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165C1 TELEGRAPH TEST SET METHOD OF OPERATION FOR MAINTENANCE CENTER TESTS OF 43A1 CHANNEL TERMINALS

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1. GENERAL

1.01 This section describes methods of bench testing 43A1 Carrier Telegraph Channel Terminals and the associated 453- and 454-type networks and 407A, 408A, and 429A electron tubes using the 165C1 Test Set. The tests outlined in this section are to be made at the maintenance center. Section E45.437 contains general descriptive information about the 165C1 Test Set.

1.02 This section is reissued as a general revision of the section. Included is an improved method for testing the discriminator of 454-type networks. As this is a general revision, the arrows normally used to indicate changes have been omitted.

1.03 Two basic types of 43A1 channel terminals may be tested: neutral loop and hub. All terminals of each type are fundamentally alike. However, terminals of each type may be operated under a number of different conditions depending upon the wiring of the connector jack into which the 43A1 terminal plug-in unit is inserted. These conditions are simulated by the

circuits of the 165C1 Test Set under the control of switches, keys, jacks, attenuators, rheostats, etc. Tests are made with sources of signals at 60 speed.

1.04 Each terminal is given a basic test under a fixed set of conditions which may reveal trouble conditions in the terminal. Each terminal may also be given a supplementary test using external connections which simulate the circuit arrangements under which it will be used. This supplementary test will serve as a check of the compatibility of the terminal with its associated operating circuits. Either test may be made first but the sequence of testing operations should be followed uniformly. Upon failure to meet a particular test the literature on the 43A1 equipment should be consulted to determine the cause of the trouble. Any 453 or 454 network may be tested in the test set.

1.05 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-ohm-meter 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 test signals (the 110C multiple sender may be used).
- (c) A 118C3 or a 164C1 or C2 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

voltmeter with a db scale is used, a 600-ohm termination and a coil must be connected across its input since such meters are high-impedance devices and their inputs are unbalanced.

(e) A frequency source and a frequency measuring device accurate to ± 1 cps within the range 300 to 6000 cps. (The 72A frequency meter is of sufficient accuracy to be used.)

(f) One 144B and one 144C coupling unit to be known as "reference coupling units." *There should be no legs relay associated with the coupling units.*

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

(h) A full complement of 453- and 454-type networks 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.

1.06 Certain items of the accessory equipment: channel terminals, networks, and coupling units, are referred to in this section as "reference" equipment. Any two channel terminals may be used as "reference terminals" provided they meet the test requirements on Pages 5 through 10. All reference equipment should be checked at intervals of not more than two months. It should also be checked after each period of nonuse of the test set for over two weeks and at any time when a test set is moved from one location to another.

1.07 Electron tubes used in reference equipment should have at least 25 hours of prior use or equivalent aging. They may be selected to enable the reference equipment to meet its limits.

1.08 Electron tubes used in channel terminals under test may be either new or used tubes and after test may or may not be shipped with the terminal unit as required.

1.09 Any electron tube used in either reference units or units under test should be able to meet the requirements on page 18 of this section.

1.10 Before starting to test a channel terminal, it should be carefully inspected for physical defects.

1.11 It is assumed that power is applied to the test set and that all supply voltage limits are correctly maintained at all times when the set is in use.

1.12 The set provides a flexibility of arrangements which will permit additional testing operations as suggested by local conditions and by the acquisition of skill and familiarity with the set on the part of the operator.

2. BASIC TESTS OF 43A1 TERMINALS USED AS REFERENCE UNITS

2.01 Test Arrangement: Two channel terminals are used with the 165C1 Test Set as reference units with which unknown or terminals under test are compared. Tests are made using a frequency of 5050 for sending and receiving for all units. One of the channel terminals to be used as a reference unit with its associated 5050 reference send and receive networks and its associated electron tubes should be mounted in position A of the test set. The other reference unit similarly equipped should be mounted in position B. Position A is normally referred to as the "test" position and position B as the "reference" position. Tests should then be made as prescribed on Pages 5 through 10. Adjust test set and terminals as given in Table A, Item 1. (Page 4)

3. BASIC TESTS OF NEUTRAL LOOP TERMINALS

3.01 Test Arrangement

(a) One of the channel terminals used as a reference unit with its associated 5050 reference send and receive networks and its associated electron tubes should be mounted in position B of the test set.

(b) A set of reference networks associated with the other reference unit and a set of electron tubes which meet the requirements of Paragraphs 1.06-.09 should be mounted in the unknown unit under test. The unit should be mounted in position A of the test set. Tests should then be made as prescribed on Pages 5 through 10. Controls should be set as specified in Table A, Item 1. (Page 4)

4. BASIC TESTS OF HUB TYPE TERMINALS

4.01 These tests are intended to indicate trouble conditions in any 43A1 carrier terminal arranged for No. 2 hub type operation. Hub type terminals differ from neutral loop type terminals in the arrangements on the dc side of the terminal where a directional control circuit is added.

4.02 Test Arrangements: The test arrangements are the same as required for neutral loop terminals except that 144B and 144C reference coupling units must be connected to the test set. These units should be wired to the set as shown on SD-70696-01, equipped with electron tubes and supplied with power. Controls on the test set and channel terminals should be adjusted per Table A, Item 2. Hub type terminals are tested in position A of the test set against a neutral type reference terminal in position B, since the carrier line por-

tions of both terminals are similar. Tests should be made as described on Pages 5 through 10.

5. SUPPLEMENTARY TESTS OF CHANNEL TERMINALS

5.01 For all supplementary tests a reference channel terminal should be mounted in position B of the test set. The unit to be tested should be equipped with networks and electron tubes and mounted in position A. Where 2-wire operation is desired, the reference networks cannot be used for both directions of transmission. Any pair of frequencies may be used for the two directions of transmission, as long as they differ by at least 170 cycles.

6. NETWORK TESTS

6.01 Frequency and voltage measurements may be made on any 453-type send or 454-type receive network. A reference channel terminal is installed in position A, and the network to be tested is inserted in the reference unit. Controls should be set as specified in Table A, Item 21, and tests made as prescribed on Page 16.

7. ELECTRON TUBE TESTS

7.01 407A, 408A, and 429A electron tubes may be tested in the tube test panel at the top of the test set. Tests are made as described on Page 18.

SUPPLEMENTARY TESTS OF CHANNEL TERMINALS

TYPE OF CHAN. TERM.	VF LINE	TYPE OF OPERATION	LOOP VOLTAGE	LOOP CURRENT (ma)	CONTROL SETTINGS — TABLE A	TEST DESCRIPTION
Neutral	4-wire	FDX	±130	62.5	Item 3	Pages 11 & 13
"	"	"	+130	62.5	4	"
"	"	"	+130	20.0	5	"
"	"	"	± 48	20.0	6	"
Neutral	4-wire	HDX	±130	62.5	7	Pages 12 & 13
"	"	"	+130	62.5	8	"
"	"	"	+130	20.0	9	"
"	"	"	± 48	20.0	10	"
Neutral	2-wire	FDX	±130	62.5	11	Pages 11 & 13
"	"	"	+130	62.5	12	"
"	"	"	+130	20.0	13	"
"	"	"	± 48	20.0	14	"
Neutral	2-wire	HDX	±130	62.5	15	Pages 12 & 13
"	"	"	+130	62.5	16	"
"	"	"	+130	20.0	17	"
"	"	"	± 48	20.0	18	"
Hub	4-wire	FDX	—	—	19	Pages
Hub	4-wire	HDX	—	—	20	

TABLE A
CONTROL SETTINGS OF 165C1 TEST SET AND CHANNEL
FOR TESTS ON FOLLOWING P

IN TEST SET

ITEM NO.	CARRIER	LINE 1 ATTN	LINE 2 ATTN	SWITCHES*		LPA		
				DXA	DXB			
*SEND switch should be set on M for all tests except where otherwise specified in text.								
1	4W	16db	16db	NEUT	FDX	FDX	±130V	62.5ma
2	4W	16db	16db	HUB	FDX	FDX	±130V	62.5ma
3	4W	16db	16db	NEUT	FDX	FDX	±130V	62.5ma
4	4W	16db	16db	NEUT	FDX	FDX	+130V	62.5ma
5	4W	16db	16db	NEUT	FDX	FDX	+130V	20.0ma
6	4W	16db	16db	NEUT	FDX	FDX	± 48V	20.0ma
7	4W	16db	16db	NEUT	HDX	HDX	±130V	62.5ma
8	4W	16db	16db	NEUT	HDX	HDX	+130V	62.5ma
9	4W	16db	16db	NEUT	HDX	HDX	+130V	20.0ma
10	4W	16db	16db	NEUT	HDX	HDX	± 48V	20.0ma
11	2W	14db	14db	NEUT	FDX	FDX	±130V	62.5ma
12	2W	14db	14db	NEUT	FDX	FDX	+130V	62.5ma
13	2W	14db	14db	NEUT	FDX	FDX	+130V	20.0ma
14	2W	14db	14db	NEUT	FDX	FDX	± 48V	20.0ma
15	2W	14db	14db	NEUT	HDX	HDX	±130V	62.5ma
16	2W	14db	14db	NEUT	HDX	HDX	+130V	62.5ma
17	2W	14db	14db	NEUT	HDX	HDX	+130V	20.0ma
18	2W	14db	14db	NEUT	HDX	HDX	± 48V	20.0ma
19	4W	16db	16db	HUB	FDX	FDX	±130V	62.5ma
20	4W	16db	16db	HUB	HDX	HDX	±130V	62.5ma
21	LOC	16db	—	NEUT	FDX	—	±130V	62.5ma

†A.P. denotes "Adjusted Position" as specified
 φPosition B terminal not required

TABLE A

TEST SET AND CHANNEL TERMINALS "A" AND "B"
TESTS ON FOLLOWING PAGES

ON CHANNEL TERMINAL

LPA		SWITCHES				CONTROLS		
		OSC	SEND	REC	SEND LEV	REC GAIN	REC BIAS	LP CUR
		<i>Position B ("Reference" Position)</i>						
		OFF	HM	H+	MAX CL	MAX CL	MID POS	62.5 ± 2.5 ma
		<i>Position A (Unit Under Test)</i>						
V	62.5ma	ON	HM	H+	MAX CL	MAX CL	MID POS	MID POS
V	62.5ma	ON	HM	L+	MAX CL	MAX CL	MID POS	**
		**Set loop current of 144B1 coupling unit at 62.5 ma						
V	62.5ma	ON	HM	H+	A.P.†	MAX CL	A.P.†	A.P.†
V	62.5ma	ON	HM	H+	A.P.	MAX CL	A.P.	A.P.
V	20.0ma	ON	HM	H+	A.P.	MAX CL	A.P.	A.P.
V	20.0ma	ON	HM	H+	A.P.	MAX CL	A.P.	A.P.
V	62.5ma	ON	HM	H+	A.P.	MAX CL	A.P.	A.P.
V	62.5ma	ON	HM	H+	A.P.	MAX CL	A.P.	A.P.
V	20.0ma	ON	HM	H+	A.P.	MAX CL	A.P.	A.P.
V	20.0ma	ON	HM	H+	A.P.	MAX CL	A.P.	A.P.
V	62.5ma	ON	HM	H+	A.P.	MAX CL	A.P.	A.P.
V	62.5ma	ON	HM	H+	A.P.	MAX CL	A.P.	A.P.
V	20.0ma	ON	HM	H+	A.P.	MAX CL	A.P.	A.P.
V	20.0ma	ON	HM	H+	A.P.	MAX CL	A.P.	A.P.
V	62.5ma	ON	HM	L+	A.P.	MAX CL	A.P.	A.P.
V	62.5ma	ON	HM	L+	A.P.	MAX CL	A.P.	A.P.
V	20.0ma	ON	HM	H+	A.P.	MAX CL	A.P.	A.P.
V	20.0ma	ON	HM	H+	A.P.	MAX CL	A.P.	A.P.
V	62.5ma	ON	HM	H+	MAX CL	MAX CL	A.P.	A.P.

Position" as specified in the testing procedure.
terminal not required for this test.

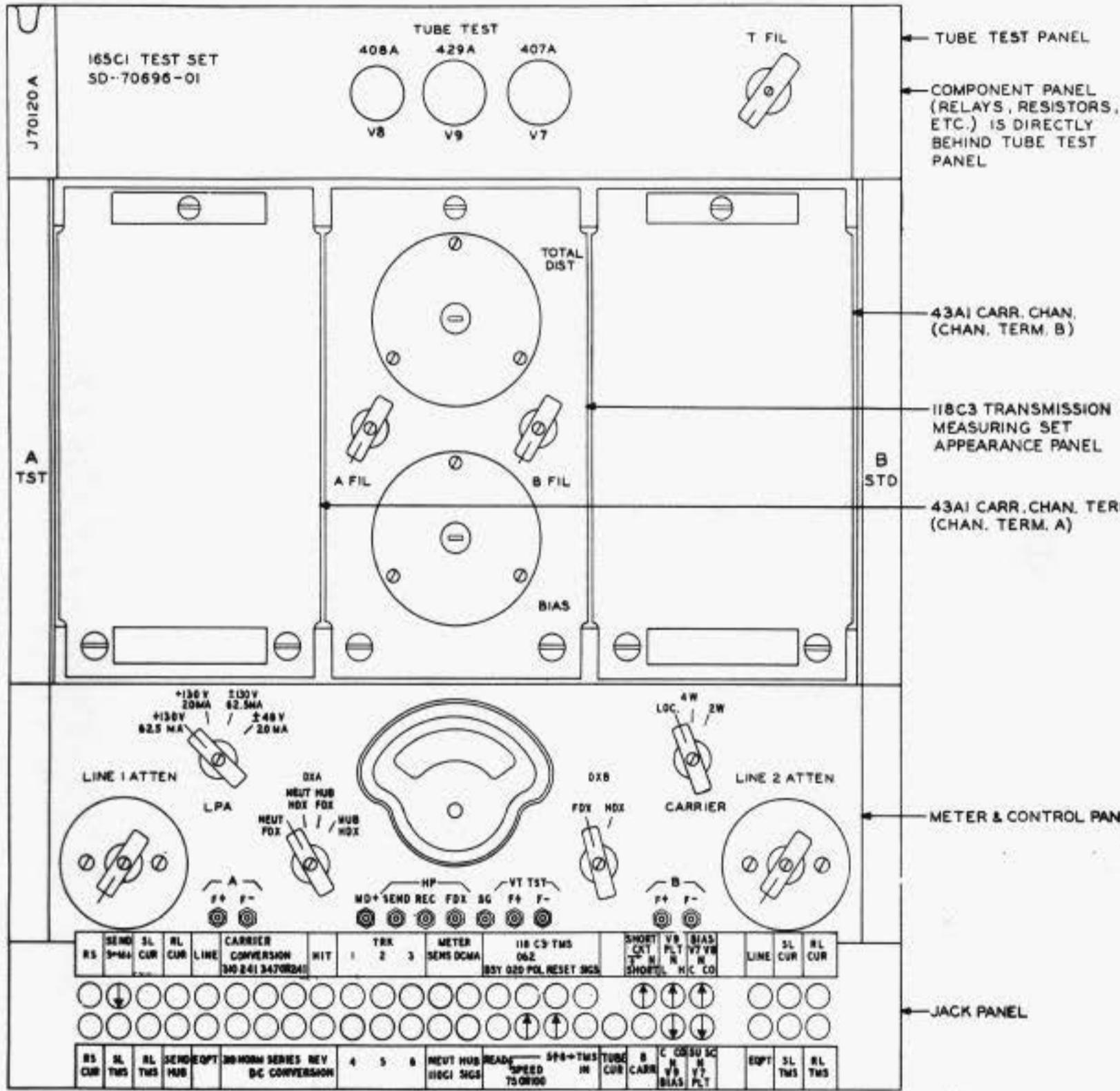


Fig. 1 — 165C1 Test Set — Front View

(Important: Perform Tests in
Numbered Sequence)

