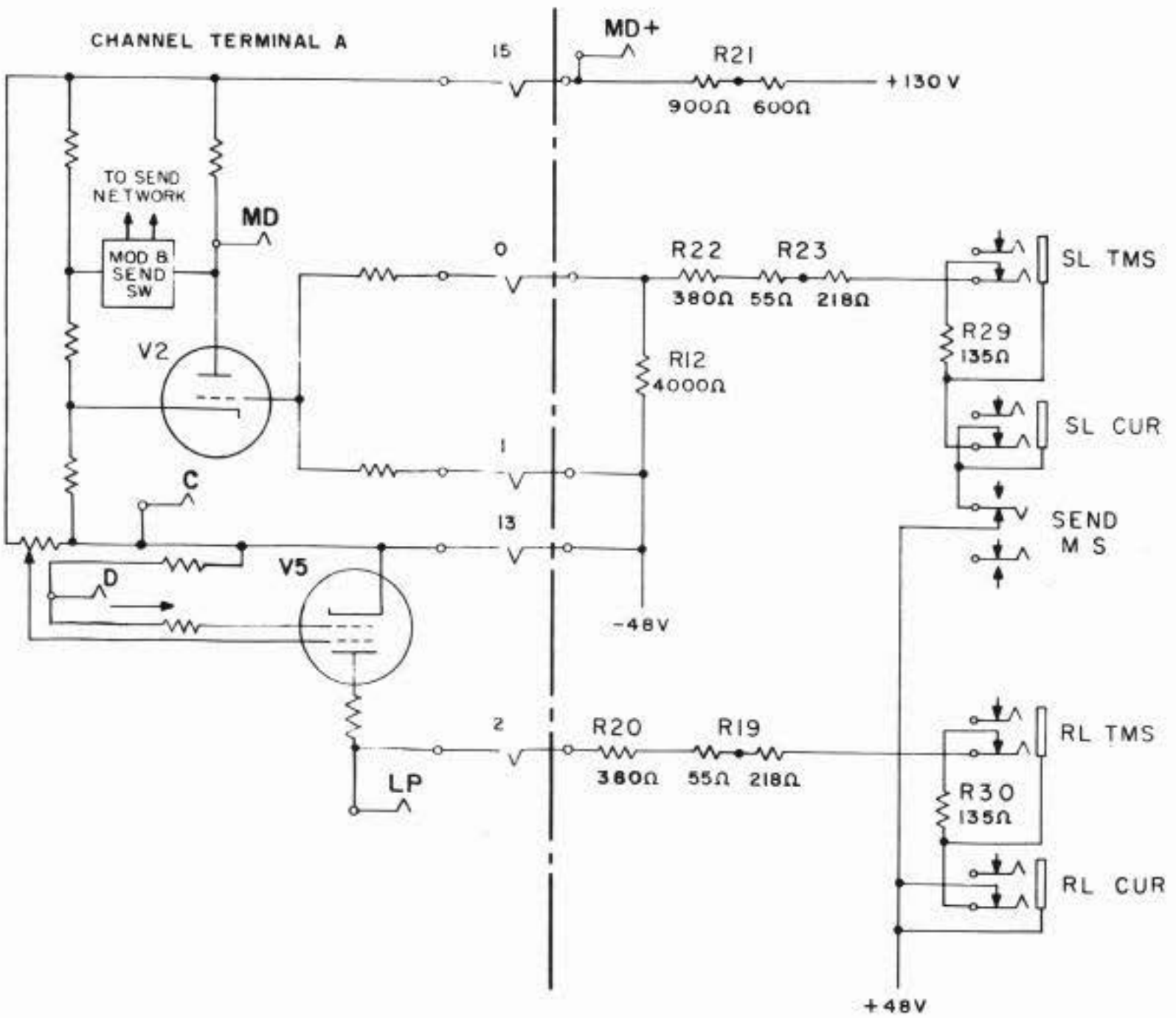

Fig. 13D – Full Duplex Neutral Loop Termination ±48 Volts, 20 Milliamperes

VERSION jack circuit may be used to patch the tip-ring-sleeve type jacks in the dc loop circuit to circuits requiring the tip-sleeve type jacks, see Fig. 22.

4.07 In order to extend the testing area, the required test jack on the test set may be patched to a TRK jack. These jacks provide circuit paths, as required, to other testing locations.

4.08 In order to test an electron tube, it must be plugged into the correctly designated socket on the tube test panel. Only one socket should be used at a time. The dc milliammeter may be patched into the tube circuit by patching from the DC MA jack to the TUBE CUR jack. The tube filament voltage may be measured by connecting a voltmeter across the F+ and F— pin jacks on the tube test circuit. The voltage may be adjusted to the required 20 volts by adjusting the T FIL rheostat which is located on the tube test panel. This should be done before beginning a series of tests and also each time the type of tube to be tested is changed.

