DEPARTMENT OF THE ARMY TECHNICAL MANUAL TM 11-2139-35

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER TO 31W1-2TCC7-64

FIELD AND DEPOT MAINTENANCE

TELEPHONE TERMINAL AN/TCC-7

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

NOVEMBER 1958

WARNING

HIGH VOLTAGE

is used in the operation
of this equipment.

DEATH ON CONTACT

may result if
personnel fail to observe
safety precautions.

All operating adjustments of this equipment are made with the power on. Be careful not to contact high-voltage connections or the 115-volt input connections when working on or near this equipment.

When repairing or replacing parts within the equipment, remove the power cord, and short-circuit the high voltage capacitors.

EXTREMELY DANGEROUS POTENTIALS EXIST IN THE FOLLOWING UNITS:

Power Supply PP-826/U (600 volts)
Power Supply PP-826A/U (600 volts)
and
Power Supply PP-827/U (200 volts)

DON'T TAKE CHANCES!

TECHNICAL MANUAL
No. 11-2139-35
TECHNICAL ORDER
No. 31W1-2TCC7-64

DEPARTMENTS OF THE ARMY
AND THE AIR FORCE

WASHINGTON 25, D.C., *14 NOVEMBER 1958*

TELEPHONE TERMINAL AN/TCC-7
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*This manual, together with TM 11-2139-10, 11 March, 1958, and TM 11-2139-20, 1 April 1958, supersedes TM 11-2139, 1 November 1953, including C 1, 29 December 1953; C 2, 2 March 1654; C 3, 19 September 1955; C 4, 11 May 1956; and C 5, 25 November 1957.

CHAPTER 1
INTRODUCTION

1. Scope

a. This manual covers field and depot maintenance for Telephone Terminal AN/TCC-7. It includes instructions appropriate to third, fourth, and fifth echelons for troubleshooting, testing, repairing and alining the equipment, replacing maintenance parts, and repairing specified maintenance parts. It also lists tools, materials, and test equipment for third, fourth, and fifth echelon maintenance. Detailed functions of the equipment are covered in chapter 2.

b. The complete technical instructions for this equipment include two other manuals.

TM 11-2139-10, Telephone Terminal AN/TCC-7, Operator's Manual
TM 11-2I39-20, Telephone Terminal AN/TCC-7, Organizational Maintenance

c. The maintenance allocation chart is published in TM 11-2139-20. The repair parts and special tools list will be published separately.

d. Forward comments concerning this manual to the Commanding Officer, United States Army Signal Publications Agency, Fort Monmouth, N. J.

Note. For applicable forms and records, see paragraph 2, TM 11-2139-10.

2. Internal Equipment Differences

The following chart lists the differences incorporated in the circuitry of components of Telephone Terminal AN/TCC-7. The component affected is listed in the equipment column. The nature of the equipment difference is summarized in the *differences* column. The serial numbers of the equipment, when applicable, are listed in the *serial No*. column. *The serial numbers listed apply to equipment procured on Order No. 14181-Phila-51 only*.

Item No.	Equipment	Differences	Serial No.
1	CHAN MODEM (figs. 2 and 139)	Shield Connected to pin 6 instead of pin 5 on connectors P101, P201, P301, and P401.	1 through 2,056 and 2,058 through 2,107.
2	GROUP PANEL (figs 7 and 144)	Top of panel not connected to chassis ground.	1 through 749.
3	Regulator and alarm unit Z6 (part of GROUP PANEL) (figs. 15 and 146).	Resistor R38 not included	Some units*.
4	JUNCTION PANEL (figs. 18, 148, and 149)	*a*. Shell of connectors P101 through P105 not connected to chassis ground.	Some units*.
		b. The wiring to the ground bus has not been modified.	Some units*.
5	TEST PANEL (figs. 29 and 155)	*a*. Capacitor C22 .27uf, 100 volts instead of .47uf, 400 volts.	1 through 873.
		b. Shield is not grounded on lead connected between standoff E16 and jack J6 not included	1 through 364.
		c. Leads C and E on connector J3 terminated on pins 3 and 4, respectively, of tube socket XV1.	1 through 419.
		d. Radio Frequency Cable RG-62/U instead of RG-58/U.	1 through 947.

Item No.	Equipment	Differences	Serial No.
6	If amplifier AR1 (part of TEST PANEL) (figs. 30 and 156).	Resistors R6 and R21 connected directly to capacitor C10.	Some units*.
7	Flat amplifier AR2 (part of Test PANEL) (figs. 31 and 15)	Resistors R6 and R21 connected directly to capacitor C10	Some units.
8	CARRIER SUPPLY PANEL (figs. 20 and 150)	Shell of connectors P1 through P3 not connected to chassis ground.	1 through 349.
9	200 VOLT POWER SUPPLY (figs. 33 and 158	Shell of connector P3 not connected to chassis ground.	1 through 799.
10	Power Supply PP-826/U (original units, figs. 39 and 159)	*a*. Resistors R6, R7, R8, R13, R14, and R15 connected directly to components.	1 through 3, 5 through 815, 817 through 859, 861 through 875, 877 through 888, 890 through 909 through 920, 922 through 955, 957 through 960, 963, 965, 966, 968, 969, 971 through 975, 978, 984, 987 through 990, 993 through 995, 997 and 1,006.
		b. Shell of connector P3 not connected to chassis ground.	1 through 1,006.
11	Power Supply PP-826/U (revised units, figs. 40 and 161	*a*. Resistor R6, R7, R8, R13, R14, and R15 relocated and connected through terminal board to components.	4,816, 860, 876, 889, 908, 921, 956, 961, 962, 964, 967, 970, 976, 977, 979 through 983, 985, 986, 991, 992, 996, 998 through 1,005, and 1,007 through 1,169.
		b. Shell of connector P3 not connected to chassis ground.	1,007 through 1,074.
		c. Resistor R6, R7, R8, R13, R14, and R15 relocated and connected directly to components.	1,170 through 2.964.
12	Power Supply PP-826A/U (figs. 35 and 163	*a*. Low-voltage rectifier and alarm Z1 is replaced by Low-voltage rectifier and alarm Z2. *b*. Main chassis same as that of Power Supply PP-286/U (revised units, item No. 11*c* above). Also shell of connector P3 is connected to chassis ground..	
13	Low-voltage rectifier and alarm Z1 (part of PP-286/U, figs. 34, 160, and 162)	*a.* R23 replaced by a strap (figs. 39 and 40).	Some units*.
		b. Resistance value of relay *U7* winding 415 ohms instead of 425 ohms (fig. 39).	Some units*.
		c. Variations in relay circuitry (figs. 39 and 40).	Some units*.

CHAPTER 2
UNIT THEORY

Section I. TELEPHONE MODEM TA-219/U

3. Block Diagram Analysis

(fig. 1)

Telephone Modem TA-219/C (CHAN MODEM) consist of a main chassis and four channel plug- n assemblies, CHAN- 1, CHAN 2, CHAN 3, and (CHAN 4. Voice frequency (vf) telephone or teletypewriter facilities may be connected to the four channels on a two-wire or four-wire basis. Each channel consists of a transmitting, a receiving, and a test circuit. Facilities are e also provided for talking and monitoring from the ORDER WIRE PANEL.

Note. Throughout this section, reference is made to components in channel 1. Its operation is identical to that of the other three channels The following reference designations have been assigned for identifying the components in each channel:

Channel No.	Reference Designations
1	101 through 199
2	201 through 299
3	301 through 399
4	101 through 499 .

a. Transmitting Circuit Two -Wire Operation

(1) 2W-4W switch S103 arranges the channel for two-wire or four-wire operation. In the 2W position, the switch connects transformer T101 into the circuit. SEND-MEAS switch S102 is used for testing and alinement purposes.

(2) The 8-decibel (db) modulator input pad reduces the vf signal to the proper level for modulation.

(3) Transformer T102 and low-pass filter FL101 prevent frequencies outside the specific vf band from being applied to the modulator circuit.

(4) The vf applied to modulator CR101 modulates the 8-kilocycle (c) carrier signal applied from the CARRIER SUPPLY PANEL, producing two sidebands. The modem pad compensates for ambient temperature variations which may affect the level of the 8-kc carrier signal applied to modulator CR101 and demodulator CR102.

(5) The 7-db modulator output pad attenuates the sidebands and compensates for ambient temperature variations.

(6) Band-pass filter FL102 selects the lower sideband (4 to 8 kc) from the modulator for transmission to the SUBGROUP PANEL in CHAN 2, 3, and 4, band-pass filters FL202, FL302, and FL402 select lower sideband frequencies of 8 to 12 kc**,** 12 to 16 kc, and 16 to 20 kc, respectively,

b. Receiving Circuit Two-Wire Operation.

(1) The 8-db receive pad attenuates the 4- to 20-kc channel input frequencies from the SUBGROUP PANEL. This pad, with the channel 8-db demodulator input pad ((3) below), provides the proper signal level for demodulation.

(2) Band-pass filter FI,103 selects the 4 to 8-kc band of frequencies from the 4- to 20-kc frequency group applied from the SUBGROUP PANEL.

(3) The 8-db demodulator input pad, with the 8-db receive pad ((1) above), provides the proper signal level for demodulation. The demodulator input pad also compensates for ambient temperature variations.

(4) The input signal applied to demodulator CR102 is demodulated by the 8-kc carrier frequency applied from the

CARRIER SUPPLY PANEL, producing two sidebands.

(5) Low-pass filter FL104 selects the lower sideband (vf) from demodulator CR102.

(6) The GAIN control, in conjunction with voice-frequency amplifier V101, provides for adjustment of the desired circuit net loss. The receiving path of the channel is completed through SEND-MEAS switch S102, transformer T101, and 2W-4W switch S103 to the vf equipment.

c. Transmitting and Receiving Circuits, Four-Wire Operation. When 2W-4W switch S103 is operated to the 4W position, transformer T101 is disconnected from the circuit; connecting the associated vf equipment directly into the channel transmitting and receiving branches. All other components of the channel function in the same manner as described in *a* and *b* above.

4. Schematic Analysis, Telephone TA-21 9/U Transmitting Circuit

(fig. 2)

a. General. The carrier frequencies applied to the CHAN MODEM from the CARRIER SUPPLY PANEL are modulated by the signals from the vf equipment. The modulated signal from each of the four channels has a bandwidth of 4 kc, resulting in an overall frequency band from the CHAN MODEM of 4 to 20 kc. The four channels in the CHAN MODEM perform identical functions.

b. 2W-4W Switch S103.

(1) *4W position.* When the channel is arranged for four-wire operation, the transmitting circuit path from the vf equipment is from the 2W 4W-T binding posts, through the contacts of 2W-4W switch S103 and SEND MEAS switch S102 to the 8-db modulator input pad.

(2) *2W position.* When the channel is arranged for two-wire operation, the circuit path is from 2W 4W-T binding posts E101 and E102, through contacts 1-2 and 15-16 of 2W-4W switch S103 to terminals 7-10 of transformer T101. The circuit is completed from terminals 1-6 of the transformer through contacts 6-7 and 3-4 of 2W-4W switch S103 and contacts 2-3 and 5-6 of SEND-MEAS S102 to the 8-db modulator input pad.

c. Transformer T101. Transformer T101 is connected in a hybrid arrangement. Resistor R101 and capacitors C103 and C104 comprise the hybrid balancing network. Capacitors C101 and C102 block direct current (dc) from transformer T101.

d. SEND-MEAS Switch S102.

(1) *SEND position.* In this position, 1,000 cycles per second (cps) is applied from the TEST PANEL to the input of the modulator input pad for lineup and test purposes.

(2) *MEAS position.* In this position, the received signal (1,000 cps) is applied to the TEST PANEL for measurement and adjustment of the channel net loss.

e. Transformer T102 and Low-Pass Filter FL101. The vf signals from the modulator input pad are applied across transformer T102 and its associated components to low-pass filter FL101.

(1) Transformer T102 and capacitors C105 and C106 comprise a high-pass filter network. The network suppresses any low-frequency (If) inputs below 300 cps such as 20-cps ringing signals and 60-cps line frequencies.

(2) Low-pass filter FL101 suppresses high-frequency (hf) inputs above 3,500 cps such as carrier frequencies and sideband signals emitted from carrier systems of previous links and multilink connections.

f. Modulator Circuit. The modulator circuit consists of varistor CR101, resistors R110 through R113, and transformers T103 and T104. Vf signals are applied across T104 and modulate the 8-kc carrier frequency which is applied through the modem pad to the center tap of both transformers. The modem pad compensates for the effects of temperature variations on the load characteristics of the modulator and demodulator. Resistors R110

Figure 1. Telephone Modem TA-219/U, block diagram.
(Contained in separate envelope)

through R113 assure uniform performance of the varistors.

g. Modulator Output Pad. The output from the modulator is coupled from transformer T103 to the 7-db modulator output pad. The pad provides for adjustment of the overall loss in the channel transmitting circuit. The pad is also thermistor regulated to compensate for variations in other circuit components with changes in ambient temperature. Resistors R116 and R143 are strapped in or out to allow for slight adjustments in the loss offered by the pad.

h. Modulator Band-Pass Filter FL102. Band-pass filter FL102 selects the lower side-band from the modulator output. Band-pass filter FL102 (CHAN 1) selects the 4-kc to 8-kc side-band band-pass filter FL202 (CHAN 2) selects the 8- to 12-kc side-band, band-pass filter FL302 (CHAN 3) selects the 12- to 16-kc side-band, and band-pass filter FL402 (CHAN 4) selects the 16- to 20-kc side-band.

i. Channel Output Circuit. The 4- to 8-kc side-band from band-pass filter FL102 is applied to the main chassis of Telephone Modem TA219/U (fig. 3) through pins 19 and 16 of connectors P101 and J1. The channel side-band frequencies from each channel (h above) are connected in parallel in the CHAN MODEM and applied to the SUBGROUP PANEL through pins A and K on TRANS-TEST-TALK jack J5 (fig. 3).

5. Schematic Analysis, Telephone Modem TA-21 9/U Receiving Circuit
(fig. 2)

a General. The three separate 4- to 20-kc input frequency bands are applied from the SUBGROUP PANEL to the three CHAN MODEMS. In each CHAN MODEM, four band-pass filters select the proper frequency band (in 4-kc bands) to be applied to each CHAN assembly. The signals selected by the channel band-pass filters are demodulated by different carrier frequencies and applied to vf equipment connected to the channel.

b. Receive Pad. The channel input frequencies from the SUBGROUP PANEL are applied from pins E and P of TRANS-TEST-TALK jack J5 (fig. 3) through the 8-db receive pad to pins 14 and 17 on jacks J1 and P101. The pad provides the correct impedance termination for the channel band-pass filters.

c. Demodulator Band-Pass Filter FL103. The input frequencies are then applied to the channel demodulator band filters (fig. 2). Band-pass filter FL103 (CHAN 1) selects the 4- to 8-kc side-band, band-pass FL203 (CHAN 2) selects the 8- to 12-kc side-band, band-pass filter FL303 (CHAN 3) selects the 12 to 16-kc side-band, and band-pass filter FL403 (CHAN 4) selects the 16- to 20-kc side-band.

d. Demodulator Input Pad. The output of band-pass filter FL103 is applied to the 8-db demodulator input pad. This pad, with the 8-db receive pad (*b* above), provides the proper input level to the demodulator. Thermistors RT105, RT109, RT110, and RT106 regulate the pad loss to compensate for variations in other circuit components with changes in ambient temperature.

e. Demodulator Circuit. The demodulator circuit consists of transformers T105 and T106, varistor CR102, resistors R122 through R125, and demodulator low-pass filter FL104. The 8-kc carrier frequency is applied through the modem pad to the center tap on both transformers. The demodulator output (upper and lower sidebands) is applied from transformer T105 to demodulator low-pass filter FL104 which selects the lower side-band (300 to 3,500 cps).

f. Gain Control Circuit. The signals are then applied to GAIN control R138. The control is part of an attenuator network composed of resistors R138, R140, and R141. GAIN control R138 is a signal level control used to adjust the circuit net loss during system lineup.

g. Voice-Frequency Amplifier V101. Voice frequency amplifier V101 is arranged as an output amplifier for the demodulated signals. The output of the amplifier is applied to 4W-R, binding posts E103 and E104 through transformer T108 and the contacts of SEND-MEAS switch S102 and 2W-4W switch S103.

(1) *Input circuit.* Transformer T107 couples the signals to the control grid of amplifier V101. Resistor R130 is a terminating resistor for this transformer. Resistor R148 serves as a

Figure 2. Telephone Modem TA-219/U, schematic diagram of CHAN 1.
(Contained in separate envelope)

sing-suppression resistor. Resistor R135 provides a dc path for the control grid.

(2) *Output circuit*. The amplified signals are developed across the 3 - and 5-6 windings of transformer T108. Resistor R131 and capacitor C110 reduce the gain of frequencies above 3,500 cps. Resistor R132 is the screen dropping resistor and capacitor C108 serves as a screen bypass. Resistor R139 is the plate dropping resistor.

(3) *Feedback circuit*. Feedback voltage is obtained from winding 3-4 of transformer T108. An alternating current (ac) voltage divider network, consisting of resistors R133 through R136 and capacitor C109, develops the feedback voltage. The amount of feedback voltage necessary for amplifier stability is applied between the control grid and the cathode of amplifier V101. The series-parallel combination of resistors R135 and R136 and capacitor C109 causes a decrease in the negative feedback voltage at 300 cps to obtain an increase in the net gain of the amplifier. Capacitor C107 blocks the dc cathode voltage (developed by cathode resistor R133) from the control grid. Capacitor C111 and resistor R137 prevent spurious oscillations in the amplifier circuit.

h. *Channel Output Circuit*.

(1) *Four-wire arrangement*. When the channel is arranged for four-wire operation (switch S103 operated to the 4W position), the output developed across terminals 1-2 of transformer T108 is applied through the contacts of SEND-MEAS switch S102 and switch S103 to the 4W-R binding posts.

(2) *Two-wire arrangement*. When the channel is arranged for two-wire operation (switch S103 operated to the 2W position), the output developed across terminals 1-2 of transformer T108 is applied through contacts 7-8 and 10-11 of SEND-MEAS switch S102 and contacts 10-11 and 13-14 of 2W 4W switch S103 to terminals 3 4 of transformer T101. The circuit is completed from terminals 7-10 of T101 through contacts 1-2 and 15-16 of 2W 4W switch S103 to the 2W 4W-T binding posts.

6. Channel Test and Talk Monitor Circuits

(figs. 2 and 3)

a. SEND-MEAS Switch S102.

(1) *SEND position*. The 1-kc test signal from the TEST PANEL is applied from pins N and D on TRANS-TEST-TALK jack J5 (fig. 3), through pins 11 and 8 on jacks J1 and P101, to contacts 4 and 1 of switch S102 (fig. 2). When the switch is operated to the SEND position, the signal is applied to the modulator input pad through contacts 1-2 and 4-5.

(2) *MEAS position*. When switch S102 is operated to the MEAS position, the output developed across transformer T108 is applied to pins F and R of TRANS-TEST-TALK jack J5 (fig. 3), though contacts 8-9 and 11-12 of switch S102 and pins 18 and 15 of connectors P101 and J1. The signal path is completed to the TEST PANEL through the SUBGROUP and JUNCTION PANELS.

b. TALK-MON Switch S101.

(1) *TALK position*. Connections to the ORDER WIRE PANEL circuits are available at pins 9 and 12 (transmitting) , and 10 and 7 (receiving) on connector P101. When switch S101 is operated to the TALK position, contacts 1 through 3 connect handset HS101 (located on ORDER WIRE PANEL) to the transmitting and receiving branches of CHAN 1 for communicating purposes.

(2) *MON position*. When switch S101 is operated to the MON position, the circuit is the same as (1) above except that contacts 9 through 16 of switch S101 make and volume limiting resistors R102 through R105 are connected into the circuit.

Figure 3. Telephone Modem TA-219/U, schematic diagram of main chassis.
(Contained in separate envelope)

Section II. TELEPHONE MODEM TA-227/U

7. Block Diagram Analysis

(fig. 4)

Telephone Modem TA-227/U (SUBGROUP PANEL) consists of subgroups 1, 2, and 3. Each subgroup has a transmitting and a receiving circuit. A single transmitting amplifier is common to the three subgroups. The 4 to 20-kc output frequency bands from each CHAN MODEM are applied to the transmitting circuit of each subgroup. The 60- to 108-kc output frequency band from the GROUP PANEL is applied to the subgroup receiving circuits.

Note. Throughout this section, reference is made to components in subgroup 1 in that the operation of this Circuit is representative of subgroups 2 and 3.

a. Transmitting Circuit.

(1) The 4-db modulator input pad attenuates the CHAN MODEM output frequencies to the proper level for modulation. The input signal is applied through the contacts of SPECIAL SERVICE 1 switch S3 to modulator CR5.

(2) In modulator CR5, the input signals modulate the 56-kc carrier frequency applied from the CARRIER SUPPLY PANEL producing upper and lower side-band frequencies. The carrier frequencies for subgroups 2 and 3 are 72- and 88-kc, respectively.

(3) The modulator output pad is provided for adjusting the output level from the transmitting branch. Band-pass filter FL8 selects the upper side-band from modulator CR5.

(4) Transformer T16 combines the upper side-band outputs of the three subgroups to form the 60- to 108-kc SUBGROUP PANEL frequency band.

(5) Transmitting amplifier V7 amplifies the output of hybrid coil T16 and applies the signal across transformer T17 to the GROUP PANEL.

b. Receiving Circuit.

(1) The band from the GROUP PANEL is applied to the 15-db receive pad. This pad reduces the incoming signal level for application across transformer T18 to the receiving branches of each subgroup.

(2) Band-pass filter FL9 selects the 60 to 76-kc band of frequencies for demodulation in subgroup 1. The frequency bands applied to subgroups 2 and 3 are 76 to 92 kc and 92 to 108 kc, respectively.

(3) The input signal level to demodulator CR6 is set by the 6-db demodulator input pad. A carrier frequency of 56 kc from the CARRIER SUPPLY PANEL demodulates the signals, producing upper and lower side-band frequencies. Carrier frequencies of 72 and 88 kc are applied to subgroups 2 and 3, respectively.

(4) Low-pass filter FL3 selects the 4- to 20-kc lower side-band from the demodulator output.

(5) Demodulator amplifiers V6 and V5 amplify the output of the low-pass filter. SPECIAL SERVICE 1 switch S3 arranges for signal application to CHAN MODEM 1.

8. Schematic Analysis, Telephone Modem TA-227/U Transmitting Circuit (fig 5)

a. Modulator Input Pad and SPECIAL SERVICE 1 Switch S3. The 4- to 20-kc frequency band from CHAN MODEM 1 is applied from pins A and K on connector P3, through the 4-db modulator input pad to the contacts of SPECIAL SERVICE 1 switch S3. The pad attenuates the input signal to the proper level to prevent over modulation.

b. SPECIAL SERVICE 1 Switch S3

(1) *CHAN MODEM position*. Continuity is established through the switch contacts 5-4 and 8-7 to the input of modulator CR5.

(2) *SPL SERV position*. Continuity is established from the special service 1 IN binding posts, through the 39-db pad and contacts 3-4 and 6-7 of switch S3, to the input of modulator

Figure 4. Telephone Modem TA-227/U, block diagram
(Contained in separate envelope)

CR5. Contacts 1-2 of switch S3 close, lighting SPL SERV indicating lamp I 1.

c. Modulator Circuit. The modulator circuit consists of transformers T11 and T12 and varistor CR5. The 4- to 20-kc input signal modulates the 56-kc carrier frequency. (The input frequencies to subgroups 2 and 3 modulate carrier frequencies of 72 and 88 kc respectively.) The carrier frequency is supplied from the CARRIER SUPPLY PANEL across terminal 2 of transformer T1 and terminal 4 of transformer T12. The output from the modulator is applied through the modulator output pads to band-pass filter FL8.

d. Modulator Output Pads. Two pads are provided at the output of modulator CR5 for adjusting the output level of the transmitting circuit.

(1) The first pad, consisting of resistors R76 through R82, is adjustable by soldered straps in 1-db steps from 3.5 to 7.5 db.

(2) The second pad, consisting of resistors R83 through R85, attenates the signal 2 db. The pad finds its widest application in subgroup 1 which has less signal loss than either of the other subgroups.

e. Band-Pass Filter FL8. The upper side-band of 60 to 76 kc is selected by band-pass filter FL8. Band-pass filter FL6 (subgroup 2) selects the 76- to 92-kc side-band, and band-pass filter FL4 (subgroup 3) selects the 92- to 108-kc side-band.

f. Transformer T16. The output frequencies of subgroups 1, 2, and 3 are applied to the primary windings of transformer T16. The transformer is connected as a hybrid arrangement, permitting the frequency attenuation requirements of the band-pass filters to be less critical. The three subgroup output frequency bands combine to form a band of frequencies from 60 to 108 kc. Resistor R103 and capacitors C34 and C42 comprise the hybrid balancing network.

g. Transmitting Amplifier V7.

(1) Transformer T16 couples the input signals to the control grid through dc blocking capacitor C5 and sing-suppression resistor R127. Resistor R104 is an impedance matching resistor; resistor R107 provides a dc return path for the control grid. Bias for the tube is developed by cathode resistor R108 and bypass capacitor C36. Capacitor C37 bypasses the screen grid to the cathode. Operating voltage for the plate is applied through resistors R114 and R113 and the 5-6 winding of transformer T17. Screen grid voltage is applied through resistors R114 and R110. Capacitor C40 and resistor R114 provide decoupling for the 200-volt supply. The output circuit is connected to transformer T17.

(2) The gain of the amplifier is 13 $\pm$ 3 db. It is controlled by varying the amount of feedback voltage by the adjustment of TR AMP GAIN control R106. The feed-back voltage is obtained from the voltage divider network consisting of resistors R111 through R113, and applied to TR AMP GAIN control R106 and resistor R105 through dc blocking capacitor C39. A small amount of dc (determined primarily by resistor R109) through TR AMP GAIN control R106 minimizes its sliding contact resistance.

h. Transformer T17. The amplified subgroup output signals are applied across transformer T17 to terminals A and L, and K and W on connector J9. Resistor R115 is an impedance balancing resistor. Subgroup output frequencies are made available at the 60-108 KC OUT binding posts and the 60-108 KC OUT ALT binding posts.

9. Schematic Analysis, Telephone Modem TA-227/U Receiving Circuit
(fig. 5)

a. Subgroup Input Circuit. Subgroup input frequencies from the GROUP PANEL are applied from terminals H and R of connector J10, through the 15-db receive pad (R117, R119, and R120), to transformer T18. Alternate

Figure 5. Telephone Modem TA-227/U, schematic diagram.

(Contained in separate envelope)

input connections are provided at the 60-108 KC IN binding posts.

b. Transformer T18 and Band-Pass Filter FL9. The input signal is applied through transformer T18 to the subgroup band-pass filters. The transformer is connected to form a hybrid arrangement similar to transformer T16 (par. 8*f*). Capacitor C41 and resistor R118 comprise the hybrid balancing network. Band-pass FL9 selects the 60- to 76-kc band from the 60- to 108-kc subgroup input frequencies. Band-pass filters FL7 (subgroup 2) and FL5 (subgroup 3) select the 76- to 92-kc and 92- to 108-kc bands respectively from the subgroup input frequencies.

c. Demodulator Input Pad. The signals selected by band-pass filter FL9 are applied through 6-db demodulator input pad to demodulator CR6. This pad, with the 15-db receive pad (*a* above) , attenuates the incoming signal to the proper level for demodulation.

d. Demodulator Circuit. The demodulator circuit is composed of varistor CR6 and transformers T15 and T14. The 60- to 76-kc input signal is coupled to the demodulator by transformer T15. The 56-kc carrier frequency is applied between terminal 2 of transformer T14 and terminal 4 of transformer T15. The signal is demodulated by the 56-kc carrier frequency, producing upper and lower sidebands. The 76 to 92-kc (subgroup 2) and 92- to 108-kc (subgroup 3) frequency bands are demodulated by carrier frequencies of 72- and 88-kc, respectively.

e. Low-Pass Filter FL3. Signals from demodulator CR6 are applied to low-pass filter FL3. The filter selects the lower side-band (4 to 20 kc) of the demodulated signal. Filters FL2 (subgroup 2) and FL1 (subgroup 3) also select 4- to 20-kc sidebands.

f. Demodulator Amplifier (1st Ampl V6). The 4- to 20-kc output from low-pass filter FL3 is applied to demodulator amplifier V6. The input signal is applied to the control grid of amplifier V6 through sing-suppression resistor R126. Resistor R99 provides the proper impedance termination for the filter and also is the dc grid return for the amplifier. Cathode bias is developed by resistor R96 and capacitor

C33. Additional biasing is provided by resistors R97 and R98. The output circuit of the amplifier contains plate resistors R93 and R95 and capacitors C30 and C31. Screen grid voltage is applied through resistors R95 and R94. Capacitor C32 is the screen bypass to the cathode. Degenerative feedback is developed by unbypassed resistors R97 and R98. The amplifier output signals are applied to amplifier V5.

g. Demodulator Amplifier (2nd Ampl V5). The circuit arrangement of amplifier V5 is similar to amplifier V6. Resistor R92 is the dc grid return for the amplifier. Resistor R125 is a sing-suppression resistor. Capacitor C28 is part of the resistive-capacitive coupling network, the remainder of which is composed of the plate load and grid input resistors. Degenerative feedback is developed by unbypassed cathode resistor R91. Resistor R89 is the screen-dropping resistor and capacitor C29 bypasses the screen to the cathode. Plate voltage is applied through resistors R90 and R87, inductor L3, and winding 4-5 of transformer T13. Resistor R90 and capacitor C25 comprise the 200-volt supply decoupling network. The amplified output signal appears across output transformer T13. Negative feedback voltage is obtained from winding 3-4 of output transformer T13, resistor R86, and capacitor C24. This voltage is applied through resistor R88 and capacitor C27 to the cathode of amplifier V6. DEM 1 GAIN control R98 varies the gain of the demodulator amplifier circuit by controlling the amount of applied feedback.

h. SPECIAL SERVICE 1 Switch S3.

(1) CHAN MODEM *position.* Continuity is established from output demodulator amplifiers V5 and V6, through contacts 13-12 and 10-9 of switch S3 to pins E and P on connector P3.

(2) SPL SERV *position.* Continuity is established from the output of demodulator amplifiers V5 and V6, through contacts 10-11 and 13-14 of switch S3 to the special service 1 OUT binding posts. Contacts 1-2 of switch S3 close, lighting SPL SERV indicating lamp I 1.

Section III. GROUP PANEL (PART OF AMPLIFIER-PILOT REGULATOR AM-707/TCC-7)

10. Block Diagram Analysis

(fig. 6)

AMPLIFIER-PILOT REGULATOR AM707/TCC-7 is composed of the GROUP PANEL and the JUNCTION PANEL (pars. 15 and 16). The GROUP PANEL has a transmitting and a receiving circuit. Input signals are applied to the transmitting circuit from the SUBGROUP PANEL, through the JUNCTION PANEL and to the receiving circuit from the JUNCTION PANEL. Facilities are also provided for automatically regulating the power of the received signals and for synchronizing the frequencies from the CARRIER SUPPLY PANEL.

a. Transmitting Circuit.

(1) The 60- to 108-kc output frequencies from the SUBGROUP PANEL are applied through the JUNCTION PANEL to the normal (REGULAR) position of 60-108 KC switch S1 to modem and amplifier AR4. Switch S1 (SPL SERV position) also provides for the connection of 60- to 108-kc external special service equipment to modem and amplifier AR4 through a 42-db impedance matching pad.

(2) In modem and amplifier AR4, the input signals modulate the 120-kc carrier frequency supplied from the CARRIER SUPPLY PANEL.

(3) The modulated signals are applied through the normal (REGULAR) position of 12 60 KC switch S2 to the 4-db modulator output pad. The pad attenuates the signal and improves the input impedance match to lowpass filter FL3. Switch S2 (SPL SERV position) also provides for the connection of 12- to 60-kc external special service equipment to the 4-db modulator output pad through a 48-db impedance matching pad.