BASIC TESTS
For Reference Units and Neutral Loops
For Hub Type Terminals
(See Part 1)

TESTS OF:			TEST	PROCEDURE												
CHAN. TERMS USED AS REFERENCE UNITS	NEUT. LOOP TERMS.	HUB TYPE TERMS.														
1	1	1	Filament Adjust	(a) Turn A FIL rheostat max. counterclockwise. Connect KS-14510 voltmeter. Adjust A FIL rheostat. (b) Turn B FIL rheostat max. counterclockwise. Connect KS-14510 voltmeter. Adjust B FIL rheostat.												
2	2		Loop Current	Patch from DC milliammeter jack of 165 set to:												
		2	Send Level	Check hub voltage with KS-14510 meter.												
3	3	3	Max. Send Level — Term. A	Operate SEND LEV control on A channel terminal clockwise. Connect 13A TMS (or equivalent) with patch cord												
4	4	4	Min. Send Level — Term. A	Operate OSC switch on A channel terminal to OFF Restore OSC switch to ON.												
5	5	5	Send Level Control	(a) Turn SEND LEV control on A channel terminal and smoothly counterclockwise. (b) Adjust SEND LEV control.												
6	6		Send Control Circuit	Recheck send loop current. Measure and record voltage using 300-volt scale of <table style="width: 100%; border: none;"> <tr> <td></td> <td style="text-align: center;">SEND SWITCH ON UNIT</td> <td style="text-align: right;">SEND SWITCH C</td> </tr> <tr> <td>(a)</td> <td style="text-align: center;">LM</td> <td style="text-align: right;">S</td> </tr> <tr> <td>(b)</td> <td style="text-align: center;">HM</td> <td style="text-align: right;">S</td> </tr> <tr> <td>(c)</td> <td style="text-align: center;">HM</td> <td style="text-align: right;">M</td> </tr> </table>		SEND SWITCH ON UNIT	SEND SWITCH C	(a)	LM	S	(b)	HM	S	(c)	HM	M
	SEND SWITCH ON UNIT	SEND SWITCH C														
(a)	LM	S														
(b)	HM	S														
(c)	HM	M														

BASIC TESTS OF CHANNEL TERMINALS

For Reference Units and Neutral Loop Terminals—Set Controls Per Table A—Item 1

For Hub Type Terminals—Set Controls Per Table A—Item 2

(See Parts 2, 3, and 4 in Text)

PROCEDURE	MEASURE AT:	MEASURED REQUIREMENT
FIL rheostat max. counterclockwise. KS-14510 voltmeter. FIL rheostat.	A F+ and F-	20 ± 0.5 volts
FIL rheostat max. counterclockwise. KS-14510 voltmeter. FIL rheostat.	B F+ and F-	20 ± 0.5 volts
C milliammeter jack of 165 set to:	Term. A — SL CUR Term. B — SL CUR Term. B — RL CUR	62.5 ± 2.5 ma 62.5 ± 2.5 ma 62.5 ± 2.5 ma <i>Note:</i> If rdgs are not obtained check battery voltage range of 125-135 volts (see SD-70696-4)
D voltage with KS-14510 meter.	HP: Send & SG	$+60 \pm 3.0$ volts
E LEV control on A channel terminal max. FMS (or equivalent) with patch cord.	Eqpt. A	Not less than +4 dbm
G switch on A channel terminal to OFF. H switch to ON.	Eqpt. A	Below -45 dbm
I LEV control on A channel terminal slowly J thly counterclockwise. K END LEV control.	Eqpt. A Eqpt. A	Level should increase slightly and then decrease smoothly to below -45 dbm -10 ± 0.5 dbm
L loop current. M record voltage using 300-volt scale on meter. N ON UNIT O SEND SWITCH ON 165 SET P M S Q M S R M M	Term. A — SL CUR Term. A — MD & C Term. A — MD & C Term. A — MD & C	62.5 ± 2.5 ma $+120$ volts min. 15 ± 2 volts less than Step (a) At least 12 volts less than Step (b)

n 1

MEASURED REQUIREMENT
20 ± 0.5 volts
20 ± 0.5 volts
62.5 ± 2.5 ma 62.5 ± 2.5 ma 62.5 ± 2.5 ma
<i>Note:</i> If rdgs are not obtained check battery range of 125-135 volts (see SD-70696-011).
+60 ± 3.0 volts
Not less than +4 dbm
Below -45 dbm
Level should increase slightly and then decrease smoothly to below -45 dbm. -10 ± 0.5 dbm
62.5 ± 2.5 ma
+120 volts min. 15 ± 2 volts less than Step (a) At least 12 volts less than Step (b)

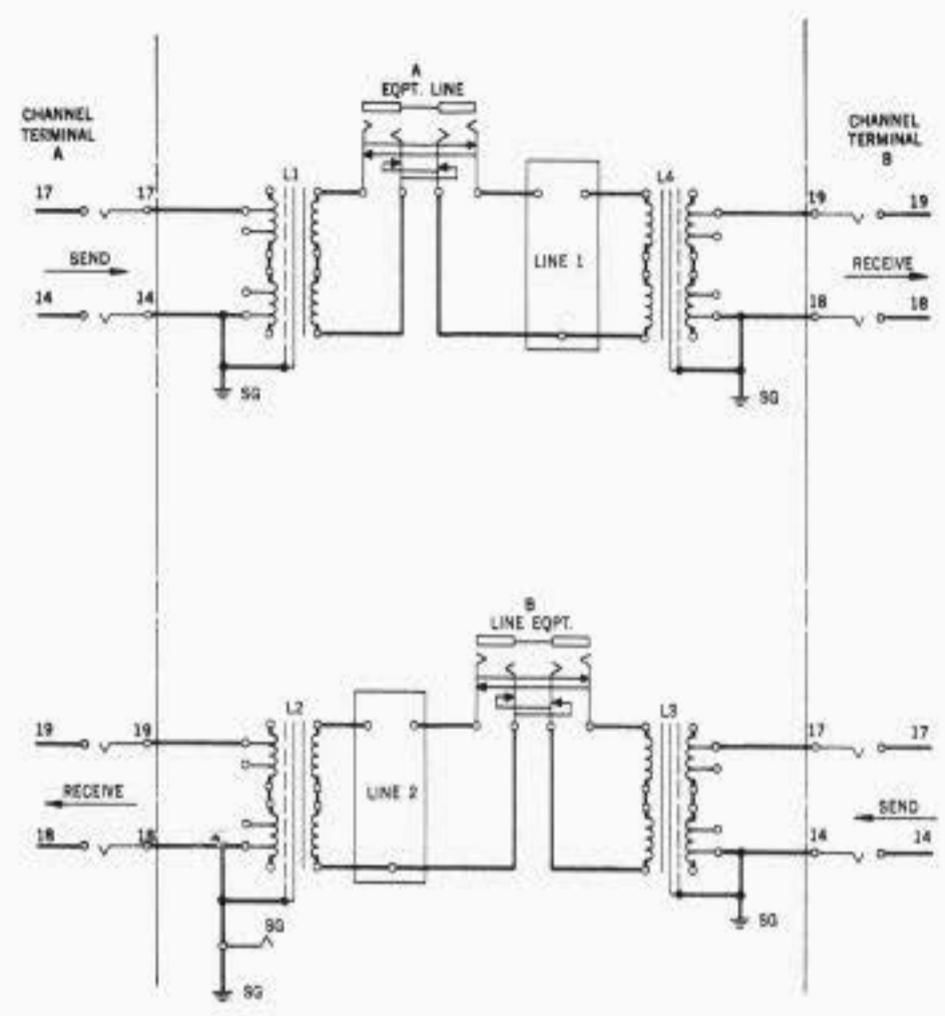


Fig. 2 — Test Set Connections with CARRIER Switch Set on 4W
(See tests 3, 4, 5, 7, and 8 for all terminals)

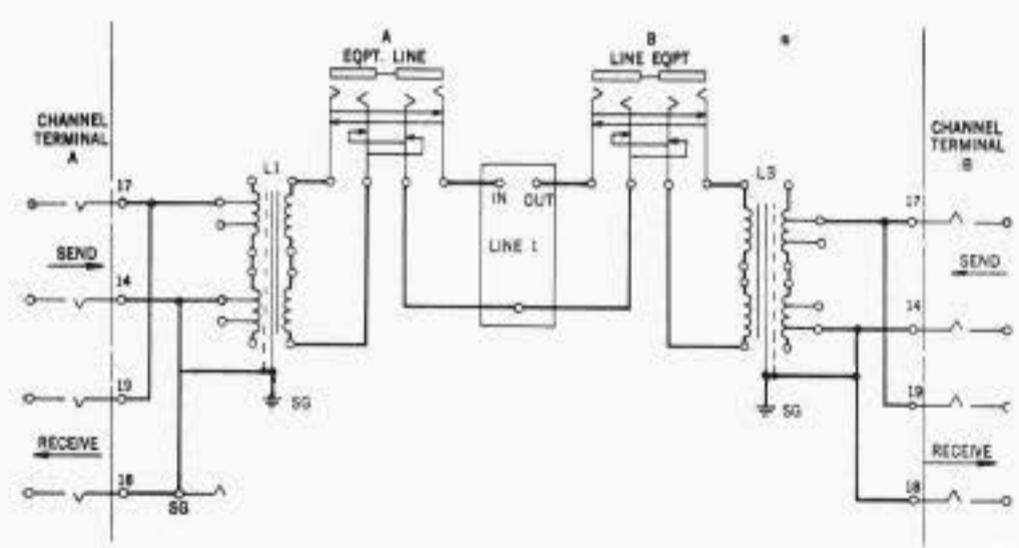


Fig. 3 — Test Set Connections with CARRIER Switch Set on 2W
(This switch setting used only in Supplementary Tests, Pages 11-13)

(Important: Perform Tests in
Numbered Sequence)

BASIC TESTS OF CHA

TESTS OF:			TEST	PROCEDURE
CHAN. TERMS USED AS REFERENCE UNITS	NEUT. LOOP TERMS.	HUB TYPE TERMS.		
		6	Send Control Circuit	<p>Measure and record voltage using 300-volt scale</p> <p style="text-align: center;">SEND SWITCH ON UNIT</p> <p style="text-align: right;">SEND SWI</p> <p>(a) LM (b) HM (c) HM</p>
7			Send Frequency	<p>Adjust output frequency using OSC control on s of A channel terminal. Measure with 72A Freq</p> <p style="text-align: center;">SEND SWITCH ON A CHAN. TERM.</p> <p style="text-align: right;">SEND SWI</p> <p>(a) HM (b) LM (c) LM (d) HM (e) HM</p>
	7	7		<p>Adjust output frequency using OSC control on of channel terminal A.</p> <p style="text-align: center;">SEND SWITCH ON UNIT UNDER TEST</p> <p style="text-align: right;">SEND SWI</p> <p>(a) HM (b) LM (c) LM (d) HM (e) HM</p>
8			Send Level M-S Turnover	<p>Alternately operate SEND switch on 165 set to M tions, respectively. Measure send level with 1 equivalent.</p> <p>Leave SEND switch in M position when through.</p>
	8	8		<p>Alternately operate SEND switch on 165 set to M tions, respectively. Measure send level with 1 equivalent.</p> <p>Leave SEND switch in M position when through.</p>
9				<p>Interchange channel terminals to be used as refer positions A and B. Repeat tests 1 through 8.</p>

BASIC TESTS OF CHANNEL TERMINALS

PROCEDURE	MEASURE AT:	MEASURED REQUIREMENT
<p>and record voltage using 300-volt scale on meter.</p> <p>SWITCH ON UNIT SEND SWITCH ON 165 SET</p> <p>LM S</p> <p>HM S</p> <p>HM M</p>	<p>Term. A — MD & C</p> <p>“</p> <p>“</p>	<p>+245 volts min.</p> <p>15 ± 2 volts less than Step (a)</p> <p>At least 12 volts less than Step (b)</p>
<p>output frequency using OSC control on send network terminal. Measure with 72A Frequency meter.</p> <p>SWITCH ON A CHAN. TERM. SEND SWITCH ON 165 SET</p> <p>HM M</p> <p>LM S</p> <p>LM M</p> <p>HM S</p> <p>HM M</p>	<p>Eqpt. A</p> <p>“</p> <p>“</p> <p>“</p> <p>“</p>	<p>5100 ± 1.0 CPS</p> <p>Less than ±1.0 CPS change</p> <p>5000 ± 3 CPS (Reference Value)</p> <p>Less than ±1.0 CPS change</p> <p>5100 ± 1.0 CPS</p>
<p>output frequency using OSC control on send network terminal A.</p> <p>SWITCH ON UNIT UNDER TEST SEND SWITCH ON 165 SET</p> <p>HM M</p> <p>LM S</p> <p>LM M</p> <p>HM S</p> <p>HM M</p>	<p>Eqpt. A</p> <p>“</p> <p>“</p> <p>“</p> <p>“</p>	<p>5100 ± 1.0 CPS</p> <p>Less than ±1.0 CPS change</p> <p>Reference Value ± 1.0 CPS</p> <p>(See Step (c) above)</p> <p>Less than ±1.0 CPS change</p> <p>5100 ± 1.0 CPS</p>
<p>operate SEND switch on 165 set to M and S positively. Measure send level with 13A TMS or 72A Frequency meter.</p> <p>SEND switch in M position when through.</p>	<p>Eqpt. A</p>	<p>Less than 3.5 db difference</p> <p>Record Send Level as “Reference Value”</p>
<p>operate SEND switch on 165 set to M and S positively. Measure send level with 13A TMS or 72A Frequency meter.</p> <p>SEND switch in M position when through.</p>	<p>Eqpt. A</p>	<p>Reference Value ± 1 db</p> <p>(See above) and less than 3.5 db difference</p>
<p>channel terminals to be used as reference units in tests 1 through 8. Repeat tests 1 through 8.</p>		