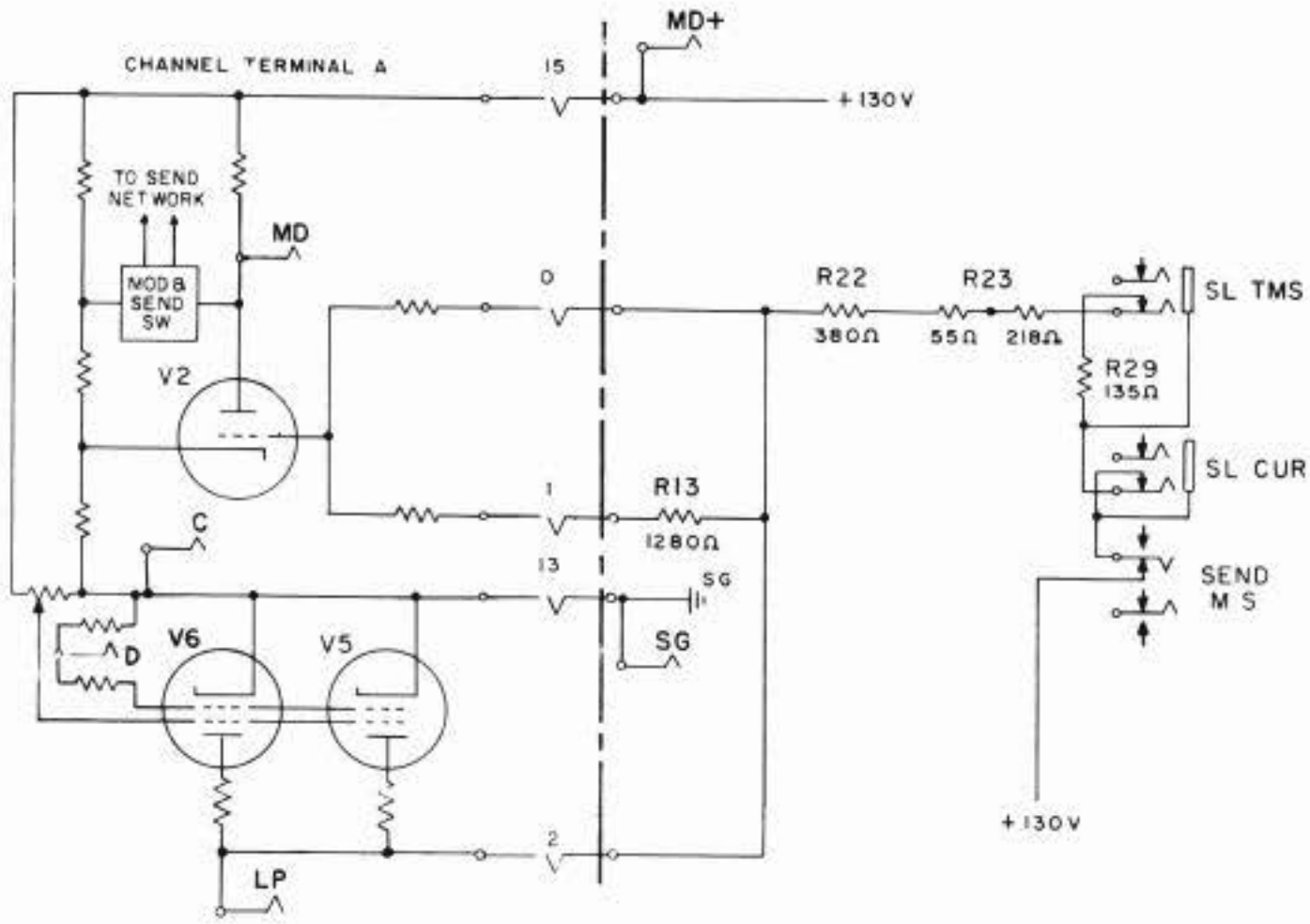

Fig. 14A – Half Duplex Neutral Loop Termination +130 Volts and Ground, 62.5 Milliamperes