(4) Low-pass filter FL3 selects the 12- to 60-kc lower sideband frequencies for application to transmitting amplifier AR3 which amplifies the signal before it is applied to cable building-out network Z1. This network is adjusted to simulate the transmission loss through 0 to 21 reels of cable. The network applies the group output frequencies to the JUNCTION PANEL.

b. *Receiving Circuit.*

(1) Signals are applied from the JUNCTION PANEL to the receiving branch of the GROUP PANEL. These signals are applied to cable building-out network Z5. This network, like Z1 (a (4) above), may be adjusted to simulate the transmission loss through 0 to 21 reels of cable. The output from cable building-out network Z5 is applied to a flat network.

(2) The flat network provides a flat loss to the received signal. The output of the flat network is applied to slope network Z4.

(3) This network provides adjustment to compensate for the slope variation of the line (par. 12b (3)). The output of slope network Z4 is applied to bulge network Z3**.**

(4) This network provides adjustment to compensate for the bulge variation of the line (par. 12b (4)). The output of bulge network Z3 is applied to delay equalizer EQ3.

(5) Delay equalizer EQ3 improves the delay distortion in the frequency band from 12 to 46 kc. It also corrects for the distortion of the high-pass sections of the high-pass, low-pass filters in the JUNCTION PANEL. The output of delay equalizer EQ3 is applied to basic equalizer EQ2.

(6) Basic equalizer EQ2 corrects for variations in attenuation for the 12- to 60-kc frequency band through 68/s miles of spiral-four cable. The equalized signals are applied to receiver amplifier AR-1.

(7) The amplified signals are applied through the deviation equalizer and regulator network Z2 to receiving amplifier AR2. The deviation equalizer compensates for deviations from

flat transmission of the transmitting and receiving circuits of the telephone terminal.

(8) Regulator network Z2 is controlled by the output of regulator and alarm Z6 ((10) below). Regulator network Z2 provides a relatively constant input level to receiving amplifier AR2.

(9) Receiving amplifier AR2 applies the output from regulator network Z2 to low-pass filter FL1. A portion of the amplified signal is also applied to regulator and alarm circuit Z6 and to 68-kc band-pass filter FL2.

(10) Regulator and alarm circuit Z6 corrects for changes in the loss characteristics of the spiral-four cable caused by temperature variations.

(11) The pilot frequency passed by 68-kc band-pass filter FL2 is applied to synchronizing amplifier V1. The output of the amplifier is applied to the CARRIER SUPPLY PANEL where it is available for synchronizing the carrier signals generated by the CARRIER SUPPLY PANEL.

(12) Low-pass filter FL1 selects only the 12- to 60-kc group input frequencies and rejects the 68-kc pilot and test frequencies.

(13) The output of low-pass filter FL1 is applied through the normal (REGULAR) position of 12-60 KC switch S2 to modem and amplifier AR4. Switch S2 (SPL SERV position) also provides for connecting the output of low-pass filter FL1 to 12- to 60-kc external special service equipment.

(14) The group input frequencies are demodulated and amplified in modem and amplifier AR4.

(15) The output of modem and amplifier AR4 is applied through the normal (REGULAR) position of 60-108 KC switch S1 to the SUBGROUP PANEL. Switch S1 (SPL SERV position) also provides for connecting the output of modem and amplifier AR4 to external 60- to 108-kc special service equipment.

11. Schematic Analysis, Group Panel Transmitting Circuit

a. General. The 60- to 108-kc transmitting subgroup output frequencies modulate the 120-kc carrier frequency applied to the transmitting circuit. The lower side-band of the modulated signal is amplified and applied to the JUNCTION PANEL.

B. Input Circuit.

(1) Subgroup output frequencies from the SUBGROUP PANEL are applied to the JUNCTION PANEL (fig. 18) through cable W104 to pins A and L on plug P104. The JUNCTION PANEL, the interconnecting unit for the telephone terminal, distributes these frequencies to pins A and L of plug P105. Cable W105 connects the JUNCTION PANEL output circuit to pins A and L of connector J1 on the GROUP PANEL (fig. 7).

(2) From connector J1, the subgroup output frequencies are applied through 60-108 KC special service switch S1 to pins 4 and 5 of connector J2, which is the input to modem and amplifier AR4.

c. Modem and Amplifier AR4 (fig. 8). The transmitting section of modem and amplifier AR4 consists of a lattice-type modulator circuit (varistor unit CR1 and transformers T3 and T4). The primary of transformers T3 is connected to terminals 4 and 5 of connector P1. The secondary of transformer T4 is connected to terminals 2 and 1 of connector P1. The 60- to 108-kc subgroup output frequencies are coupled to the modulator circuit by transformer T3 and modulate the 120-kc carrier frequency. The 120-kc carrier frequency from the CARRIER SUPPLY PANEL is connected to terminal 2 on each transformer. The resulting modulated signals are coupled to the output circuit by repeating coil T4.

d. 4-DB Attenuator Pad (fig. 7). Output signals from modem and amplifier AR4 are

Figure 6. Amplifier-Pilot Regulator AM-707/TCC-7, block diagram.
Figure 7. Amplifier-Pilot Regulator AM-707/TCC-7, schematic diagram.
Figure 8. Modem and amplifier ARE (part of GROUP PANEL), schematic diagram.
(Contained in separate envelope)

applied through 12-60 KC special service switch S2 and the 4-db pad to low-pass filter FL3.

(1) The 4-db attenuator pad is composed of resistors R11 through R13. This pad improves the input impedance of low-pass filter FL3.

(2) The lower side-band (12- to 60-kc) of the attenuated modulator output is selected by low-pass filter FL3. These frequencies, the group output frequencies, are applied to transmitting amplifier AR3.

e. 12-68 Kc Amplifier AR3 (fig. 9). This amplifier is a two-stage negative feedback amplifier with a nominal gain of 52 db.

Note. Transmitting amplifier AR3 is one of three identical amplifiers assigned the common name of 12- to 68-kc amplifier. Whenever receiving amplifiers AR1 and AR2 are discussed, reference will be made to this paragraph; however, the differences in each amplifier circuit resulting from external connections will be covered where the amplifiers appear in the circuit.

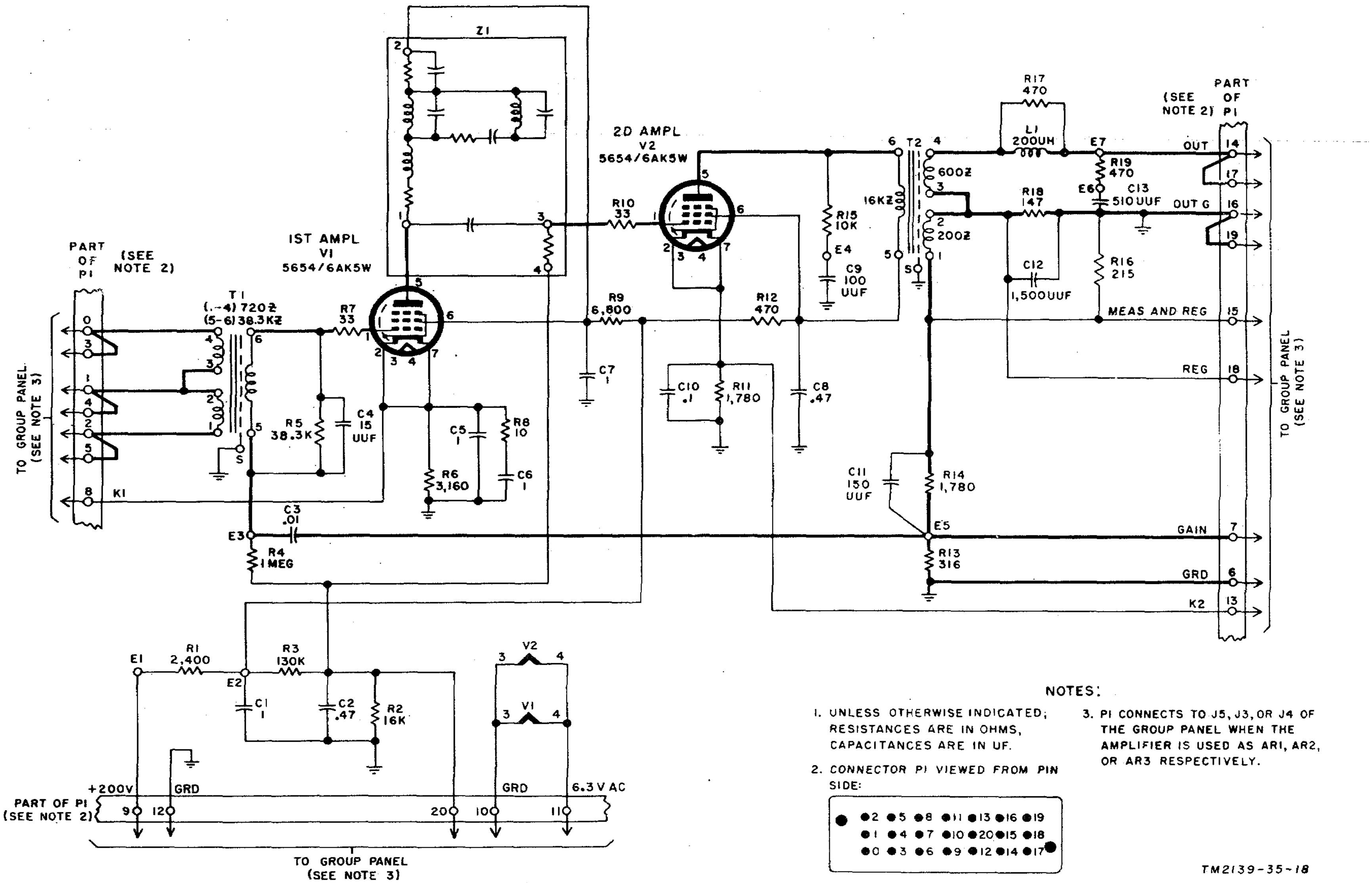
(1) *Input circuit*. Group output frequencies passed by low-pass filter FL3, are applied to terminals 0 and 1 on connector P1 in transmitting amplifier AR3. These terminals connect to windings 3-4 of hybrid transformer T1. This 600-ohm winding provides the correct impedance termination for low-pass filter FL3. The 68-kc pilot frequency and the 12- and 28-kc test frequencies (supplied by the CARRIER SUPPLY PANEL) and the 65-kc and fault test frequencies (supplied by the TEST PANEL) are applied to winding 1-2 of the hybrid transformer, from pins K and W of TO JUNCTION PANEL connector J1 (fig. 7) through a pad consisting of resistors R46 through R48, to pins 1 and 2 of connectors J4 and P1.

(2) *Amplifier V1*. Amplifier V1 is designed with negative feedback in the input circuit. Input signals are applied through winding 6-5 of hybrid transformer T1 to the control grid of the amplifier through sing-suppression resistor R7. Resistor R5 and capacitor C4 provide the proper impedance termination for the input transformer. Resistors R1 through R3 form a voltage divider network to provide dc voltage for the grid circuit. Resistor R6 and capacitor C5 develop cathode bias for the tube. To overcome the excessively large dc cathode voltage developed by resistor R6, +15 volts dc is applied to the control grid. Capacitor C6 and resistor R8 provide a singing margin at low frequencies. Resistor R1 and capacitor C1 comprise the decoupling network and part of the plate voltage divider network. Resistor R9 is the plate and screen grid voltage-dropping resistor. Capacitor C2 decouples the voltage developed by resistors R2 and R3. The amplified output is applied to interstage network Z1 which assures the proper gain and phase of the signal throughout the 12- to 68-kc range.

(3) *Amplifier V2*. Input signals to amplifier V2 are applied from interstage network Z1 through resistor R10. This resistor prevents spurious oscillations at high frequencies. Positive voltage is furnished to the control grid as described in (2) above. A resistor in the interstage network provides a dc return path for the grid. Cathode bias is developed by resistor R11 and capacitor C10. Resistor R12 and capacitor C8 are the screen-dropping resistor and screen bypass capacitor respectively. Resistor R15 and capacitor C9 provide a singing margin at high frequencies. The amplified output signal is applied to winding 5-6 of transformer T2.

(4) *Feedback circuit*.

(a) Feedback voltage is obtained from the 1-2 winding of output transformer T2. This voltage is applied to a voltage divider network (resistors R13 and R14) and phase-shifting capacitor C11. An external network (fig. 7), composed of resistors R15 and R16 and capacitor C6, shunts resistor R13 through terminals 6 and 7 on connector P1. This network establishes a feedback voltage of approximately 30 db.



NOTES:

1. UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UF.
2. CONNECTOR P1 VIEWED FROM PIN SIDE:
3. P1 CONNECTS TO J5, J3, OR J4 OF THE GROUP PANEL WHEN THE AMPLIFIER IS USED AS AR1, AR2, OR AR3 RESPECTIVELY.

2 5 8 11 13 16 19
1 4 7 10 20 15 18
0 3 6 9 12 14 17

Figure 9. 12-68 KC Amplifier ART, AR2, or AR3 (parts of GROUP PANEL), schematic diagram.

(b) The feedback voltage developed across resistor R13 (fig. 9) is applied to the control grid of amplifier V1 through dc blocking capacitor C3. Resistor R4 develops the feedback voltage in the grid circuit.

(5) *Output circuit*. The 3-4 winding of output transformer T2 is connected to a special terminating network composed of resistors R17 and R19, capacitor C13, and inductor L1. This network prevents spurious oscillations in the amplifier circuit. Resistor R18 and capacitor C12 comprise the balancing network for transformer T2. The amplifier output is applied to pins 14 and 16 of connector P1. TR AMP OUT jack J2 (fig. 7) is connected through an attenuator pad composed of resistors R17 and R18 to the feedback network in the amplifier circuit. TR 62 KC jack J13 and resistor R19 are bridged across the output of transmitting amplifier AR3.

f. Cable Building-Out Network Z1 (fig. 7). The output of transmitting amplifier AR3 is applied

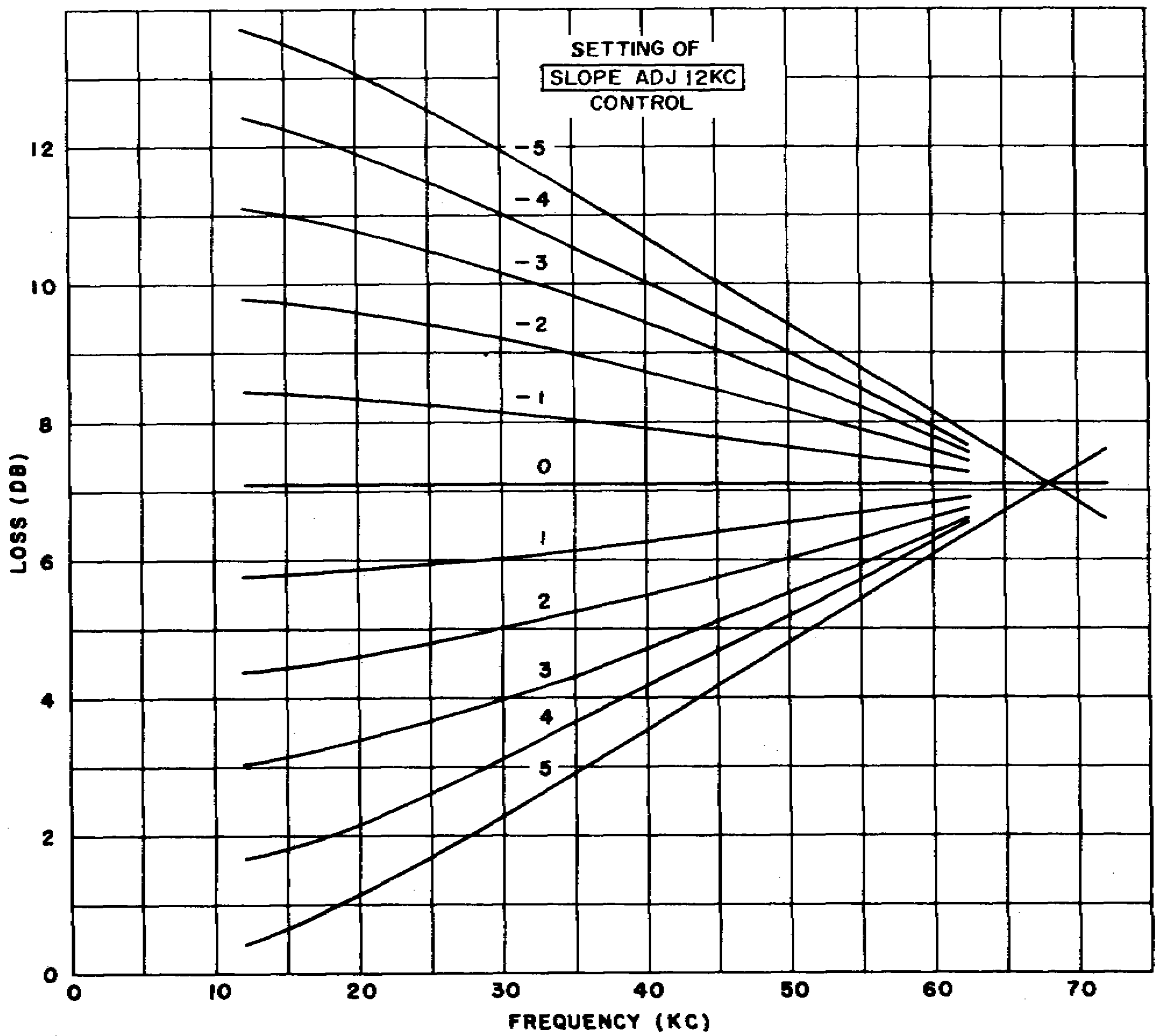


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Figure 10. GROUP PANEL, slope network Z4, attenuation characteristics.

to cable building-out network Z1 through pins 14 and 16 on connector J4. This network is adjusted by TR CABLE REELS TO FIRST AN/TCC-11 control S6 to simulate transmission loss through 0 to 21 reels of cable in steps of 3 reels. Cable building-out network Z1 connects to pins F and S on GROUP PANEL connector J1.

12. Schematic Analysis, Receiving Circuit

(fig. 7).

a. General. The 12- to 60-kc group input frequencies are demodulated in the receiving circuit with a 120-kc carrier signal supplied by the CARRIER SUPPLY PANEL. The lower side-band of the demodulated signal is selected by a band filter for application to the SUBGROUP PANEL. A regulator circuit, controlled by the pilot frequency, regulates the power of the signals in the receiving circuit.

b. Equalizers. The signals from the JUNCTION PANEL are applied through a series of equalizer networks to receiving amplifier ART. These networks and their specific functions are listed below in the order of their action.

(1) Cable building-out network Z5. Cable building-out network Z5 is varied by

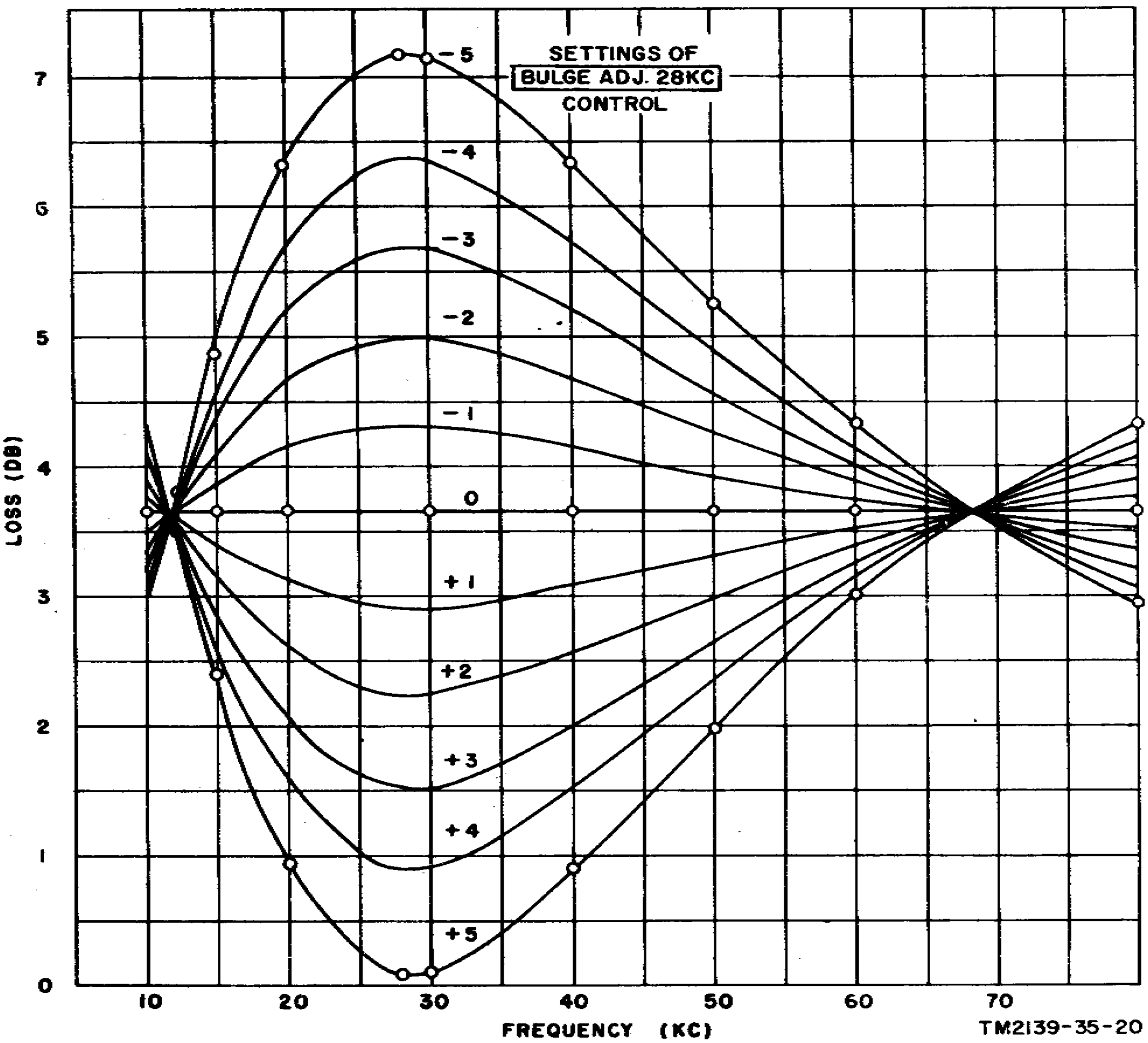

Figure 11. GROUP PANEL, bulge network Z3 attenuation characteristics.

means of REC CABLE REELS TO FIRST AN/TCC-11 controls S5 to simulate the transmission loss through 0 to 21 reels of cable in steps of 3 cable reels. The network is used to build out the cable section to the first Telephone Repeater AN/TCC-11 to a total of 23 reels.

(2) *Flat network*. The flat network is arranged as a bridged-T pad. The FLAT ADJ 68 KC control is a double variable resistor, adjustable to provide a flat loss to the received signals.

(3) *Slope network Z4*. Slope network Z4 compensates for the slope variation (68-kc loss minus 12-kc loss) of the line. Figure 10 shows attenuation characteristics of slope network Z4 for various settings of the SLOPE ADJ 12 KC control.

(4) *Bulge network Z3*. Bulge network Z3 compensates for the bulge variation (68-kc loss minus 28-kc loss after the slope has been reduced to 0 db) of the line. Figure 11 shows the attenuation characteristics of bulge network Z3 for the various settings of the BULGE ADJ 28 KC control.

(5) *Delay equalizer EQ3*. Delay equalizer EQ3 improves the delay distortion in the frequency band from 15 to 45 kc in the 12- to 60-kc special service circuit (fig. 7). The delay equalizer corrects for the delay distortion of the high-pass sections of high-pass, low-pass filter FL102 in the JUNCTION PANEL (fig. 17).

(6) *Basic equalizer EQ2*. Basic equalizer EQ2 corrects for variations in attenuation through 5 3/4, miles of spiral-four cable. Figure 12 shows the frequency attenuation characteristic of the spiral-four cable end of basic equalizer EQ2. The two curves are complementary and add up to uniform attenuation at all frequencies. When the temperature is other than a mean temperature of 45° F., the cable attenuation characteristic and basic equalizer EQ2 no longer correct the

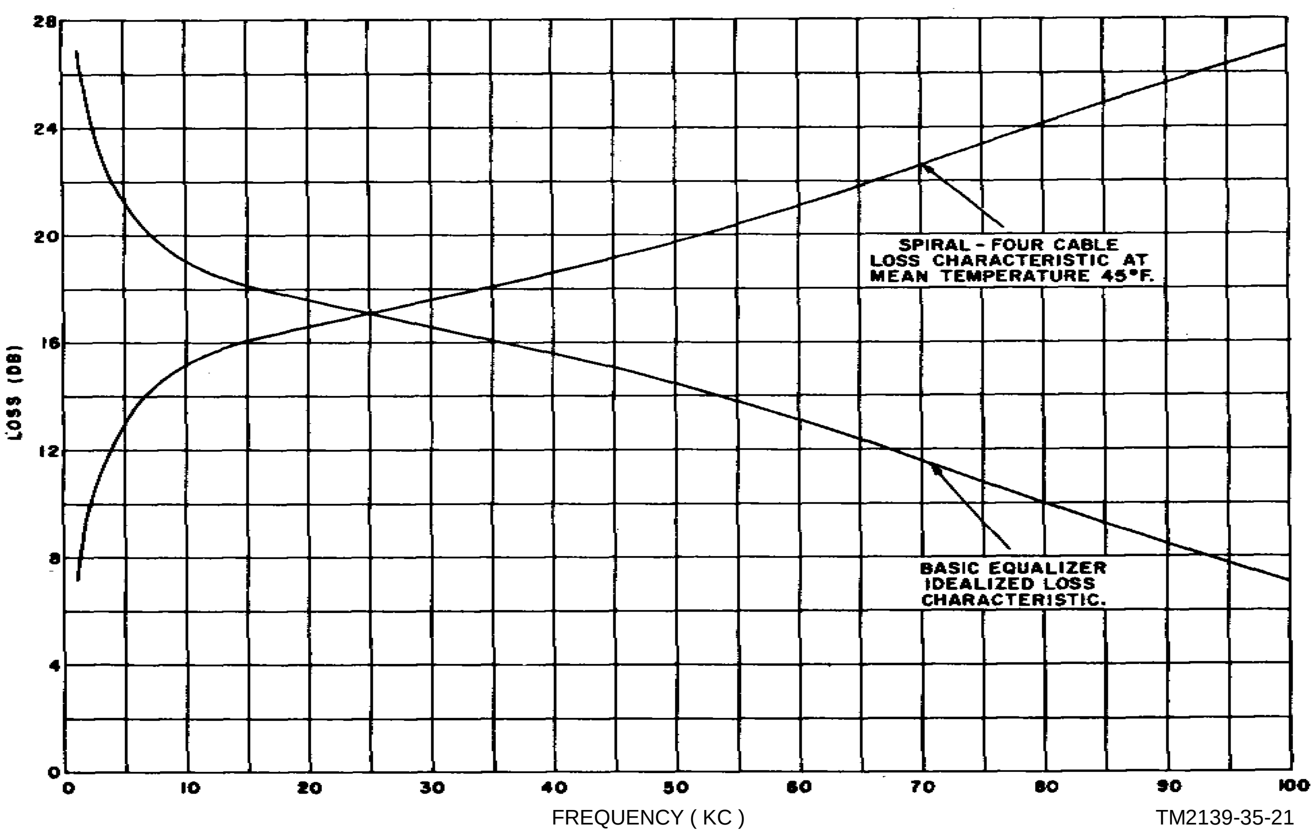

Figure 12. Spiral-four cable and equalizer EQ2, attenuation characteristics.

signal adequately. Correction at other temperatures is applied in the regulator circuit (par. 14).

c. Amplifier AR1 (fig. 9). Receiving amplifier AR1 is identical with transmitting amplifier AR3 (par. 11*e*). The impedance across terminals 1 and 4 of the input transformer is 720 ohms, which is the proper terminating impedance for basic equalizer EQ2. This series connection is made when receiving amplifier AR1 is plugged into connector J5. The input signals are applied to pins 0 and 5 on connector J5. Negative feedback of approximately 40 db is provided because no external network shunts feedback resistor R13. The nominal gain of receiver amplifier AR1 is 42 db. The output impedance is 600 ohms. REC AMP 1 OUT jack J14 and a pad composed of resistors R29 and R30 (fig. 7) are bridged across the 1-2 winding of receiving amplifier AR1 output transformer T2.

d. Deviation Equalizer and Regulator Networks (fig. 7). The output of receiving amplifier AR1 is applied through a deviation equalizer network to regulator network Z2.

(1) *Deviation equalizer*. The deviation equalizer is composer of resistors R45, and R49 through R51, and capacitor C14. The deviation equalizer network compensates for deviation from flat transmission of the transmitting and receiving circuits of Telephone Terminal AN/TCC-7.

(2) *Regulator network Z2*. Signals from the deviation equalizer are coupled to regulator network Z2 by transformer T3. Resistor R27 provides the correct impedance termination for the transformer. This network is controlled by thermistor RT1, which in turn is controlled by the regulator and alarm circuit Z6 (par. 14).

e. Receiving Amplifier AR2 (fig. 9). Receiving amplifier AR2 is identical with transmitting amplifier AR3 (par. 11*e*), except for external connections resulting in slight differences in the gain and feedback circuits. In addition to applying the output signal to filter FL1, amplifier AR2 also supplies the input signal to regulator and alarm circuit Z6 (par. 14) and synchronizing amplifier V1 (*f* below).

(1) The regulated input signal is applied between terminals 1 and 2 on connector P1. Externally connected resistor R26 and capacitor C12 (fig. 7) are connected to the cathode of amplifier V2 through pins 13 and 19 on connector J3 to improve the singing margin at low frequencies in amplifier V2.

(2) Negative feedback of approximately 30 db controls the gain of receiving amplifier AR2 when signals are applied to input transformer T1. The nominal gain of receiving amplifier AR2 is 50 db.

(3) The output impedance of the amplifier is 600 ohms. REC 62 KC jack J10 and protective resistor R20 are bridged across the output of the amplifier. REC AMP 2 OUT jack J11 and an attenuator composed of resistors R22 and R23 are bridged across the 1-2 winding of output transformer T2.

f. Carrier Synchronizing Circuit (fig. 7). The CARRIER SUPPLY PANEL may be synchronized to the frequency of the other terminal used in the carrier telephone system by operating the CARR SYNC switch on the CARRIER SUPPLY PANEL (fig. 20) to the REMOTE position. When the switch is operated, the 68-kc pilot signal, which is received from the spiral-four cable, is passed through the GROUP PANEL and JUNCTION PANEL to the CARRIER SUPPLY PANEL (par. 23*a*).

(1) *Synchronizing signal path*. A 68-kc pilot frequency and the group input frequencies (12 kc to 60 kc) are received from spiral-four cable connector J103 in the JUNCTION PANEL and passed through the GROUP PANEL receiving circuits. The 68-kc pilot signal is selected from the output of receiving amplifier AR2 by 68-kc band-pass filter FL2. Filter FL2 is bridged on the transmission path through resistor R21, which provides the proper impedance for the filter input. Resistor R42 provides a termination for the filter. The 68-kc pilot signal is amplified by tube V1 and applied through repeating coil T4 to terminals F and P on connector P2. These terminals connect through cable W2 to the JUNCTION PANEL

Cable W103 conducts the 68-kc pilot signal from the JUNCTION PANEL to the SUPPLY PANEL where it is available for synchronizing the carrier signals generated in the CARRIER SUPPLY PANEL.