MEASURED REQUIREMENT

+245 volts min.
 15 ± 2 volts less than Step (a)
 At least 12 volts less than Step (b)

5100 ± 1.0 CPS
 Less than ±1.0 CPS change
 5000 ± 3 CPS (Reference Value)
 Less than ±1.0 CPS change
 5100 ± 1.0 CPS

5100 ± 1.0 CPS
 Less than ±1.0 CPS change
 Reference Value ± 1.0 CPS
 (See Step (c) above)
 Less than ±1.0 CPS change
 5100 ± 1.0 CPS

Less than 3.5 db difference
 Record Send Level as
 "Reference Value"

Reference Value ± 1 db
 (See above) and less than
 3.5 db difference

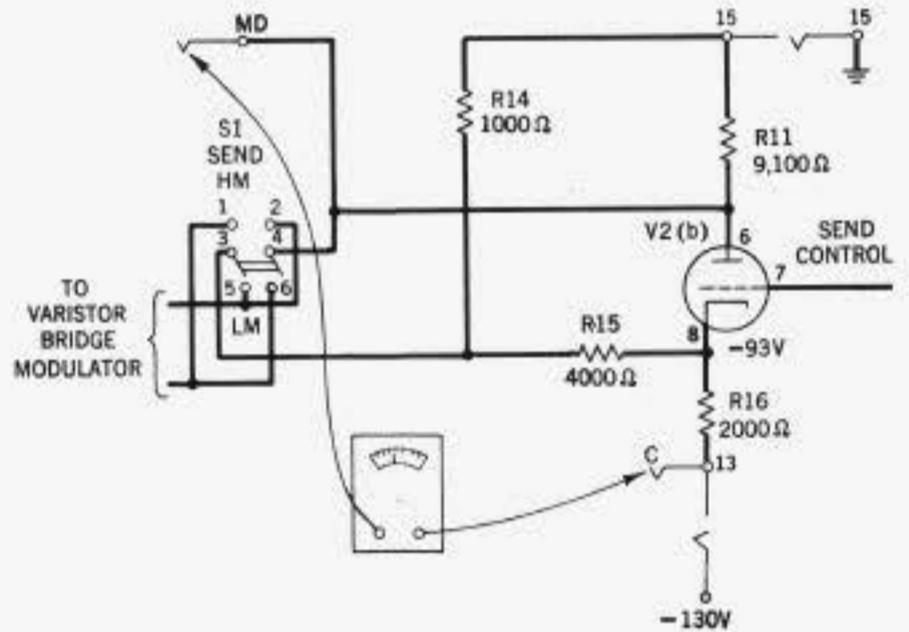


Fig. 4a — Measurement at MD and C Jacks in Neutral Loop Terminals (See test 6 on preceding page)

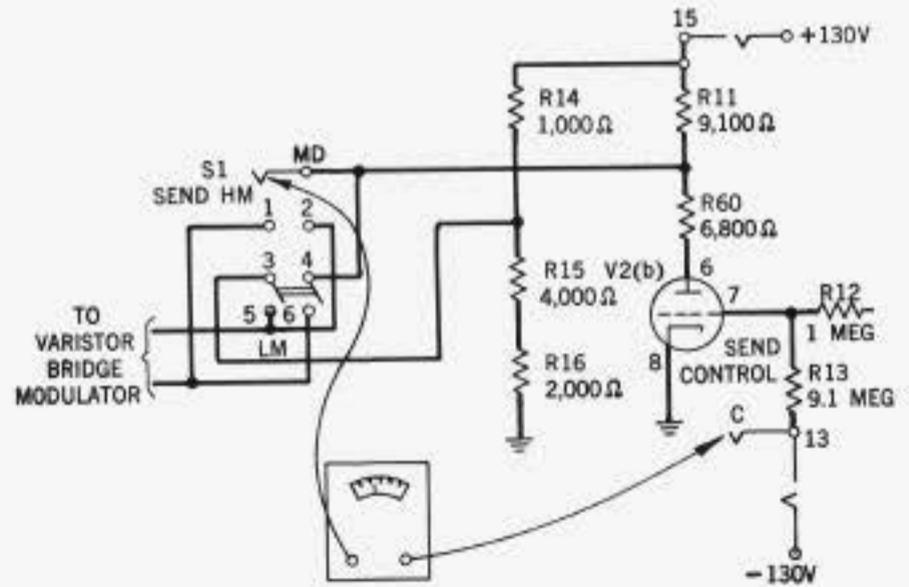


Fig. 4b — Measurement at MD and C Jacks in Hub Type Terminals (See test 6 this page)

(Important: Perform Tests in
Numbered Sequence)

BASIC T

TESTS OF:			TEST	PROCEDURE
CHAN. TERMS USED AS REFERENCE UNITS	NEUT. LOOP TERMS.	HUB TYPE TERMS.		
10	9	9	Receiving Amplifier Output	Operate OSC switch on reference ter Measure levels using db scale on v OSC SWITCH ON UNIT UNDER TEST (a) ON (b) ON (c) ON (d) OFF (e) ON Turn REC Gain control on Termina counterclockwise. <i>Restore REC GAIN control to max</i>
11	10	10	Receive- to-Send Crossfire	(a) Using 13A TMS (or equivalent) level. (Both OSC switches should (b) Operate OSC switch on Terminal (c) Restore OSC switch on Terminal
12	11	11	Supervisory Circuit and Send-to- Receive Crossfire	(a) Measure supervisory circuit cur (b) Operate OSC switch on reference Restore OSC switch to ON. (c) Increase LINE 2 attenuator to Restore LINE 2 attenuator to 1
13	12		Receive Loop Current Control	(a) Using LP CUR control of A ch receive loop current. (b) Turn LP CUR control to max. (c) Turn LP CUR control to max. (d) Restore adjusted value. (e) Using dummy plug to open SL check current as follows: REC SWITCH IN UNIT UNDER TEST (1) H+ (2) H+ (3) L+ (4) L+ (5) H+

BASIC TESTS OF CHANNEL TERMINALS

PROCEDURE	MEASURE AT:	MEASURED REQUIREMENT												
<p>switch on reference terminal in position B to ON. Read level using db scale on vacuum tube voltmeter.</p> <table border="0"> <tr> <td>OSC SWITCH ON UNIT UNDER TEST</td> <td>OSC SWITCH ON REFERENCE UNIT</td> </tr> <tr> <td>ON</td> <td>ON</td> </tr> <tr> <td>ON</td> <td>ON</td> </tr> <tr> <td>ON</td> <td>OFF</td> </tr> <tr> <td>OFF</td> <td>OFF</td> </tr> <tr> <td>ON</td> <td>ON</td> </tr> </table> <p>Turn gain control on Terminal A slowly and smoothly clockwise to max. position.</p>	OSC SWITCH ON UNIT UNDER TEST	OSC SWITCH ON REFERENCE UNIT	ON	ON	ON	ON	ON	OFF	OFF	OFF	ON	ON	<p>A chan. term. pin jacks: A1-G A2-G A2-G A2-G A2-G</p>	<p>+16 ± 3.0 dbm +31 ± 4.0 dbm below +2.0 dbm below -20 dbm +31 ± 4.0 dbm</p> <p>Level should decrease smoothly to below -20 dbm at extreme counterclockwise position of control.</p>
OSC SWITCH ON UNIT UNDER TEST	OSC SWITCH ON REFERENCE UNIT													
ON	ON													
ON	ON													
ON	OFF													
OFF	OFF													
ON	ON													
<p>With TMS (or equivalent), recheck output carrier level with both OSC switches should be ON)</p> <p>Turn OSC switch on Terminal A to OFF.</p> <p>Turn OSC switch on Terminal A to ON.</p>	<p>Eqpt. A Eqpt. A</p>	<p>-10 ± 0.5 dbm Below -45 dbm</p>												
<p>Check supervisory circuit current.</p> <p>Turn OSC switch on reference unit (position B) to OFF.</p> <p>Turn OSC switch to ON.</p> <p>Turn LINE 2 attenuator to 36 db.</p> <p>Turn LINE 2 attenuator to 16 db.</p>	<p>RS CUR RS CUR RS CUR</p>	<p>Between 8 and 13 ma, SU relay operated, RS lamp lighted.</p> <p>0 ma, SU relay released. RS lamp extinguished.</p> <p>Greater than 5 ma (SU relay may or may not operate, depending on adjustment.)</p>												
<p>Adjust RL CUR control of A channel terminal, adjust loop current.</p> <p>Turn RL CUR control to max. clockwise position.</p> <p>Turn RL CUR control to max. counterclockwise position.</p> <p>Return RL CUR control to adjusted value.</p> <p>Remove dummy plug to open SL CUR B jack in 165 set, and measure current as follows:</p> <table border="0"> <tr> <td>SL CUR B JACK</td> <td>SL CUR B JACK</td> </tr> <tr> <td>H+</td> <td>Closed (M)</td> </tr> <tr> <td>H+</td> <td>Open (S)</td> </tr> <tr> <td>L+</td> <td>Open (S)</td> </tr> <tr> <td>L+</td> <td>Closed (M)</td> </tr> <tr> <td>H+</td> <td>Closed (M)</td> </tr> </table>	SL CUR B JACK	SL CUR B JACK	H+	Closed (M)	H+	Open (S)	L+	Open (S)	L+	Closed (M)	H+	Closed (M)	<p>RL CUR-A RL CUR-A RL CUR-A RL CUR-A RL CUR-A RL CUR-A RL CUR-A</p>	<p>62.5 ± 2.5 ma</p> <p>At least 10 ma increase above adjusted value.</p> <p>At least 10 ma decrease below adjusted value.</p> <p>62.5 ± 2.5 ma</p> <p>62.5 ± 2.5 ma</p> <p>Less than 3 ma</p> <p>Same as Step (1)</p> <p>Less than 3 ma</p> <p>62.5 ± 2.5 ma</p>
SL CUR B JACK	SL CUR B JACK													
H+	Closed (M)													
H+	Open (S)													
L+	Open (S)													
L+	Closed (M)													
H+	Closed (M)													

MEASURED REQUIREMENT

decrease smoothly to below
the counterclockwise position

13 ma,
ted,
d.
released.
quished.

ma
r or may not operate,
adjustment.)

increase above adjusted
decrease below adjusted

(1)

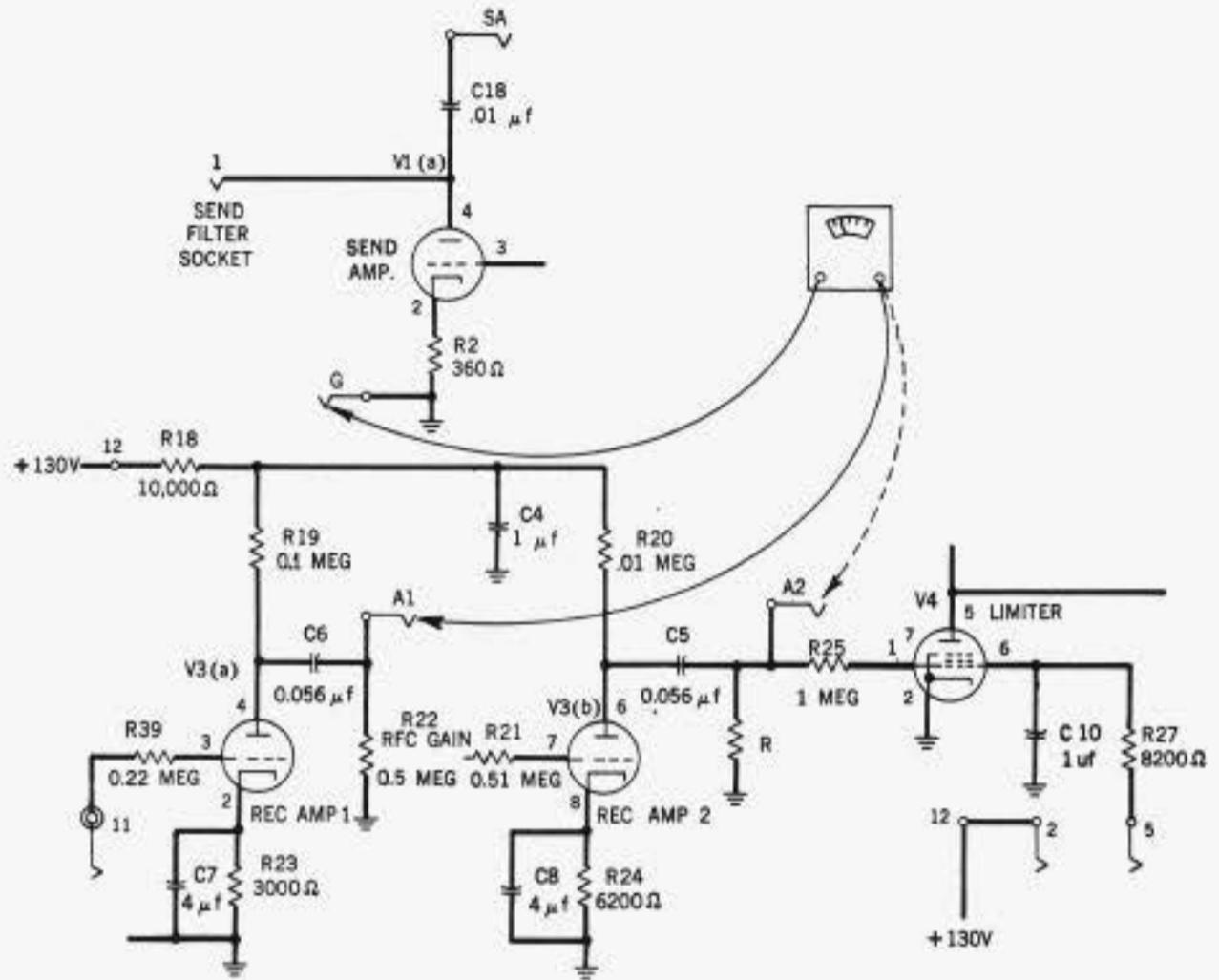


Fig. 5 — Circuit Arrangements for Tests of Receiving Amplifier Output (See top of this page)

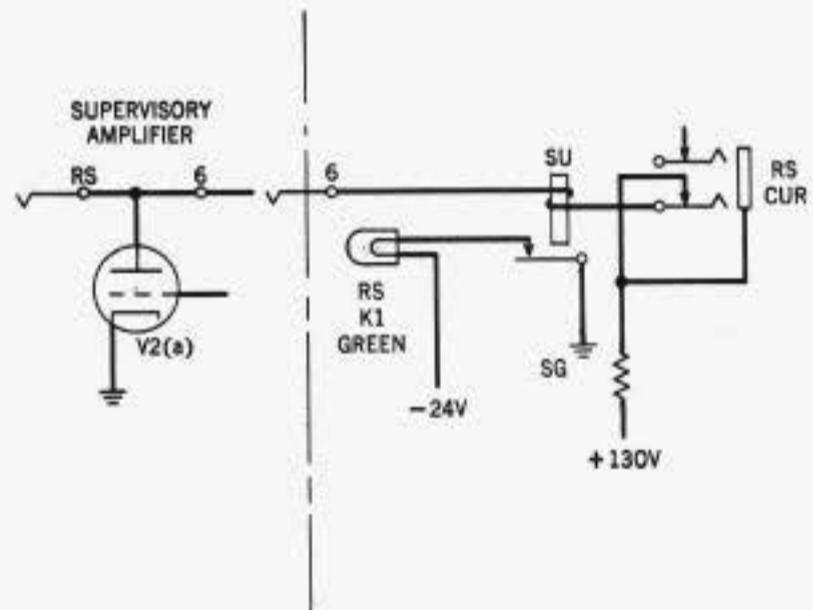


Fig. 6 — Test Set Arrangement of Supervisory Circuit (See test of Supervisory Circuit on this page)

(Important: Perform Tests in
Numbered Sequence.)