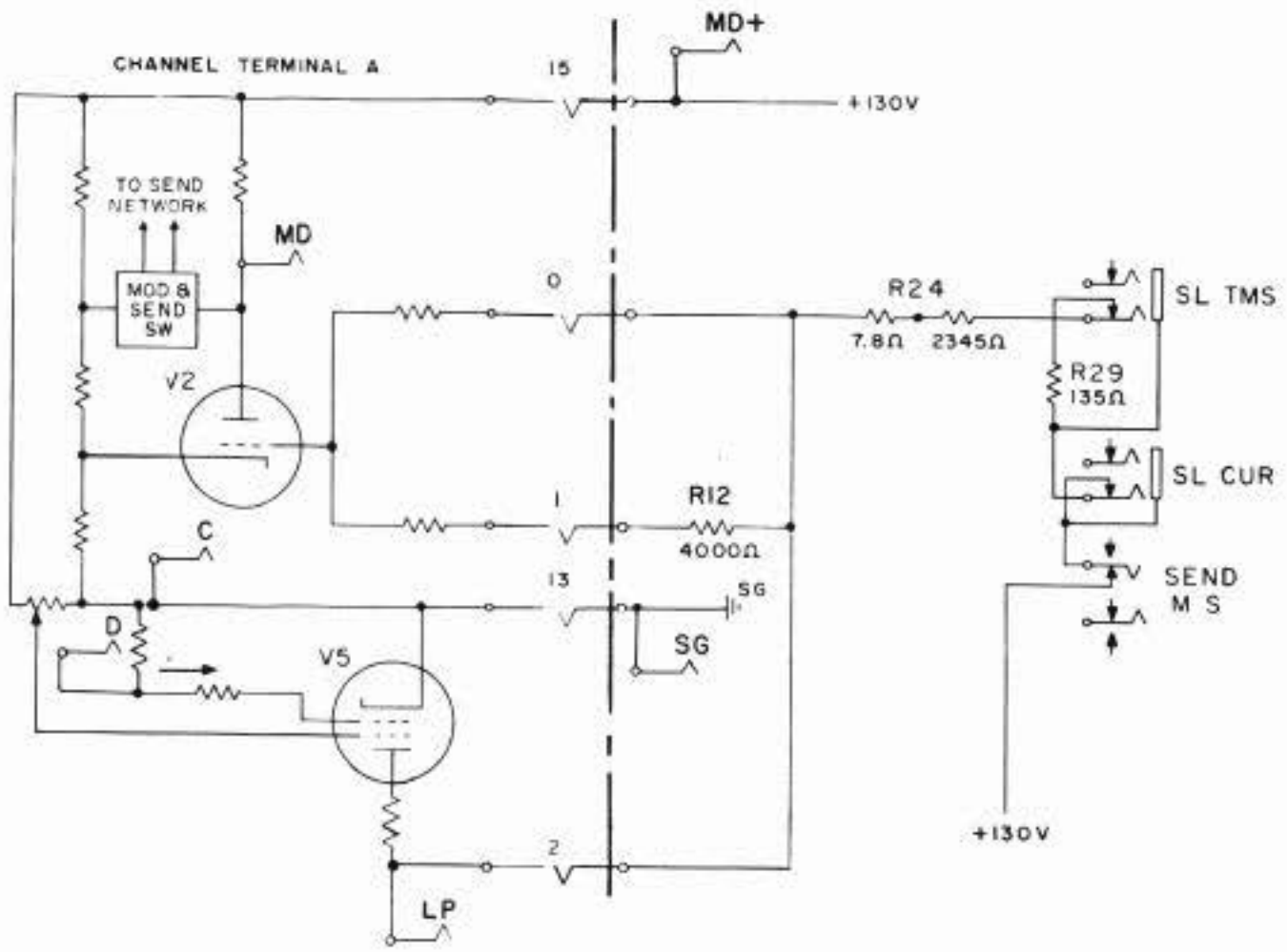

Fig. 14B – Half Duplex Neutral Loop Termination +130 Volts and Ground, 20 Milliamperes