(2) *Synchronizing amplifier V1*. Resistor R41 provides cathode bias and degenerative feedback. The screen grid is connected to the cathode circuit through capacitor C13. Resistor R40 is the screen-dropping resistor. Repeating coil T4 is the output transformer of the amplifier. Plate voltage is applied through resistor R39 and bypass by capacitor C11.

g. Low-Pass Filter FL1 (fig. 7). The signals applied to low-pass filter FL1 include the 12- to 60-kc group input, 68-kc pilot, and 12 and 28-kc test frequencies. Low-pass filter FL1 rejects the pilot and test frequencies and selects the 12- to 60-kc group input frequencies. The output signals of filter FL1 are applied through contacts 10-9 and 13-12 of special service switch S2 to modem and amplifier AR4.

h. Modem and Amplifier AR4 (fig. 7). The 12- to 60-kc group input frequencies from lowpass filter FL1 are demodulated and amplified in modem and amplifier AR4. The output frequencies of the modem and amplifier become the 60- to 108-kc subgroup input frequencies.

(1) *Demodulator input pad* (fig. 8). The group input frequencies are applied through the 34-db demodulator input pad which attenuates the signal to the proper level for demodulation.

(2) *Demodulator circuit*. The attenuated group frequencies are applied to transformer T6 which couples the signals to lattice-type demodulator CR2. The resulting demodulated signals are the 60- to 108-kc subgroup input frequencies.

(3) *Demodulator output pad*. Transformer T5 couples the demodulated signals to the attenuator pad. The attenuator pad, composed of resistors R13 and R14, improves the impedance termination of filter FL1 and attenuates the demodulated signals 3.5 db.

(4) Low-pass Filter FLI. The 108-kc low-pass filter FL1 allows only subgroup input frequencies between 60 to 108 kc to pass to first amplifier V1 in modem and amplifier AR4. Capacitor C10 and inductor L1 provide correction for the loss-frequency characteristic introduced by transformer T2. The transformer couples subgroup input frequencies 60 to 108 kc to first amplifier V2.

(5) *First amplifier V2*. The input to first amplifier V2 is applied through sing suppression resistor R19. Resistor R12 provides proper impedance termination for input transformer T2. Bias is obtained by resistors R10 and R11, and DEM GAIN control R7 (fig. 7). The DEM GAIN control is used to adjust the gain of the amplifier. Cathode bias resistor R10 (fig. 8) is bypassed by capacitor C7. Cathode bias resistors R11 and R7 are not bypassed and therefore introduce a small amount of degenerative feedback. Screen grid voltage is supplied through resistor R9. A small amount of negative feedback is introduced by returning screen bypass capacitor C6 directly to the cathode of tube V2. Negative feedback also is applied through capacitor C4 to cathode resistor R11 from the output of second amplifier V1. Plate voltage is supplied through resistor R8, bypassed by capacitor C5 and the 1-2 winding of interstage network Z1. The output of first amplifier V2 is applied through interstage network Zl to second amplifier V1.

(6) *Second amplifier V1*. Interstage network Z1 couples the signals to the control grid through sing-suppressing resistor R18. Cathode bias is provided by resistor R6, bypassed by capacitor C3. Screen grid voltage is supplied through resistor R5, bypassed by capacitor C2. Resistors R2 through R4 form a voltage divider which determines the feedback voltage applied to first amplifier V2 through capacitor C4. Plate voltage is applied through resistors R7 and R4 and winding 5-6 of transformer T1. Capacitor C1 is the decoupling

capacitor. Capacitors C9 and C8 are feedback phase-shifting capacitors. The output of second amplifier V1 is applied to output transformer T1.

(7) *Output transformer T1*. Transformer T1 is connected in a hybrid arrangement. Resistor R1 is the balancing resistor for the circuit. The 60- to 108-kc output from second amplifier V1 is applied to pins H and R of connector P1 through pins 14 and 17 of connectors P1 and J2 and the contacts of 60-108 KC switch S1 (fig. 7). An alternate output is applied to the DEM OUT ALT binding posts through pins 15 and 18 of connectors P1 and J2. Resistor R1 is an impedance terminating resistor.

i. Special Service Switch S1, 60-108 KC (fig. 7).

(1) *REGULAR position*. Establishes continuity from the output of modem and amplifier AR4 to pins H and R of connector P1.

(2) *SPL SERV position*. When operated to this position, continuity is established from the output of modem and amplifier AR4, through contacts 10 and 11 and 13 and 14 of switch S1 to the SPL SERV 60-108 KC binding posts.

13. Block Diagram Analysis, Regulator and Alarm Circuit Z6

(fig. 13)

Regulator and alarm circuit Z6 regulates the group receiving gain of the GROUP PANEL according to the strength of the received 68-kc signal. The strength of the pilot frequency varies inversely as the loss (which varies directly as the temperature) of the spiral-four cable. Regulation of the output of receiving amplifier AR2 is held to $\pm$ 1 db. When the output signal variation exceeds $\pm$ 1 db, an alarm indicates the abnormal condition.

a. Input Circuit. The input circuit consists of band-pass filter FL1 and first amplifier V1.

(1) *Band-pass filter FL1*. The 68-kc pilot frequency is applied from receiving amplifier AR2 to band-pass filter FL1 which selects only the 68-kc pilot frequency from the received group input frequencies and applies it to regulator amplifier V1.

(2) *Amplifier V1*. From amplifier V1, the amplified signal is applied to voltage doubler rectifier V2 of the regulator section and alarm amplifier V4A of the alarm section.

b. Regulator Circuit. The output of rectifier V2 controls the operation of thermistor current supply tube V3. Tube V3 operates in conjunction with regulator network Z2 and thermistor RT1 (fig. 6) to control the gain of receiving amplifier AR2.

c. Alarm Circuits.

(1) *Alarm amplifier V4A*. If regulator network Z2 and thermistor RT1 fail to restore the normal signal outputs, an alarm sounds to indicate the condition. Heavily biased amplifier V4A permits only a small portion of its input signal to appear at the output circuit to operate the alarm circuits. The output of amplifier V4A is applied to alarm rectifier V4B.

(2) *Alarm rectifier V4B*. Tube V4B rectifies the 68-kc pilot frequency and develops negative and positive voltages at its plate and cathode circuits to be further applied to the high and low alarm circuits.

(3) *High alarm*. The negative voltage from the alarm rectifier is applied to high alarm dc amplifier V5A. Only a prolonged variation due to spiral-4 cable temperature changes in the 68-kc pilot frequency will be amplified and operate the high alarm circuit (par. 14f). Normally, tube V5A conducts sufficient current to keep relay K1 energized; however, should the pilot frequency to the input circuit exceed 1 db, the plate current of amplifier V5A would decrease sufficiently to deenergize the relay. When relay K1 deenergizes, HIGH ALARM lamp I 3 and buzzer I 1 (fig. 6) actuate to indicate the abnormal condition.

(4) *Low alarm*. The positive voltage from the alarm rectifier is applied to low alarm dc amplifier V5B. Only a prolonged variation in the 68-kc

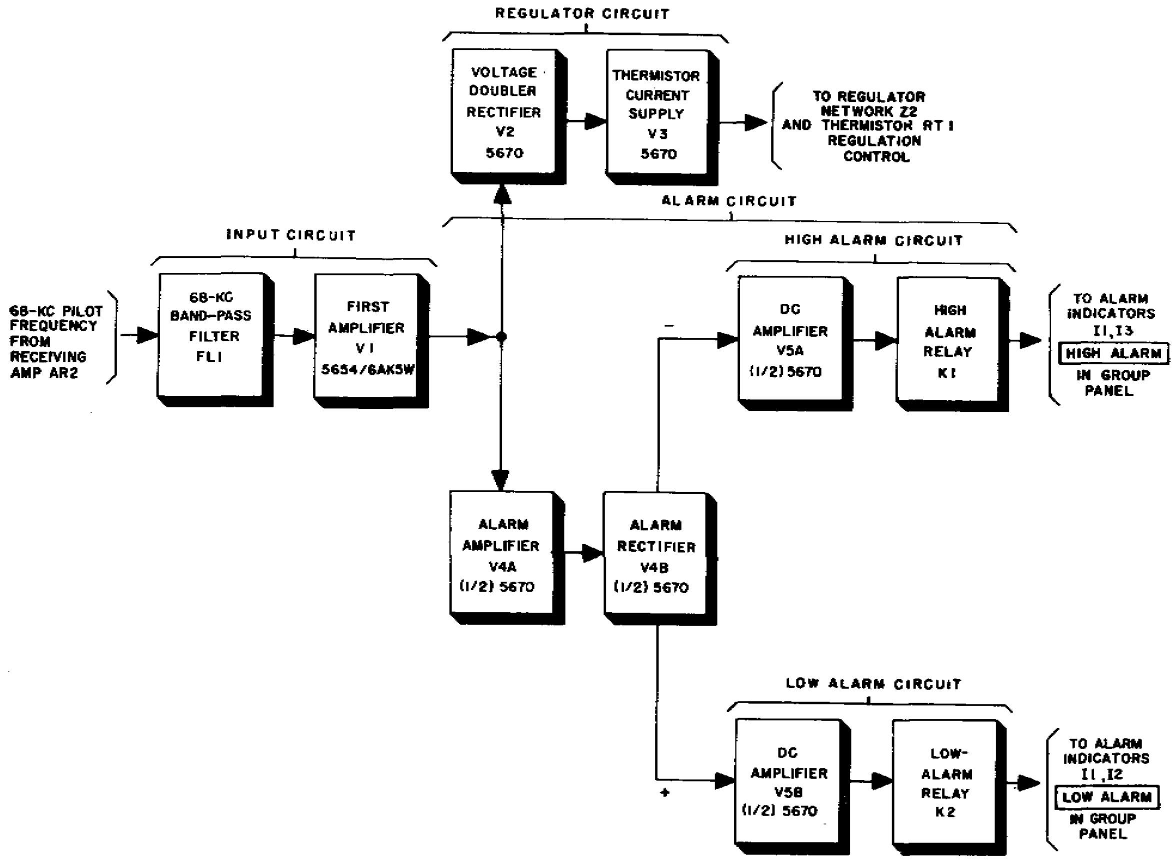

Figure 13 Regulator and Alarm Unit Z6, block diagram.

pilot frequency due to spiral-four cable temperature changes will be amplified and operate the low alarm circuit (par. 14*f*). Normally, tube V5B conducts sufficient current to keep low alarm relay K2 energized; however, should the pilot frequency applied to the input of the regulator and alarm circuit decrease below -1 db, the plate current of amplifier V5B would decrease sufficiently to deenergize the relay. When relay K2 deenergizes, LOW ALARM lamp I 2 lights and buzzer I 1 (fig. 6) sounds to indicate the abnormal condition.

14. Schematic Analysis, Regulator and Alarm Unit Z6

a. General.

(1) The regulator circuit (regulator and alarm Z6, on the GROUP PANEL) compensates for changes in the loss characteristics of the spiral-four cable at temperatures other than the mean temperature, 45° F. Basic equalizer EQ2 (par. 12*b*(6)) compensates for the cable loss characteristics at the mean temperature. Changes in the output of the 68-kc pilot frequency that accompanies the 12- to 60-kc signal frequencies along the spiral-four cable are used as a measure of the changes in the output of the signal frequencies. Variations in the output of the 68-kc pilot frequency control the regulator circuit which, in turn, controls the output of the signal frequencies passing through the receiving circuit. Figure 14 is a graph of the input to the regulator circuit versus the output of the circuit. The curve is essentially a straight line, because

the regulator circuit responds linearly to its input. The regulator circuit can maintain a ±.7-db flat gain error with ± 5-db changes in the signal input. The ±5-db changes in the signal input can include changes in the signal input resulting from the most extreme combinations of ±20° F. ambient temperature change and ±30° F. spiral-four cable temperature change. The control is made by regulator network Z2 and thermistor RT1 shown on the block diagram in figure 6.

(2) If the 68-kc pilot signal received from the spiral-four line exceeds or falls below its normal output, the regulator circuit will operate to restore the normal output of the signals. If the range of the regulator circuit is not sufficient to restore the 68-kc pilot to within 1 db of its normal output, an alarm will sound.

b. Band-Pass Filter FL1 and First Amplifier V1. The input to regulator and alarm circuit Z6 is applied from receiver amplifier AR2 (12-68 KC AMPLIFIER) through the pad composed of resistors R22 through R24, and R31 in the GROUP PANEL (fig. 7). The signal is applied to terminals 0 and 3 of connector P1 on REGULATOR AND ALARM Z6 (fig. 15). From connector P1, the signal is applied through resistor R1, which is a part of the pad, to input transformer T1. Input transformer T1 steps up the input voltage and applies it to band-pass filter FL1. Filter FL1 Passes only 68 kc to the grid of regulator amplifier V1 through sing-suppression resistor R3. The 68-kc pilot signal voltage is applied to the grid of regulator amplifier V1. Resistor R2 is the grid leak and a terminating resistor for filter FL1. Some degenerative feedback is obtained through resistor-capacitor combination R5 and C2. A control grid voltage of 20 volts dc is developed by the voltage divider network

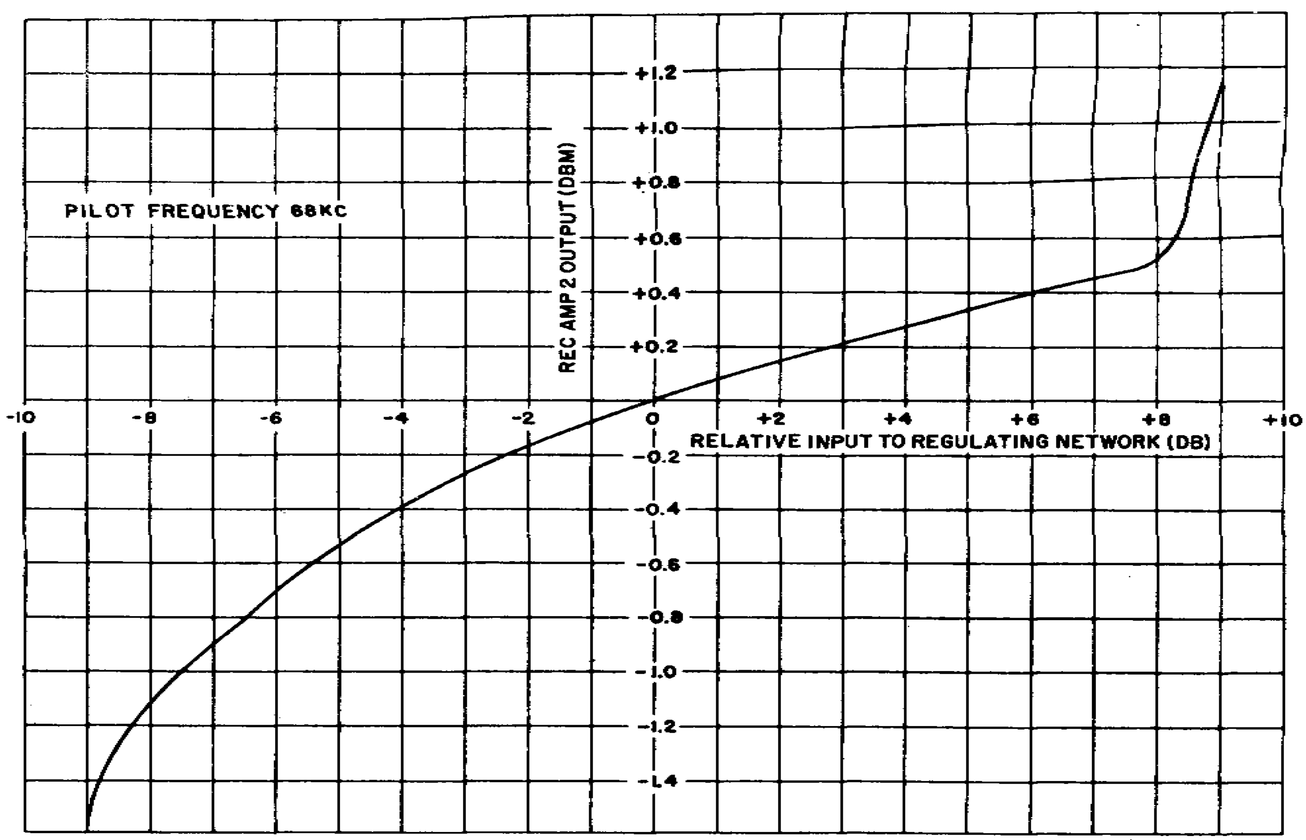

Figure 14 Regulator input versus amplifier output.

work composed of resistors R32 and R33. Capacitor C14 provides decoupling action of this voltage. This voltage partially cancels the high cathode voltage developed by cathode resistor R6. The plate voltage for tube V1 is fed through inductor L1. The screen and plate voltages are limited by resistor R7 and bypassed by capacitor C1. The output of the regulator amplifier is developed across resistor R4 and inductor L1.

c. Voltage Double Rectifier V2 (fig. 15). The 68-kc pilot frequency voltage is applied to the grid and plate of one-half of voltage double rectifier V2 through capacitor C3. The frequency voltage applied to the voltage doubler rectifier is rectified and doubled by the circuit arrangement. A negative dc voltage approximately equal to twice the peak signal voltage from tube V1 is developed across resistor R8 and capacitor C5. This negative voltage is opposed by an adjustable positive voltage applied to terminal 14 of connector P1 from AUTO REG OUTPUT potentiometer R44 (fig. 7) and resistor R43. The positive voltage is bypassed by capacitor C4. The combination of the negative output voltage and the adjustable positive opposing voltage produces an adjustable voltage on the paralleled grids of tube V3. Capacitor C6 and resistor R9 filter out rapid variations in the voltage applied to the grids of tube V3.

d. Thermistor Current Supply V3 (fig. 15). The rectified and doubled 68-kc pilot frequency is applied to the grids of dc amplifier V3 through resistors R10 and R11 which prevent spurious oscillations of the dc amplifier. The bias on tube V3 is adjusted by means of the adjustable positive opposing voltage, so that when the 68-kc frequency is at its normal voltage, approximately 6 ma of current flows from the paralleled plates of V3 through the parallel combination of current-limiting resistors R12 and R34 to pin 19 of connector P1. This current flows by way of an external connection (fig. 7) through transformer T3, regulator network Z2, thermistor RT1 in the GROUP PANEL (fig. 9), and then through input transformer T1 in amplifier AR2 and resistor R25 in the GROUP PANEL, to the 200-volt supply. Resistor R25 protects input transformer T1 in amplifier AR2 against excessive currents. Capacitor C4 acts as a filter. A check can be made at REG VOLTS jack J1 and J2 (fig. 15) to determine if the proper amount of current is flowing. Resistor R13 is the cathode bias resistor. Capacitor C7 provides filtering of the thermistor current. Regulator network Z2 (fig. 7) is in series with the received signal path in the GROUP PANEL. Changes in the loss of regulator network Z2 control the output of the received signals (par. 12*d* (2)). The loss of regulator network Z2 is controlled by the resistance of thermistor RT1. Thermistor RT1 is in series with tube V3 (fig. 15), and when the plate current changes in tube V3 the thermistor current changes. When the current flowing through the thermistor changes, the resistance of the thermistor changes. Figure 16 shows the loss of regulator network Z2 plotted against the frequency for different values of thermistor resistance.

(1) *Increase in pilot frequency level*. When the temperature of the spiral-four cable decreases, the loss of the cable decreases, increasing the output level of the 68-kc pilot frequency. As the output level of the 68-kc pilot frequency increases above its normal value, the negative voltage on the paralleled grids of tube V3 increases. When the grid voltage on tube V3 becomes more negative, the plate current decreases. This decreases the current through thermistor RT1. The resistance of the thermistor then increases. An increase in thermistor resistance increases the loss of the regulator network. Since the regulator network is in series with the received signal path in the GROUP PANEL (par. 12*d*(2)), the signal outputs are reduced to their normal values.

(2) *Decrease in pilot frequency level*. When the temperature of the spiral-four cable increases, the loss of the

Figure 15. Regulator and alarm unit Z6, schematic diagram.

(Contained in separate envelope)

cable increases and the output level of the 68-kc pilot frequency decreases. As the output of the 68-kc pilot frequency decreases below its normal value, the negative voltage on the paralled grids of tube V3 becomes less negative. As the current through tube V3 increases, the resistance of the thermistor in series with tube V3 tends to decrease; the loss of the regulator network decreases and the received signal levels increase to their normal values.

e. Alarm Amplifier V4A (fig. 15). The 68-kc pilot frequency is passed by capacitor C8 to the grid of alarm amplifier tube V4A. The cathode of tube V4A is positively biased (approximately 30 volts) by the voltage-divider circuit composed of resistors R17 through R19. ADJ HIGH resistor R18 determines the value of 68-kc input at which the alarm circuit will just indicate a high alarm. Since tube V4A is heavily biased, only a small portion of the input is permitted to produce an output voltage at the plate. A small amount of denegeration is provided by resistor R21 and capacitor C10

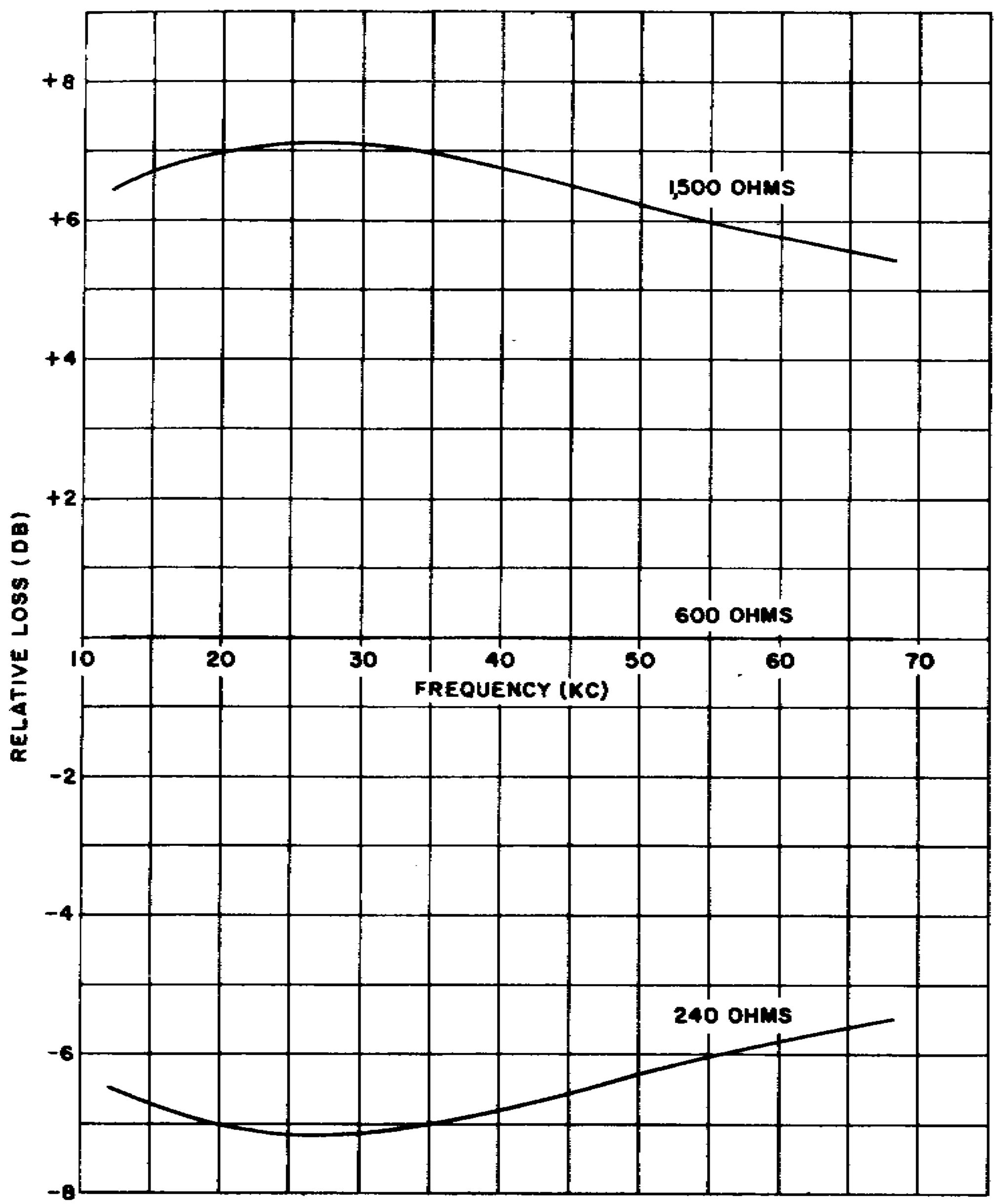

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Figure 16. Regulator network Z2 attenuation versus thermistor RT1 resistance.

Resistor R15 is the dc return to the grid of tube V4A. Resistor R16 masks the shunting effect of the input capacity. Resistor R37 is the plate load resistor. Resistor R36 and capacitor C16 decouple the plate circuit. The output signal is applied through coupling capacitor C9 to the cathode of the alarm rectifier half of tube V4.

f. Alarm Rectifier V4B (fig. 15). The alarm rectifier rectifies the 68-kc pilot frequency and develops negative and positive voltages proportional to the level of the 68-kc pilot frequency applied. A positive voltage proportional to the output of V4A is developed across resistor R22 at the cathode of the rectifier. A negative voltage is developed across resistor R23, shunted by capacitor C11, at the plate of the rectifier.

(1) *Normal condition*. The positive voltage at the cathode of tube V4B is applied through the contacts of ALARM TEST switch S1 and resistor R27 to the grid of dc amplifier V5B. Resistor R27 and capacitor C13 provide a time delay of about 1 second to insure that only prolonged voltage variations in the 68-kc pilot frequency level (due to temperature changes) will affect the low alarm circuit. Resistor R38 prevents tube V5B from oscillating. The cathode of tube V5B is positively biased by means of the voltage divider composed of ADJ LOW potentiometer R28 and resistors R29 through R31, so that the grid to cathode bias is sufficient to keep the desired value of plate current flowing through the tube. The plate current is of sufficient magnitude to keep relay K2 energized under normal conditions. The ADJ LOW control is used to fix the value of 68-kc input at which the alarm circuit will just indicate a low alarm.

(2) *Operated condition*. When the level of the 68-kc pilot frequency decreases, the voltage at the load resistor combination, R22 and R35, in the cathode of tube V4B becomes less positive. When the cathode of tube V5B becomes less positive, the following actions occur:

(a) The grid of tube V5B becomes more negative and the plate current through the tube and series relay decreases.

(b) After the current through relay K2 decreases sufficiently to deenergize it, contacts 5 and 6, and 1 and 2 close to complete the circuit from terminal 1 to terminals 13 and 2 of connector P1. These contacts connect the ground side of the 6.3 voltage to the low alarm indicators (lamp I 2 and buzzer I 1) in the GROUP PANEL (fig. 7) for operation to indicate a low alarm condition.

(c) External ALARM CUTOFF switch S3, located on the front panel, is provided to permit the buzzer to be silenced. If the signal restores to normal, the bias on tube V5B becomes normal, plate current flows through the tube, and relay K2 operates again. When relay K2 is reenergized, it operates and causes the buzzer to sound again until ALARM CUTOFF switch S3 is restored to normal.

g. Alarm Rectifier V4B, High Alarm Condition (fig. 15).

(1) *Normal condition*. The negative voltage at the plate is applied through resistor R26 to the grid of tube V5A. Resistor R26 and capacitor C12 provide a time delay of about 1 second to insure that only prolonged voltage variations in the 68-kc pilot frequency will affect the alarm system. The combination of the negative voltage output from the plate of tube V4B and a slight positive bias derived from the voltage divider composed of resistors R25 and R24 produces a grid to cathode bias on tube V5A of sufficient magnitude to keep normal plate current flowing through the tube. The plate current is of sufficient magnitude to keep relay K1 operated under normal conditions.

(2) *Operated condition*. When the level of the 68-kc pilot frequency increases, the output of tube V4B increases and

the negative voltage across plate load resistor R23 increases. As a result, the plate becomes more negative and the grid of tube V5A becomes more negative. When the grid of tube V5A becomes more negative, the following actions occur:

(a) The plate current through the tube and relay K1 decreases.

(b) After the current through relay K1 decreases sufficiently to deenergize it, contacts 5 and 6 and 3 and 1 close to complete the circuit between terminal 1 of connector PI and terminals 16 and 5 of the same connector to indicate a high alarm. These contacts connect the ground side of the 6.3-volt alarm voltage to HIGH ALARM lamp I 1 and buzzer I 5 in the GROUP PANEL (fig. 7).

(c External ALARM CUTOFF switch S3, located on the front panel, is provided for silencing the buzzer. If the signal restores to normal, the bias on tube V5A becomes normal, plate current flows, and relay K1 operates again and causes buzzer I 1 to sound again until ALARM CUTOFF switch S3 is restored to normal.

h. Alarm Circuit Adjustments. Adjustments of the alarm are necessary to cause it to respond to the desired variations of the 68-kc pilot frequency. Three-position nonlocking switch S1 (ALARM TEST) (fig. 15) is provided to simulate a pilot frequency increase or decrease of approximately 1 db.

(1) *HIGH alarm*.

(a) When switch S1 is operated in the 1 HIGH position, resistor R20 shunts load resistor R22. The combination of resistors R20 and R22 provides an increase in the negative voltage across resistor R23 corresponding to an increase of 1 db in the 68-kc pilot frequency.

(b) In the same position, switch S1 connects the grid of tube V5B to the cathode so that the low alarm circuit is inoperative; the time constant of the high alarm circuit is lowered by the adding of capacitor C15 to the time delay combination of resistor R26 and capacitor C12. The time constant is lowered, so that the circuit will respond immediately to variations in adjustment ADJ HIGH resistor R18. The ADJ HIGH control then may be adjusted until a high alarm is just indicated.

***Caution*: The alarms must never be adjusted without measuring the 68 kc pilot level at the output of AMPLIFIER-PILOT REGULATOR AM-707/TCC7. *The HIGH alarm must be adjusted first*.**

(2) LOW *alarm*. When switch S1 is operated to the 2 LOW position, a short circuit is removed from resistor R14, and the positive voltage applied to the grid of tube V5B is reduced by an amount corresponding to a decrease of 1 db in the 68-kc pilot frequency. The circuit then may be adjusted by variable resistor R28 (ADJ LOW) until a low alarm is just indicated.

Section IV. JUNCTION PANEL (PART OF AMPLIFIER PILOT REGULATOR AM-707/TCC-7)

15. Block Diagram Analysis (fig. 17)

The JUNCTION PANEL is used primarily as an interconnecting unit for the components of Telephone Terminal AN/TCC-7. The JUNCTION PANEL is also used to connect the transmitting and receiving circuits of the telephone terminal to the spiral-four cable.

a. Transmitting Circuit.

(1) The group output frequencies from the GROUP PANEL are applied to the high-pass section of filter FL101. This filter passes only the 12- to 60-kc band of frequencies. The low-pass section of the filter selects the 300- to 1,700-cps frequency band from the ORDER WIRE PANEL.

(2) Signals from filter FL101 are applied across output transformer T101 to connector J103. The 600 VOLT

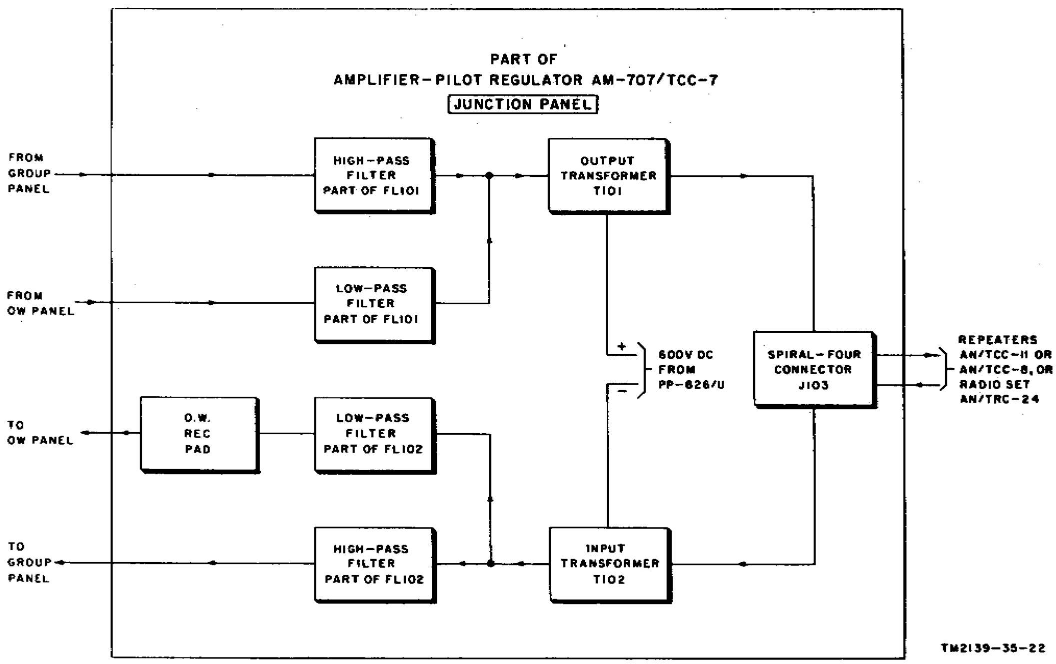

Figure 17. Junction Panel, (Part of Amplifier-Pilot Regulator AM-707/TCC-7), block diagram.