BASIC TESTS OF CHAN

TESTS OF:			TEST	PROCEDURE
CHAN. TERMS USED AS REFERENCE UNITS	NEUT. LOOP TERMS.	HUB TYPE TERMS.		
		12	Directional Control Circuit	Measure DC voltage and current for Channel Term accordance with the sequence of steps in Table B
14	13	13	"Mark Hold" Operation	(a) Operate OSC switch on reference unit (position (b) Restore OSC switch on reference unit to ON.
15	14		DX Control	(a) Operate DXA switch in 165 set to NEUT HDX (b) Open SL CUR B jack in 165 set with dummy Close SL CUR B jack. (c) Operate SEND switch in 165 set to S. Restore SEND switch to M and DXA switch to
16				Interchange channel terminals to be used as refe in positions A and B. Repeat tests 10 through 15.
17	15		Receiving Bias and Distortion	(a) <u>Insert source of undistorted miscellaneous test</u> SL CUR B jack in 165 set. Connect transmission measuring set (such as RL TMS A jack in 165 set. Vary REC BIAS control on unit A. <i>Note:</i> If 100A Distributor is used as test sig (not normally desirable), a suitable bias me such as the 160A1 Test Set must be used. (b) Operate REC switch on unit A to L+ and SEN reference unit to LM. Vary REC BIAS control in unit A. Restore REC switch to H+ and SEND switch (c) Adjust average bias to $0 \pm 0.5\%$. Change LINE 2 attenuator to 4 db. (d) Change LINE 2 attenuator to 34 db. Restore attenuator to 16 db.

BASIC TESTS OF CHANNEL TERMINALS

PROCEDURE	MEASURE AT:	MEASURED REQUIREMENT
voltage and current for Channel Terminal "A" in with the sequence of steps in Table B on Page 9.	See Page 9	See Page 9
OSC switch on reference unit (position B) to OFF. OSC switch on reference unit to ON.	RL CUR-A RL CUR-A	Greater than 50 ma (RS lamp extinguished) 62.5 ± 2.5 ma (RS lamp lighted)
DXA switch in 165 set to NEUT HDX. CUR B jack in 165 set with dummy plug. CUR B jack. SEND switch in 165 set to S. SEND switch to M and DXA switch to NEUT FDX.	RL CUR-B RL CUR-B RL CUR-B	62.5 ± 2.5 ma No change Less than 3 ma
Channel terminals to be used as reference units and B. 10 through 15.		
<p>Source of undistorted miscellaneous test signals in B jack in 165 set. transmission measuring set (such as 118C) in A jack in 165 set. C BIAS control on unit A. If 100A Distributor is used as test signal source (normally desirable), a suitable bias measuring set the 160A1 Test Set must be used.</p> <p>REC switch on unit A to L+ and SEND switch in unit to LM. C BIAS control in unit A. REC switch to H+ and SEND switch to HM.</p> <p>Average bias to 0 ± 0.5%. LINE 2 attenuator to 4 db. LINE 2 attenuator to 34 db. attenuator to 16 db.</p>	<p>RL TMS A</p> <p>RL TMS A</p> <p>RL TMS A</p> <p>RL TMS A</p>	<p>Average bias reading on 118 set should come more positive as control is turned clockwise. Range of +10% to -10% average bias. Algebraic sum of maximum & minus not greater than 15. Total distortion not to exceed bias by more than 5.</p> <p>Same limits as above apply.</p> <p>0 ± 2% bias</p> <p>0 ± 5% bias</p>

MEASURED REQUIREMENT	
See Page 9	
Greater than 50 ma (RS lamp extinguished)	
62.5 ± 2.5 ma (RS lamp lighted)	
62.5 ± 2.5 ma No change	
Less than 3 ma	
Average bias reading on 118 set should become more positive as control is turned clockwise. Range of +10% to -10% average bias. Algebraic sum of maximum plus & minus not greater than 15. Total distortion not to exceed bias by more than 5.	
Same limits as above apply.	
0 ± 2% bias	
0 ± 5% bias	

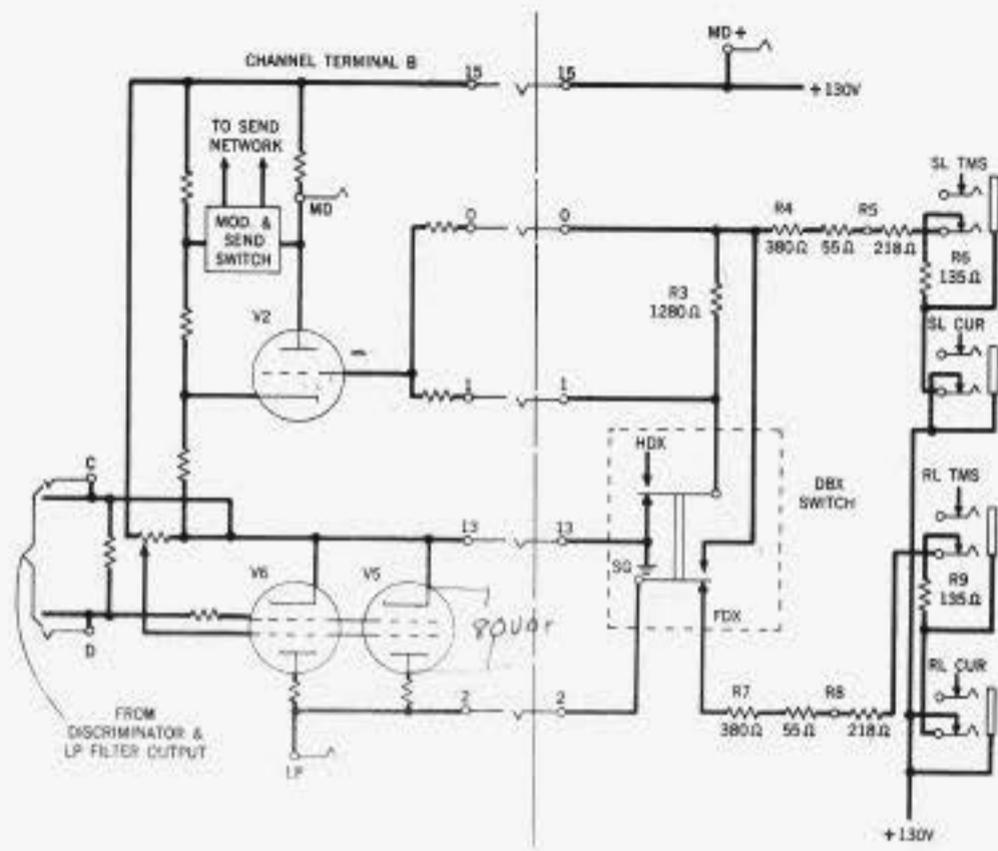


Fig. 7 — Test Set Termination for Channel Terminal B (Reference Unit): +130 Volts and Ground, 62.5 Milliamperes, either Full or Half Duplex

(Channel Terminal "A" Arrangements Are Shown in Figs. 9, 10, and 13 through 20)

.6
 $I = \frac{E}{R} = \frac{800}{130} = 6.15$

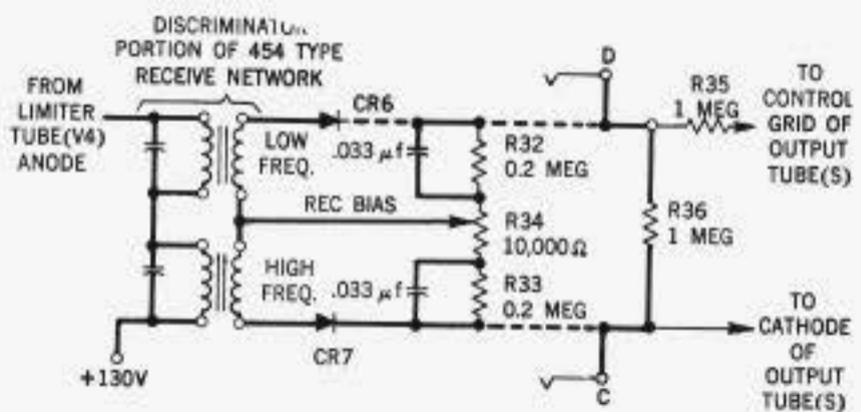


Fig. 8 — Simplified Schematic Showing Circuit Arrangements Involving REC BIAS Control (See tests of Receiving Bias and Distortion — bottom of this page)

TABLE B

TESTS OF DIRECTIONAL CONTROL CIRCUIT

(See Hub Terminal Procedures — Test No. 12)

Very Important:

These tests must be performed in numbered sequence.

STEP*	DXA SWITCH	REC SWITCH UNIT UNDER TEST	SL CUR-B JACK	SEND KEY IN TEST SET	VOLTAGE TO PIN JACK 5G FROM PIN JACKS IN TEST SET***			
					SEND HP	REC HP	FDX HP	
1	HUB-HDX	L+	Open (S)	M	-30 ± 2	—	—	-1
2	HDX	L+	Closed (M)	M	+60 ± 3	—	—	+
3	HDX	L+	Closed (M)	S	-30 ± 2	—	—	-
4	HDX	L+	Closed (M)	M	+60 ± 3	—	—	+
5	HDX	L+	Open (S)	S	-60 ± 10	—	—	-1
6	HDX	H+	Closed (M)	M	-30 ± 2	—	—	-1
7	HDX	H+	Open (S)	M	+60 ± 3	—	—	+
8	HUB-FDX	L+	Closed (M)	M	+60 ± 3	+60 ± 3	-10 ± 2	-
9	FDX	L+	Open (S)	M	+60 ± 3	-30 ± 2	-65 ± 5	-1
10	Restore Step 1							

*To obtain the specified voltage and current readings, the operations should be performed in sequence.

**To adjust current in the RL CUR-A jack, use the LP CUR control in the 144B1 coupling unit to adjust current at the SL CUR-B jack at any point in the testing procedure.

***All voltage measurements with the KS-14510 voltmeter should be made using 300-volt scale.

VOLTAGE TO PIN JACK G FROM PIN JACKS IN UNIT UNDER TEST (POS A)***			RL CUR-A JACK ma**	HIT LAMP
LP	DR	SC		
7 ± 4	+46 ± 3	+46 ± 3	Less than 3	ON
0 ± 3	+60 ± 3	+60 ± 3	62.5 ± 2.5	OFF
0 ± 2	-26 ± 10	-26 ± 6	Less than 3	OFF
0 ± 3	-26 ± 10	+60 ± 3	62.5 ± 2.5	OFF
9 ± 4	-26 ± 10	-26 ± 6	Less than 3	ON
7 ± 4	+46 ± 3	+46 ± 3	Less than 3	ON
0 ± 3	+60 ± 3	+60 ± 3	62.5 ± 2.5	OFF
0 ± 10	-20 ± 10	+60 ± 3	62.5 ± 2.5	OFF
7 ± 4	-20 ± 10	+60 ± 3	Less than 3	ON

ence from left to right for each step.

. The current at this jack should be the same as the

Note: See also Fig. 11, next page, for measurements in channel terminal.

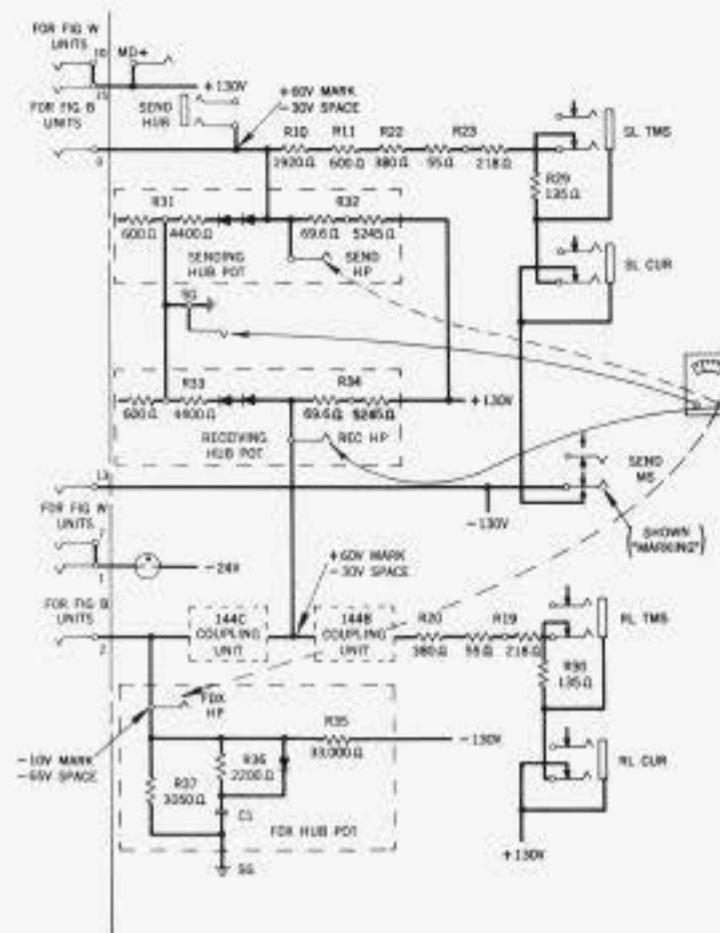


Fig. 9 — Circuit Arrangements for Tests of Directional Control Circuit in HDX Hub Terminal (See Steps 1-7 this page)