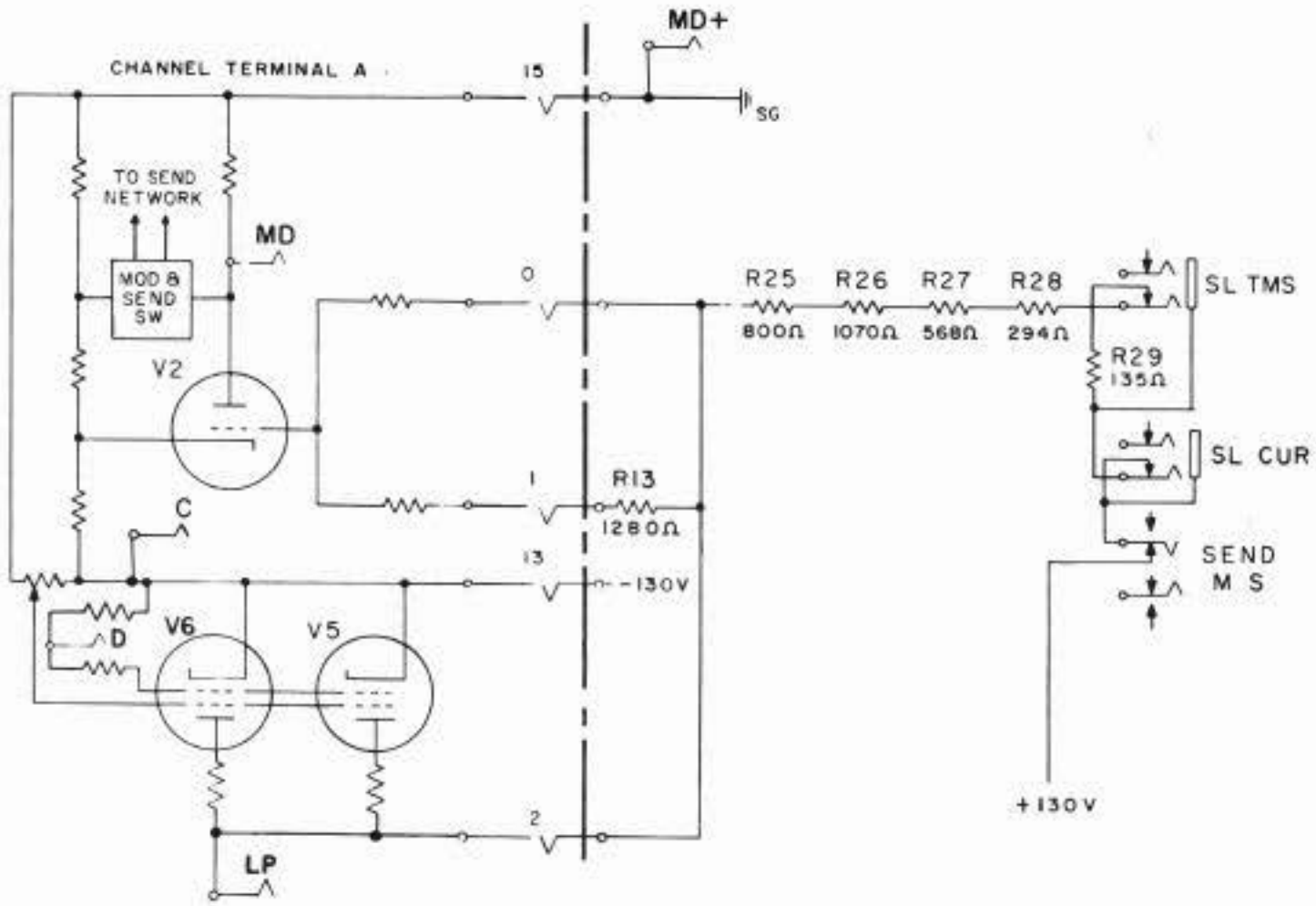

Fig. 14C – Half Duplex Neutral Loop Termination ±130 Volts, 62.5 Milliamperes

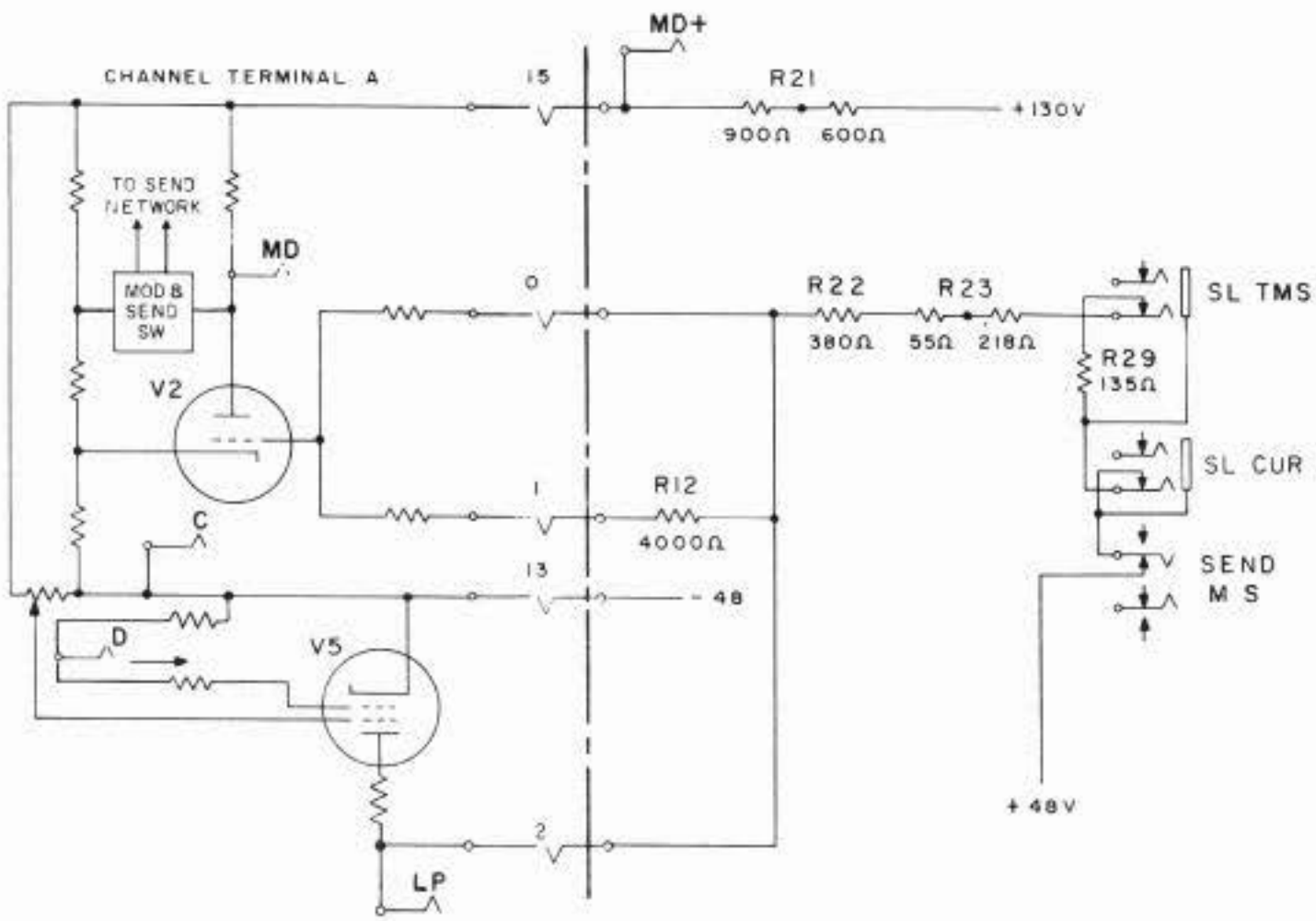

Fig. 14D – Half Duplex Neutral Termination ±48 Volts, 20 Milliamperes

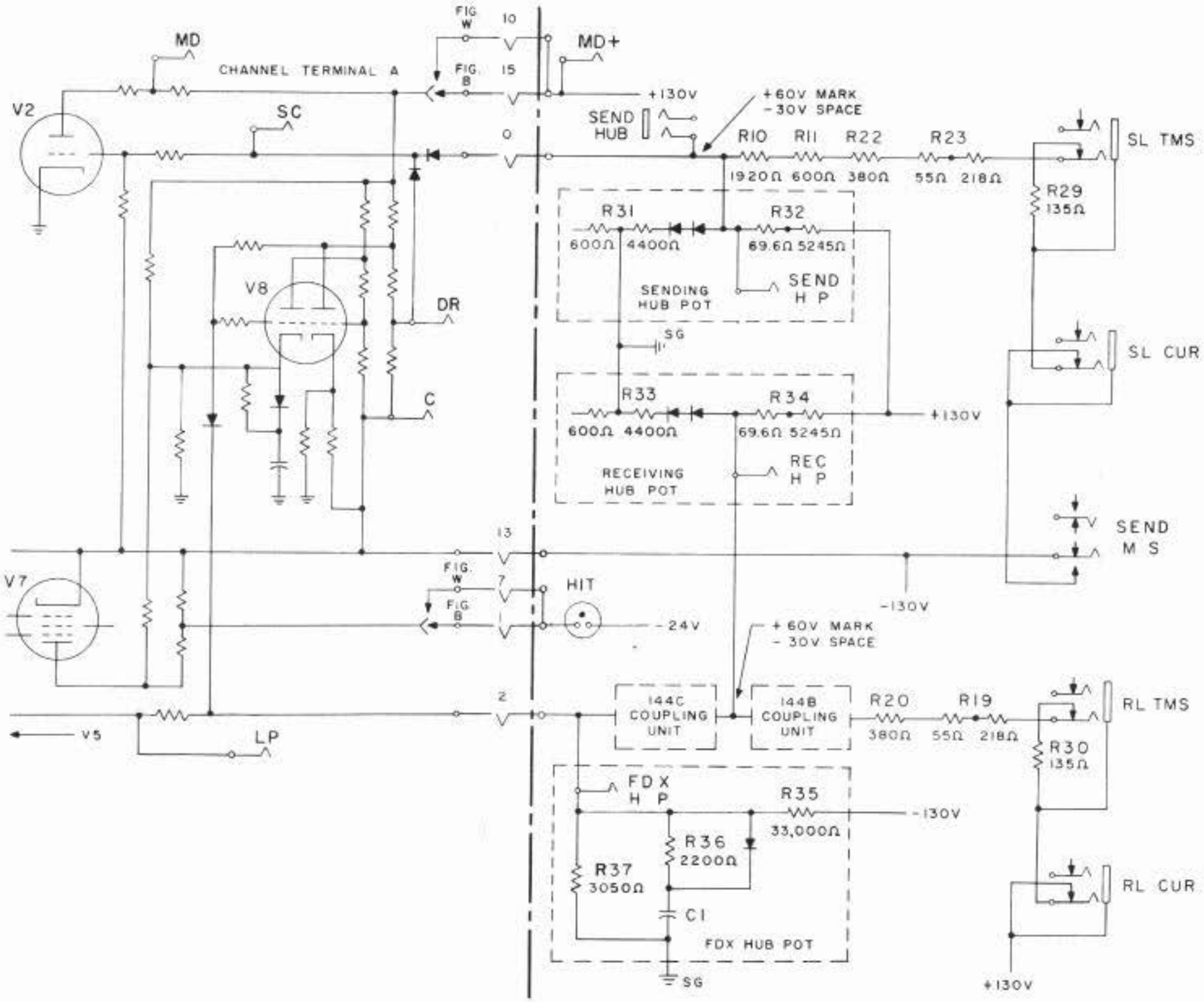