POWER SUPPLY introduces 600 volts dc to transformer T101 to be applied to connector J103 with the group output frequencies. This dc voltage is supplied as operating voltage for Telephone Repeaters AN/ TCC-11 (unattended repeaters).

b. *Receiving Circuit.*

(1) The input signals are applied from connector J103 to transformer T102. The transformer couples the received signals to filter FL102.

(2) The high-pass section of filter FL102 selects the 12- to 60-kc group input, test, and pilot frequencies and applies them to the GROUP PANEL. The low-pass section of filter FL102 selects the order-wire frequencies for application to the ORDER WIRE PANEL through the order-wire receive pad. The pad provides the proper impedance termination for low-pass filter FL102 and offers a loss of approximately 2.5 db.

16. Schematic Analysis

(fig. 18)

a. Transmitting Circuit. The 12- to 60-kc frequency band and the test frequencies from the GROUP PANEL are applied from pins F and S on connector P105, through the highpass section of filter FL101 and transformer T101 to the spiral-four cable. The 300- to 1,700-cps order-wire frequencies are applied from pins M and L of connector P101 through the low-pass section of FL101 and transformer T101 to the spiral-four cable.

b. Receiving Circuit. The 12- to 60-kc frequency band and test frequencies from the spiral-four cable are applied to the GROUP PANEL through transformer T102, the highpass section of filter FL102, and pins C and P of connector P105. The 300- to 1,700-cps order wire frequencies are applied from the spiral-four cable to the ORDER WIRE PANEL through transformer T102, low-pass section of filter FL102, the order wire receive pad, (R102 through R104) and pins F and S of connector P101.

Figure 18. Junction Panel, (Part of Amplifier-Pilot Regulator AM-707/TCC-7), schematic diagram.
(Contained in separate envelope)

Section V. TELEPHONE FREQUENCY SUPPLY TA-228/TCC-7

17. General

The modulator and demodulator circuits of Telephone Terminal AN/TCC-7 require several stable carrier-frequency signals for proper operation of the equipment. In addition, a pilot and two test frequencies are necessary for operation of the telephone terminal as a component part of the 12-channel telephone carrier system. These frequencies are furnished by Telephone Carrier Frequency Supply TA-228/TCC-7.

a. Carrier and Test Frequencies. The CARRIER SUPPLY PANEL supplies precise, stable, harmonically related frequencies for use in circuits indicated in (1) through (5) below

(1) Carrier frequencies of 8, 12, 16, and 20 kc are supplied for the modulator and demodulator circuits of CHAN MODEM 1, 2, and 3.

(2) Carrier frequencies of 56, 72, and 88 kc are supplied for the modulator and demodulator circuits of the SUBGROUP PANEL.

(3) A 120 kc carrier frequency is supplied for the modulator and demodulator circuits of the GROUP PANEL.

(4) A 68-kc pilot frequency provides automatic signal level regulation in the receiving amplifier circuits and manual adjustment of the flat network of the remote AN/TCC-7 terminal. The 68-kc pilot frequency also is used for automatic signal level regulation in amplifier circuits of Telephone Repeaters AN/TCC-8, and AN/TCC-11, and for manual adjustment of flat networks, when this equipment is used as a component of the 12-channel telephone carrier system.

(5) Test frequencies of 12 and 28 kc are supplied, when required, for manual adjustment of slope and bulge networks of the remote AN/TCC-7 terminal. The 12- and 28-kc test frequencies are also used for manual adjustment of slope and bulge networks of Telephone Repeater AN/TCC-8 when this equipment is used in a system.

b. Synchronization of Carrier Frequencies. To avoid the possibility of frequency-shift distortion that occurs when the frequencies of carriers at one telephone terminal differ from those at the other, provisions are included in the CARRIER SUPPLY PANEL to use the 68-kc pilot frequency received from the distant terminal as a synchronizing frequency for local equipment.

18. Block Diagram Analysis, CARRIER SUPPLY PANEL

(fig. 19)

a. Oscillator Circuit, 64-kc. The 64-kc oscillator circuit consists of an oscillator and a stabilizing network. In this text, the oscillator has been arbitrarily separated into a 64-kc oscillator stage VIA and a 64-kc feedback amplifier stage V1B.

(1) *Oscillator Stage, VIA, 64-kc*. Oscillator tube VIA can be considered the prime generator of the 64-kc signal. The frequency of this signal is controlled by a quartz crystal in frequency stabilizer network Z1. The 64-kc output of VIA is applied to the input of 64-kc feedback amplifier V1B.

(2) *Feedback amplifier V1B, 64-kc*. Feedback amplifier V1B amplifies the signal from the 64-kc oscillator. The amplifier inverts the signal polarity, so that when fed back (through frequency stabilizer network Z1) it is of proper phase to sustain oscillations in 64-kc oscillator stage VIA. The output is coupled to 64-kc amplifier V2.

(3) *Frequency stabilizer network Z1*. The frequency stabilizer network consists of a temperature-controlled quartz crystal. The quartz crystal permits only 64 kc to be fed back from 64-kc feedback amplifier V1B to 64-kc oscillator stage VIA. The 6.3 volts applied to the heater circuit in the network maintains the frequency

controlling quartz crystal at a constant temperature.

b. Amplifier V2, 64-kc. Amplifier V2 isolates the 64-kc oscillator circuit from loading effects that would decrease the frequency stability of the 64-kc oscillator. The 64-kc amplifier is operative except when the synchronizing circuit (par. 12*f*) is in operation. The 64-kc amplifier then is cut off by negative dc voltage from rectifier V3. In normal operation, the 64-kc amplifier supplies power sufficient to drive the 64- to 4-kc frequency divider circuits.

c. Hybrid Network. The output of 64-kc amplifier V2 (or remote 64-kc amplifier V7) is applied to the resistor hybrid network to drive 64- to 16-kc divider V4. The hybrid network serves to isolate the output of 64-kc amplifier V2 from the output of remote 64-kc amplifier V7 to prevent unstable circuit operation.

d. Frequency Divider Circuits. The carrier frequencies, pilot frequency, and test frequencies supplied by the CARRIER SUPPLY PANEL are multiples of 4 kc. The 4-kc base frequency is obtained from 64 kc by frequency division in the frequency divider circuits. These circuits consist of a 64- to 16-kc frequency divider and a 16- to 4-kc frequency divider.

(1) *Frequency divider, 64- to 16-kc*. The 64-kc frequency from the resistor hybrid network is decreased to 16 kc by the 64- to 16-kc frequency divider. This circuit uses regenerative modulators CR1 and CR2, and first divider amplifier V4. The signal level is amplified by amplifier V4 to overcome losses introduced in the modulator and associated circuits. The 16-kc frequency is then applied to the 16 to 4-kc divider circuit.

(2) *Frequency divider, 16- to 4-kc*. The 16-kc frequency is decreased by the 16- to 4-kc frequency divider to a 4-kc base frequency. This circuit contains modulators CR3 and CR4 and second divider amplifier V5. This circuit functions similarly to the 64- to 16-kc frequency divider circuit. The 4-kc output is applied to 4-kc amplifier V6.

e. Amplifier V6, 4-kc. Amplifier V6 is used as an overdriven amplifier. The 4-kc signal from the 16- to 4-kc frequency divider is limited by amplifier V6 to provide a constant amplitude of output signal. The output of the 4-kc amplifier is applied to the harmonic generating circuits and synchronizing modulator CR5.

f. Harmonic Generating Circuits. The harmonic generating circuits distort the 4-kc base frequency and thereby produce harmonic frequency components. Separate outputs are provided for odd and even harmonics to simplify the frequency selectivity requirements of the band-pass filters.

(1) *Odd harmonic generator*. The odd harmonic generator consists of capacitor C32 and inductor L4. These circuit components distort the 4-kc frequency to obtain odd harmonic frequencies. The output of the odd harmonic generator is applied to the even harmonic generator circuit and the four odd harmonic band-pass filters.

(2) *Even harmonic producer*. The 4-kc base frequency and the odd harmonics from the odd harmonic generator are converted to even harmonics by varistors CR10 and CR11 connected as a full-wave rectifier. The output of the even harmonic producer is applied to the six even harmonic band-pass filters.

g. Odd Harmonic Filter and Amplifier Circuits

(1) *Band-pass filters*. Band-pass filters, FL3, FL2, FL4, and FL5 select the third (12 kc), fifth (20 kc), seventh (28 kc) and seventeenth (68 kc) harmonic frequencies, respectively, from the output of the odd harmonic generator. The 20-kc signal selected by FL2 is applied to 20-kc amplifier V9. The 12-kc signal selected by filter FL3 is applied to 12-kc amplifier V10 and also to the 12-kc adjust pad. The 28-kc signal selected by filter FL4 is

Figure 19. Telephone Carrier Frequency Supply TA-228/TCC-7, block diagram.
(Contained in separate envelope)

applied to the 28-kc adjust pad. The 68-kc signal selected by filter FL5 is applied to the 68-kc adjust pad and to 68-kc alarm amplifier V8A (j(1) below) .

(2) *Amplifiers, 12- and 20-kc.* Amplifiers V10 and V9 amplify the 12- and 20-kc signals, respectively, from the band-pass filters to the required level for use as carrier frequencies in modulation and demodulation. The outputs of the amplifiers are applied through the 12-and 20-kc isolation resistors, respectively, to CHAN MODEMS 1, 2, and 3.

(3) *Isolation resistors, 12- and 20-kc.* The isolation resistors prevent interaction between the three CHAN MODEMS.

(4) *Adjust pads, 12-, 28- and 68-kc.* These adjust pads provide means for adjusting the levels of the 68-kc pilot and the 12- and 28-kc test frequencies. The pads also provide isolation between each output of the 12-, 28-, and 68-kc band-pass filters to prevent interaction of the adjustments. The 68-kc pilot frequency is applied through the JUNCTION PANEL to transmitting amplifier AR3. The 12- and 28-kc test frequencies are applied to 12 & 28KC test switch S4.

(5) *Test Switch S4, 12 & 28KC.* Switch S4, when operated, permits the 12- and 28-kc test frequencies to be applied, with the 68-kc pilot frequency, through the JUNCTION PANEL to transmitting amplifier AR3.

h. Even Harmonic Filter and Amplifier Circuit. The even harmonic filter and amplifier circuit selects and amplifies the even harmonic frequencies for use in modulation and demodulation.

(1) *Band pass filters.* Band-pass filters FL6 through FL11 select the second (8 kc), fourth (16 kc), fourteenth (56 kc), eighteenth (72 kc), twenty-second (88 kc), and thirtieth (120 kc) harmonic frequencies from the output of the even harmonic producer.

(2) *Amplifiers.* Amplifiers V11 through V16 amplify the signals to the required level for use as carrier frequencies in the modulator and demodulator circuits throughout the telephone terminal. The 8- and 16-kc frequencies are applied to their respective isolation resistors. The outputs from amplifiers V13 through V15 are applied to the SUBGROUP PANEL through the GROUP PANEL. The 120-kc output of amplifier V16 is applied to the GROUP PANEL and 120-kc alarm circuit V8B.

(3) *Isolation resistors, 8- and 16-kc.* The isolation resistors prevent interaction between the three CHAN MODEMS.

i. Synchronizing Circuits. The synchronizing circuits synchronize the carrier frequencies used at the local telephone terminal with those used at the remote telephone terminal. When the circuit is placed in operation by operating the CARR SYNC switch to the REMOTE position, the 4-kc base frequency is obtained indirectly from the 64-kc oscillator in the distant telephone terminal.

(1) *CARR SYNC switch S1.* In the REMOTE position, CARR SYNC switch S1 activates the synchronizing circuit by applying the 68-kc synchronizing signal (received pilot frequency from the GROUP PANEL) to synchronizing modulator CR5. In the LOCAL position or when failure of the 64-kc synchronizing signal of synchronizing circuit components occurs, rectifier V3 does not furnish cutoff voltage to amplifier V2. The amplifier then applies the local 64 kc to the frequency divider circuits.

(2) *Synchronizing modulator CR5.* In synchronizing modulator CR5, the 4-kc signal modulates the synchronizing signal, thus producing the upper and lower sideband frequencies.

(3) *Band-pass filter FL1 64-kc.* Band-pass filter FL1 selects the lower sideband (64-kc) from the modulator output and applies it to remote 64-kc amplifier V7.

(4) *Remote 64-kc amplifier V7.* Amplifier V7 amplifies the lower sideband from filter FL1 and applies it through the

hybrid resistor network to the 64- to 4-kc frequency divided circuits and to rectifier V3.

(5) *Rectifier V3*. Rectifier V3 rectifies the 64-kc signal received from remote 64-kc amplifier V7 and applies a negative bias on 64-kc amplifier V2. The negative bias cuts off the amplifier, preventing the local 64-kc signal from being applied to the resistor hybrid network when the remote 64-kc signal is present.

(6) *Resistor hybrid network*. The resistor hybrid network isolates the outputs of 64-kc amplifier V2 and remote 64-kc amplifier V7 from each other.

j. Alarm Circuits, 68- and 120-kc. The alarm circuits give visual and audible indications of the absence of the 68-kc pilot or the 120-kc carrier frequencies.

(1) *Alarm amplifier V8A, 68-kc*. Alarm amplifier V8A lights 68KC indicator lamp I 1 and sounds transmission alarm buzzer I 1 when the 68-kc pilot frequency output fails.

(2) *Alarm amplifier V8B, 120-kc*. Alarm amplifier V8B lights 120KC indicator lamp I 2 and sounds transmission alarm buzzer I 1 when the 120-kc carrier frequency output fails.

19. Schematic Analysis, CARRIER SUPPLY PANEL

(fig. 20)

a. Oscillator Circuit, 64-kc. The 64-kc oscillator circuit supplies a stable 64-kc signal. The circuit is essentially a two-stage amplifier with feedback from the output to the input. The circuit consists of frequency stabilizer network Z1, 64-kc oscillator VIA, and 64-kc feedback amplifier V1B. Since the oscillator and the amplifier stages both provide signal gain, only a small amount of feedback is necessary to maintain oscillation.

(1) *Frequency stabilizer network Z1*. Frequency stabilizer network Z1 contains a heater unit and the frequency determining circuit for the oscillator. The frequency determining circuit is composed of an NT cut quartz crystal and its series capacitor, both of which, set the oscillator frequency at exactly 64 kc. The frequency stability is maintained by mounting the crystal in a hermetically sealed can surrounded by the heater unit. The crystal heater unit is in parallel with an ambient temperature-sensing disk thermistor and connected through an internal resistor and resistor R173 to a 6.3 volt source. The thermistor has a negative temperature-resistance characteristic. The crystal is maintained at a temperature of between 60° C. and 75° C. over an ambient temperature range of -40° C. to +65° C. This degree of temperature control is sufficient to maintain the required frequency stability. The crystal of frequency stabilizer network Z1 is connected as the frequency-determining element in the feedback circuit between 64-kc feedback amplifier V1B and 64-kc oscillator VIA. The series-resonant crystal offers very low resistance and no phase shift at a frequency of 64 kc. The crystal offers high impedance and phase shift to other frequencies. Therefore, only 64 kc is fed back to maintain oscillation.

(2) *Oscillator VIA, 64-kc*. The 64 kc from the crystal in the frequency stabilizer network is applied to the control grid of VIA through series resistor R172. Resistor R172 isolates the tube capacity from the crystal, so that the tube changes will not affect the frequency. Resistor B1 is the grid input resistor. When large input signals are applied, the control grid draws more current; this causes a greater negative voltage drop across resistor R1 and thereby increases the bias. The gain of the output signal is regulated by this action and, as a result the output amplitude, is nearly

Figure 20. Telephone Carrier Frequency Supply TA-228/TCC-7, schematic diagram.

(Contained in separate envelope)

constant. Cathode resistor R3 and bypass capacitor C1 develop cathode bias. Resistor R5 is the plate load resistor. Plate resistor R2 is used to minimize the effects of tube capacitance on the output frequency. The amplified 64 kc at the plate is coupled through resistor R2 and blocking capacitor C2 to the grid of 64-kc feedback amplifier V1B.

(3) *Feedback amplifier V1B, 64-kc*. The signal from 64-kc oscillator VIA is applied to the grid of 64-kc feedback amplifier V1B. Resistor R163 is the dc grid return. Cathode resistor R4 and bypass capacitor C48 furnish dc operating bias. The amplified 64-kc signal at the plate of tube V1B is coupled by blocking capacitor C3 to the LC tuned circuit (inductor L1 and capacitors C4, C49A, and C49B), which is resonant at 64 kc. Resistor R6 is the plate load. Voltage-divider resistors R7 and R8 are connected across the LC tuned circuit. The fraction of the 64-kc signal across resistor R8 is fed back through frequency-stabilizer network Z1 to 64-kc oscillator VIA. The voltage divider, consisting of capacitor C5 and resistors R9 and R10, couples a fraction of the 64-kc output to the grid of 64-kc amplifier V2. Because of this light loading provided by the grid of the 64-kc amplifier, the oscillator frequency stability will be unaffected by load variations.

b. Amplifier V2, 64-kc. The output of the 64-kc oscillator circuit is amplified in 64-kc amplifier V2 when no negative voltage is applied to the suppressor grid from rectifier V3 (par. 23*e*). Resistor R10 is the dc grid return. Unbypassed cathode resistor R11 provides cathode bias and also degeneration. Impedance matching transformer T1 couples the 64-kc output from amplifier V2 to the 64- to 4-kc frequency divider circuits through the hybrid resistor network. Capacitor C7 tunes the primary of transformer T1 to 64 kc. Capacitor C6 is the screen bypass capacitor. Resistor R12 is the screen voltage dropping resistor. Capacitor C8 is the suppressor grid bypass capacitor. An attenuator pad composed of resistors R13 through R15 provides the proper level of test voltage at 64KC LOCAL test jack J1.

c. Resistor Hybrid Network. The resistor hybrid permits either 64-kc amplifier V2 or remote 64-kc amplifier V7 to drive modulator CRT. This arrangement is possible, because the resistor hybrid network isolates the two amplifiers from each other. The network forms a balanced bridge which consists of resistors R20 through R23 in addition to the load. This network attenuates the applied signal by 6 db.

d. Frequency Divider Circuits, 64- to 4-kc.

(1) *General*. The 64-kc signal from amplifier V2 and remote amplifier V7 is divided by the 64- to 4-kc frequency divider circuits to obtain a 4-kc base frequency. For frequency division, regenerative modulators are used in a double-balanced arrangement. The arrangement is regenerative in that the output frequency of the modulator is modulated by the input to obtain the same output frequency. The desired difference frequencies are selected by LC circuits. Four modulators are used to divide the frequency from 64 to 4 kc. The regenerative action may be considered as starting on the 32-kc component of the noise, and building up by amplification until the output frequency is obtained. This output maintains itself by regeneration.

(2) *Frequency divider, 64- to 16-kc*. The 64-kc signal from the resistor hybrid network is applied through bridging resistors R24 through R27 to modulator CRT. A 32-kc signal from the feedback loop is fed to terminal 1 and 4 of the modulator. Since the modulator is balanced, neither of these signals appears in the output; but the sums and differences appear at terminals 5 and 2; that is, 96 kc and 32 kc. The 32 kc is the same signal as that in the feedback loop but is obtained as the difference between the two inputs. Transformer T2 couples the signals through sing-suppression resistor

R170 to the grid of first divider amplifier V4. The amplifier overcomes losses in the circuit. Resistor R28 supplies cathode bias for the amplifier. In the plate of amplifier V4, the primary of transformer T3 is tuned by capacitor C10 and selects 32 kc from the output. One secondary of the transformer supplies 32-kc regenerative feedback through resistor R29 to modulator CR1 as explained above. The other secondary supplies 32 kc to modulator CR2 through bridging resistors R30 through R33. Modulator CR2 mixes the 32-kc signal with a regenerative 16-kc signal to obtain 16 and 48 kc. This output is combined with the output of modulator CRT. The combined outputs are applied through transformer T2 and antising resistor R170 to first divider amplifier V4. The primaries of transformers T4 and T3 are in series. Transformer T4 is tuned by capacitor C11 and selects the 16-kc signal. Winding 1-2 of transformer T4 applies the 16-kc regenerative signal to modulator CR2 through R34. Winding 3-4 applies the 16-kc signal to modulator CR3. Resistors R35 through R37 comprise an attenuator pad for providing the proper test voltage at DIV 1 test jack J2.

(3) *Frequency divider, 16- to 4-kc*. The 16- to 4-kc frequency divider is similar to the 64- to 16-kc frequency divider. The 16-kc signal from the secondary of transformer T4 is applied through bridging resistors R39 through R42 to modulator CR3. An 8-kc signal from the feedback loop is applied to terminals 1 and 4 of the modulator. The 16- and 8-kc signals are mixed in the modulator and the sum and difference frequencies (8 and 24 kc) appear at output terminals 5 and 2. Transformer T5 couples the signals through antising resistor R171 to the grid of second divider amplifier V5. The amplifier reestablishes the proper signal level. Resistor R43 develops cathode bias for the amplifier. Transformer T6, tuned by capacitor C12, selects the 8-kc output. Winding 3-4 applies the 8-kc regenerative feedback used in modulator CR3. Winding 1-2 applies 8 kc to modulator CR4 through bridging resistors R45 through R48. Modulator CR4 mixes the 8-kc signals with a regenerative 4-kc signal to obtain 4 kc and 12 kc. This output is applied with the output of modulator CR3 through transformer T5 and antising resistor R171, and is amplified in second divider amplifier V5. The primaries of transformers T7 and T6 are in series. Transformer T7 is tuned by capacitor C13 and selects the 4-kc signal. One secondary supplies a 4-kc regenerative signal to modulator CR4 through resistor R44. The other secondary supplies 4 kc to amplifier V6. Resistors R49 through R51 comprise an attenuator pad for providing the proper test voltage at DIV 2 test jack J3.

e. Amplifier V6, 4-kc. Amplifier V6 is an overdriven amplifier that gives a steady 3/4-watt output despite variations that may occur in the input level. The peak positive voltage is limited at each grid by grid current limiting resistors R52 and R53. The signal negative peaks are limited, because the grids are driven beyond cutoff. The high impedance plate load of transformer T9 reduces variations in output caused by any change of characteristics in the relatively lower impedance of tube V6. The two sections of tube V6 are operated as a push-pull amplifier.

(1) The 4 kc from the 16- to 4-kc frequency divider circuit at the secondary of transformer T7 is coupled by capacitor C14 to the primary of transformer T8. Capacitor C14 partially tunes the windings of transformers T7 and T8 to 4 kc. Transformer T8 steps up the 4-kc signal voltage. Capacitor C15 tunes the secondary of the transformer to 4 kc. Cathode resistor R54 and bypass capacitor C16 develop dc bias for the stage.

(2) Transformer T9 matches the amplifier plate output impedance to that of

the harmonic generating circuit. Capacitor C17 tunes the transformer primary to 4 kc. A fraction of the 4 -kc output across transformer T9 is applied through resistor R57 to synchronizing modulator CR5 in the synchronizing circuit. Resistors R55 and R56 provide the proper test voltage at 4 KC output test jack J4.

20. Harmonic Generating Circuits

(figs. 20 and 21)

The carrier, pilot, and test frequencies required are all multiples (harmonics) of the 4-kc base frequency. In the odd harmonic generator, nonlinear coil L4 and capacitor C32 peak the 4-kc sine wave to generate odd harmonics. The even harmonic generator, consisting of full-wave rectifier CR10 and CR11 produces even harmonics from the odd harmonic input. The separate odd and even harmonic outputs simplify the filter requirements because any frequency to be rejected is at least 8 kc from the desired frequency.

a. *Odd Harmonic Generator* (fig. 20).

(1) *Circuit arrangement*. Inductor L3 and capacitor C29 form a series-resonant circuit which acts as a selective filter for the 4-kc input signal. Inductor L4 and capacitor C32 comprise the odd harmonic generator. Capacitors C30 and C31 are used during manufacture to tune the circuit for 4 kc. These capacitors require no further attention unless the associated parts are replaced. The load consists of the following components: resistor R74, filters FL2 through FL5, and the-even harmonic generator (CR10 and CR11).

(2) *Circuit operation* (fig. 21). When transformer T9 applies the 4-kc sine wave to nonlinear inductor L4, the impedance of the inductor presented to the signal varies according to the rate of change of current. On the initial rise of current (A, fig. 21), the impedance presented to the signal between points X and Y is high; therefore, the larger amount of voltage is applied to the load, thus charging capacitor C32. Positive current increases in the load circuit due to the charging of capacitor C32. When inductor L4 is saturated, it presents a low impedance to the incoming signal and capacitor C32. Capacitor C32 then discharges through the load circuit and L4, the larger amount of discharge current flowing through the inductor. The discharge of the capacitor produces sharply peaked negative surges of current in the load circuit. During the negative halfcycle of the applied signal, the operation of the circuit is the same as that of the positive half-cycle except that the polarities are opposite. The output developed in the load circuit by the odd harmonic generator consists of alternately positive and negative peaks. This wave form is very rich in odd harmonics of 4 kc.

b. *Even Harmonic Generator* (fig. 20).

(1) The input pulses to the even harmonic

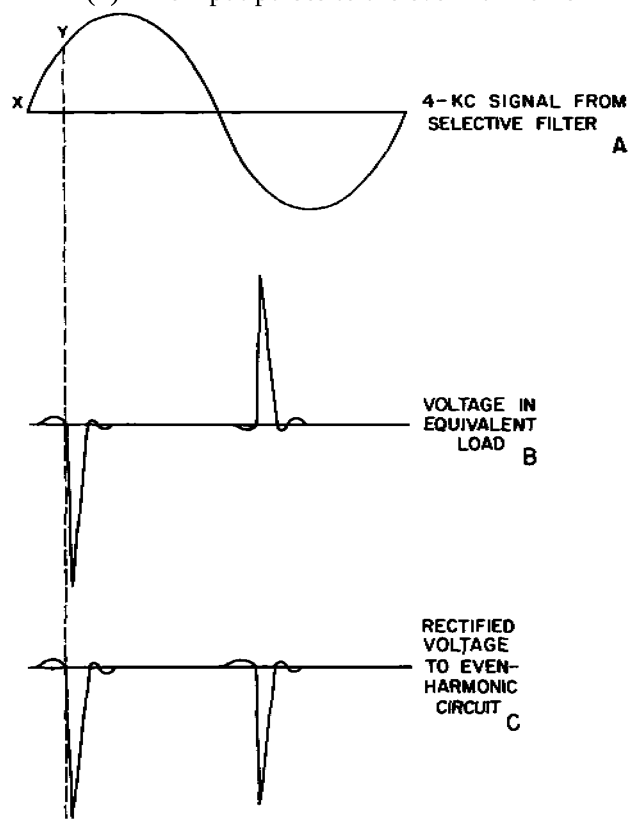

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Figure 21. Voltage curves, harmonic generating circuits (part of Telephone Carrier Frequency Supply TA-228/TCC-7)

generator from the odd harmonic generator consist of the 4-kc fundamental and odd harmonic frequencies. The even harmonic generator consists of two full-wave copper-oxide bridge rectifiers CR10 and CR11. To reduce losses, the two rectifiers are connected in parallel. The output of the full-wave rectifier is shown in C, figure 21.

(2) The output contains dc and the even harmonics of the input frequencies. The input frequencies are balanced out in the bridge circuit. Any odd harmonics remaining in the output that are caused by unbalance in the bridge rectifiers are at least 25 db below the desired level of the even harmonics. The output is applied to impedance matching transformer T18 (fig. 20). This transformer also isolates the dc and the ungrounded input from the grounded band-pass filters of the load. These filters, FL6 through FL11, are connected in parallel.

21. Odd Harmonic Filters and Amplifier Circuits

(fig. 20)

The output of the odd harmonic generator is also applied to the odd harmonic filter and amplifier circuit. The circuit selects and amplifies 12- and 20-kc carrier frequencies; selects and provides for adjusting 68-kc pilot frequency; and selects and provides for adjusting and switching the 12- and 28-kc test frequencies. The circuit consists of the carrier supply filters for 12 kc, 20 kc, 28 kc, and 68 kc; amplifiers for 12 kc and 20 kc; isolation resistors for 12 kc and 20 kc; adjust pads for 12 kc, 20 kc, and 68 kc; and 12 & 28KC switch S4.

a. Band-Pass Filters. Band-pass filters FL2 through FL5 select 12-, 20-, 28-, and 68-kc signals from the output of the odd harmonic generator. The signal selected by 20-kc bandpass filter FL2 is applied to amplifier V9. The signal selected by 12-kc band-pass filter FL3 is supplied to amplifier VI0 and also to the 12-kc adjust pad. The signal selected by 28-kc band-pass filter FL4 is supplied to the 28-kc adjust pad. The signal selected by 68-kc bandpass filter FL5 is supplied to the 68-kc adjust pad and also to 68-kc alarm amplifier V8A. The input impedance of each band-pass filter is 135 ohms. The 20-kc band-pass filter (FL2), which feeds an amplifier grid directly, has an output impedance of 40,000 ohms. The other three band-pass filters have output impedances of 135 ohms.

b. Amplifiers 12- and 20-kc. Amplifiers V10 and V9 amplify the 12- and 20-kc signals from their respective band-pass filters. The amplifiers use negative feedback developed by unbypassed cathode resistors. The amplifiers raise the signals to the required level for use as carriers in modulation and demodulation. The 12- and 20-kc amplifiers are electrically identical except for their input circuits. Amplifier V9, 20-kc, has its input directly coupled to the control grid since band-pass filter FL2 has a high impedance output. The two circuits are discussed simultaneously and parentheses are used in the text to indicate the 20-kc amplifier.

(1) The output of 12-kc band-pass filter FL3 is applied to the 12-kc adjust pad and amplifier V10. The output of 20-kc band-pass filter FL2 is applied to amplifier V9. Resistor R83 (R75) terminates the filter in the proper impedance. Transformer T16 steps up and couples the signal to the control grid of amplifier VI0. The primaries are in parallel to provide greater voltage step-up. Capacitor C35 tunes the transformer secondary to 12 kc. Sing-suppression resistor R84 (R76) reduces any tendency of the amplifier to oscillate. The value of resistor R86 (R78) is predetermined at the time of manufacture; it controls the amount of degeneration in the circuit. Inductor L6 (L5) provides an effective short for dc across resistor R86 (R78). Only resistor R85 (R77) is effective in providing cathode bias for the tube. At the signal frequency, inductor L6 (L5) has a much higher impedance than resistor R86 (R78); therefore, at the signal frequency the inductor may be neglected.