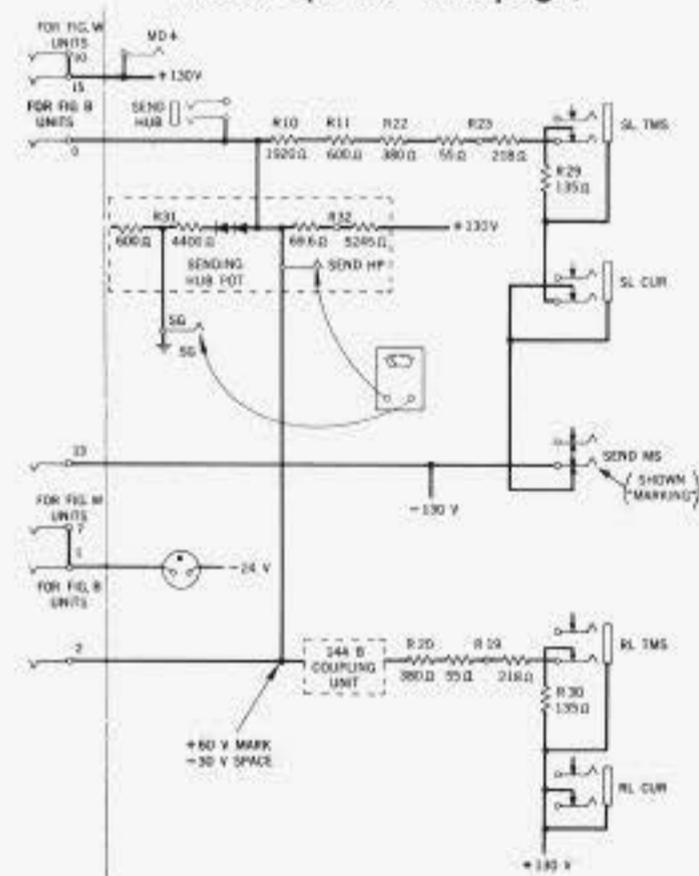


Fig. 10 — Circuit Arrangements for Tests of Directional Control Circuit in FDX Hub Terminal (See Steps 8-9 this page)

(Important: Perform Tests in
Numbered Sequence)

BASIC TESTS OF CHAN

CHAN. TERMS. USED AS REFERENCE UNITS	TESTS OF:		TEST	PROCEDURE
	NEUT. LOOP TERMS.	HUB TYPE TERMS.		
		14	Receiving Bias and Distortion	<p>(a) Connect undistorted miscellaneous test signals to B jack in 165 set. Connect transmission measuring set (such as RL TMS A jack in 165 set). Vary REC BIAS control on unit A. <i>Note:</i> If a 100A distributor is used as test set (not normally desirable), a suitable bias measuring set such as the 160A1 test set must be used.</p> <p>(b) Operate REC switch on unit under test to L+ position. Operate REC switch in reference unit to LM. Vary REC BIAS control in unit A.</p> <p>(c) Operate SEND switch in reference unit to H position. Adjust average bias to $0 \pm 0.5\%$. Change LINE 2 attenuator to 4 db.</p> <p>(d) Change LINE 2 attenuator to 34 db. Restore attenuator to 16 db.</p>
18	16	15	Sending Bias and Distortion	<p>(a) Connect undistorted signals to SL CUR A jack (or SEND HUB jack for hub terminals). Connect transmission measuring set in RL TMS A jack in 165 set.</p> <p>(b) Operate SEND switch in unit A to LM and REC switch in reference unit to L+. Restore SEND switch to HM and REC switch to L+. Disconnect signals and transmission measuring set.</p>
19	17	16	Discriminator Voltage	<p>(a) Measure DC voltage — Unit A.</p> <p>(b) Operate REC switch on unit under test to L+ position.</p> <p>(a) Measure DC voltage — Unit A.</p> <p>(b) Operate REC switch on unit under test to L+ position.</p>
20				Interchange channel terminals to be used as reference positions A and B. Repeat tests 17 through 19.
21				Seal or mark controls on both reference terminals. Controls should be in the sealed positions unless otherwise specified. The next basic test of reference terminals is made.

MEASURED REQUIREMENT

Average bias reading on 118 set should become more positive as control is turned counterclockwise. Range of +10% to -10% average bias. Algebraic sum of max. plus & minus not greater than 5. Total distortion not to exceed bias by more than 5.

Same limits as above apply.

$0 \pm 2\%$ bias.

$0 \pm 5\%$ bias.

Average bias should be $0 \pm 2\%$. Controls in receiving circuit of reference unit should be in same position as at last previous check of ref. units.

$0 \pm 5\%$ bias.

+35 \pm 5 volts
Record as "Reference Value."

-47 \pm 7 volts
Record as "Reference Value."

Reference value ± 3 volts. (See above)

Reference value ± 3 volts. (See above)

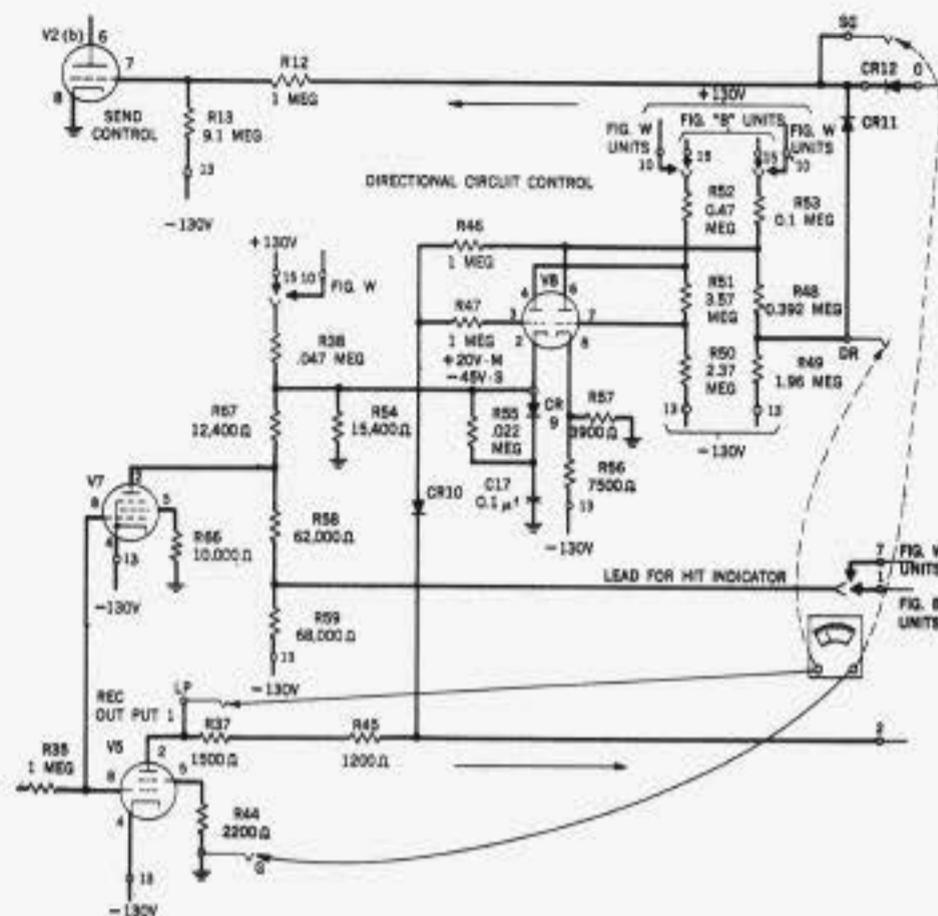


Fig. 11 — Illustration of Voltage Measurements in Directional Control Circuit (See Steps 1-9 on preceding page)

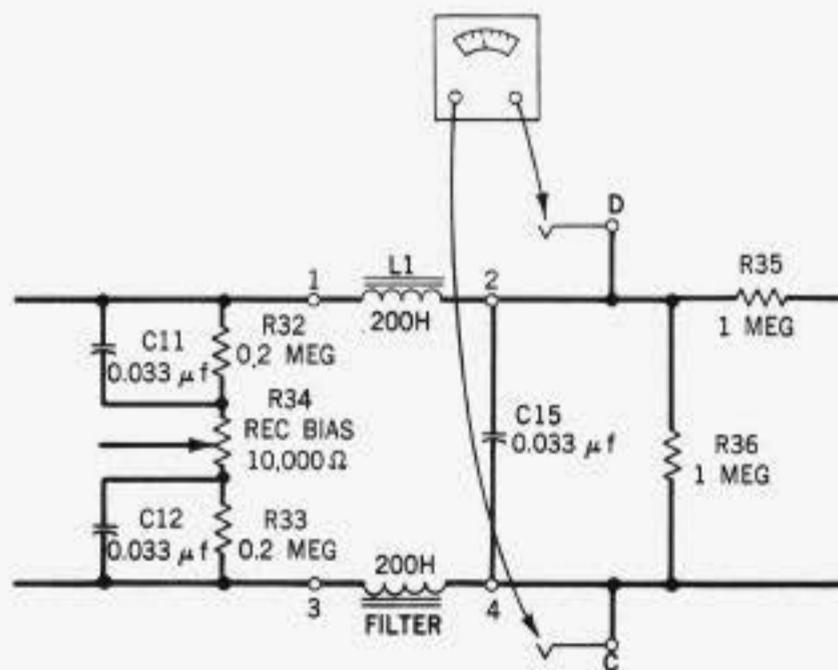


Fig. 12 — Circuit Schematic Showing Where Measurements Are Made in Discriminator Voltage Test (This page)

**(Important: Perform Tests in
Numbered Sequence)**

SUPPLEMENTARY TESTS OF

(See Part 5)

**FDX NEUTRAL LOOP TERMINALS
CONTROL SETTINGS - TABLE A ITEM:**

4W	3	4	5	6		
2W	11	12	13	14		
	$\pm 130V$ 62.5 MA LOOPS	+130V 62.5 MA LOOPS	+130V 20 MA LOOPS	$\pm 48V$ 20 MA LOOPS	TEST	P R
	1	1	1	1	Line-up Procedure	Adjust output level using SEND Operate OSC switch on Reference
	2	2	2	2		Check output level adjusting, if control in reference unit.
	3	3	3	3		Set LINE 1 attenuator for difference -26 dbm. Set LINE 2 attenuator for difference value of receiving level for unit
	4	4				Using LP CUR control on unit
			4	4		Using LP CUR control on unit
	5	5				Check loop currents.
			5	5		Check loop currents.
	6	6	6	6		Operate SEND key in 165 set to Restore SEND key to M.
	7	7	7	7		Open SL TMS B jack. Check current Close SL TMS B jack.

**(Remainder of Supplementary Tests
for FDX Terminals on Page 13)**

SUPPLEMENTARY TESTS OF CHANNEL TERMINALS

(See Part 5 in Text)

PROCEDURE	MEASURE AT:	MEASURED REQUIREMENT
Adjust output level using SEND LEV control in unit under test. Operate OSC switch on Reference Unit to ON.	Eqpt. A	-10 ± 0.5 dbm or value for unit under
Check output level adjusting, if necessary, by means of SEND LEV control in reference unit.	Eqpt. B	-10 ± 0.5 dbm
Set LINE 1 attenuator for difference between specified value and -26 dbm. Set LINE 2 attenuator for difference between -10 dbm and specified value of receiving level for unit under test.		
Using LP CUR control on unit under test, adjust current in 165 set.	RL CUR A	62.5 ± 2.5 ma
Using LP CUR control on unit under test, adjust current in 165 set.	RL CUR A	20 ± 2 ma
Check loop currents.	RL CUR B SL CUR B SL CUR A	62.5 ± 2.5 ma 62.5 ± 2.5 ma 62.5 ± 2.5 ma
Check loop currents.	RL CUR B SL CUR B SL CUR A	62.5 ± 2.5 ma 62.5 ± 2.5 ma 20 ± 2 ma
Operate SEND key in 165 set to S. Restore SEND key to M.	RL CUR A SL CUR B RL CUR B	No change from Step No change Less than 3 ma
Open SL TMS B jack. Check current. Close SL TMS B jack.	RL CUR B SL CUR A RL CUR A	No change from Step No change from Step Less than 3 ma

MEASURE AT: MEASURED REQUIREMENT

Eqpt. A	-10 ± 0.5 dbm or specified value for unit under test
Eqpt. B	-10 ± 0.5 dbm
RL CUR A	62.5 ± 2.5 ma
RL CUR A	20 ± 2 ma
RL CUR B SL CUR B SL CUR A	62.5 ± 2.5 ma 62.5 ± 2.5 ma 62.5 ± 2.5 ma
RL CUR B SL CUR B SL CUR A	62.5 ± 2.5 ma 62.5 ± 2.5 ma 20 ± 2 ma
RL CUR A SL CUR B RL CUR B	No change from Step 4 No change Less than 3 ma
RL CUR B SL CUR A RL CUR A	No change from Step 5 No change from Step 5 Less than 3 ma

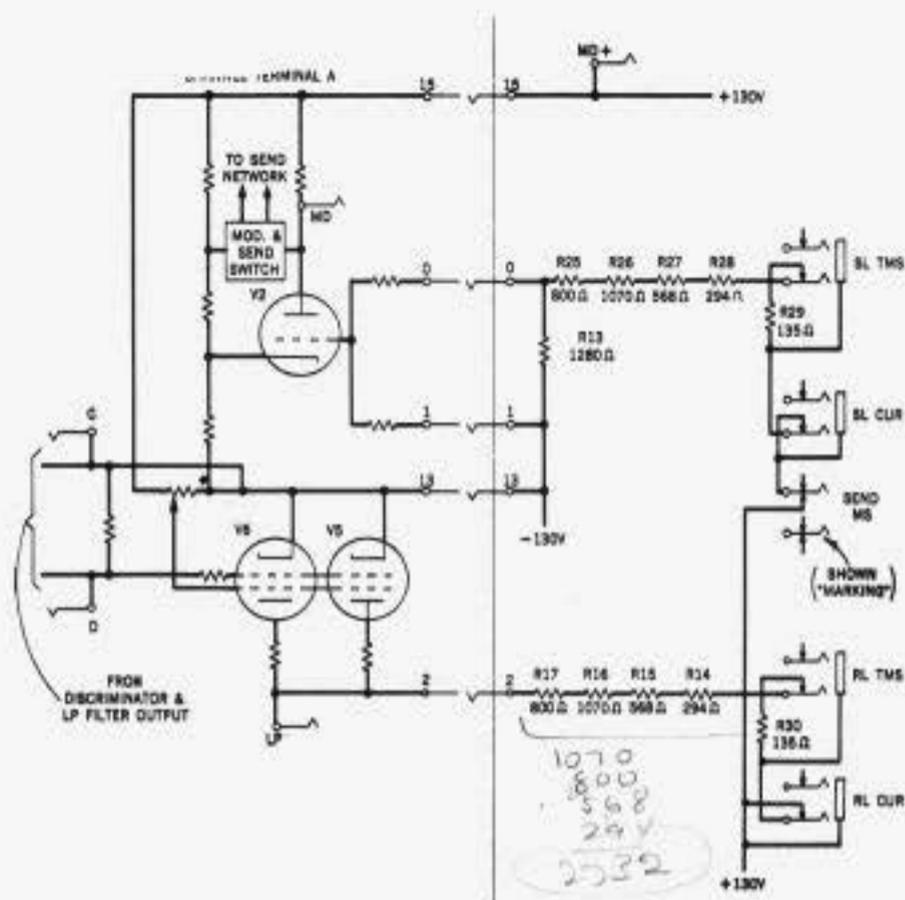


Fig. 13 — Full-duplex Neutral Loop Termination
 ± 130 Volts, 62.5 Milliamperes
(See tests in first column,
Pages 11 and 13)