Fig. 15 – Full Duplex Type 2 Hub Termination

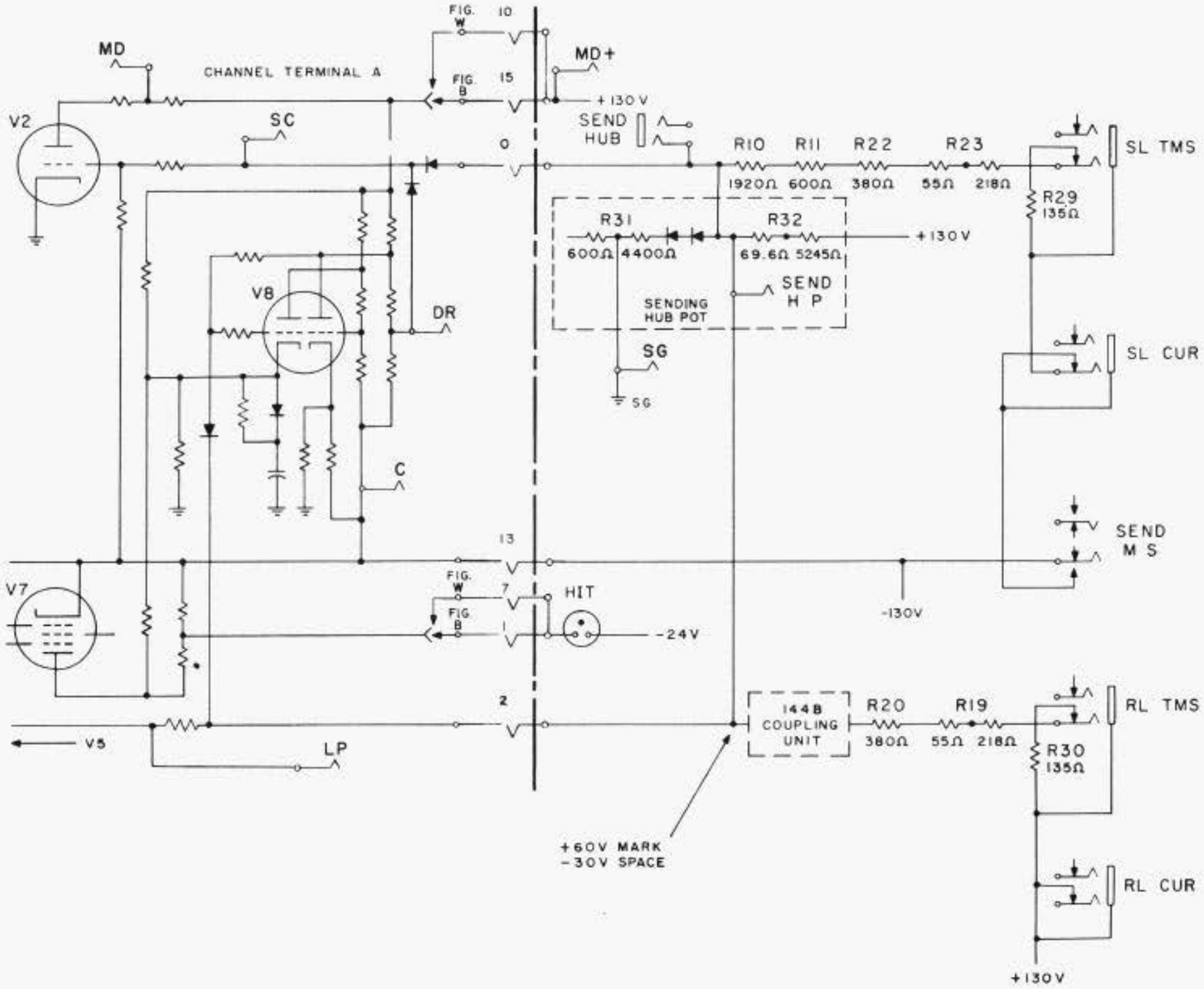

Fig. 16 – Half Duplex Type 2 Hub Termination

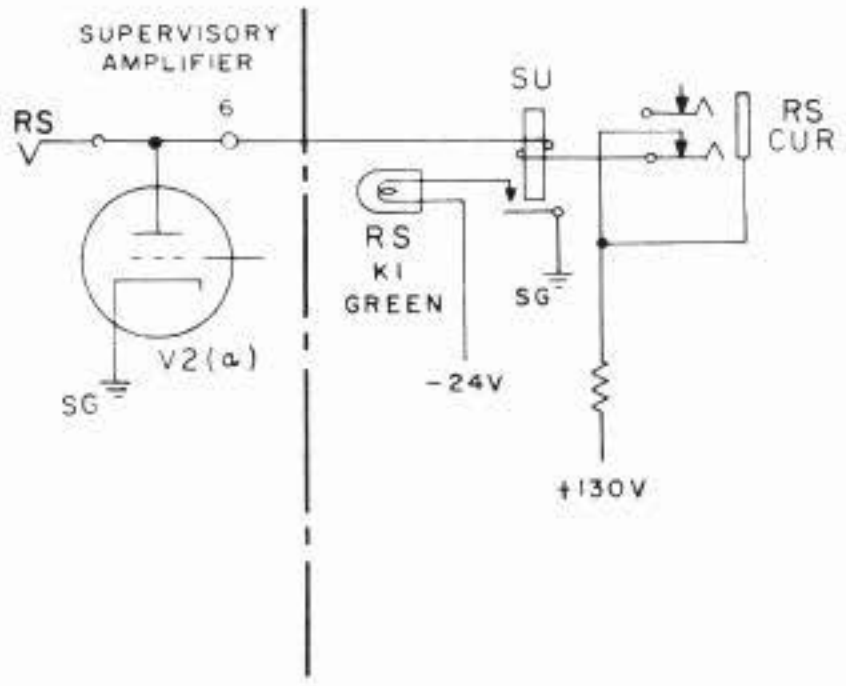

Fig. 17 – Supervisory Test Circuit

5. MAINTENANCE

5.01 Since this test set consists entirely of passive circuit elements, no maintenance is required other than to preserve the continuity of wiring and see that no circuit element becomes defective. This need be done only when the set is not operating correctly.