(2) The amplified signal at the plate of 12-kc (20-kc) amplifier V10 (V9) is coupled by step-down transformer T17 (T15) to the 12-kc (20-kc) isolation resistors R145 through R150 (R139 through R144). Resistors R88 through R90 (R80 through R82) comprise an attenuator pad to provide the proper test voltage at 12 KC (20 KC) test jack J8 (J7). Resistor R87 (R79) is the screen-dropping resistor and capacitor C36 (C34) is the screen bypass capacitor.

c. Isolation Resistors, 1:2- and 20-kc. The outputs of the 12- and 20-kc amplifiers are used as carriers in the channels of CHAN MODEM 1, 2, and 3 (par. 3). Since each CHAN MODEM uses the same carriers, the outputs of the amplifiers are distributed through isolation resistors. These resistors provide isolation and reduce interaction between the CHAN MODEMS. The 12-kc carrier signal is supplied to CHAN MODEM 1 through resistors R145 and R146, to CHAN MODEM 2 through resistors R147 and R148, and to CHAN MODEM 3 through resistors R149 and R160 through pins D and N on connectors P1, P2, and P3 respectively. Similarly the 20-kc carrier signal is applied to CHAN MODEMS 1, 2, and 3 through their respective isolation resistors and pins F and R on connectors P1, P2, and P3 respectively.

d. Adjust Pads 12-, 28-, and 68-kc. These adjust pads provide means for adjusting the levels of the 68-kc pilot and the 12- and 28-kc test frequencies. The pads also provide isolation (attenuation) between the 12-, 28-, and 68-kc adjustments to prevent interaction of the adjustment.

(1) The 12-, 28-, and 68-kc signal level may be adjusted by variable resistors R92, R95, and R99, respectively, for proper output at the transmitting amplifier output. Resistor R91 is a series element in the 12-kc pad.

(2) Resistor R93 terminates 28-kc carrier supply filter FL4 in the proper impedance. Resistor R94 is a series element in the 28-kc pad. Resistor R96 terminates the 28-kc and the 12-kc pads, so that the two signals now are combined.

(3) Resistor R97 terminates 68-kc carrier supply filter FL5 in the proper impedance. Resistor R169 terminates the 68-kc pad.

(4) Series resistors R164 and R101 and terminating resistors R100 and R102 form another pad element to combine the 68-kc pilot with the 12- and 28-kc test signals, provided that 12 & 28KC switch S4 is in the ON position.

(5) The 68-kc pilot is applied through the JUNCTION PANEL to transmitting amplifier AR3 (GROUP PANEL) (par. 11e). The 12- and 28-kc test frequencies are applied to 12 & 28KC test switch S4.

e. Switch S4, 12- & 28 KC.

(1) When the 12 & 28KC switch is operated to the ON position, the 12- and 28-kc test frequencies are applied through contacts 4-5 and 8-9, resistors R100 through R102, and combined with the 68-kc pilot frequency. The signals are further applied to pins H and J of connector J16. The signal path is completed through the junction panel to transmitting amplifier AR3 (GROUP PANEL). When switch S4 is in the OFF position, contacts 5-6 and 7-8 are grounded to prevent the test frequencies from being applied through the switch capacitance to the output circuit.

(2) To indicate that the test frequencies are applied on the line, lamp I 3 is energized when contacts 1-2 of the switch are made.

22. Even Harmonic Filters and Amplifier Circuits

(fig. 20)

The even harmonic filter and amplifier circuit selects and amplifies carriers for use in modulation and demodulation. The circuits are similar to the odd harmonic filters and amplifier circuits, but they are treated separately for convenience. The circuit consists of six band-pass filters and six amplifiers.

a. Band-Pass Filters. Band-pass filters FL6, FL7, FL8, FL9, FL10, and FL11 select 8, 16, 56, 72, 88, and 120 kc, respectively, from the even harmonic output from matching transformer T18. Each filter has an input impedance of 135 ohms and an output impedance of 40,000 ohms. The signals selected are applied to their respective amplifiers.

b. Amplifier. The amplifiers amplify the respective signals selected by the band-pass filters. The amplifiers raise the signals to the required level for use as carriers in modulation and demodulation. The six amplifiers are similar. The 8-kc amplifier (V11) is representative and is discussed below.

(1) Resistor R103 terminates 8-kc filter FL6 in the proper impedance. Antising resistor R104 reduces any tendency of the amplifier to oscillate. The value of resistor R106 is predetermined at the time of manufacture; it controls the amount of degeneration in the circuit. Inductor L7 provides an effective short for de across resistor R106. Resistor R105 effectively provides cathode bias for the tube. At the signal frequency, inductor L7 has a much higher impedance than resistor R106; therefore the inductance is negligible.

(2) The amplified signal at the plate of the 8-kc amplifier is coupled by transformer T19 to 8-kc isolation resistors R151 through R156. Resistors R108 through R110 comprise an attenuator pad that provides the proper test voltage at 8 KC jack J9. Resistor R107 is the screen grid dropping resistor and capacitor C37 serves as the screen bypass.

(3) The other amplifier circuits are similar except in the following eases: test jack circuits for jacks J11 through J14 contain no attenuating resistors; band-pass filter FL10, for 88-kc has no terminating resistor because loading the filter introduces additional attenuation to the harmonic frequencies. The outputs of transformers T21 and T24 are applied directly to TO GROUP PANEL connector J15. The output of 120-kc amplifier V16 is also applied to the 120-kc alarm circuit (par. 24b).

c. Isolation Resistors, 8- and 1 6-kc. The outputs of the 8- and 16-kc amplifiers are used as carriers in the three CHAN MODEMS. Since the same carrier frequencies are distributed to each CHAN MODEM, the outputs of the amplifiers are applied through isolation resistors to reduce interaction between the CHAN MODEMS. The 8-kc carrier applied to the CHAN MODEM 1, 2, and 3 through the isolation resistors and pins C and M of TO JUNCTION PANEL connectors P1, P2, and P3, respectively.

23. Synchronizing Circuits

(fig. 20)

The synchronizing circuit provides for synchronization of the carrier frequencies with those used at the distant telephone terminal. When the synchronizing circuit is placed in operation by operating the CARR SYNC switch to the REMOTE position, the 4-kc base frequency is obtained indirectly from the 64-kc oscillator in the distant telephone terminal; the local 64-kc oscillator output is not used. Should the synchronizing operation fail, the output of the local 64-kc oscillator is automatically switched in and used as described in paragraph 18b. The synchronizing circuit consists of CARR SYNC switch S1, synchronizing modulator CR5, 64-kc band-pass filter FL1, remote 64-kc amplifier V7, and rectifier V3. In addition, the frequency divider circuits (par. 19d) and the 4-kc amplifier (par. 19e) are necessary to the operation of the synchronizing circuit. These circuits supply 4 kc to synchronizing modulator CR5 to complete the regenerative path.

a. CARR SYNC Switch S1. CARR SYNC switch S1 selects the type of operation for Telephone Terminal AN/TCC-7. The switch has two positions: LOCAL and REMOTE.

(1) *LOCAL position.* When switch S1 is in the LOCAL position, the 4-kc base frequency is generated in the local CARRIER SUPPLY PANEL. Oscillator V1 supplies the 64-kc frequency to the frequency divider circuits.

(2) *REMOTE position.* When the switch is operated to the REMOTE position the synchronizing circuit is activated by the 68-kc pilot frequency received from the distant telephone terminal. The 68-kc pilot frequency is applied

from the GROUP PANEL to the CARRIER SUPPLY PANEL through pins P and F on TO GROUP PANEL connector J15.

b. Sync Modulator CR5. Resistor R57 and transformer T10 couple 4-kc from 4-kc amplifier V6 to synchronizing modulator CR5. The modulator combines the 68-kc synchronizing frequency with the output of 4-kc amplifier V6. The output contains the sum and difference frequencies of 72 kc and 64 kc, respectfully. Transformer T11 matches the modulator output to 64-kc band-pass filter FL1. Transformers T10 and T11 also balance the 68-kc synchronizing input to the modulator.

c. Band-Pass Filter FL1, 64-kc. Band-pass filter FL1 selects 64 kc from the synchronizing modulator CR5 output and passes it to remote 64-kc amplifier V7. Resistor R58 provides the proper impedance load for the filter.

d. Remote 64-kc Amplifier V7. Amplifier V7 amplifies the 64-kc signal from the band-pass filter to the proper level to drive the 64 to 4-kc frequency divider circuits. The 64-kc signal also is applied through capacitor C9 to rectifier V3.

(1) Input transformer T12 matches the low impedance output of the filter to the high input impedance of remote 64-kc amplifier V7. Capacitor C19 tunes the transformer secondary to 64 kc.

(2) Resistor R59 and capacitor C20 provide cathode bias for the amplifier.

(3) A portion of the 64-kc signal at the plate of the tube is coupled to rectifier V3. Transformer T13 matches the output of the amplifier to the resistor hybrid network. Capacitor C21 tunes the transformer T13 primary to 64 kc.

(4) Resistors R60 through R62 constitute the isolation and attenuation pad for 64 KC REMOTE test jack J5.

e. Rectifier V3. Rectifier V3 rectifies the 64-kc signal received from remote 64-kc amplifier V7 and applies a negative dc output to the suppressor grid of 64-kc amplifier V2 (par. l9*b*). The negative dc voltage cuts off 64-kc amplifier V2, preventing the 64-kc oscillator circuit output from reaching the resistor hybrid network (par. 19*c*).

(1) Capacitor C9 couples the 64-kc signal at the plate of remote 64-kc amplifier V7 to rectifier V3. Capacitor C9 is also the charging capacitor for the voltage doubling action. The two sections of rectifier V3 are connected as diodes in a voltage doubler circuit. The dc load on the rectifier is composed of resistors R17 and R18. The negative dc voltage at the junction of resistors R17 and R18 is supplied to the suppressor grid of 64-kc amplifier V2. Capacitor C8 filters the rectifier output.

(2) When the synchronizing circuit is not in operation, and rectifier V3 is not providing the negative cutoff voltage, voltage divider resistors R19 and R16 provide (through resistor R17) a small positive voltage to the suppressor grid of 64-kc amplifier V2.

f. Resistor Hybrid Network. The resistor hybrid network (R20 through R23) isolates the 64-kc amplifier V2 and the remote 64-kc amplifier V7 outputs from each other. Thus, 64-kc amplifier V2 is prevented from cutting itself off by feeding 64 kc to rectifier V3.

24. Alarm Circuits, 68- and 1 20-kc

(fig. 20)

Visual and audible alarms are provided at the output circuits of the 68-kc pilot and 120-kc carrier frequencies. A failure or substantial drop in output level will cause the corresponding alarm to operate. Since the alarm relays are maintained in the operated condition, failure of heater or plate voltage to the tube will release the relay and close the circuit to the lamps and to the transmission alarm buzzer.

a. Alarm Amplifier V8A, 68-kc. Alarm amplifier V8A lights 68KC indicator lamp I 1 and sounds transmission alarm buzzer I 1 (fig. 7) when the 68-kc pilot output fails.

(1) The 68-kc pilot frequency at filter FL5 is supplied through resistor R98 to transformer T14. The output of 68-kc filter FL5 is stepped up by transformer T14 and applied to 68-kc alarm amplifier V8A. The secondary of transformer T14 is tuned to 68 kc by capacitor C23. Capacitor C26 provides

a low impedance path to ground for the 68-kc signal.

(2) The inductance of alarm relay K1 is the plate impedance. The amplified 68-kc signal is coupled by capacitor C24 to the voltage doubler rectifier, CR6 and CR7. Capacitor C24 is the charging capacitor for the voltage doubling action. The filter and load for the rectifier is resistor R64 and capacitor C25. Resistor R65 decouples the 68-kc signal input at transformer T14 from the rectifier to prevent oscillation in the amplifier tube. The positive dc voltage at the junction of resistors R64 and R65 is applied in series with the 68-kc signal supplied by transformer T14 to the control grid of alarm amplifier V8A.

(3) Voltage divider resistors R66 through RS8 supply positive voltage to the cathode of 68-kc alarm amplifier V8A. If the 68-kc pilot frequency decreases in amplitude, less positive voltage is supplied to the V8A control grid, and the dc plate current decreases. When the signal decreases 6 db or more, 68-kc alarm relay K1 closes one set of contacts to connect 68KC indicator I 1 to ground. Another set of contacts supplies a ground through 68KC ALARM CUTOFF switch S2, to transmission alarm buzzer I 1 in the GROUP PANEL (fig. 7).

(4) The operator may silence the buzzer by operating 68KC ALARM CUTOFF switch S2. If, during an alarm condition, the cutoff switch is operated to silence the buzzer, the relay will operate and sound the buzzer again when conditions return to normal. To silence the buzzer, switch S2 must be operated to its original position.

b. Alarm Amplifier V8B, 120-kc. Alarm amplifier V8B lights 120KC indicator lamp I 2 and sounds transmission alarm buzzer I 1 (fig. 7) when the 120-kc carrier output fails. The corresponding parts perform the same functions as those in the 68-kc alarm amplifier. The 120-kc carrier is coupled from the plate of 120-kc amplifier V16 at a high level, so that the signal is supplied to rectifiers CR8 and CR9 without further amplification. Therefore, fewer circuit components are required in the 120-kc alarm amplifier V8B. Resistor R73 provides attenuation to supply the rectifiers with the proper signal amplitude. The positive dc rectified output is applied directly to the control grid of tube V8B. Loss of the 120-kc carrier signal will cause 120KC indicator lamp I 2 to light and transmission alarm buzzer I 1 (fig.. 7) to sound. The function of 120KC ALARM CUTOFF switch S3 is identical with that described for 68KC ALARM CUTOFF switch S2 (a(4) above).

Section VI. ORDER WIRE RECEIVER-TRANSMITTER RT-280/TCC-7 (PART OF RECEIVER-TRANSMITTER TEST SET GROUP OA-43/TCC-7)

25. General

Order Wire Receiver-Transmitter RT-280/ TCC-7 provides facilities for transmitting and receiving signals in a vf band of 300 to 1,700 cps over the order wire circuit to the distant telephone terminal, attended repeaters, and unattended repeaters. Ringer-oscillator Y101 provides a means for transmitting ringing signals to the distant terminal and attended repeaters, and for receiving ringing signals from the distant terminal, attended repeaters, and unattended repeaters.

26. Order Wire Voice Transmission Circuits, Block Diagram Analysis

(fig. 22)

a. Transmitting Circuit.

(1) ORDER WIRE switch S104 arranges the circuit, so that voice signals from the transmitter of handset HS101 are applied through transformer T101 and SEND OW switch S102 (nonoperated position) , to line transformer T103.

(2) SEND OW switch S102 (operated

position) permits the 1-kc test signal from the TEST PANEL (par. 38*d*) to be applied over the order wire transmitting circuit for alinement and transmission measurements.

(3) Line transformer T103 is used to couple a balanced line to an unbalanced line. The voice and ringing signals are combined at the output of the transmitting pad.

(4) The combined voice and ringing signals are applied to equalizing network EQ101. This network precompensates for the shape of the loss-frequency characteristic of the succeeding spiral-four cable and circuit components.

(5) From the cable equalizing network, the signal is amplified by transmitting amplifier AR101, and applied to auxiliary low-pass filter FL101. The level of the amplified output signal may be adjusted by means of TR GAIN control R114.

(6) Auxiliary low-pass filter FL100 rejects undesirable intermodulation products developed by transmitting amplifier AR101. The output signal is then applied to the JUNCTION PANEL (par. 16).

b. Receiving Circuit.

(1) The received signal from the JUNCTION PANEL is applied through receiving gain control R124 to receiving amplifier AR102. The signal is amplified and applied to the attenuator pad.

(2) The attenuator pad reduces the level of the signal to the proper amplitude for application to the telephone receiver.

(3) Line transformer T105 is used to couple a balanced line to an unbalanced line. Transformer T102 couples the signal through ORDER WIRE switch S104 (TALK position) to the receiver of handset HS101.

c. Auxiliary Order Wire Connections.

(1) Hybrid coil T104 is connected to the receiving and transmitting circuits of the order wire, making it possible to talk over the order wire circuit from an external two-wire telephone set. Signaling from the extension point requires vf ringing equipment such as Telegraph-Telephone Signal Converter TA-182/U (TM 11-2137).

(2) CHANNEL TALK switch S101 (LINE position) permits communication to the distant terminal over the vf channels of CHAN MODEM 1, 2, or 3 from order wire handset HS101. When the switch is operated to the TEST BD position, connection is made between handset HS101 and the switchboard side of the vf channels.

d. Ringer-Oscillator Y101 (fig. 22).

(1) *Transmitting.* When ORDER WIRE switch S104 is operated to the RING position, ringer-oscillator Y101 is arranged to function as a 1,600-cps oscillator. The output of ringer-oscillator Y101 is applied through the RING contacts of ORDER WIRE switch S104 to the order wire transmitting circuit.

(2) *Receiving.* When ORDER WIRE switch S104 is operated to the TALK position, ringer-oscillator Y101 is arranged to amplify and rectify the received 1,600-cps ringing signals. Audible and visual indications are provided.

27. Schematic Analysis, Transmitting Circuit

(figs. 23 and 24)

a. Handset HS101 (fig. 23). When the press-to-talk switch is operated on handset HS101, the telephone transmitter is connected in series with the primary of transformer T101, current limiting resistor R101, and a 10-volt supply. The -10 volts is applied from the JUNCTION PANEL through terminals A and T of connector J101. The voice signal is induced into the secondary of transformer T101.

b. ORDER WIRE Switch S104 (fig. 23).

Figure 22. Order Wire Receiver-Transmitter RT-280/TCC-7, (part of Receiver-Transmitter Test Set Group OA-448/TCC-7), block diagram.
(Contained in separate envelope)

When ORDER WIRE switch S104 is operated to the TALK position, the voice signal from the secondary of transformer T101 is applied through contacts 12-13 and 11-14 of ORDER WIRE switch S104 and the contacts of SEND OW switch S102 to the primary of transformer T103. Transformer T103 matches the balanced line to the unbalanced line.

c. Transmitting Pad (fig. 23). The voice signal induced in the secondary of transformer T103 is applied to the transmitting pad (R109 through R111). The pad reduces the level of the voice signal to that of the 1,600-cps ringing signal injected at the pad output, so that all transmitted signals will be at relatively the same level. The output of the transmitting pad is applied through the RING contacts of ORDER WIRE switch S104 to equalizer EQ101. CABLE REELS TO NEXT AN/ TCC-7 OR AN/TCC-8 switch S103 controls the loss-frequency characteristics of equalizer EQ101.

d. CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 Switch S103 (fig. 23).

(1) Switch S103, in conjunction with equalizer EQ101 provides a means for compensating for the loss-frequency characteristic of the spiral-four cable, the repeating coils, and the filters in the order wire circuit. The nine available steps make it possible to approximately preequalize the order wire circuit to the next attended repeater for 0 to 160 cable reels.

(2) Variations in temperature will cause a considerable change in the loss-frequency characteristic of the spiral-four cable. Adjustment of switch S103 can partially overcome the effects of these temperature variations on the order wire circuit.

(3) When the AN/TCC-7 terminal is used in conjunction with a radio set, switch S103 is operated to the RADIO position. In the RADIO position, resistor R138 is connected in place of equalizer EQ101, producing a flat loss, and resistor R113 is connected across terminals F and S on connector J101 (par. 28*a*(2)). No frequency compensation by equalizer EQ101 is required.

(4) For transmitting through 0 to 11 reels of cable, no frequency compensation is required. With switch S103 in the 0-11 position, resistor R138 remains connected and resistor R113 is disconnected from terminals F and S on connector J101. For 12 to 160 reels of cable, equalization is required. Switch S103 provides the proper circuit configuration of resistors R127 through R143 and equalizer EQ101, so that the loss-frequency characteristic of the network precompensates for the spiral-four cable loss-frequency characteristics. The output of equalizer EQ101 is applied to transmitting amplifier AR101.

e. Transmitting Amplifier AR101 (fig. 24).

(1) Circuit arrangement. Operating and signal voltages are applied to the amplifier circuit through connector P1. Transformer T1 is the input transformer, and resistors R1 and R4 provide the correct termination for it. Resistor R12 builds out the amplifier input impedance to the required 600 ohms. Resistors R10 and R11 limit the screen and plate voltages, respectively. Capacitors C1 and C2 provide signal decoupling at the 200-volt dc input. Common cathode resistor R7 provides cathode bias for amplifiers V1 and V2.

(2) Circuit operation. The vf signal is coupled through transformer T1 and sing-suppression resistor R5 to the control grid of amplifier V1, and through sing-suppression resistor R9 to the control grid of amplifier V2. The amplifiers are arranged for push-pull operation. The output of amplifier AR101 is applied across output transformer T2 to pins 17 and 19 of connector P1. Feedback is obtained from the 4-5 winding of transformer T2 and applied across resistors R8

Figure 23. Order Wire Receiver-Transmitter RT-280/TCC-7, (part of Receiver-Transmitter Test Set Group OA-443/TCC-7), schematic diagram.

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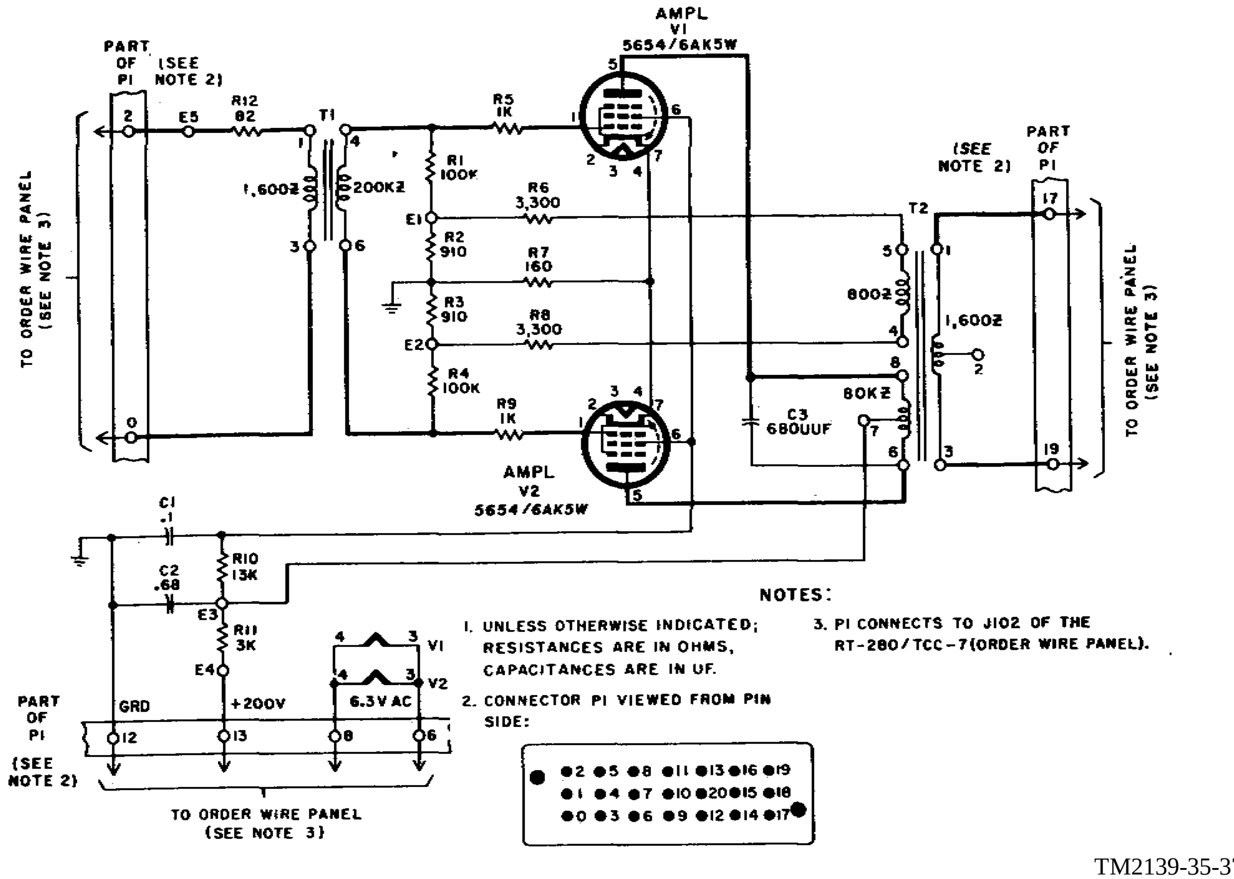

Figure 24. Transmitting Amplifier AR101 (part of Order Wire Receiver-Transmitter RT-280/TCC-7 panel), schematic diagram.

and R3 for the control grid of amplifier V2. Resistors R6 and R2 develop the feedback voltage for the control grid circuit of amplifier V1. Capacitor C3 provides a singing margin for the amplifier.

f. TR GAIN Control Network (fig. 23).

(1) The amplified voice output signal of transmitting amplifier AR101 is applied from pins 17 and 19 of connector P1 through corresponding pins of connector J102 to the transmitting gain control circuit. This circuit consists of a bridged-T pad that uses resistors R115, R116 and TR GAIN control R114. The TR GAIN control provides a means for adjusting the level of the signal to be transmitted over the spinal-four cable.

(2) When the order wire circuit is initially adjusted, the transmitting gain control is used to establish the level of the transmitted signal. The level of the l-kc test signal is adjusted in accordance with the OW TR AMP OUT table on the front panel of the ORDER WIRE PANEL.

g. Auxiliary Low-Pass Filter FL101 (fig. 23). The signal is then applied through auxiliary low-pass filter FL101 which suppresses undesirable modulation products above 12 kc generated by the transmitting amplifier. The output of FL101 is connected to terminals L and M of connector J101. The signal passes through connector P101 and cable W101 to the low-pass section of low-pass, high-pass filter FL101 (on the JUNCTION PANEL), which separates the order wire voice frequencies from the carrier frequencies.

28. Receiving Circuit, Schematic Analysis

(figs. 23 and 25)

a. REC GAIN Control Network (fig. 23).

(1) Signals from the JUNCTION PANEL are applied from terminals F and S

of connector J101 to the REC GAIN control network (resistors R125, R126, R124A, and R124B, all of which form a bridged-T network). REC GAIN control R124 provides a means of adjusting the input level of the signal to receiving amplifier AR102.

(2) The RADIO position of CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch S103 connects resistor R113 across terminals F and S of connector J101. This additional loss permits proper adjustment of the signal level received from a radio set.

b. Receiving Amplifier AR102 (fig. 25). The operating and signal voltages are applied to the amplifier circuit through connector P1. This circuit is a two-stage voltage amplifier with negative feedback.

(1) *Amplifier V1.* Transformer T1 is the input transformer for the amplifier circuit. Capacitor C1 tunes the secondary of the transformer to 1,000 cps. Resistor R1 provides the proper impedance termination for the transformer. Resistor R2 provides cathode bias and degeneration for the stage. Resistor R4 is the screen-dropping resistor and capacitor C2 is the screen bypass. Input signals are applied through transformer T1 to the control grid of tube V1. The amplified signal is developed across plate load resistor R6.

(2) Amplifier V2. Capacitor C3 and resistor R7 form the resistance-capacitance coupling network between amplifiers V1 and V2. Resistor R9 develops cathode bias and degeneration for the amplifier circuit. Resistor R8 limits the plate voltage for the amplifier. Resistors R8, R10, and R11 form a voltage divider network to provide the proper screen grid volt-age. Capacitor C3 couples the output

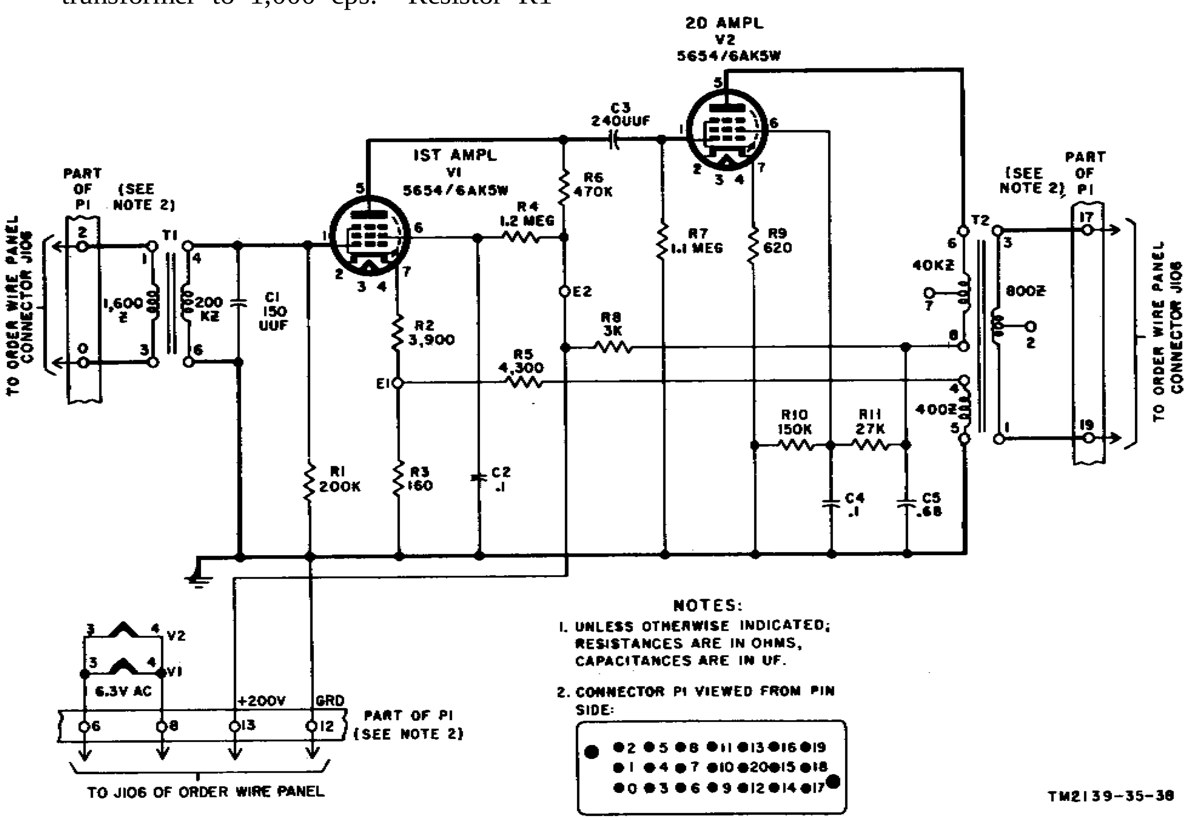

Figure 25. Receiving amplifier AR102, (part of Order Wire Receiver-Transmitter RT-280/TCC-7), schematic diagram.

of amplifier V1 to the control grid of amplifier V2. The amplified signal is applied to output transformer T2. Negative feedback, in addition to that provided by unbypassed resistors R2 and R9, is provided for receiving amplifier AR102 by the 4-5 winding of output transformer T2. The feedback path is through resistors R5 and R3 to the cathode of amplifier V1.

c. REC AMP OUT Jack (fig. 23). This jack (J105) and resistors R122 and R123, bridged across the output of the amplifier, provide a test point for measuring the output of the amplifier.

d. Receiving Pad (fig. 23). The amplified voice signal is applied to the receive pad (composed of resistors R119 through R121) which reduces the signal level applied to the telephone receiver. The signal is then applied through line balancing transformer T105 and contacts 15-16 and 17-18 of ORDER WIRE switch S104 (TALK position). From the order wire switch, the received signal path is completed through impedance matching transformer T102 to the receiver of handset HS101.

29. Order Wire Auxiliary Connections

a. Two-Wire Telephone Extension (fig. 23). Transformer T104 is connected in a hybrid arrangement and interconnects the transmitting and receiving circuits of the order wire circuit to the 2W EXT binding posts. A telephone set connected to the 2W EXT binding posts can be used to talk over the order wire circuit from a remote point. For a detailed description of connections to the CHAN MODEMS refer to paragraph 6b. Capacitors C101 through C104, and resistor R117 are connected to transformer T104 to provide correct hybrid balance.

b. CHANNEL TALK Switch S101 (figs. 23 and 26). CHANNEL TALK switch S101, in conjunction with the TALK-MON switches of the CHAN MODEMS, permits the use of handset HS101 for talking over any one of the 12 message channels. Subparagraphs (1) through (4) below cover circuit conditions when arranging order wire handset HS101 for talking over CHAN 1 of CHAN MODEM 1. The switching operation for talking over any of the message channels is identical with that of CHAN 1.