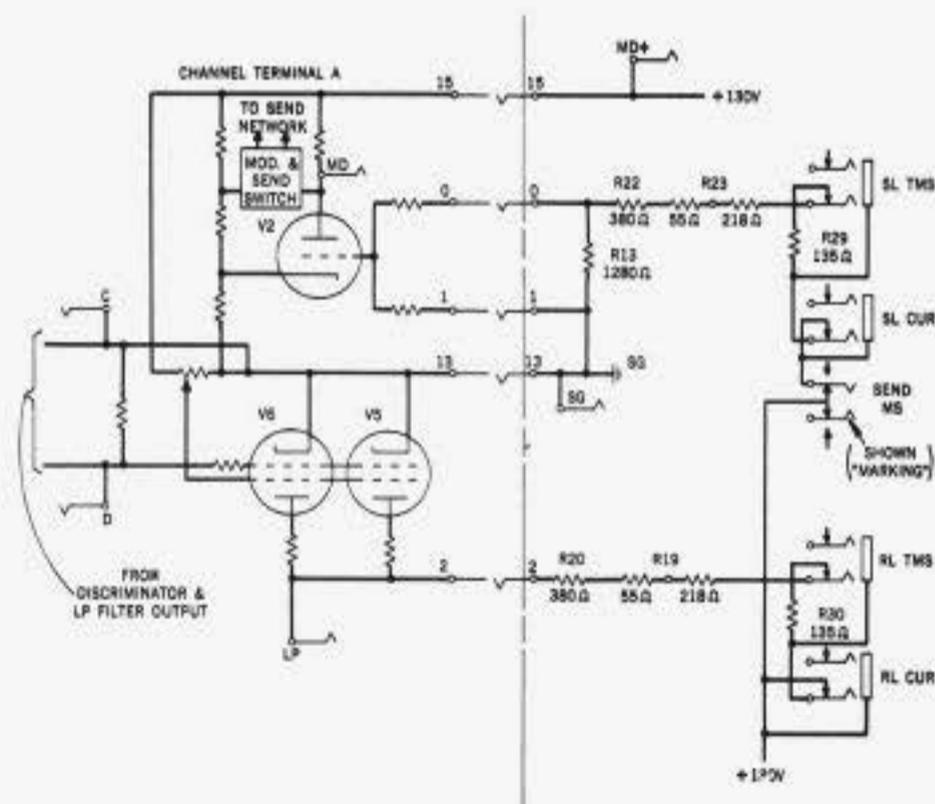


Fig. 14 — Full-duplex Neutral Loop Termination
 $+130$ Volts and Ground,
62.5 Milliamperes
(See tests in second column,
Pages 11 and 13)

(Important: Perform Tests in
Numbered Sequence)

SUPPLE

HDX NEUTRAL LOOP TERMINALS
CONTROL SETTINGS - TABLE A ITEM:

4W	7	8	9	10	TEST	
2W	15	16	17	18		
	$\pm 130V$ 62.5 MA LOOPS	+130V 62.5 MA LOOPS	+130V 20 MA LOOPS	$\pm 48V$ 20 MA LOOPS		
	1	1	1	1	Line-up Procedure	Adjust output Operate OSC s
	2	2	2	2		Check output le in reference uni
	3	3	3	3		Set LINE 1 at -26 dbm. Set LINE 2 at value of receivi
	4	4				Using LP CUR
			4	4		Using LP CUR
	5	5				Check current.
			5	5		Check current.
	6	6	6	6		Operate SEND Check current. Restore SEND I
	7	7	7	7		Open SL TMS B Check current. Close SL TMS

(Remainder of Supplementary Tests
for HDX Terminals on next page)

SUPPLEMENTARY TESTS OF CHANNEL TERMINALS

(See Part 5 in Text)

	PROCEDURE	MEASURE AT:	MEASURED REQ
Procedure	Adjust output level using SEND LEV control in unit under test. Operate OSC switch on Reference Unit to ON.	Eqpt. A	-10 ± 0.5 dbm value for unit under test
	Check output level. Adjust, if necessary, by means of SEND LEV control in reference unit.	Eqpt. B	-10 ± 0.5 dbm
	Set LINE 1 attenuator for difference between specified value and -26 dbm. Set LINE 2 attenuator for difference between -10 dbm and specified value of receiving level for unit under test.		
	Using LP CUR control on unit under test, adjust current.	SL CUR A	62.5 ± 2.5 ma
	Using LP CUR control on unit under test, adjust current.	SL CUR A	20 ± 2 ma
	Check current.	SL CUR B	62.5 ± 2.5 ma
	Check current.	SL CUR B	20 ± 2 ma
	Operate SEND key in the 165 set to S. Check current. Restore SEND key to M.	SL CUR A SL CUR B	Less than 3 ma Less than 3 ma
	Open SL TMS B jack and check current. Check current. Close SL TMS B jack.	SL CUR A SL CUR B	Less than 3 ma Less than 3 ma

(Important: Perform Tests in
Numbered Sequence)

SUPPLEMENTARY TESTS OF C

NEUTRAL LOOP TERMINALS

Both FDX & HDX, Both 2W & 4W				TEST	PROCEDURE
$\pm 130V$ 62.5 MA LOOPS	+130V 62.5 MA LOOPS	+130V 20 MA LOOPS	$\pm 48V$ 20 MA LOOPS		
8	8	8	8	Transmission Tests — Receiving	Connect source of undistorted signal and transmission measuring set to R jack (HDX). Operate REC BIAS control in unit under test to then maximum counterclockwise position.
9	9	9	9		Adjust bias using REC BIAS control. Operate REC switch in unit under test to reference unit to LM. Restore REC switch to H+ and SEND.
10	10	10	10		Decrease attenuation of LINE 2 attenuator. Restore attenuator to original setting.
11	11	11	11		Increase attenuation of LINE 2 attenuator. Restore attenuator to original setting.
12	12	12	12	Transmission Tests — Sending	Connect source of undistorted signal and transmission measuring set to TMS B jack (HDX).
13	13	13	13		Operate SEND switch in unit under test to reference unit to L+. Operate OSC switch on Reference Unit.

SUPPLEMENTARY TESTS OF CHANNEL TERMINALS

PROCEDURE	MEASURE AT:	MEASURED REQUIREMENT
<p>Connect source of undistorted signals to SL CUR B jack in the 165 set and transmission measuring set to RL TMS A jack (FDX) or SL TMS A jack (HDX).</p> <p>Operate REC BIAS control in unit under test to maximum clockwise and then maximum counterclockwise position.</p>	RL TMS A or SL TMS A	Range of +10% to -10% bias. "Total distortion" reading should not differ by more than 5 points from "average bias" reading.
<p>Adjust bias using REC BIAS control.</p> <p>Operate REC switch in unit under test to L+ and SEND switch in reference unit to LM.</p> <p>Restore REC switch to H+ and SEND switch to HM.</p>	RL TMS A or SL TMS A	0 ± 1% bias 0 ± 2% bias
<p>Decrease attenuation of LINE 2 attenuator by 10 db.</p> <p>Restore attenuator to original setting.</p>	RL TMS A or SL TMS A	0 ± 2% bias
<p>Increase attenuation of LINE 2 attenuator by 20 db.</p> <p>Restore attenuator to original setting.</p>	RL TMS A or SL TMS A	0 ± 5% bias
<p>Connect source of undistorted signals to SL CUR A jack in the 165 set and transmission measuring set to the RL TMS B jack (FDX) or SL TMS B jack (HDX).</p>	RL TMS B or SL TMS B	0 ± 2% bias
<p>Operate SEND switch in unit under test to LM and REC switch in reference unit to L+.</p> <p>Operate OSC switch on Reference Unit to OFF.</p>	RL TMS B or SL TMS B	0 ± 3% bias

MEASURE AT:	MEASURED REQUIREMENT
TMS A or TMS A	Range of +10% to -10% bias. "Total distortion" reading should not differ by more than 5 points from "average bias" reading.
TMS A or TMS A	0 ± 1% bias
TMS A or TMS A	0 ± 2% bias
TMS A or TMS A	0 ± 2% bias
TMS A or TMS A	0 ± 5% bias
TMS B or TMS B	0 ± 2% bias
TMS B or TMS B	0 ± 3% bias

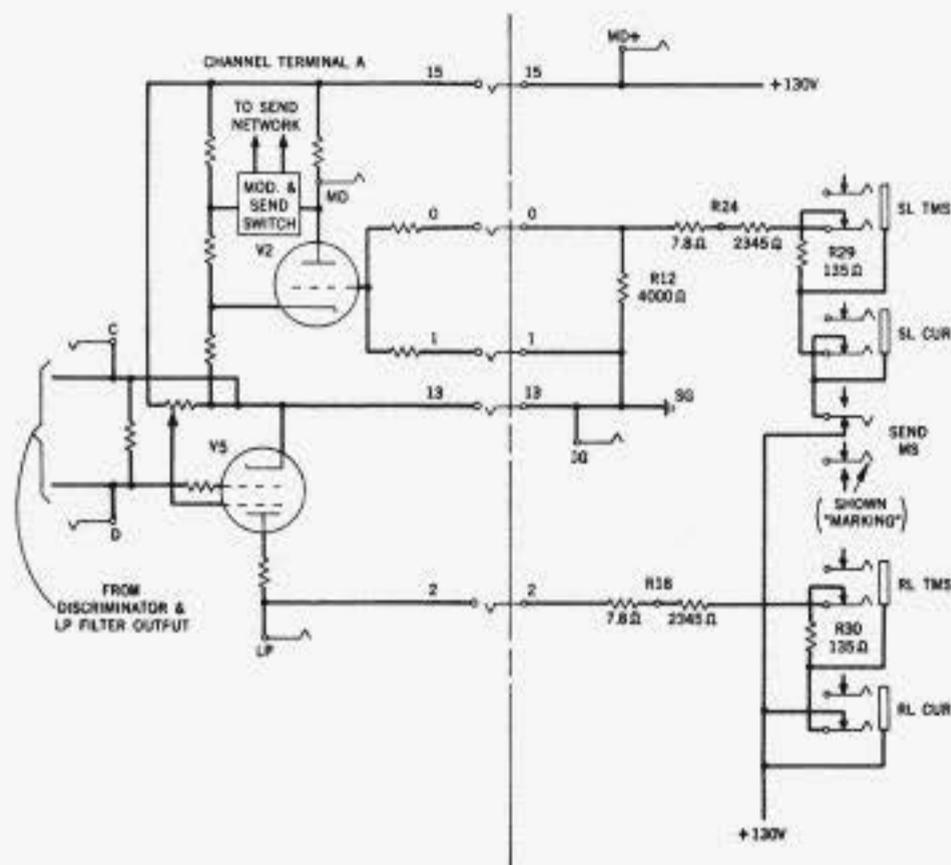


Fig. 17 — Full-duplex Neutral Loop Termination +130 Volts and Ground, 20 Milliamperes (See tests in third column, Pages 11 and 13)

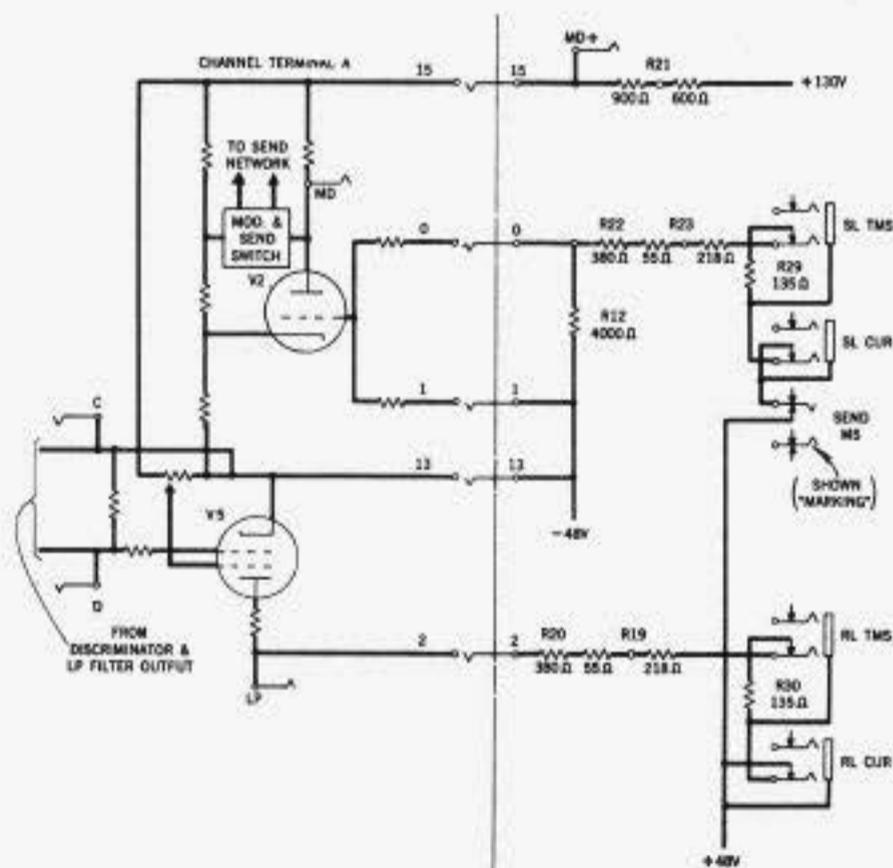


Fig. 18 — Full-duplex Neutral Loop Termination ±48 Volts, 20 Milliamperes (See tests in fourth column, Pages 11 and 13)

(Important: Perform Tests in
Numbered Sequence)

SUPPLEMENTARY TESTS OF CHAN
(See Part 5 in Text)

HUB TYPE TERMINALS

TABLE A SETTINGS

ITEM 19 4W FDX	ITEM 20 4W HDX	TEST	PROCEDURE
1		Line-up Procedure	Operate OSC switch on Reference Unit to ON. Check voltage in 165 set.
2			Check current. Current in RL CUR B jack may be adjusted reference unit. Current in RL CUR A jack may be adjusted 144B coupling unit.
3			Operate SEND key in 165 set to S. Restore SEND key to M. Check current.
4			Open SL TMS B jack. Check voltage and current. Close SL TMS B jack.
5			Adjust output level using SEND LEV control Check output level. Adjust, if necessary, by means in reference unit.
FDX tests continue on next page.			
	1		Operate OSC switch on Reference Unit to ON. Check voltage in 165 set.
	2		Check current.