5.02 In making wiring continuity checks, care should be taken that no direct current is passed through the windings of the L1, L2, L3 and L4 line coils.

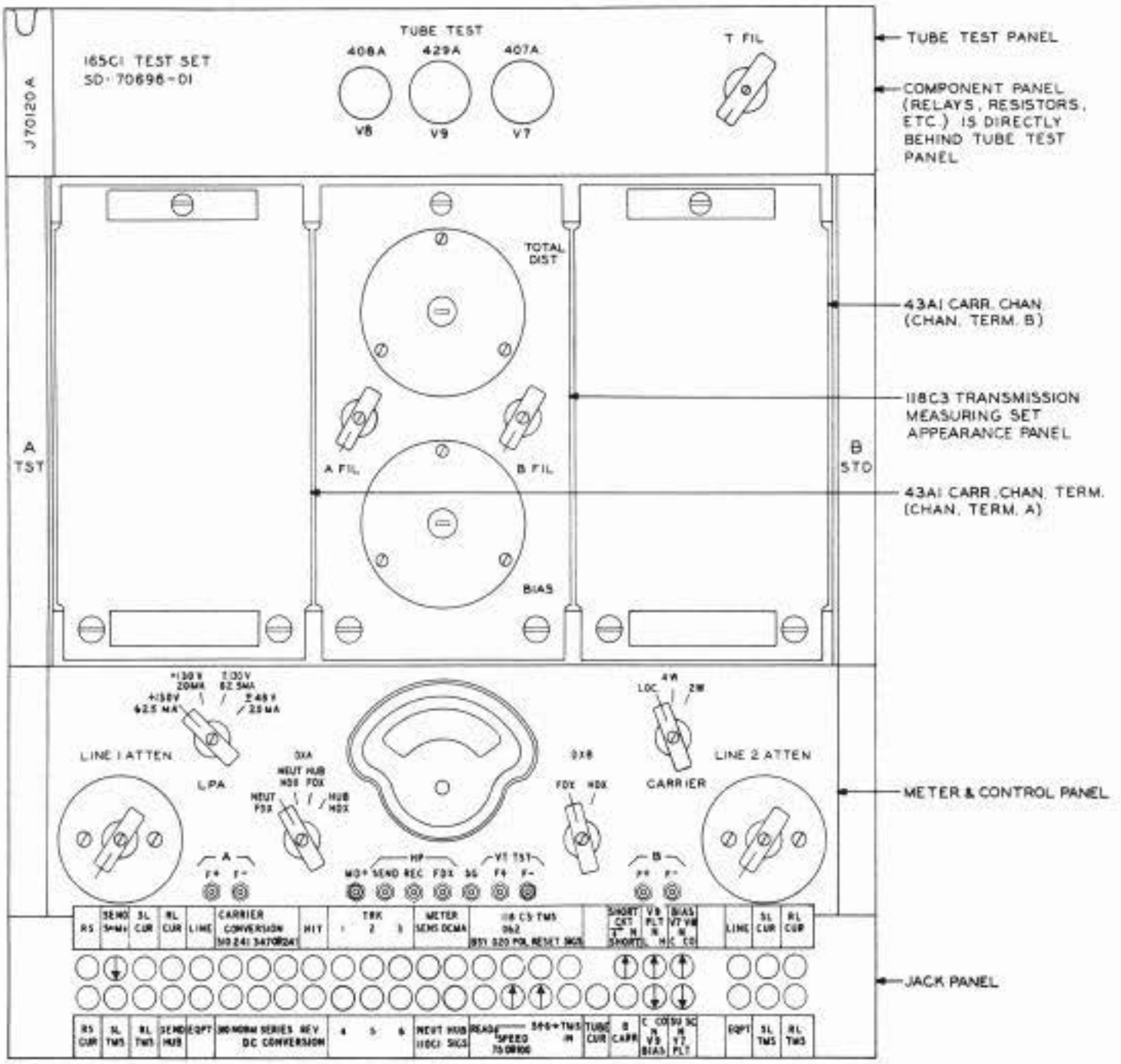

Fig. 18 – 165C1 Test Set — Front View

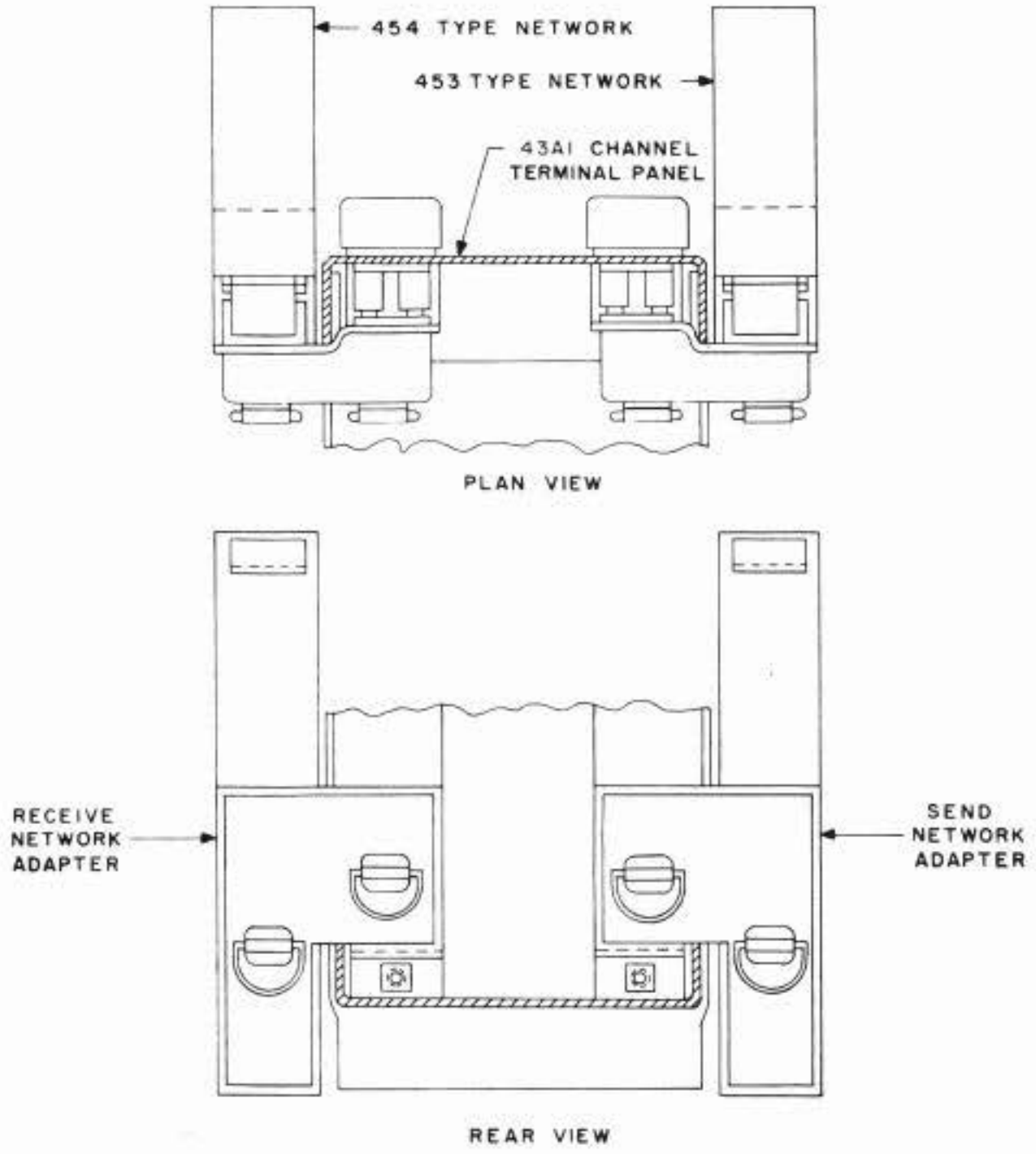

Fig. 19 – Method of Mounting Adapters on 43A1 Channel Terminal

6. REFERENCE INFORMATION