(1) CHANNEL TALK switch S101 (ORDER WIRE PANEL) is connected to terminals C, P. D, and R of connector J101. These pins are connected through connector P101 to the JUNCTION PANEL, and through connector P104 to connector J9 on the SUBGROUP PANEL. In the SUBGROUP PANEL, pins C and P and D and R of connector J9 are connected to pins M and C and L and B respectively of parallel connectors P1, P2, and P3.

(2) When handset HS101 is to be used to communicate over the channel, CHANNEL TALK switch S101 is operated to LINE and TALK-MON switch S101 (CHAN MODEM) is operated to TALK. Thus, handset HS101 is connected through the contacts of the TALK-MON switch to the transmitting and receiving circuits of the CHAN MODEM.

(3) When CHANNEL TALK switch S101 is operated to TEST BD, and TALK-MON switch S101 is operated to TALK, the transmitter of handset HS101 is connected through the contacts of the TALK-MON switch to the output of the channel demodulator. This connection provides a transmitting path from the handset to the receiving circuit of the switchboard. At the same time, the receiver of handset HS101 is connected to the input of the channel modulator. This connection permits handset HS101 to receive signals from the transmitting circuit of the switchboard.

(4) When the TALK-MON switch is operated to MON, and the CHANNEL TALK switch operated to LINE, handset HS101 is connected through the contacts of TALK-MON switch

Figure 26. Order Wire Receiver-Transmitter RT-280/TCC-7, handset connected to CHAN MODEM, functional schematic diagram.
(Contained in separate envelope)

S101 and resistors R102 and R103 to the transmitting of the channel The handset is connected to the channel receiving circuit through resistors R104 and R105. The resistance of resistors R102 through R105 permits bridging the handset across the channel transmitting and receiving circuits with only relatively small loss to channel transmission.

c. SEND OW Switch S102 (fig. 23). When SEND OW switch S102 is operated to ON, a 1-kc test frequency is transmitted over the order wire circuit for testing and alinement. The 1-kc test signal from the TEST PANEL is applied to the transmitting circuit of the ORDER WIRE PANEL through pins K and W of connector J101 and resistors R107 and R108. Resistors R107 and R108 build out the output impedance of the 1-kc oscillator to a nominal 600 ohms to match the input impedance of transformer T103.

30. Ringer-Oscillator Circuit

When ORDER WIRE switch S104 (fig. 23) is in the nonoperated or TALK position, ringer-oscillator Y101 is arranged to receive an incoming 1,600-cps ringing signal from a terminal, an attended repeater, or an unattended repeater. In the RING position, the circuit is arranged as a 1,600-cps oscillator to signal a distant terminal or attended repeater. When functioning as a ringer, the circuit amplifies and rectifies the 1,600-cps and provides an audible and visual signal. When functioning as an oscillator, the circuit produces the 1,600cps ringing signal.

a. Ringer Circuit.

(1) *Input amplifier*. An incoming signal from the primary of transformer T105 (fig. 23) is applied through resistor R118 and the normal contacts of ORDER WIRE switch S104 to terminal 1 of connector PI (fig. 27). Resistor R118 limits the input to the amplifier to the proper operating level. The 1,600-cps input signal is stepped up by transformer T1 and is applied through coupling capacitor C12 and grid current limiting resistor R2 to the grid of amplifier-oscillator tube VIA. Capacitor C12 reduces the response of the amplifier to frequencies below 300 cycles. Resistor R1 (used only when the circuit functions as an oscillator) is shortened by contacts 4-5 of ORDER WIRE switch S104 (fig. 23) when the switch is in the unoperated position. Resistor R3 (fig. 27) terminates input transformer T1. Resistor R5 serves as a cathode bias resistor for tube VIA.

(2) *Signal response circuit, 1,600-cps*. The 1,600-cps signal response circuit consists primarily of transformer T3 and 1,600-cps detector tube V2B. The 5-3 winding of transformer T3 is shunt-tuned to 1,600-cps by adjustable capacitor C5 and fixed capacitors C6 through C9 (as required). The 1,600-cps output of this tuned circuit is taken across terminals 3 and 4 of transformer T3 and applied to the cathode of tube V2B and through capacitor C11 to the plate of tube V2B. On the negative half-cycle of the input signal, tube V2B conducts, charging capacitor C11. During the positive half-cycle of the input signal, while V2B is not conducting, resistor R15 tends to maintain the voltage developed across capacitor C11. The negative voltage developed across capacitor C11 is applied to the control grid of tube V1B through resistor R8 and across capacitor C1 to ground. The time constant of this resistance capacitance circuit is of such magnitude that it takes approximately .2 second for a sufficiently negative voltage to build up on the grid of tube V1B to reduce the plate current of tube V1B and release relay K1. This delay prevents momentary response of the ringer from speech signals in the vicinity of 1,600-cps.

(3) *Relay control circuit*. Relay control tube V1B controls the operating current through relay K1. Normally, the control grid is slightly positive with respect to the cathode, and sufficient plate current flows to energize relay K1. When a ringing signal

is received, the negative voltage from the junction of capacitor C11 and resistor R15 reduces the plate current of tube V1B, releasing relay K1. Contacts 4-5 break and contacts 5-6 make, discharging time delay capacitor C1. The relay will reoperate immediately when the ringing signal is removed. Make contacts 1-2 connect buzzer I1 across 6.3 volts through terminals 12 and 15 of connector P1. The CALL lamp (fig. 23), which is connected in parallel with the buzzer through terminals 7 and 17 of connector P1, lights.

(4) *Guard channel circuit*. The guard channel circuit consists primarily of transformer T2 and guard channel detector tube V2A. The secondary winding of transformer T2 is shunted by a 1,600-cps series-resonant circuit consisting of capacitors C3 and C4 and inductor L1. Therefore, only those frequencies outside a narrow band centered about 1,600 cps are passed by this circuit. Shunt capacitor C13 imposes an upper limit on the resonant circuit of about 2,500 cps. The output developed across the secondary of transformer T2 is rectified by guard channel detector V2A. During the conduction period of the tube V2A, capacitor C10 charges across resistors R14 and R17. This rectified positive voltage is taken from the junction of voltage dividers R14 and R17 and applied through resistor R8 to the control grid of tube V1B. This voltage is in series with the negative voltage developed across capacitor C11 by the 1,600-cps signal ((2) above). Speech signals containing a 1,600-cps component may develop an appreciable negative voltage across capacitor C11 that could cause false operation of the ringer. However, the guard channel circuit develops a positive voltage across capacitor C10 from speech frequencies other than 1,600 cps. The resultant voltage applied to the grid of relay control tube V1B would be near zero. Capacitors C12 and C13 limit the band of frequencies to which the guard circuit may respond.

(5) *Clipper circuit*. Varistors CR3 and CR4 limit the amplitude of negative peaks of 1,600-cps signals. This prevents unusually high level speech signals (containing 1,600 cps) from overdriving the guard circuit and causing false operation of the ringer. A-10 volts, obtained from terminal 13 of connector P1, develops a bias voltage of approximately -9 volts at the junction of voltage divider resistors R12 and R13. Thus, when a negative input voltage at the cathode of tube V2B exceeds the bias voltage, the varistors conduct, reducing the voltage at the cathode of tube V2B to approximately that of the bias voltage.

b. Oscillator Circuit (figs. 23 and 27). When ORDER WIRE switch S104 (fig. 23) is operated to the RING position, the ringer-oscillator circuit is arranged as an oscillator.

(1) A feedback path is provided for the 1,600-cps signal from terminal 4 of transformer T3 (fig. 27) to the grid circuit of tube V1A through pin 6 of connector P1 and contacts 1-2 of ORDER WIRE switch S104 (fig. 23), pin 2 of connector P1, voltage divider resistor R1 (fig. 27), pin 5 of connector P1 contacts 3 4 of switch S104 (fig. 23), and pin 8 of connector P1 to current limiting resistor R2 and grid resistor R3. The amplitude of the 1,600-cps oscillations is limited by the bias developed by varistors CR3 and CR4. Capacitor C12 is shorted by contacts 3-4 of ORDER WIRE switch S104 through pins 5 and 8 of connector P1 (fig. 23).

Oscillator-amplifier VIA amplifies the signal causing buzzer I 1 to sound and CALL lamp I 101 to light.

(2) Transformer T1(fig. 27) serves as an output transformer for oscillator-amplifier V1A by coupling the 1,600cps signal to the order wire transmitting circuit through contacts 8-9 of ORDER WIRE switch S104 (fig. 23).

Figure 27. Ringer-oscillator Y101, (part of Order Wire Receiver-Transmitter RT-280/TCC-7), schematic diagram.
(Contained in separate envelope)

Section VII. TELEPHONE TEST SET TS-760/TCC-7 (PART OF RECEIVER-TRANSMITTER TEST SET GROUP OA 443/TCC-7)

31. General

The TEST PANEL contains circuits for making selective and nonselective transmission measurements at various points in the transmission circuits of Telephone Terminal AN/TCC-7. The sensitivity and selectivity of the measuring circuits are controlled by the operation of two rotary switches. To make measurements, a measure cord terminated in a measure plug is provided. The measure plug is inserted into various test jacks located on the front panel or chassis of the AN/TCC-7 terminal components. These measurements are made without disturbing the operation of the system. The result of these measurements is indicated on a meter calibrated in decibels. In addition, circuits are provided to measure the voltage of the power supplies. Two oscillators generate test signals that are used for-calibration of the selective measuring circuits, telephone system line-up, system modulation tests, and localizing trouble to unattended repeaters.

32. Block Diagram Analysis of TEST PANEL

(fig. 28)

a. Input Circuit. The input circuit consists of flexible measure cord W1 and measure plug P1, input transformer T2, and ATTENUATOR switch S2.

(1) The measure cord and plug are used to connect the measuring circuit to the various test jacks in the telephone terminal. Input transformer T2 presents a high input impedance for minimum bridging loss at each measuring point. The input transformer also permits balanced-or unbalanced-to-ground circuit measurements. From the input transformer, signals are applied to the attenuator.

(2) The attenuator, controlled by ATTENUATOR switch S2, is used to adjust the level of the signals being tested. A maximum of 35-db attenuation may be introduced into the circuit in 5-db steps.

b. Nonselective Control Circuit. The nonselective control circuit consists of MEASURE NON-SELECTIVE switch S4, frequency discriminating filters FL4 and FL5, and attenuators. By operating switch S4, the test signals may be applied to either the selective control circuit, filter FL4 or FL5, the attenuators, or directly to the amplifier-detector circuit (*e* below).

c. Selective Control Circuit.

(1) For selective measurements, a highly selective superheterodyne type of receiver is used. The selective control circuit consists of attenuator and GAIN control R71, MEASURE SELECTIVE switch S3, attenuators, and 62-kc band-pass filter FL1. Attenuator and GAIN control R71 is used to adjust the input level to the circuit during calibration of the circuit. Selective measurements are necessary when one frequency among many

Figure 28. Telephone Test Set TS-760/TCC-7, (part of Receiver-Transmitter Test diagram. Set Group OA-443/TCC-7), block diagram
(Contained in separate envelope)

must be chosen for test, and in an operating system where speech and stray frequency disturbances interfere with precise measurements. When MEASURE NON-SELECTIVE switch S4 is in the OFF position, all signals are applied to the selective control circuit.

(2) When MEASURE SELECTIVE switch S3 is operated to the GRP PANEL 62KC or CHECK GAIN positions, band-pass filter FL1 and the attenuators are connected in the circuit, respectively, to prearrange the sensitivity and selectivity of the modulator-amplifier circuit.

(3) When switch S3 is operated to either the 12KC, 28KC, 67KC, 83KC, or 99KC position, the test signals are applied directly to the modulator amplifier circuit.

d. Modulator-Amplifier Circuit. The modulator-amplifier circuit consists of a modulator circuit (transformer T3, varistor CR1 and the transformer contained in 194-kc crystal FL2), carrier oscillator V2, 194-kc crystal filter FL2, amplifier AR1, 194-kc band-pass filter FL3, and the output attenuator.

(1) The incoming signal from the selective control circuit is applied to the modulator where it modulates the carrier oscillator frequency. The carrier oscillator frequency is maintained at 194 kc *above* the incoming signal frequency by MEASURE SELECTIVE switch S3. Upper and lower sideband frequencies are produced in the modulator circuit. The output of modulator is applied to crystal filter FL2.

(2) Crystal filter FL2 is tuned to the lower sideband (194 kc) of the modulator output. The filter has a narrow band-pass characteristic which makes the modulator-amplifier circuit highly selective. The output of filter FL2 is then applied to IF amplifier AR1.

(3) Intermediate frequency (IF) amplifier AR1 has characteristics similar to flat amplifier AR2 except that the gain of the IF amplifier is higher. The input signal is amplified and applied to band-pass filter FL3.

(4) Band-pass filter FL3 permits the 194kc IF to pass and suppresses all others. The signal is then applied through the output attenuator to the amplifier-detector circuit (*e* below).

e. Amplifier-Detector Circuit. The amplifier detector circuit consists of flat amplifier AR2, meter rectifier V3, and test indicating meter M1.

(1) The input to flat amplifier AR2 is controlled by the nonselective control circuit, so that numerous level measurements of preselected test points may be made. The amplifier is stable and has a wide frequency response in order to accept all signals undergoing test. The test signal is amplified and applied to meter rectifier V3.

(2) Meter rectifier V3 rectifies the signals from flat amplifier AR2 and applies the rectified voltages to meter M1.

(3) Meter M1 is a dc microammeter calibrated in db. The input to the meter is selected by MEASURE switch S1. In the TRANSMISSION position, the meter is connected to the output of the meter rectifier. When switch S1 is in the 200 VOLTS and 600 VOLTS position, the meter is connected to the 200-volt and 600-volt power supplies, respectively.

f. Test Oscillators. High-frequency (hf) oscillator V4 and 1-kc oscillator V1 supply signals that are used for system lineup, system modulation tests, and for locating trouble throughout the system.

(1) The hf oscillator generates frequencies of 65, 68, 83, 91, and 99 KC. The 65- and 68-kc test frequencies: are controlled by SEND switch S5. The 81-, 91-, and 99-kc test frequencies are controlled by FAULT TEST switch S6. These test frequencies are used for testing, calibration purposes, and for system checks of unattended repeater troubles.

(2) The 1-kc oscillator generates a 1-kc test tone for each channel of CHAN

MODEM 1, 2, and 3 for the ORDER WIRE PANEL.

33. Input Circuit, TEST PANEL, Schematic Analysis

(fig. 29)

a. From measure plug P1, test signals are applied to terminals 4 and 1 of input transformer T2. Input transformer T2 is approximately a 2 to 1 ratio transformer with an effective input impedance of 52,000 ohms. A bridging loss of .3 db less occurs in the circuit undergoing test because of the high impedance of transformer T2. From terminals 6 and 5 of transformer T2, signals are applied to the attenuator circuit.

b. The attenuator circuit is controlled by ATTENUATOR switch S2, which is a three section, nonlocking, push-button switch.

(1) *5DB position*. When the 5DB push button is pressed, the input signal passes through a 5-db attenuating pad composed of resistors R25 through R27 before being applied to the nonselective control circuit.

(2) *10DB position*. When the 10DB push button is pressed, the input signal is applied through 10-db attenuating pad composed of resistors R28 through R30 before being applied to the nonselective control circuit.

(3) *20DB position*. When the 20DB push button is pressed, the input signal is applied through 20-db attenuating pad composed of resistors R31 through R33 before being applied to the nonselective control circuit.

34. Nonselective Control Circuit

(fig. 29)

a. Section 1 of MEASURE NON-SELECTIVE switch S4 receives signals from the input circuit on contact 12. In positions corresponding to contacts 1 and 11, the input signal is directed to section 2 of MEASURE SELECTIVE switch S3. In positions corresponding to contacts 2 through 10, the input signal is connected to section 2 of MEASURE NONSELECTIVE switch S4 either directly, through attenuators, or through frequency discriminating filters.

b. Section 2 of MEASURE NON-SELECTIVE switch S4 controls the input to the amplifier-detector circuit. The signal from contact 12 is applied to the input of the amplifier-detector in all 11 positions (par. 37).

c. Section 3 of MEASURE NON-SELECTIVE switch S4 controls the output of the modulator-amplifier. In the position corresponding to contact 1, the output signals of the modulator-amplifier are applied to section 2 of MEASURE NON-SELECTIVE switch S4 through an attenuating pad composed of resistors R43 and R39 and potentiometer R44. Potentiometer R44 is a factor-adjusted gain control. In the position corresponding to contact 11 of section 3, the output signals of the modulator-amplifier are applied directly to section 2 of MEASURE NON-SELECTIVE switch S4. In positions corresponding to contacts 2 through 10 of section 3, the output of the modulator-amplifier is shorted to ground.

35. Selective Control Circuit

(fig. 29)

An adjustable T pad (resistors R69 through R72) is connected at the input of the selective control circuit to adjust the input level to the circuit. Attenuator and GAIN control R71 is adjusted as required during the initial calibration of the selective control circuit. The function of each section of MEASURE SELECTIVE switch S3 is given in *a* through *c* below.

a. Section 1 of MEASURE SELECTIVE switch S3 connects the various capacitors to the tank circuit of the carrier oscillator. Contact 12 connects the capacitors to the plate of the carrier oscillator (one side of tank circuit) when the switch is operated to contacts 2 through 11. Contact 1 is not connected.

b. Section 2 of MEASURE SELECTIVE switch S3 receives signals from the input circuit on contact 12. Contacts 2 through 11 apply the input signal to section 3 of switch S3 either directly, through attenuators, or through a frequency discriminating filter. Contact 1 is not connected.

Figure 29. Telephone Test Set TS-760/TCC-7 (part of Receiver-Transmitter Test Set Group OA-443/TCC-7), schematic diagram.

(Contained in separate envelope)

c. Section 3 of MEASURE SELECTIVE switch S3 controls the input to the modulator amplifier circuit (par. 36). Contact 1 applies the signal to the input of the modulator amplifier from contacts 2 through 10, and 12. The rotating pole is divided into two sections. This is necessary to reduce the capacity between the pole and the other contacts, when the switch is operated to contact 12. To insure correct measurements in this position, it is essential that no signals bypass 62-kc filter FL1 to the input of the modulator-amplifier circuit.

36. Modulator-Amplifier Circuit

a. Carrier Oscillator (fig. 29). The feedback circuit for carrier oscillator tube V2 is composed of the 3-4 winding of transformer T4, coupling capacitor C13, and grid resistor R16. Feedback voltage of the proper phase and magnitude is developed across the 3-4 winding of transformer T4 and applied to the control grid of oscillator tube V2. A portion of the oscillator tank circuit consists of the 5-6 winding of transformer T4, and capacitors C7 through C12. The remaining portion of the tank circuit consists of the capacitors connected into the circuit by section 3 of MEASURE SELECTIVE switch S3. Plate and screen grid operating voltages are supplied through resistor R21. Capacitor C20 bypasses the screen grid to ground. COARSE TUNE capacitor C9 and FINE TUNE capacitor C8 tune the oscillator for maximum response. A carrier voltage of approximately .75 volt root mean square (rms) is developed across the 1-2 winding of transformer T4 and applied to the modulator circuit.

b. Modulator Circuit (fig. 29).

(1) The modulator circuit consists of varistor CR1, connected as a lattice type circuit, input transformer T3, and 194-kc crystal filter FL2. The carrier frequency from oscillator tube V2 is connected through resistors R82 and R83 to terminal 2 of input transformer T3 and terminal 3 of the output transformer (in filter FL2). The oscillator supplies a frequency 194 kc greater than the input frequency that is to be selected. The modulation products in the modulator output include a 194-kc component that has a voltage proportional to the input voltage of the frequency under measurement. The modulator output is connected to the 1-4 terminals of the transformer incorporated in 194kc crystal filter FL2.

(2) Crystal filter FL2 selects the 194-kc $\pm$25-cps modulation product from the modulator circuit and offers a loss of approximately 40 db at $\pm$500 cycles away from the, band pass. This extreme selectivity is necessary, so that the desired frequencies of the system may be selected and measured in the presence of speech on adjacent channels. The output of crystal filter FL2 is applied to IF amplifier AR1 through pin D of connector P3.

c. IF Amplifier AR1 (fig. 30).

(1) Intermediate frequency (IF) amplifier AR1 is essentially the same in circuit and equipment features as flat amplifier AR2 (par. *37a*). However, they are not interchangeable electrically and cannot be substituted mechanically. In IF amplifier AR1, the phase correcting resistance (R1 of flat amplifier AR2) in series with the grid of first amplifier tube V1 is not used. In addition, less feedback is used. These differences result in slightly more gain in IF amplifier AR1. AMP GAIN control R17 is used to supplement the range of adjustment provided by basic GAIN control R71 (fig. 29). The corresponding control in flat amplifier AR2 does not have a chassis marking, and is factory sealed.

(2) From IF amplifier AR1, signals are applied to terminals 1-2 of 194-kc band-pass filter FL3 (fig 29). The signals are applied to the band-pass filter through coupling capacitor C14 and an attenuating pad composed of resistors R17 and R77. The 194-kc band-pass filter selects a norrow frequency band centered at 194-kc to increase selectivity of crystal filter FL2. A peak of discrimination is provided at about 256 kc to further

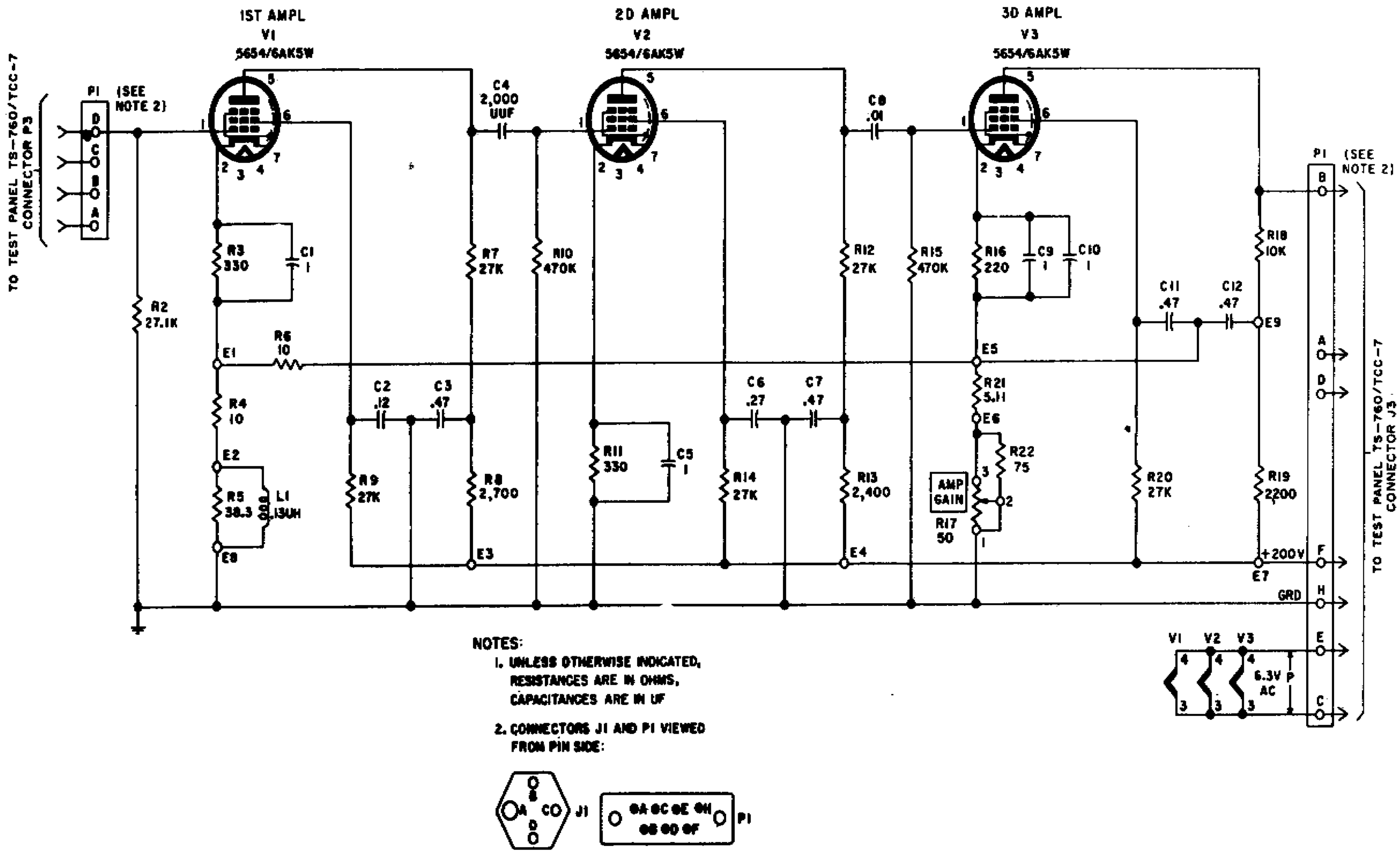

Figure 30 IF amplifier ARI (part of Telephone Test Set TS-760/TCC-7), schematic diagram.

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suppress carrier leak from the modulator when maximum sensitivity is required for modulation measurements at 62 kc.

(3) The output of 194-kc band-pass filter FL3 is applied to MEASURE NONSELECTIVE switch S4 through an attenuating pad composed of resistors R18 through R20. This pad isolates the band-pass filter from circuit capacitance changes caused by the operation of MEASURE NON-SELECTIVE switch S4.

37. Amplifier-Detector Circuit

(figs. 29 and 31)

The amplifier-detector circuit consists of flat amplifier AR2, a meter rectifier, and test indicating meter M1. The input to flat amplifier AR2 is applied from the outputs of the measure nonselective (par. 34) and measure selective (par. 35) control circuits.

a. Flat Amplifier AR2 (fig. 31). Flat amplifier AR2 is a three-stage, wide-band amplifier with negative feedback. To improve the IF characteristics of the flat amplifier, the value of the cathode, screen, and plate filter components are different for each stage of amplification. To improve the hf response, stray capacitance is reduced by placing circuit components away from ground. The frequency response of flat amplifier AR2 is essentially linear from 1,000 to 200,000 cps. The amount of negative feedback in the amplifier circuit is approximately 40 db.

(1) *First amplifier V1*. The input to flat amplifier AR2 is applied through terminal D of connector P2 to first amplifier V1. Resistor R1 provides isolation from the different impedances presented to the amplifier input in the various positions of MEASURE NON-SELECTIVE switch S4 (fig. 29); thus, adequate phase margins at high frequencies are insured. Resistor R2 (fig. 31) provides a grid return path. Cathode bias is provided by resistor R3. Capacitor C1 is a cathode filter connected in parallel with resistor R3. Resistors R4 and R6 are unbypassed, providing degenerative feedback for all frequencies. Resistor R5 lowers the Q of inductor L1 and damps any oscillations that may occur. Inductor L1 improves the hf response and phase margins, making a large amount of negative feedback possible. Resistor R9 drops the voltage to the screen grid and capacitor C2 bypasses variations in the screen grid voltage to ground. Resistor R8 and capacitor C3 provide plate decoupling. The output of first amplifier V1 is developed across plate load resistor R7 and applied through coupling capacitor C4 to the input of second amplifier V2.

(2) *Second amplifier V2*. Resistor R10 provides a grid return path. Cathode bias is provided by resistor R11, and bypassed by capacitor C5. Resistor R14 drops the voltage to the screen grid and capacitor C6 bypasses the screen grid voltage variations to ground. Resistor R13 and capacitor C7 provide plate decoupling. The output of second amplifier V2 is developed across plate load resistor R12 and applied to the input of third amplifier V3 through coupling capacitor C8.

(3) *Third amplifier V3*. Resistor R15 provides a grid return path. Capacitors C9 and C10 bypass cathode bias resistor R16. Degenerative feedback is provided by unbypassed resistor R21. Resistor R22 is a current limiting resistor for potentiometer R17. Potentiometer R17, sealed at the time of manufacture, is used for circuit gain adjustment. Resistor R20 and capacitor C11 are the screen dropping resistor and bypass capacitor, respectively. Resistor R19 and capacitor C12 provide plate decoupling. The output of the amplifier is developed across plate load resistor R18 and is applied through pin B of connector P1 and coupling capacitor C18 (fig. 29) to the input of rectifier tube V3.

b. Meter Rectifier V3 and MEASURE switch S1 (fig. 29).

(1) The input signals from flat amplifier AR2 are applied through coupling

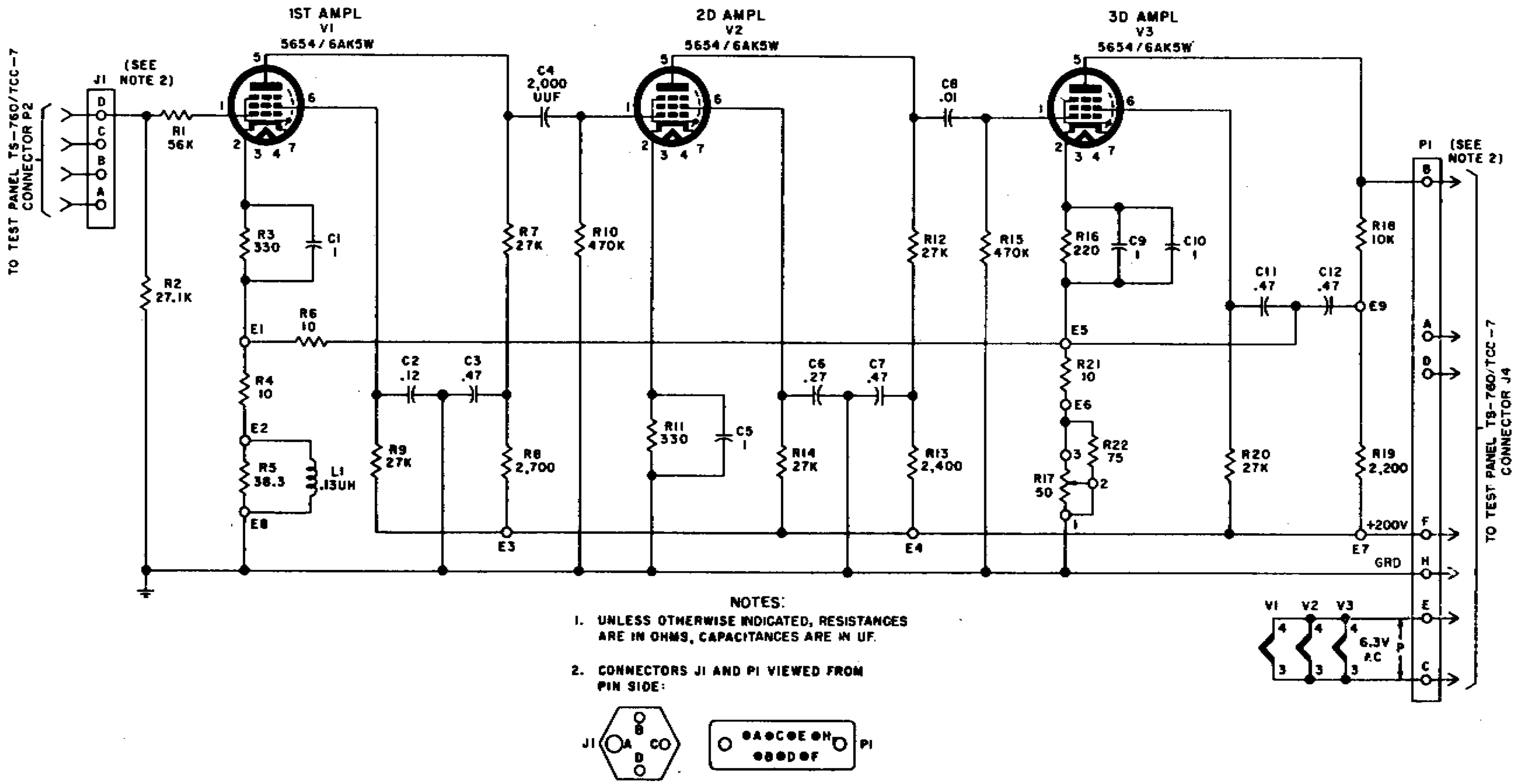

Figure 31. Flat amplifier AR2 (part of Telephone Test Set TS-760/TCC-7), schematic diagram.