SUPPLEMENTARY TESTS OF CHANNEL TERMINALS

(See Part 5 in Text)

PROCEDURE	MEASURE AT:	MEASURED REQUIREMENT
OSC switch on Reference Unit to ON. Stage in 165 set.	SEND HP REC HP	+60 ± 3 volts +60 ± 3 volts
Current. RL CUR B jack may be adjusted by LP CUR control on unit. RL CUR A jack may be adjusted by LP CUR control in polarizing unit.	SL CUR B RL CUR B RL CUR A SL CUR A	62.5 ± 2.5 ma 62.5 ± 2.5 ma 62.5 ± 2.5 ma 0
SEND key in 165 set to S.	SEND HP REC HP RL CUR B	-30 ± 2 volts No change (60 ± 3 volts) Less than 3 ma
SEND key to M. Check current.	SL CUR A	0
TMS B jack. Stage and current.	REC HP SL CUR B RL CUR A SEND HP	-30 ± 2 volts Less than 3 ma Less than 3 ma No change (60 ± 3 volts)
TMS B jack.		
Output level using SEND LEV control in unit under test.	Eqpt. A	-10 ± 0.5 dbm or specified value for unit under test
Output level. Adjust, if necessary, by means of SEND LEV control of reference unit.	Eqpt. B	-10 ± 0.5 dbm
OSC switch on Reference Unit to ON. Stage in 165 set.	SEND HP	+60 ± 3 volts
Current.	SL CUR B RL CUR A SL CUR A	62.5 ± 2.5 ma 62.5 ± 2.5 ma 0

MEASURED REQUIREMENT	
+60 ± 3 volts	+60 ± 3 volts
62.5 ± 2.5 ma	62.5 ± 2.5 ma
62.5 ± 2.5 ma	62.5 ± 2.5 ma
0	
-30 ± 2 volts	No change (60 ± 3 volts)
	Less than 3 ma
0	
-30 ± 2 volts	Less than 3 ma
	Less than 3 ma
	No change (60 ± 3 volts)
-10 ± 0.5 dbm or specified value for unit under test	
-10 ± 0.5 dbm	
+60 ± 3 volts	
62.5 ± 2.5 ma	62.5 ± 2.5 ma
62.5 ± 2.5 ma	62.5 ± 2.5 ma
0	

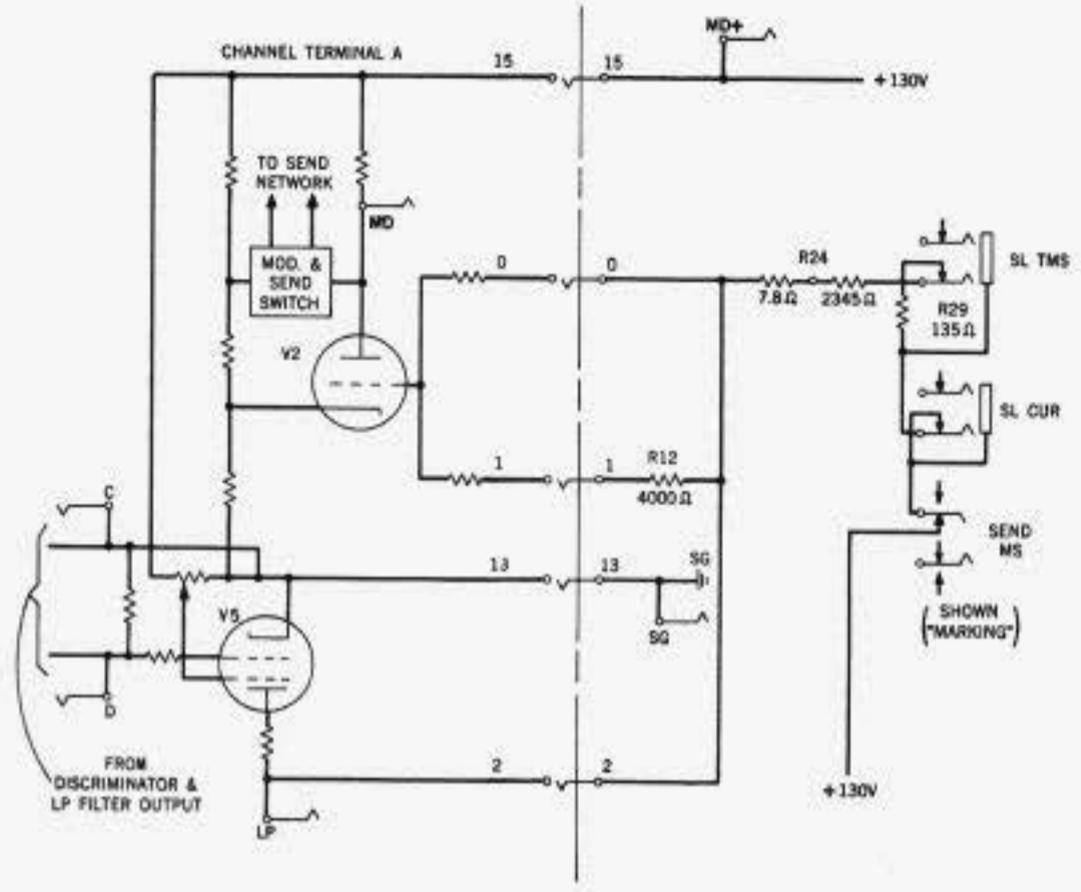


Fig. 19 — Half-duplex Neutral Loop Termination +130 Volts and Ground, 20 Milliamperes (See tests in third column, Pages 12 and 13)

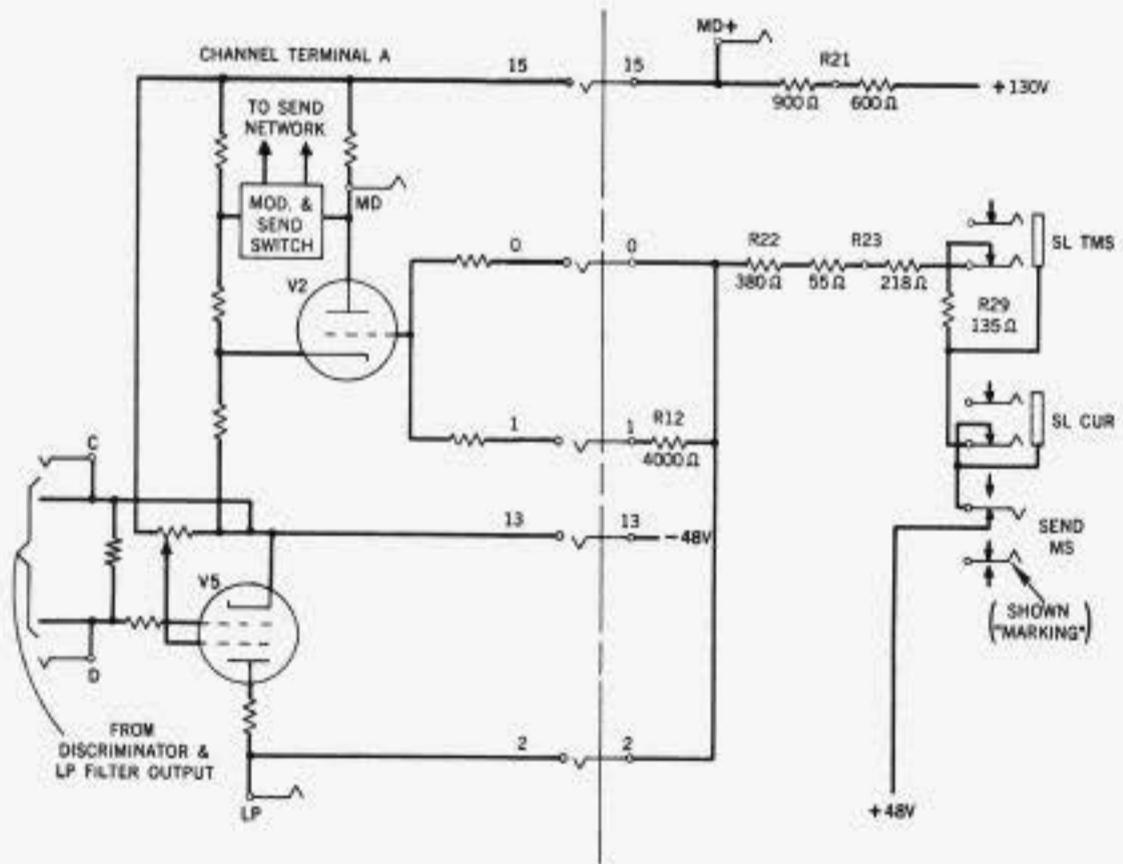


Fig. 20 — Half-duplex Neutral Loop Termination ±48 Volts, 20 Milliamperes (See tests in fourth column, Pages 12 and 13)

(Important: Perform Tests in
Numbered Sequence)

SUPPLEMENTARY TESTS OF CHA

HUB TYPE TERMINALS

TABLE A SETTINGS

ITEM 19 4W FDX	ITEM 20 4W HDX	TEST	PROCEDURE
	3		Operate SEND key in 165 set to S.
	4		Open SL TMS B jack. Close SL TMS B jack. Restore SEND key to M.
	5		Adjust output level using SEND LEV control in Check output level. Adjust, if necessary, by means in reference unit.
6	6	Transmission Tests — Receiving	<u>Patch the source of test signals to SL CUR B jack</u> <u>transmission measuring set to RL TMS A jack</u> Operate REC BIAS control in unit under test to then maximum counterclockwise positions. Adjust bias.
7	7		Decrease attenuation of LINE 2 attenuator by Restore attenuator to original setting. Increase attenuation of LINE 2 attenuator by Restore attenuator to original setting.
8	8	Transmission Test — Sending	<u>Patch the source of Hub type test signals (+60</u> <u>in 165 set and telegraph transmission measuring</u> Operate OSC switch on Reference Unit to OFF.

SUPPLEMENTARY TESTS OF CHANNEL TERMINALS

PROCEDURE	MEASURE AT:	MEASURED REQUIREMENT
D key in 165 set to S.	SEND HP SL CUR B RL CUR A SL CUR A	-30 ± 2 volts Less than 3 ma Less than 3 ma 30 ± 3 ma (reverse meter)
S B jack.	SEND HP SL CUR B RL CUR A SL CUR A	At least -60 volts Less than 3 ma Less than 3 ma Less than 2.5 ma (reverse meter)
S B jack. D key to M.	Eqpt. A Eqpt. B	-10 ± 0.5 dbm or specified value for unit under test -10 ± 0.5 dbm
Level using SEND LEV control in unit under test.	Eqpt. B	-10 ± 0.5 dbm
Level. Adjust, if necessary, by means of SEND LEV control unit.	RL TMS A RL TMS A	Average bias of at least +10% to -10% should be obtainable "Total Distortion" reading should not differ by more than 5 from "average bias" 0 ± 1% bias
Force of test signals to SL CUR B jack in 165 set and telegraph measuring set to RL TMS A jack.	RL TMS A	0 ± 2% bias
BIAS control in unit under test to maximum clockwise and counterclockwise positions.	RL TMS A	0 ± 5% bias
Reduction of LINE 2 attenuator by 10 db. Attenuator to original setting.	RL TMS B	0 ± 2% bias
Reduction of LINE 2 attenuator by 20 db. Attenuator to original setting.	RL TMS B	0 ± 2% bias
Force of Hub type test signals (+60, -30) to SEND HUB jack and telegraph transmission measuring set to RL TMS B jack.	RL TMS B	0 ± 2% bias
Switch on Reference Unit to OFF.		

(Important: Perform Tests in
Numbered Sequence)

NETW
Set Controls pe
(See Po

NETWORK TYPE — STEPS	TEST	PROCEDURE
Send (458 Type) 1	Maximum Output Level	Install a reference channel unit in position A or 165 Insert sending network under test in reference unit. See that SEND key on 165 set is in M position. Measure output level with 13A TMS or equivalent.
2	Normal Output Level	Using SEND LEV control in reference unit, adjust
3	Output Frequency — Marking	Measure output frequency using 72A Frequency Met
4	Output Frequency — Spacing	Operate SEND key in test set to S. Restore SEND key to M.
5	Send Level M-S Turnover	Measure change in level when SEND key is operated <i>Note:</i> The OSC control and the strapping of test the networks should be used if necessary to meet tests 3, 4, and 5.
Receive (454 Type) 1	Received Level — Marking	(a) Install reference unit in position A of 165 set. Insert receiving network under test in reference Connect source of frequency to LINE A jack. frequency should be not less than -20 dbm. (b) Set LINE 1 attenuator for difference between source and -26 dbm. Set frequency of the source for the nominal va quency of the network under test ± 1 cycle. (c) Measure level in reference unit.
(Balance of Network Tests on following page)		

NETWORK TESTS

Set Controls per Table A — Item 21
(See Part 6 in Text)

PROCEDURE	MEASURE AT:	MEASURED REQUIREMENT
<p>reference channel unit in position A or 165 set. receiving network under test in reference unit. SEND key on 165 set is in M position. output level with 13A TMS or equivalent.</p>	Eqpt. A	Not less than +4 dbm
<p>LEVEL control in reference unit, adjust output level.</p>	Eqpt. A	-10 ± 1 dbm
<p>output frequency using 72A Frequency Meter.</p>	Eqpt. A	Within ±3 cycles of nominal value of higher frequency of the network.
<p>SEND key in test set to S.</p>	Eqpt. A	Within ±3 cycles of nominal value of lower frequency of the network. Average of the measured values of higher and lower frequencies should be within 1 cycle of the nominal midband frequency of network.
<p>SEND key to M.</p>	Eqpt. A	Not more than 3 db change
<p>OSC control and the strapping of terminals 5, 6, and 7 on test set should be used if necessary to meet the requirements of Part 6 and 5.</p>		
<p>reference unit in position A of 165 set. receiving network under test in reference unit. output source of frequency to LINE A jack. The level of the output should be not less than -20 dbm. Set 1 attenuator for difference between level of the frequency and -26 dbm. frequency of the source for the nominal value of the higher frequency of the network under test ± 1 cycle. output level in reference unit.</p>	A1-G	Not less than +16 db for networks having nominal midband frequency of 3145 CPS or less. Not less than +12 db for networks having nominal midband frequency of more than 3145 CPS.

MEASURED REQUIREMENT

Not less than +4 dbm

-10 ± 1 dbm

Within ±3 cycles of nominal value of the higher frequency of the network.