6.01 *165C1 Test Set*

Equipment Design Requirements — Section AA282.819 (J70120)

Equipment Drawing — ED-71188-01

Circuit Drawing — SD-70696-01

Method of Operation — Section E35.437

Fig. 20 – DC Milliammeter Circuit

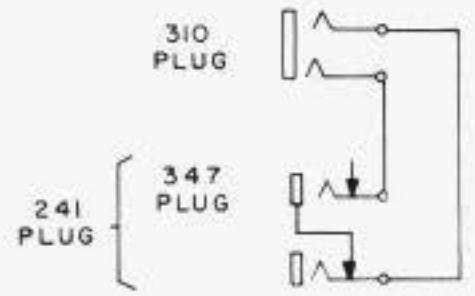

Fig. 21 – Carrier Jack Conversion Circuit

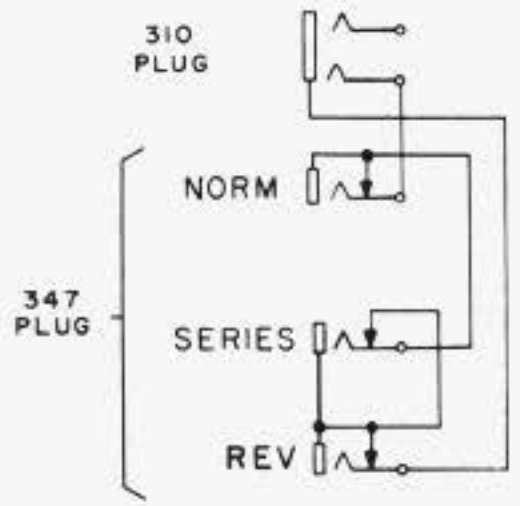

Fig. 22 – DC Jack Conversion Circuit