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capacitor C18 to rectifier tube V3. Tube V3 is a duotriode connected as a duodiode. Resistor R22 balances the dc resistance of the meter. The meter and resistor R22 are bypassed by capacitors C17 and C16, respectively. Resistors R22 and R23 form a voltage divider circuit. The voltage developed across resistor R22 provides a reverse bias current that effectively opposes the zero-signal diode current. The rectified output from tube V3 is applied to test indicating meter M1 through the contacts of MEASURE switch S1.

(2) When MEASURE switch S1 is operated to 200 VOLTS or 600 VOLTS, the output voltage of 200 volt and 600 volt Power Supplies PP-827/U and PP-826 (*)/U, respectively are measured through voltage-dropping resistors R12 and R11. These resistors are connected in series with the positive side of the meter through section 2 of switch S1. The negative side of meter M1 is grounded through contact 2 (200 VOLTS position) or 4 (600 VOLTS position) of section 1 of switch S1. When MEASURE switch S1 is operated to TRANSMISSION, the input polarities to meter M1 are reversed because the negative output of rectifier V3B is used.

38. Test Panel Oscillator Circuits

(fig. 29)

The hf and the 1-kc oscillators supply frequencies that are used for calibration of the selective measuring circuits, system modulation tests, and locating system troubles.

a. Hf Oscillator.

(1) The hf oscillator uses pentode tube V4 as its amplifier. The feed-back circuit is composed of the 6-7 winding of transformer T5, coupling capacitor C25, and grid resistor R56. A portion of the oscillator tank circuit consists of the 1-3 winding of transformer T5 and capacitors C23 and C24, which are common to the frequencies generated by the oscillator. The remaining portion of the tank circuit consists of capacitors C49 through C59 which are connected in the oscillator tank circuit through the contacts of SEND switch S5 (*b* below) or FAULT TEST switch S6 (*c* below). Plate and screen grid voltages are supplied through voltage dropping resistor R57. Capacitor C22 bypasses the screen grid to ground. Feed-back voltage for the circuit is developed across the 6-7 winding of transformer T5.

(2) When any one of push buttons REP1, REP2, or REPS of FAULT TEST switch S6 is not pressed, the output of the oscillator is applied to section 1, terminal 6 of SEND switch S5 through an attenuating pad composed of resistors R52 through R55. Hf potentiometer R55 provides for adjusting the output level of high frequency oscillator V4.

(3) When any one of push buttons REP1, REP2, or REPS of FAULT TEST switch S6 is pressed, the attenuating pad is changed by disconnecting resistor R53 from the circuit and inserting potentiometer R38 and resistor R79 in its place. Potentiometer R38 is factory adjusted and sealed.

b. SEND Switch S5. SEND switch S5 controls the distribution of signals generated by hf oscillator V4 and also the selection of the 65- or 68-kc frequency signal.

(1) When SEND switch S5 is operated to the 65KC TR OR FAULT TEST position, SEND lamp I 1 lights and the output of high-frequency oscillator V4 is applied to pins K and R of connector J2, through an attenuating pad composed of resistors R48 through R51. 65KC TR OR FAULT TEST resistor R48 provides for adjusting the output level of the 65-kc test frequency.

(2) When SEND switch S5 is operated to the CHECK GAIN CHECK HF position, the 68-kc output of high-frequency oscillator V4 is applied to CHECK HF test jack J6 through an attenuating pad composed of resistors

R45 through R47, and R80. The 68kc output is also applied to pin R of TO TS-712/TCC-11 TEST SET connector J5, from the junction of divider resistors R46 and R80. Resistor R24 provides proper impedance termination when adjusting Telephone Test Set TS-712/TCC-11.

(3) When switch S5 is operated to 65KC REC position, SEND lamp I 1 lights and the output of the high oscillator is applied to pins D and R of connector J2 through an attenuating pad composed of resistor R81 and 65KC REC potentiometer R37.

(4) The tank circuit of high-frequency oscillator V4 is connected to section 2, contact 12 of SEND switch S5. When SEND switch S5 is operated to 65KC TR OR FAULT TEST or 65KC REC, capacitors C58 and C59 are connected across the tank circuit to lower the basic oscillator frequency from 68 to 65 kc.

c. FAULT TEST Switch S6. FAULT TEST switch S6 controls the output of the 91-, 83-, and 99-kc fault test frequencies through the operation of push buttons REP 1, REP 2, and REP 3. When any one of the push buttons is pressed, capacitors C49 through C51 are disconnected from the oscillator tank circuit, and output signal level of the oscillator is changed by substituting potentiometer R38 and resistor R79 for resistor R53.

(1) When the REP 1 push-button is pressed, capacitors C53 and C52 are connected across the oscillator tank circuit and an oscillator frequency of 99kc is produced.

(2) When the REP 2 push-button is pressed, capacitors C55 and C54 are connected across the oscillator tank circuit and an oscillator frequency of 91 kc is produced.

(3) When the REP 3 push-button is pressed, capacitors C57 and C56 are connected across the oscillator tank circuit and an oscillator frequency of 83 kc is produced.

d. Oscillator, 1-kc. The output from tube V1 is developed across the 6-7 winding of transformer T1. Feedback of the proper phase and magnitude is developed across the 4-5 winding of the transformer and through coupling capacitor C1 and grid resistor R1. The tank circuit consists of capacitors C2 and C3 and winding 1-3 of transformer T1. Resistor R74 is a grid limiting resistor. Resistor R2 develops cathode bias. Plate voltage is supplied through dropping resistor R3. Capacitors C4 and C5 are plate decoupling and screen grid bypass capacitors, respectively. Control of the output level of 1-kc oscillator V1 is provided by potentiometer R5. Resistors R7 and R75 shunt the output winding of the transformer to prevent load variations from affecting the operation of the 1-kc oscillator. Resistors R8 through R10 terminate CHECK 1KC test jack J1. The output of the 1-kc oscillator is applied to the ORDER WIRE PANEL and the CHAN MODEMS through pins C and P. and S and F of connector J2, respectively.

Section VIII. POWER SUPPLY PP 827/U

39. Block Diagram Analysis

(fig. 32)

a. Input Power Circuit. Either 115 or 230 volts, 49 to 65 cps, is applied to the 200 VOLT POWER SUPPLY. The two TO 600V POWER SUPPLY outlets, J2 and J3, are connected across the input. The primary voltage is applied to AC POWER switch S1, which is operated to energize or deenergize the circuits of the 200 VOLT POWER SUPPLY.

(1) *AC POWER switch S1*. When AC POWER switch S1 is in the ON position, the input voltage is applied through 115/230 V 6 AMP fuses F1 and F2 to 115V-230V change-over switch S3. Power is supplied directly to the transformers from the switch.

(2) *Change-over switch S3, 115V-230V*. When switch S3 is in the 115V position, power is applied through fuse F3 to 115 V CONVENIENCE OUTLETS J4 and J5. When switch S3 is in the 230V position, these outlets are not energized. Power is supplied through 230V 3 AMP fuse F4 to the transformers.

b. Filament Supply and Blotter Circuit.

(1) *Filament supply*. The filament voltages required for the electron tubes of components of Telephone Terminal AN/TCC-7 are provided by the output of four secondaries of filament supply transformer T3.

(2) *Blower circuit*. The blower circuit operates on 115 volts ac, which is supplied from the input power circuit. Power is applied to blower motor B1 through thermostat switch S2. Thermostat switch S2 is controlled by ambient temperature variations within the 200 VOLT POWER SUPPLY PANEL.

c. Low-Voltage Rectifier Circuit.

(1) The low-voltage rectifier circuit is energized by voltage from one secondary of transformer T1. The output of this secondary is applied to bridge-type full-wave rectifier CR1. The negative 10-volt dc output of the rectifier is filtered by inductor L2 and capacitor C9 and applied through the JUNCTION PANEL to the transmitting and limiting circuits in the ORDER WIRE PANEL.

(2) Two other secondaries of low-voltage rectifier transformer T1 supply power to the filaments of high-voltage rectifiers V1 through V3, to the filaments of series-regulator tubes V4 through V7, and to regulator control amplifier V8.

(3) AC POWER pilot lamp I 1, lights when power is applied through AC POWER switch S1.

d. High-Voltage Rectifier Circuit. Power is applied to the primary of transformer T2 from the input power circuit. Transformer T2 is a step-up transformer which delivers high voltage to high-voltage rectifiers V1 through V3. The rectifiers convert the ac to pulsating dc. The dc output of the rectifiers is applied through the high-voltage filter consisting of inductor L1 and capacitors C1 and C2 to the voltage regulator circuit.

e. Voltage Regulator Circuit. The voltage regulator circuit consists of series-regulator tubes V4 through V7, reference voltage regulator tube V9, and regulator control amplifier V8. These circuits function together to maintain the output of the 200 VOLT POWER SUPPLY at a constant 200 volts.

40. Schematic Analysis, Power Supply PP 827/U

(fig. 33)

a. Input Circuit. Voltage of 115 volts or 230 volts 49 to 65 cps, is supplied to the 200 VOLT POWER SUPPLY through connector P2 and cable W1. The input circuit contains TO 600V POWER SUPPLY outlets J2 and J3, AC POWER switch S1, 115V-230V switch S3, and 115V CONVENIENCE OUTLETS J4 and J5.

(1) *AC POWER switch S1*. AC POWER switch S1 controls the input to power transformers T1 through T3 and to blower motor B1.

(2) *115V-230V switch S3*.

(a) 115V position. When 115V-230V switch S3 is operated to the 115V position, 115 volts ac is applied to parallel-connected primary windings 1-2 and 3-4of power transformers T1 through T3. The 115 volt ac input is also applied through thermostat switch S2 to blower motor B1. In this position, 115 volts ac is available at 115V CONVENIENCE OUTLETS J4 and J5. This circuit is protected by CONV OUT 6 AMP fuse F3. When 115V-230V switch S3 is operated to the 230V position, the convenience outlets are disconnected.

(b) 230V position. When 115V-230V switch S3 is operated to the 230V position, ac power is applied to series-connected windings 1-2 and 3-4 of power transformers T1 through T3. In this position, 230V 3 AMP fuse F4 is connected into the line to provide additional protection against overload.

Figure 32. Power Supply PP-827/U, block diagram.
Figure 33. Power Supply P-827/U, schematic diagram.
(Contained in separate envelope)

b. Filament Supply and Blower Circuit.

(1) *Filament supply*. Filament voltage of 5.1 volts ac for rectifiers V1 through V3 is obtained from terminals 9 and 10 of transformer T1. Filament voltage of 6.4 volts ac for series regulator tubes V4 through V7 and for regulator control amplifier V8 is obtained from terminals 5 and 6 of transformer T1. This winding also supplies the voltage for AC POWER indicating lamp I 1. Tube filament voltage of 6.55 volts for the components of Telephone Terminal AN/ TCC-7 is obtained from four secondary windings of power transformer T3. Voltage drops in the interconnecting cables reduce the voltage to 6.3 volts at the tubes.

(2) *Blower circuit*. To prevent an excessive temperature rise inside the 200 VOLT POWER SUPPLY, blower motor B1 furnishes forced ventilation whenever the temperature inside the unit exceeds approximately 80° F. The motor is connected to the input power circuit through connectors P1 and J1, and power is applied through thermostat switch S2. Switch S2 remains open until the ambient temperature of the power supply rises to approximately 80° F. At this temperature, the switch closes and the blower motor is energized. When the ambient temperature falls to approximately 65° F., switch S2 opens and the ac power is removed from the motor. Capacitor C8 provides the phase shift which is necessary for operating the motor.

c. Low-Voltage Rectifier Circuit.

(1) The secondary winding between terminals 7 and 8 of transformer T1 supplies 14.5 volts to low-voltage rectifier CR1. The positive dc output appears at terminal 3 of the rectifier; the negative dc output appears at terminal 1. The choke input filter, consisting of inductor L2 and capacitor C9, filters the rectified output. The 10-volt output of the low-voltage rectifier circuit is connected through terminals ED and EH on terminal board TB1 to pins D and H. respectively, of connector P3.

(2) The positive 10 volts dc at pin H of connector P3 is grounded to the chassis of the JUNCTION PANEL which, in turn, is connected through pin R on connector P3 to the chassis ground of the 200 VOLT POWER SUPPLY. The negative 10 volts dc at pin D is applied through the JUNCTION PANEL to the ORDER WIRE PANEL.

d. High-Voltage Rectifier Circuit.

(1) The plates of high-voltage rectifier tubes V1 through V3 are connected to the secondary winding of high-voltage transformer T2 in a conventional full-wave rectifier circuit. The three rectifiers are paralleled to handle the required heavy current load.

(2) The rectifier output is filtered by a choke input filter consisting of inductor L1 and series capacitors C1 and C2. Capacitors C1 and C2 are series-connected, so that their voltage ratings are not exceeded.

(3) Resistors R1 and R2 are connected across capacitors C1 and C2, respectively, to divide the dc voltage evenly between the two capacitors. Because of differences in capacitor leakage resistance, these resistors prevent a difference in voltage from appearing across each capacitor. In addition, resistors R1 and R2 provide a slow discharge path across the capacitors when the power supply is turned off.

e Voltage Regulator Circuit.

(1) *Series-regulator tubes V4 through V7.* The positive dc output voltage from the filter circuit (*d*(2) above) is applied to plate pins 2 and 5 of parallel-connected series regulator tubes V4 through V7. Resistors R5 through R12, connected to the control grids of the series-regulator tubes, are antising resistors. Resistors R13 through R20 at the cathodes of the series-regulator tubes keep the load current balanced among the triode sections of the four tubes by varying the bias on the triode

section which tends to draw more current. Resistor R3 is connected in parallel with the four parallel series-regulator tubes to shunt some of the heavy load current around the series-regulator tubes.

(2) *Regulator control amplifier V8.* Regulator control amplifier V8 is a twin triode which provides two stages of amplification for the changes in the output voltage of the power supply. Output voltage changes appear as bias voltage changes on amplifier V8A.

(a) *Regulator control amplifier V8A.* The center tap of 200V ADJ potentiometer R28 is connected to the control grid of V8A to provide grid excitation for the operation of the first stage of amplification. Potentiometer R28 is part of the voltage divider circuit, consisting of resistors R24 and R23, connected across the 200-volt output. Capacitor C3 maintains the control grid voltage relatively constant in relation to the negative side of the voltage output circuit, and thus makes the input circuit to regulator control amplifier V8A more sensitive to rapid changes in output voltage. The input signal to amplifier V8A is developed across cathode resistor R27, which is also part of a voltage divider circuit, including resistors R25 and R26. Resistor R22 is the plate load resistor for amplifier V8A. Resistor R21 and capacitor C4 eliminate any tendency of the amplifier to oscillate.

(b) *Regulator control amplifier V8B.* The amplified output at the plate of amplifier V8A is coupled directly to the control grid of amplifier V8B. Resistor R4 is the plate load resistor for tube V8B. The cathode is held at a constant voltage, with relation to the varying input voltage on the control grid, by the connection to the constant voltage across R26. The voltage across R26 is held constant by the action of voltage regulator tube V9. Capacitor C5 is connected between the cathode and plate supply circuit of amplifier V8B to prevent oscillation at low frequencies. The amplified voltage variations at the plate of amplifier V8B are applied to the control grids of the series-regulator (*e*(1) above) tubes.

(3) *Reference voltage regulator tube V9.* Voltage regulator tube V9 provides a constant voltage drop (108 volts) across resistors R25 and R26. All the rapid variations in the output voltage appear across resistor R27. Because resistor R27 is also the cathode resistor of regulator control amplifier V8A, the variations across it serve as the signal input to that stage. Capacitor C6 aids in keeping the voltage drop across V9 constant, especially when rapidly changing voltages are applied to the tube.

f. Output circuit. Capacitor C7 is a filter capacitor across the 200-volt output of the power supply which lowers the output ripple voltage and provides a low impedance shunt for high frequencies that may appear across the output. The output of the 200 VOLT POWER SUPPLY is connected through terminals EA and EK of terminal board TB1 to pins A and K, respectively, of connector P3.

g. Regulation under Varying Load Voltages.

(1) *General.* A tendency for the output voltage to vary results in change in voltage and current across the voltage divider circuit composed of resistors R25 through R27. Reference voltage regulator tube V9 provides a constant voltage drop of 108 volts across resistors R25 and R26. A voltage is developed across resistor R27 proportional to the change in the output voltage. Resistor R27 is connected to the cathode of regulator control amplifier V8B; the control grid is connected to terminal 2 of 200V ADJ potentiometer R28. The voltage developed across the 1-2 resistance of potentiometer R28 and resistor R24 is held constant to rapid output voltage variations by capacitor C3. The variation in voltage across resistor R27 changes the

bias of regulator Control V8A.

(2) *Increase in output voltage*. When the output of the power supply momentarily increases, the voltage change developed across resistor R27 increases the bias of regulator control amplifier V8A. The increase bias on amplifier V8A causes an increase in plate voltage. The rise in plate voltage is impressed on the control grid of V8B, decreasing its bias. Cathode voltage on amplifier V8B is held constant, with relation to the signal input, by the constant voltage drop across resistor R25. The decrease in bias on the control grid of V8B causes a decrease in plate voltage at pin 6. This decrease in voltage is applied through grid resistors R5 through R12, increasing the grid bias (and dc plate resistance) on series-regulator tubes V4 through V7. The increased dc plate resistance of the series-regulator tubes causes a greater dc voltage drop across the tubes. The increased voltage drop across the series-regulator tubes counteracts the tendency for the output voltage to rise.

(3) *Decrease in output voltage*. A decrease in the output voltage has exactly the opposite effect to that described in (2) above.

Section IX. POWER SUPPLY PP-826A/U

41. General

Power Supply PP-826A/U furnishes a regulated current of .1 ampere dc at a nominal 600 volts to the spiral-four line, to supply operating voltages for Telephone Repeaters AN/TCC-11. Dummy-load resistors are used to compensate for a load decrease when less than three repeaters are used. Protective features include lamp- and buzzer-alarm indicators, and cutoff circuits. The cutoff circuits automatically remove input power from the high-voltage transformers when abnormal operating conditions are encountered.

42. Block Diagram Analysis

(fig. 34)

a. Input Power Circuit. Primary power of 115 or 230 volts is applied through the input power circuit (consisting of AC POWER switch S1, line fuses F1 and F2, and 115V-230V changeover switch S2) to low-voltage transformer T1 on low-voltage rectifier and alarm unit Z2. The output of low-voltage rectifier and alarm unit Z2 provides continuous audible and visual alarms, if any abnormal operating conditions occur. Power cutoff relay K1 is energized through the contacts of RESTORE switch S5, establishing continuity between the input power circuit and high-voltage rectifier transformer TI and reference voltage rectifier transformer T2. Fuses F3 and F4 are connected into the circuit when 115V-230V changeover switch S2 is operated to 230V.

b. High-Voltage Rectifier Circuit. The high-voltage rectifier circuit consists of a conventional full-wave rectifier circuit (transformer T1, rectifiers V1 and V2), and a high-voltage capacitive input filter (capacitors C1 and C2 and inductor L1). The high-voltage rectifier circuit supplies filtered dc voltage to the current regulator circuit.

c. Current Regulator Circuit. The current regulator circuit controls the current output of the high-voltage rectifier circuit. The circuit consists of parallel regulator tubes V3 and V4, regulator control amplifier V5, and load resistor R6.

d. Reference Voltage Rectifier Circuit. Reference voltage rectifier transformer T2 provides filament voltages for the electron tubes on the 600 VOLT POWER SUPPLY, and input voltage to reference voltage rectifier V6. The dc output of the rectifier filter circuit (capacitors C1 and C2 and inductor L1) is applied to regulator reference voltage tubes V2 through V4. The regulator reference voltage tubes provide standard operating voltages for regulator control amplifier V5 and current regulator tubes V3 and V4.

e. Output Circuit. The output circuit consists of REPEATER switch S6 and load resistors R16 and R17 (not shown). This circuit functions to maintain a constant load on the power supply whether one, two, three or no Telephone Repeaters AN/TCC-11 are installed on the spiral-four line. In addition, one switch position inserts a dummy load across the power supply output for purposes of test and adjustment.

f. Low-Voltage Rectifier and Alarm Unit Z2. This circuit contains visual and audible alarm circuits that operate to protect equipment and to indicate circuit failures. The low-voltage rectifier and alarm circuit consists of power-cutoff relay K1, which removes ac power from the high-voltage rectifier when the dc output voltage increases during operation, low- and high-voltage alarm circuit, a relay control circuit, and two low-voltage rectifiers which provide power to energize the various relays.

43. Input Power Circuit

(fig. 35)

a. Either 115- or 230-volt primary power for Power Supply PP-826A/U is obtained through connector P1 and cable W1. AC POWER switch S1 applies the 115- or 230-volt input to the power supply. Fuses F1 and F2 protect the primary input power circuit. Switch S2 is the 115- to 230-volt changeover switch. Whenever the temperature within the unit reaches 80° F., thermostat switch S3 closes and operates blower motor B1.

(1) With 115V-230V switch S2 in the 115V position, the 1-2 and 3-4 windings of transformers T1 and T2 on the main chassis and transformer T1 on low-voltage rectifier and alarm unit Z2 (subchassis) are connected in parallel. Blower motor B1 is then connected across the 115-volt line.

(2) With 115V-230V switch S2 in the 230V position, the 1-2 and 3-4 windings in each transformer are connected in series, and blower motor B1 is connected across the 115-volt windings of the transformers. Fuses F3 and F4 protect transformers T1 and T2 on the main chassis and transformer T1 on the subchassis, respectively.

b. When AC POWER switch S1 is operated to ON, voltage is applied to the primary windings of transformer T1 on low-voltage rectifier and alarm unit Z2. Under normal operating conditions, transformer T1 supplies power to rectifier CR2 which energizes the relay circuits to actuate power-cutoff relay K1. When relay K1 operates, power is applied to the primary windings of transformers T1 and T2 and the blower motor circuit on the main chassis.

44. High-Voltage Rectifier Circuit

(fig. 35)

a. The high-voltage rectifier is a conventional full-wave rectifier and filter system consisting of power transformer T1, rectifiers V1 and V2, filter capacitors C1 and C2, and inductor L1. The secondary winding of transformer T1 supplies 1,980 volts ac to- rectifiers V1 and V2. Filament voltage for rectifiers V1 and V2 is supplied from the 10 and 11 windings of power transformer T2.

b. The dc voltage output from rectifiers V1 and V2 is filtered by capacitors C1 and C2 and inductor L1. Resistors R6, R7, R10, and R11 on the main chassis, and resistors R10 and R11 and LOW-VOLT ALARM potentiometer R13 on the subchassis form a bleeder path for filter capacitors C1 and C2. From the filter circuit, the output is applied to the plates of current regulator tubes V3 and V4.

45. Reference Voltage Rectifier Circuit

(fig. 35)

a. The reference voltage rectifier circuit consists of transformer T2 and rectifier tube V6 located in the main chassis, and capacitor input filter consisting of capacitors C1 and C2, and inductor L1, voltage regulator tubes V2 through V4, and voltage divider network R4, R5, and R14 located in low-voltage rectifier and alarm unit Z2 (subchassis). Transformer T2 steps up the primary voltage (115 or 230 volts ac) to 770 volts ac in the 5-7 secondary winding. This voltage is applied to full-wave rectifier tube V6. The rectified output of full-wave rectifier tube V6 is filtered by filter capacitors C1 and C2 and inductor L1. The

Figure 34. Power Supply PP-826A/U, block diagram.

Figure 35. Power Supply PP-826A/U, schematic diagram.

(Contained in separate envelope)

ripple from the output of the filter is further reduced by the action of current regulator tubes V3 and V4 (main chassis) and resistors R1 and R2, located on the subchassis. Terminal 6 on transformer T2 serves as a common negative point for the rectifier circuit.

b. A constant potential of 300 volts dc is maintained across series current regulator tubes V3 and V4. The permissible 15 percent input voltage variation, the normal dc load of current regulator and control amplifier tubes (main chassis) have no effect on the magnitude of the 300 volts dc. Additional filtering action is provided by resistor R9 and capacitors C4 and C5. These capacitors require approximately 8 seconds to charge up to the full value of the 150 volts developed across voltage regulator tube V4 (located in the subchassis). This 150-volt delayed voltage is applied to the plate of control amplifier tube V5 through plate-load resistor R5, and through resistors R1 and R2 to the screen grids of current regulator tubes V3 and V4, all located in the main chassis.

c. To develop a stable reference voltage for close regulation, the voltage across current regulator tube V3 is further stabilized by current-limiting resistor R3 and voltage regulator tube V2 located in the subchassis. The voltage divider network, consisting of resistors R4 and R5 and potentiometer R14 on the subchassis, is connected to the control grid of control amplifier tube V5 on the main chassis for regulating action (par. 47).

46. Current Regulator Circuit

(fig. 35)

The high voltage from the rectifier and filter circuit (par. 44) is applied to the current regulator circuit which regulates this output at 100 milliamperes. The current regulator circuit consists of regulator tubes V3 and V4, control amplifier tube V5, and load resistor R6, all located in the main chassis.

a. From the negative side of the current regulator circuit (terminal B of TB1) , the current flows through pin B of connector P3 to the external load. From the external load, the current path is completed through A of connector P3 and TB1, resistors R12 through R15, CURRENT meter M1, and resistor R6 to the cathodes of regulator tubes V3 and V4. REPEATER switch S6 (par. 48) controls the selection of load resistors R13 through R15 to obtain a fixed load according to the number of unattended repeaters being used. Resistors R10 and R11 provide a voltage divider circuit for the current regulator tubes. The current path for the high-voltage rectifier current regulator circuit is completed from the plates of regulator tubes V3 and V4 to terminal B of TB1 through inductor L1, rectifiers V1 and V2, and terminal 6 of transformer T1.

b. About two seconds after the input power is applied, approximately 80 milliamperes are delivered to the load. The current path is through current-limiting resistor R7, bypassing current regulator tubes V3 and V4 which have not yet reached their operating point. Time delay network resistor R9 and capacitors C4 and C5 introduce a delay of approximately 8 seconds before the full 150 volts from the reference voltage circuit is applied to the screen grids of regulator tubes V3 and V4 and the plate of control amplifier V5. When the delay time has elapsed, the current to the load reaches the full operating value of 100 milliamperes. This delay is necessary to prevent an excessively high voltage from being applied to the tube circuits in the unattended telephone repeaters before their warmup time is reached. This excessive voltage would materially shorten the lives of these tubes and might cause arcing across the lightning arresters used in the system.

47. Regulating Action

(fig. 35)

For automatic regulation, the voltage drop across load resistor R6, which carries the total load current, is compared with a voltage developed in the reference voltage circuit. This voltage is derived from the voltage drop across voltage regulator tube V2 and a parallel voltage-divider circuit consisting of resistors R4 and R5 and LOAD CURRENT potentiometer R14 located in the subchassis.

a. The positive side of load resistor R6 is connected to voltage-regulator tube V2 and the screen grid of control amplifier V5. The net bias between the cathode and grid of control amplifier V5 is the difference between the voltage drop across load resistor R6 and the independent reference voltage on the grid of control amplifier V5. The reference voltage is developed across voltage regulator tube V2 and the voltage-divider network. Resistors R1 through R4, connected to the screen and grid circuits of current regulator tubes V3 and V4, are used to prevent oscillation. A 600V ADJ variable resistor, R12, is used to compensate for the variations in voltage drop in the spiral-four cable used between repeaters. This condition is caused by variations in the dc resistance of the cable due to temperature changes. Capacitor C3, across the output, is used to provide additional filtering. Resistors R10 and R11 provide a voltage-divider network, whereby the voltage developed across resistor R11 is used as a reference when measuring the output voltage on the meter of the TEST PANEL.

b. An increase in the voltage drop across load resistor R6 will decrease the difference between the cathode and the grid of control amplifier V5, reducing the bias on this tube. This difference between the voltage drop across R6 and the reference voltage from voltage regulator tube V2 is amplified in control amplifier V5 and appears as an increase in plate current. The current rise increases the voltage drop across plate-load resistor R5.

c. Since the plate of amplifier V5 is also connected to the control grids of current regulator tubes V3 and V4, an increase in the voltage drop across R5 will make the bias on regulator tubes V3 and V4 more negative, increasing their dc plate resistance until the load current through resistor R6 is reduced to the proper value of 100 milliamperes.

d. A decrease in the voltage drop across R6 (caused by a decrease in load current) increases the bias on amplifier V5. This results in a decrease in the voltage drop across plate load resistor R5 which, in turn, makes the bias on regulator tubes V3 and V4 less negative. Tubes V3 and V4 conduct just enough to increase the current through resistor R6 to its proper value of 100 milliamperes. The combined output current from regulator tubes V3 and V4 and the current through resistor R7 is measured by CURRENT meter M1 and is adjusted by LOAD CURRENT potentiometer R14 in the voltage reference circuit.

48. REPEATER Switch S6

(fig. 35)

REPEATER switch S6 is provided to insert dummy load resistors R13 through R15 to maintain a constant load on the 600 VOLT POWER SUPPLY when less than three unattended repeaters are used in the power loop. The switch has five positions-0, 1, 2, 3, and TEST.

a. Position 0. REPEATER switch S6 is operated to 0 when no unattended repeaters are used in the power loop. Resistors R13 through R15 simulate the resistance that would be offered by three unattended repeaters and cable. In this position, conditioning current is applied to the cable to lower the contact resistance of the spiral-four cable connectors.

b. Position 1. When only one repeater is used in the power loop, switch S6 is operated to position 1. In this position, resistors R13 and R14 simulate the resistance that would be offered by two unattended repeaters and cable.

c. Position 2. When two repeaters are used in the power loop, switch S6 is operated to position 2. In this position, resistor R13 simulates the resistance that would be offered by one unattended repeater and cable.

d. Position 3. When three repeaters are used in the power loop, switch S6 is operated to position 3. In this position, resistors R13 through R15 are shorted out. 600V ADJ resistor R12 remains in series with the load to provide a means of adjusting the output voltage of the power supply.

e. Position TEST. In this position, resistors R13 through R15 are connected as described in *a* above, except that the output of the power supply is shorted out by contacts 2 and 8 of section 2 of REPEATER switch S6. This position is used when performing initial tests on the unit.

49. Low-Voltage Rectifier and Alarm Unit Z2, General

Low-voltage rectifier and alarm unit Z2 is a subassembly mounted on the main chassis of Power Supply PP-826A/U, and is interconnected with the main chassis by connectors J11 and P11. The major functions of the subassembly are as follows:

a. Senses the resistance of the power loop (dc of the spiral-four cable, the unattended repeaters, and resistors R12 and R13 through R15 (depending on the position of REPEATER switch S6)) immediately after the power supply is energized (par. 51).

b. Applies input power to the high-voltage rectifier circuit, if the line resistance is correct or, if the line resistance is not correct, will not apply input power to the high-voltage rectifier circuit. Visible and audible alarms indicate incorrect power loop resistance.

c. Disables the sensing and starting circuits if the output of the high-voltage rectifier is not applied to the line within 1 second after the input power is applied to the high-voltage rectifier circuit. This prevents placing high-voltage dc on the line, if line resistance is not correct.

d. Provides visual and audible alarms, if the dc output voltage of the 600-VOLT POWER SUPPLY decreases during operation.

e. Removes input power from the high-voltage rectifier circuit, if the dc output voltage increases during operation.

f. Provides a means of checking the resistance of the power loop with RESTORE switch S5 and CURRENT meter M1.