Within ±3 cycles of nominal value of the lower frequency of the network. Average of the measured values of higher and lower frequencies should be within 1 cycle of the nominal midband frequency of the network.

Not more than 3 db change

Not less than +16 db for networks having nominal midband frequency of 3145 CPS or less. Not less than +12 db for networks having nominal midband frequency of more than 3145 CPS.

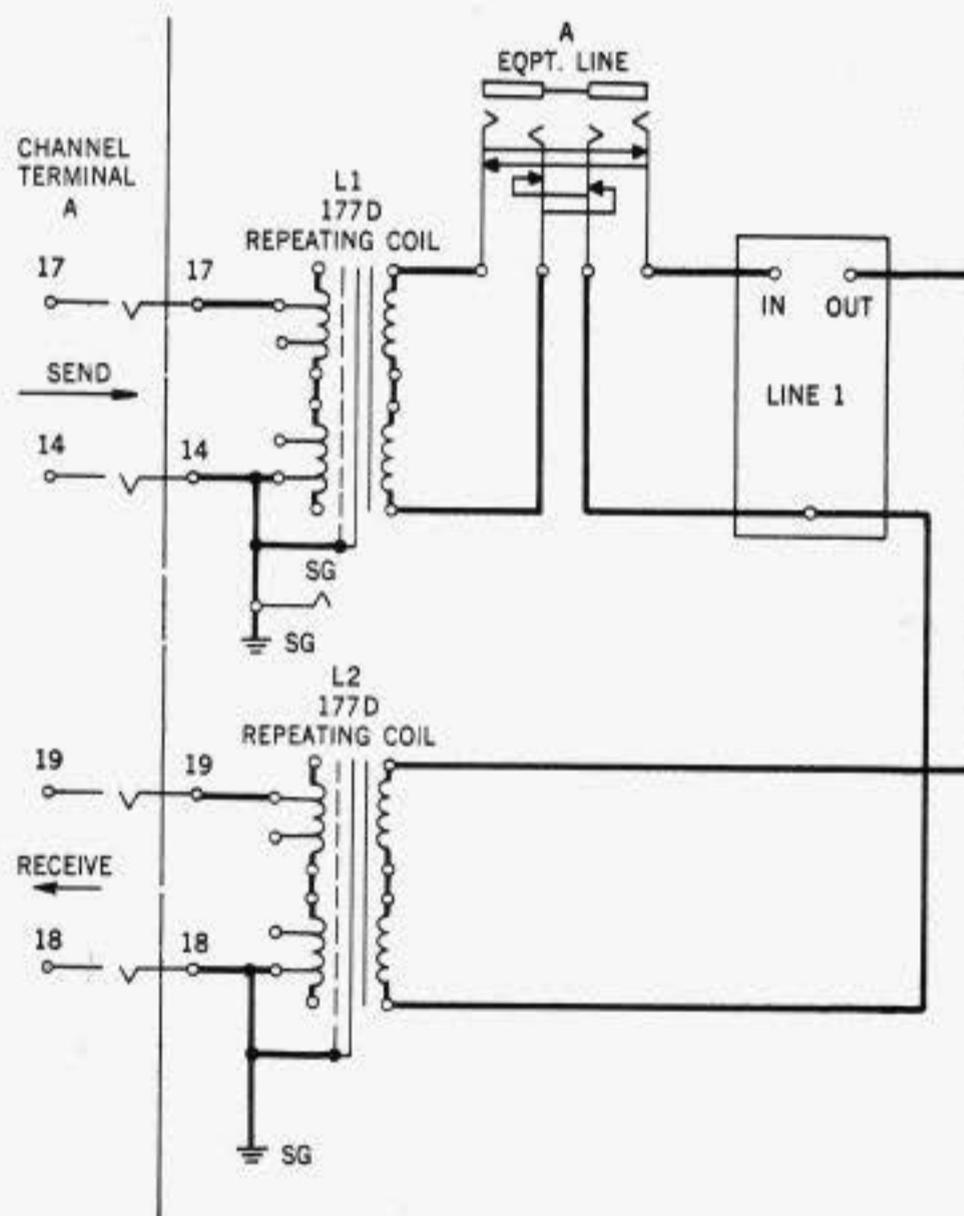


Fig. 21 — Test Set Line Connections for Network Tests with CARRIER Switch Set on LOC (As specified in Table A, Item 21)

*(Important: Perform Tests in
Numbered Sequence)*

NETWORK TESTS

Set Controls per Table A — Item 21
(See Part 6 in Text)

NETWORK TYPE	TEST	PROCEDURE
Receive (454 Type) Cont. 2	Received Level — Spacing	Set frequency of source for nominal value of the lower frequency of work under test ± 1 cycle. (See that level of source does not change.) Measure level in reference unit.
3	Discriminator	<ol style="list-style-type: none"> (a) Select a 408A tube which has a minimum plate current of 10 ma w measured according to Step 8 on Page 18. Use this tube as V4 in the reference unit. (b) Remove tubes V5 and V6 from reference unit. (c) Carefully short out resistor R42 in reference unit. (d) Apply the nominal mid-band frequency of the network using method as in receiving network tests 1 (a) and (b) above. (e) Adjust REC BIAS control in reference unit until equal and opposite voltages are obtained when the REC switch in the terminal is operated alternately to the H+ and L+ positions. (f) Leave the REC switch in the H+ position. (g) Apply the higher frequency of the network as in receiving network tests 1 (a) and 1 (b) above. (h) Measure the discriminator output voltage in the H+ and L+ positions of the REC switch. (j) Leave switch in H+ position. (k) Apply the lower frequency of the network using method as in receiving network tests in 1 (a) and 1 (b) above. (l) Measure the discriminator output voltage with the polarity of voltmeter leads reversed from that of step (h) above.

NETWORK TESTS

Set Controls per Table A — Item 21
(See Part 6 in Text)

PROCEDURE	MEASURE AT:	MEASURED REQUIREMENT
<p>for nominal value of the lower frequency of network. (See does not change.) reference unit.</p>	A1-G	<p>Same as requirements in test 1 above. Results should not differ by more than 1.5 db from those in test 1.</p>
<p>which has a minimum plate current of 10 ma when going to Step 8 on Page 18. in the reference unit.</p>		
<p>and V6 from reference unit.</p>		
<p>at resistor R42 in reference unit.</p>		
<p>mid-band frequency of the network using method network tests 1 (a) and (b) above.</p>		
<p>control in reference unit until equal and opposite reading when the REC switch in the terminal is oper- ated in the H+ and L+ positions.</p>	D and C	<p>Reading in either position not greater than 5 volts.</p>
<p>switch in the H+ position.</p>		
<p>frequency of the network as in receiving network (b) above.</p>		
<p>minimator output voltage in the H+ and L+ posi- tions.</p>	D and C	<p>Greater than +35 volts and both within ± 1 volt.</p>
<p>H+ position.</p>		
<p>frequency of the network using method as in receiv- ing network 1 (a) and 1 (b) above.</p>		
<p>minimator output voltage with the polarity of the reversed from that of step (h) above.</p>	D and C	<p>Greater than +35 volts and not more than 5 volts different from measurement in (h) above.</p>

ELECTRON TUBE TESTS

(See Part 7 in Text)

STEP	ELECTRON TUBE CODE NO.	PLT. KEY POS.		BIAS KEY POS.		SHORT CKT KEY POS.	POSITION IN CHAN. TERM.
		V7	V9	V7, V8	V9		
1	407A	SU	N	C	N	N	V1, V3
2	407A	SC	N	C	N	N	V1, V3
3	407A	SU	N	C	N	N	V2, V8
4	407A	SC	N	C	N	N	V2, V8
5	407A	SU	N	CO	N	N	V1, V2, V3
6	407A	SC	N	CO	N	N	V1, V2, V3
7	407A	N	N	N	N	SHORT	V1, V2, V3
8	408A	N	N	C	N	N	V4, V7
9	408A	N	N	CO	N	N	V4, V7
10	408A	N	N	N	N	SHORT	V4, V7
11	429A	N	L	N	C	N	V5, V6
12	429A	N	H	N	C	N	V5, V6
13	429A	N	L	N	CO	N	V5, V6
14	429A	N	H	N	CO	N	V5, V6
15	429A	N	N	N	N	SHORT	V5, V6

*Tapping tube lightly should not change meter reading.

+ Minimum current 10 Ma when tube is to be used to test 454 networks.

IRON TUBE TESTS

Part 7 in Text)

KEY POS.		SHORT CKT KEY POS.	POSITION IN CHAN. TERM.	CURRENT MA
	V9			
	N	N	V1, V3	MIN 7
	N	N	V1, V3	MIN 7
	N	N	V2, V8	MIN 8
	N	N	V2, V8	MIN 8
	N	N	V1, V2, V3	MAX 0.4
	N	N	V1, V2, V3	MAX 0.4
	N	SHORT	V1, V2, V3	0*
	N	N	V4, V7	MIN 9 +
	N	N	V4, V7	MAX 1.4
	N	SHORT	V4, V7	0*
	C	N	V5, V6	MIN 32
	C	N	V5, V6	MIN 29
	CO	N	V5, V6	MAX 0.5
	CO	N	V5, V6	MAX 0.5
	N	SHORT	V5, V6	0*

not change meter reading.

When tube is to be used to test 454 networks.

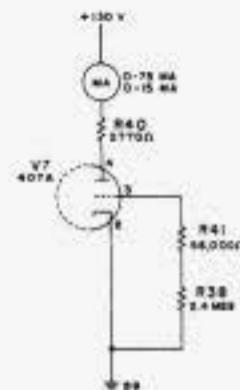


Fig. 22 — BIAS V7, V8 Key in C Position for 407A Tube (See Steps 1-4)

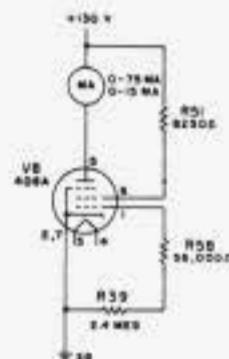


Fig. 25 — BIAS V7, V8 Key in C Position for 408A Tube (See Step 8)

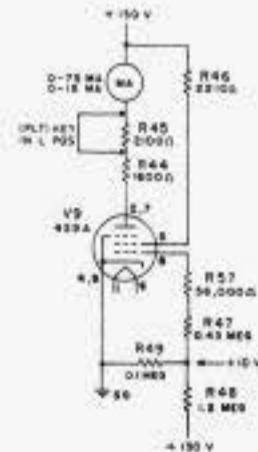


Fig. 28 — V9 BIAS Key in C Position for 429A Tube R45 S/C in Step 11 (See Steps 11-12)

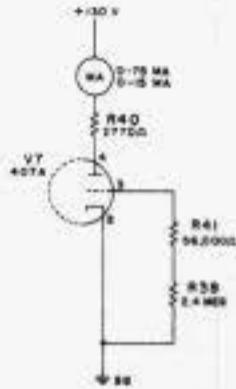


Fig. 22 — BIAS V7, V8 Key in C Position for 407A Tube (See Steps 1-4)

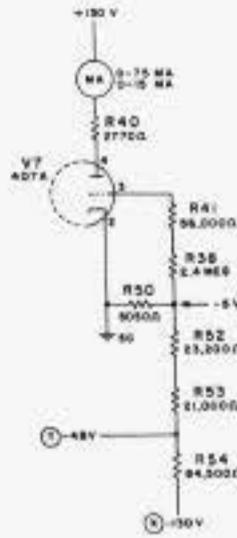


Fig. 23 — BIAS V7, V8 Key in CO Position for 407A Tube (See Steps 5-6)

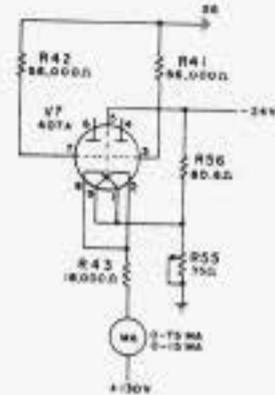


Fig. 24 — SHORT-CKT Key in SHORT Position for 407A Tube (See Step 7)

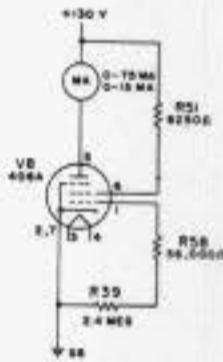


Fig. 25 — BIAS V7, V8 Key in C Position for 408A Tube (See Step 8)



Fig. 26 — BIAS V7, V8 Key in CO Position for 408A Tube (See Step 9)

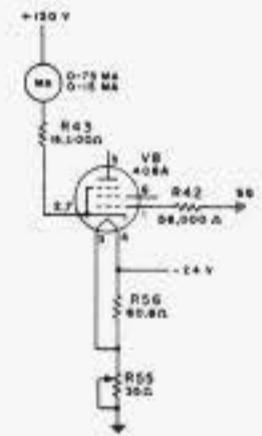


Fig. 27 — SHORT-CKT Key in SHORT Position for 408A Tube (See Step 10)

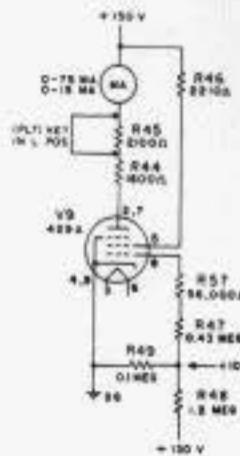


Fig. 28 — V9 BIAS Key in C Position for 429A Tube R45 S/C in Step 11 (See Steps 11-12)

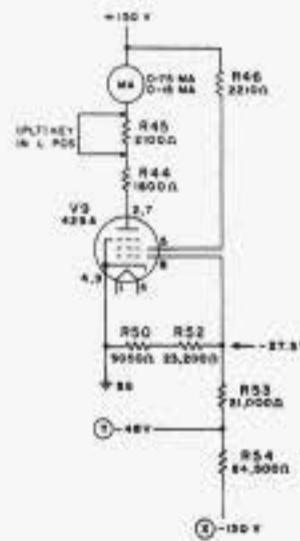


Fig. 29 — V9 BIAS Key in CO Position for 429A Tube R45 S/C in Step 13 (See Steps 13-14)

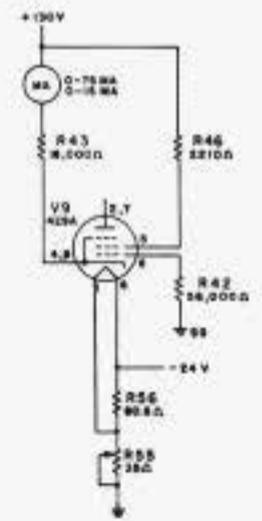


Fig. 30 — SHORT-CKT Key in SHORT Position for 429A Tube (See Step 15)