50. Starting, Initial Circuit Conditions

(fig. 35)

Immediately after AC POWER switch is operated to ON, the following conditions exist:

a. A regulated voltage of +108 volts dc (produced by rectifier CR2 and voltage regulator VI) is applied through terminal 22 of connectors P11 and J11, the contacts of RESTORE switch S5, terminal 24 of connectors J11 and P11, and contacts 3-10 of relay K5, to terminal 8 of relay K6. Terminal 7 of relay K6 is connected to ground through three parallel current paths. One current path is from ground through terminal B of connector P3, the power loop, terminal A of connector P3, the circuit elements between terminal A of connector P3 and terminal 29 of connectors J11 and P11, contacts 6-11 of relay K2, contacts 10-3 of relay K7, to the winding of relay K6. A second current path is from ground through resistors R11, R13, and R10, (on subchassis), through contacts .6-11 of relay K2, contacts 10-3 of relay K7, to the winding of relay K6. A third current path is from ground through closed contacts 8-12 of relay K7, resistor R27, to the winding of relay K6.

b. A dc voltage is produced by a low-voltage power supply that consists of rectifier CR1 and its associated circuit elements. Terminal 21 of relay K7 is connected to +24 volts dc from rectifier CRT. Terminal 22 of relay K7 is connected, *before the operation of relay K6*, through parallel resistors R29 and R30, contacts 3-1 of relay K6, resistor R32, the winding of relay K10, contacts 8-12 of relay K5, terminals 25 of connectors P11 and J11, the contacts of RESTORE switch S5, and terminals 26 of connectors J11 and P11 to the-24-volt dc output of rectifier CR1. Because of the resistance of the winding of relay K10 and resistor R32, relay K7 will not operate.

c. The +24-volt dc output of rectifier CR1 is applied to terminal 7 of relay K1. Terminal 8 of relay K1 is connected through resistors R26 and R32, the winding of relay K10, contacts 8-12 of relay K5, terminals 25 of connectors P11 and J11, the contacts of RESTORE switch S5, and terminals 26 of connectors J11 and P11 to the -24-volt dc side of rectifier CR1. Because of the resistance of the winding of relay K10 and resistor R32, relay K1 will not operate.

a. described in *b* and *c* above, the winding of relay K10 is in the path from the -24-volt dc side of rectifier CR1 to terminal 8 of relay K1 and terminal 22 of relay K7. However, capacitor C7, which is connected across the winding of relay K10 and is not charged initially, acts as a shunt immediately after the AC POWER switch is operated to ON. Therefore, the initial current flow through the winding of relay K10 is not large enough to energize the relay. Relay K10 remains unoperated throughout normal operation unless the power supply fails to start or, after having started, is turned off by a high-voltage output condition (par. 53*b*).

e. The operating path of relay K5 is open and remains so throughout normal operation unless the power supply fails to start or, after having started, is turned off by a high-voltage output condition.

f. Seven volts ac is developed across winding 11-12 of transformer T1 on the subchassis. One terminal of each of the three alarm lamps (I 1, I 2, and I 3) and ac buzzer I 4 is connected to terminal 11 of the 7-volt winding. However, before the operation of relay K2, K5, or K7, the 7 volts ac is not connected to any of the lamps or the buzzer. Therefore, the lamps are not lighted and the buzzer is silent.

51. Line Resistance Sensing Circuit, General

(fig. 36)

a. Power Supply PP-826A/U has been designed to operate into a nearly constant load equal to the resistance of a power loop that incorporates a maximum of three unattended repeaters. If fewer than three unattended repeaters are used, additional resistance is inserted into the power loop by the operation of REPEATER switch S6 (par. 48) to make the total loop resistance approximately equal to that of a system with three unattended repeaters. The resistance of each unattended repeater is between 1,100 and 1,800 ohms. Therefore, together with the dc resistance of the spiral-four cable sections, the total resistance of a power loop containing three unattended repeaters, should be approximately 5,000 ohms.

b. If the power loop resistance is between 3,500 ohms and 6,500 ohms, input power is applied to the high-voltage rectifier. The sensing and starting functions are accomplished as follows: Relay K6 operates when the line resistance is 6,500 ohms or less. The operation of relay K6 causes relay K7 to operate. After relay K7 has operated, relay K6 will release if the line resistance is more than 3,500 ohms. Relay K1 operates when relay K6 releases, applying ac input power to the high-voltage rectifier.

52. Relay Starting Action

a. Operation of Relay K6 (fig. 36).

(1) The current that flows through the winding of relay K6 will be enough to operate relay K6 if the resistance of the line load does not exceed 6,500 ohms (par 51 *b*)).

Note. Relay K6 is hermetically sealed. It cannot be adjusted. Generally, relay K6 will not operate if the loop resistance is more than 6,500 ohms. However, because of manufacturing variations, some of these relays will operate between 6,500 and 16,000 ohms.

(2) The operation of relay K6 closes contacts 4-5 and contacts 2-3 (fig. 37), operating relay K7.

b. Operation of Relay K7 (fig. 37).

(1) When relay K6 is energized, its 2--3 contacts close, providing a lower resistance path to operate relay K7. This path is from terminal 22 of relay K7 through parallel resistors R29 and R30, contacts 3-2 of relay K6, contacts 11-6 of relay K5, terminals 25 of connectors J11 and P11, the contacts of RESTORE switch S5 and terminals 26 of connectors J11 and P11 to the-24-volt dc side of rectifier CR1. Contacts 2-9 of relay K7 provide holding action for the relay.

(2) When relay K7 is energized, its 3-10 contacts (fig. 35) open and relay K6 deenergizes, if the power loop is not less than 3,500 ohms (*c* below).

c. Deenergizing Relay K6 (fig. 36).

(1) Before the operation of relay K7, contacts 4-5 of relay K6 are closed, and variable resistor R16 is shorted by closed contacts 3-10 of relay K7.

(2) After relay K7 operates, its 3-10 contacts open. The energizing path for relay K6 is now through resistor R16.

(3) Resistor R16 is adjusted, so that the current through the winding of relay K6 will decrease to the point where relay K6 will deenergize, if the resistance of the power loop is greater than 3,500 ohms.

(4) If relay K6 deenergizes, relay K1 is operated (fig. 35) and 115 volts ac is applied to power transformers T1 and T2 on the main chassis (*d* and *e* below).

(5) When relay K6 deenergizes, its 4-5 contacts open (fig. 36). Since contacts 3-10 of operated relay K7 are also open, the winding of relay K6 will therefore be isolated from the

Figure 36. Power Supply PP - 26A / U. sensing circuits, schematic diagram.

(Contained in separate envelope)

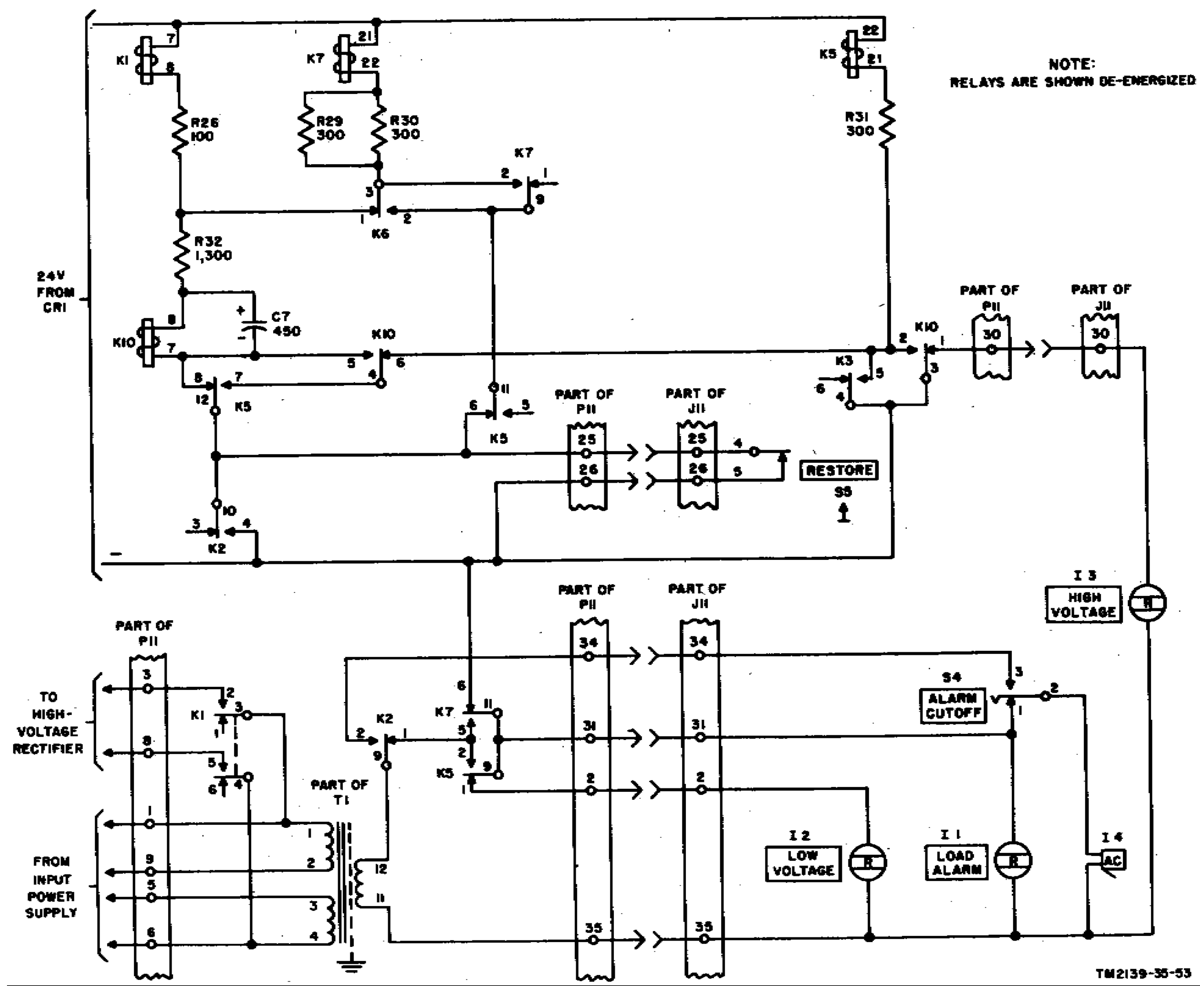

Figure 37. Power Supply PP-826A/U, starting and alarm indicating circuits, schematic diagram.

600 volts dc that will appear at terminal 29 of connector P11 after input power has been applied to the high-voltage rectifier circuit.

d. Operation of Relay K1 (fig. 37).

(1) When relay K6 operates (*c* above), its contacts 1-3 open without affecting the resistance of the energizing path of relay K1.

(2) When relay K7 operates (*b* above), its 2-9 contacts close. However, this will not affect the resistance of the energizing path of relay K1 unless K6 has deenergized (*c* above).

(3) With relay K7 operated and relay K6 deenergized, the-24-volt dc side of rectifier CR1 is connected to terminal 8 of relay K1 through a lower resistance path, operating relay K1. This lower resistance path is from terminal 8 of relay K1, through resistor R26, contacts 1-3 of released relay K6, contacts 2-9 of operated relay K7, contacts 11-6 of unoperated relay K5, terminals 25 of connectors P11 and J11, the contacts of RESTORE switch S5, and terminals 26 of connectors J11 and P11 to the -24-volt dc side of rectifier CR1.

e. Applying Power to High-Voltage Rectifier Circuit (fig. 37). The high-voltage rectifier circuit receives 115 volts ac through terminals 1 and 6 of connector P11, contacts 4-5 and 3-2- of operated relay K1, and terminals 3 and 8 of connector P11.

f. Visual and Audible Indications (fig. 37).

(1) After relay K7 operates (*b* above), its contacts 5-11 close, energizing, LOAD ALARM and LOW VOLTAGE lamps I 1 and I 2, respectively, and buzzer I 4 sounds. The buzzer can be silenced by operating ALARM CUTOFF switch S4.

(2) Relay K2 operates approximately 20 seconds after the high-voltage rectifier circuit has been activated. Contacts 1-9 of relay K2 open, deenergizing LOAD ALARM and LOW VOLTAGE lamps I 1 and I 2, respectively. If the ALARM CUTOFF switch is in its operated position, the buzzer will sound. Operating the switch to its normal position will silence the buzzer.

53. Sensing and Failure To Operate, General

(figs. 36 and 37)

If the power loop resistance is too high (6,500 ohms) or too low (3,000 ohms), the power supply will not start. In either case, failure to start causes relay K10 to operate and after a delay of approximately 1 second, relay K5 will also operate. The operation of relay K5 disables the sensing and starting circuits. If an intermittent open or short in the power loop initially prevents the power supply from starting, it will not be able to start automatically until the intermittent condition is cleared. The power supply can be made to sense the line conditions again by operating RESTORE switch S5 or by resetting AC POWER switch S1 (fig. 35). A detailed description of sensing and starting functions is given in paragraphs 54 through 56.

54. Failure To Operate, Resistance Above 6,500 Ohms

a. If the resistance of the power loop is too high, relay K6 (fig. 36) will not operate (par. 52*a*). Although relays K1, K7, and K10 (fig. 37) are connected across the output of rectifier CR1, the current through the relay windings is insufficient to cause the operation of relays K7 and K1.

b. Capacitor C7 prevents current from flowing through the winding of relay K10 immediately after AC POWER switch S1 is set to ON (par. 50*d*). The capacitor also prevents the current through the winding of relay K10 from reaching the value required to operate the relay for approximately 1 second after the AC POWER switch is operated to ON. This prevents disabling the sensing and starting circuits before the power has been able to start into the correct power loop resistance.

c. When relay K7 operates and relay K6 deenergizes, relay K10 is prevented from operating by a short circuit connected across its winding. The short circuit is traced from the junction of resistors R26 and R32 through contacts 1-3 of deenergized relay K6, contacts 2-9 of operated relay K7, contacts 11-6 of unoperated relay K5, and contacts 12-8 of relay . K5, to terminal 7 of the winding of relay K10. Therefore, relay K10 operates approximately 1 second after AC POWER switch S1 is operated to ON, only if the power supply has not been activated during this period.

d. Following the 1-second time delay (*b* above), relay K10 energizes, operating relay K5. The energizing path for relay K5 is from the-24-volt dc side of rectifier CR1 through contacts 3-2 of relay K10, current-limiting resistor R31, and the winding of relay K5 to the +24-volt dc side of rectifier CR1. Contacts 4-5 of relay K10 close immediately without affecting the operation of any other relay.

e. The operation of relay K5 causes the following actions:

(1) Contacts 3-10 of relay K5 open (fig. 36), removing the +108 volts from terminal 8 of relay K6. This disables the sensing functions because relay K6 cannot operate regardless of the power loop resistance.

(2) Contacts 4-10 or relay K5 close, providing a discharge path for capacitor C6. If the sensing function is initiated again by operating RESTORE switch S5 (par. 53), capacitor C6 will recharge and prevent the power supply from starting into an open line.

(3) Contacts 6-11 of relay K5 open the locking path for relay K7 (fig. 37).

(4) When contacts 8-12 of relay K5 open, capacitor C7 discharges through the

winding of relay K10. The capacitor discharge current will be enough to keep relay K10 operated until contact 12 of relay KS moves from contact 8 to contact 7. The winding of relay K10 remains connected to the —24-volt dc side of rectifier CR1 through contacts 7-12 of relay KS.

(5) When relay KS operates, contacts 2-9 close and LOAD ALARM lamp I 1 is energized by the ac voltage developed across winding 11-12 of transformer T1 on the subchassis. If ALARM CUTOFF switch S4 is in the unoperated position, the ac buzzer will sound.

55. Failure To Operate, Resistance Below 3,500 Ohms

a. If the resistance of the power loop is less than 3,500 ohms, enough current from the +108-volt supply (CR2 and associated circuit elements) will operate relay K6 (fig. 36). Relay K7 will then operate and lock itself (fig. 37). The energizing path of relay K6 is through potentiometer R16 (fig. 36). This potentiometer is adjusted, so that K6 releases *only* if the power loop resistance is *greater than 3,500 ohms.* Relay K6 remains operated.

b. Under the condition stated in *a* above, current flows through relay K1, but it is not enough to operate the relay (fig. 37). This current path is from the —24-volt dc side of rectifier CR1 through terminals 26 of connectors P11 and J11, contacts of the RESTORE switch, terminals 25 of connectors J11 and P11, contacts 12-8 of relay KS, the winding of relay K10, resistors R32 and R26, and the winding of relay K1, to the +24-volt de side of rectifier CR1.

c. When the 600 VOLT POWER SUPPLY fails to operate because of a high resistance power loop, relay K10 energizes after a time delay of approximately 1 second (par. 54*b*) As a result of relay K10 energizing, relay KS energizes; when relay KS energizes, the same actions as those described in paragraph 54*c* occur except that LOAD ALARM and LOW VOLTAGE lamps I 1 and I 2, respectively, will light and buzzer I 4 will sound before relay KS operates.

d. When relay KS operates, its contacts 1-9 open and LOW VOLTAGE lamp I 2 is extinguished.

e. Contacts 6-11 of relay KS open, deenergizing relay K7. Contacts 5-11 of relay K7 open; however, LOAD ALARM lamp I 1 will not be extinguished. The lamp remains connected to terminal 12 of transformer T1 through contacts 2-9 of relay KS and contacts 1-9 of relay K2.

56. Resensing After Failure To Operate (fig. 37)

After the 600 VOLT POWER SUPPLY has failed to operate, it can be made to resense either by operating and releasing nonlocking RESTORE switch S5 or resetting AC POWER switch S1. The power supply will then operate if the power loop resistance is correct.

a. The operation of RESTORE switch S5 opens the path from the —24-volt dc side of rectifier CR1 to the winding of relay K10. When relay K10 deenergizes, contacts 2-3 of relay K10 open and relay KS deenergizes.

b. To initiate resensing action, RESTORE switch S5 must be held in the operated position long enough for relay K10 to deenergize. Relay K10 does not deenergize immediately, because the discharge current of capacitor C7 holds the relay energized for approximately 2 seconds.

c. By relay K10 and relay KS energizing, LOAD ALARM lamp I 1 and ac buzzer I 4 energize (if ALARM CUTOFF switch S4 is unoperated). The LOAD ALARM lamp provides an indication of the release of relay K10. To be sure that relays K10 and KS deenergize, RESTORE switch S5 is held operated until the LOAD ALARM lamp extinguishes.

57. Central Amplifier, General

The control amplifier circuit includes amplifier V6, voltage regulator V5, low-voltage relay K2, and high-voltage relay K3 (fig. 38). This circuit responds to variations of the 600-volt dc output and actuates alarms when this voltage is either too low or too high Approximately 20 seconds after the high-voltage rectifier circuit has been energized, the plate current of amplifier V6 will respond to the 600-volt dc output voltage of the power supply. If this voltage is normal *(a* below), low-voltage relay K2 is operated and high-voltage relay K3

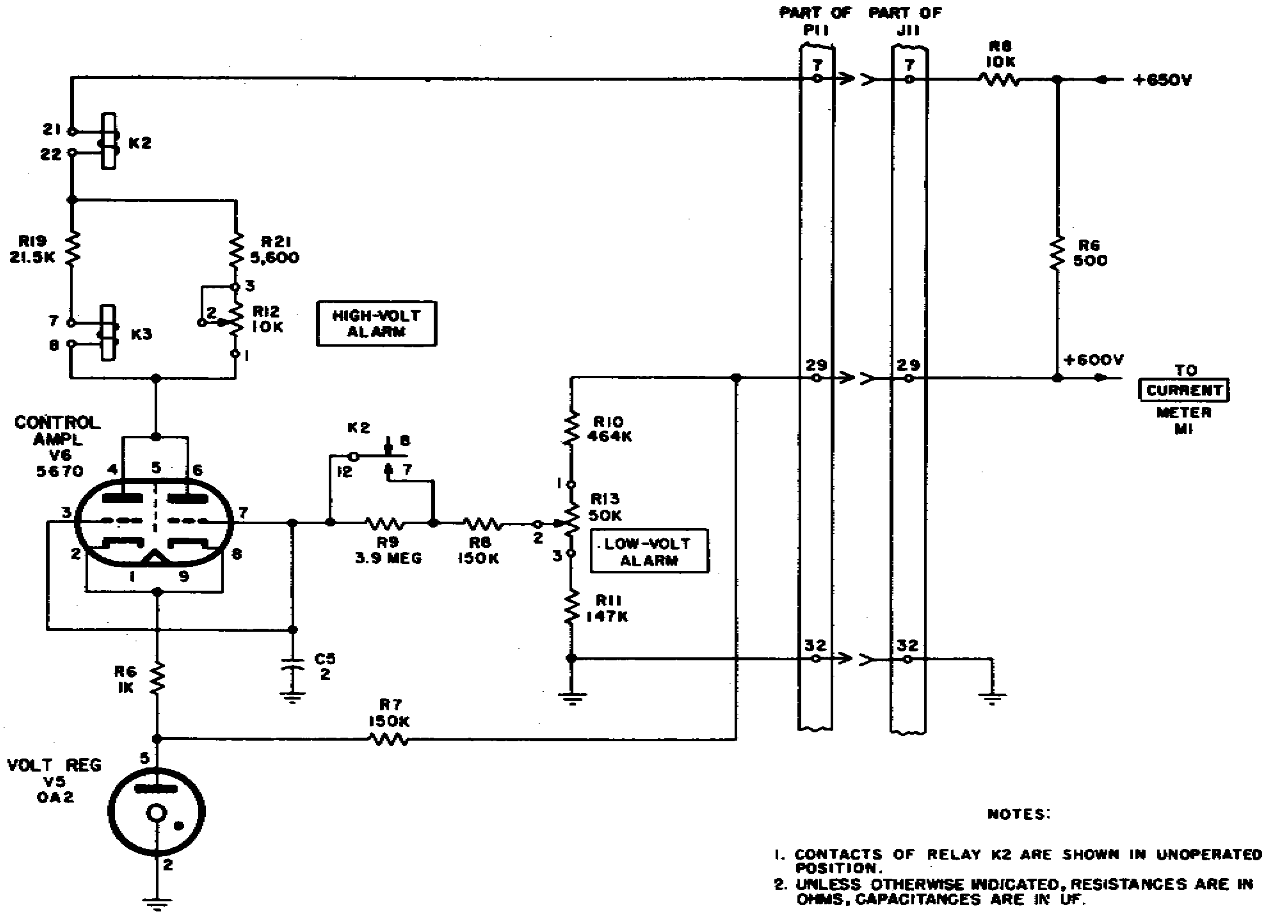

Figure 38. Power Supply PP-826A/U, control amplifier circuit, schematic diagram.

is unoperated. If the output voltage is too low (*b* below) (power loop resistance less than that of a normal system), relay K2 releases. If the output voltage is too high (*c* below) (power loop resistance greater than that of a normal system), relay K3 operates.

a. Normal Output Voltage Condition (fig. 38). Amplifier V6 functions as a single-stage dc amplifier with two paralleled sections. A voltage of 650v dc from the high-voltage regulator circuit is applied through resistor R8 to the plate circuit of control amplifier V6. The cathode of amplifier V6 is maintained at a fixed potential by voltage regulator tube V5. The 600-volt dc output voltage of the power supply is applied across resistors R10, R13, and R11, and across voltage-dropping resistor R7 and voltage regulator tube V5 (on the subchassis).

(1) Immediately after the high-voltage rectifier circuit is energized, the potential at terminal 2 of LOW-VOLT ALARM potentiometer R13 is applied through resistors R8 and R9 to the grids of amplifier V6. Initially, uncharged capacitor C5 acts as a low impedance path to ground for the grids of tube V6. The plate current of amplifier V6 will not be enough to make relay K2 or K3 operate. The impedance of capacitor C5 increases as it charges through resistor R8 and R9, increasing the voltage applied to the grids of amplifier V6. The values of resistors R8 and R9 and capacitor C5 are chosen, so that the full voltage present at terminal 2 of LOW-VOLT ALARM potentiometer R13 is applied

to the grids after a time delay of approximately 20 seconds. The plate current of amplifier V6 is then enough to operate relay K2.

(2) The 20-second delay in applying the voltage to the grids of tube V6 ((2) above) is necessary, because the output voltage of the power supply is higher than 600 volts dc until the filaments of the tubes in the unattended repeaters have reached operating temperature. An excessively high voltage initially applied to the grids of amplifier tube V6 would immediately energize relay K3, interrupting the dc output of the power supply. However, because of the 20-second time delay, the initial high-voltage output does not affect the potential at the grids of amplifier tube V6. During the 20-second time delay, the dc output voltage of the power supply returns to its normal value of 600 volts, applying the correct voltage to the grids of amplifier tube V6.

b. Energizing of Relay K2 (fig. 37). The energizing of relay K2 causes the following changes in circuit condition:

(1) LOAD ALARM and LOW VOLTAGE lamps I 1 and I 2 extinguish.

(2) Contacts 4-10 of operated relay K2 close, bypassing the contacts of RESTORE switch S5. Therefore, the operation of this switch cannot break the energizing paths of relays K7 and K1.

(3) Contacts 7-12 short out resistor R9 (fig. 38). The time constant of the RC network in the grid circuit of amplifier tube V6 is shortened to enable the plate current of the tube to change very quickly in response to variations of the output voltage of the power supply.

(4) Contacts 6-11 of operated relay K2 open (fig. 36), removing the +600 volts dc that appears at terminal 29 of connector P11 from the +108-volt circuit (rectifier CR2 associated circuit elements).

58. Low-Voltage Relay Circuit

a. General (fig. 38). If the resistance of the power loop decreases, the output voltage of the 600 VOLT POWER SUPPLY will decrease, and its output current will increase. The decrease in output voltage results in a decrease of the voltage applied to the grids of amplifier tube V6. This action decreases the plate current of the tube, causing relay K2 to release. LOW-VOLT ALARM control R13 is adjusted during initial adjustments of the power supply to make relay K2 release when the output voltage of the power supply decreases to 530 volts dc.

b. Deenergizing of Relay K2. When relay K2 deenergizes, the dc output of the power supply is not interrupted, and relays K1 and K7 remain energized (fig. 37). The deenergizing of relay K2 causes the following changes in circuit condition:

(1) Contacts 4-10 of relay K2 open. The energizing path for relays K1 and K7 is through the contacts of RESTORE switch S5. The RESTORE switch may be operated to determine the resistance of the power loop (par. 61).

(2) Contacts 6-11 of relay K2 close (fig. 36), enabling the measurement of power loop resistance (par. 61).

(3) Contacts 1-9 of relay K2 close, energizing LOAD ALARM lamp I 1 and buzzer I 4 through contacts 5-11 of operated relay K7 (fig. 37). The buzzer can be silenced by operating ALARM CUTOFF switch S4.

59. High-Voltage Relay Circuit

a. Operation (fig. 38).

(1) The voltage output of the 600 VOLT POWER SUPPLY will increase, if the resistance of the power loop increases. The increase in output voltage results in an increase of the voltage applied to the grids of amplifier tube V6. This increases the plate current of the tube, energizing relay K2.

(2) HIGH-VOLT ALARM control R12 and resistors R19 and R21 control the portion of the plate current that flows

through relay K3. The control is adjusted during initial adjustment of the power supply to operate relay K3 when the output voltage of the power supply increases to 670 volts dc.

(3) When relay K3 energizes, its 4-5 contacts close to complete the energizing path for relay K5 (fig. 37).

b. Energizing of Relay K5 (fig. 37). The energizing path for relay K5 is from the-24-volt dc side of rectifier CR1, through contacts 4 5 of relay K3, current-limiting resistor R31, and the winding of relay K5, to the +24-volt dc side of rectifier CR1. The energizing of relay K5 causes the following changes in circuit conditions:

(1) Contacts 7-12 of relay K5 close, locking relay K5 through contacts 4-6 of unoperated relay K10.

(2) Contacts 6-11 of relay K5 open, breaking the energizing path of relay K7 (par. 52b). The release of the 2-9 contacts of relay K7 causes relay K1 to deenergize, removing the ac input voltage from the high-voltage rectifier circuit. The interruption of the 600-volt dc output causes relays K2 and K3 to deenergize (fig. 38).

(3) Contacts 4-10 of relay K5 close, disabling the sensing circuit and discharging capacitor C6 (fig. 36).

(4) LOAD ALARM lamp I 1 and buzzer I 4 energize through closed contacts 2-9 of relay K5 (fig. 37). The buzzer can be silenced by operating ALARM CUTOFF switch S4.

(5) HIGH VOLTAGE lamp I 3 is also energized when contacts 2-9 of relay K5 close. The energizing path for HIGH VOLTAGE lamp I 3 is from terminal 12 of transformer T1, contacts 9-1 of unoperated relay K2, contacts 2-9 of operated relay K5, contacts 11 -6 of unoperated relay K7, contacts 3-1 of unoperated relay K10, terminal 30 of connectors P11 and J11 to HIGH VOLTAGE alarm lamp I 3. The circuit is completed from the lamp to terminal 11 of transformer T1.

c. Resensing After High-Voltage *Condition*.

(1) An excessively high-voltage output interrupts the 600-volt dc output of the power supply and disables its sensing circuit (par. 59). When this condition occurs, the LOAD ALARM and HIGH VOLTAGE alarm lamps light and the buzzer sounds.

(2) When the power supply fails to operate, sensing can be initiated by momentarily operating the RESTORE switch or resetting AC POWER switch S1.

60. Protection Against Operating into Open Power Loop

a. The distributed capacitance of an open spiral-four line, the unattended repeaters, and the capacitance of capacitors C1 and C2 on the main chassis (fig. 35) initially permit enough current to flow through relay K6 to operate the relay. Since this capacitance is not initially charged, it presents a short circuit to the +108-volt dc from rectifier CR2 (fig. 36) immediately after the AC POWER switch has been operated to ON. This would cause the power supply to start into an open line.

b. The 600 VOLT POWER SUPPLY is prevented from operating into an open power loop by capacitor C6 and resistor R28 (fig. 36). Capacitor C6 acts as a short, preventing current from the +108-volt dc supply from rectifier CR2 from flowing through the winding of relay K6. As capacitor C6 charges, the reactance of the capacitor increases, and current begins to flow through the winding of relay K6. Since the increase of current through the relay is gradual, relay K6 does not operate.

c. When relay K7 operates, which occurs as part of the starting sequence, its contacts 7-12 close (fig. 36) and a low-resistance discharge path for capacitor C6 is provided through current-limiting resistor R28. It is necessary to discharge capacitor C6 quickly after the power supply has started, so that the capacitor may again momentarily short out relay K6 should the operation of the power supply be interrupted and started again after a short interval.

61. Determining Power Loop Resistance

(figs. 36 and 37)

a. CURRENT meter M1 and RESTORE switch S5 provide the means of measuring the resistance of the power loop. The power loop resistance should be determined whenever anyone of the following conditions occurs:

(1) The 600 VOLT POWER fails to operate. This condition is indicated by the energizing of LOAD ALARM lamp I 1 and ac buzzer I 4.

(2) Approximately 20 seconds after the power supply has been energized, the LOW VOLTAGE and LOAD ALARM lamps do not extinguish.

(3) After the power supply has been operating normally, the LOW VOLTAGE and LOAD ALARM lamps light.

(4) The output of the 600 VOLT POWER SUPPLY is interrupted during operation, as indicated by the lighting of HIGH VOLTAGE lamp I 3.

b. Under the conditions given in *a*(l) and (4) above, relay K5 is operated and its open contacts 3-10 remove the 108 volts dc from the sensing circuit (fig. 36). When RESTORE switch S5 is operated, relay K5 deenergizes and 108-volts dc is applied to the sensing circuits through closed contacts 3-10 of relay K5. The current path is through the-power loop resistance, internal resistors R15 through R12 (depending upon the position of REPEATER switch S6), CURRENT meter M1, contacts 6-11 of relay K2, contacts 10 3 of relay K7, the winding of relay K6, contacts 10 3 of relay K5, and current-limiting resistor R33 (which is not shorted by operating the RESTORE switch), to the +108-volt dc from rectifier CR2. The current reading on the meter can be converted to the resistance of the power loop by the following formula: where (R) equals the resistance of the power loop and (I) equals the indication on CURRENT meter M1.

$$R\ (\text{ohms}) = \frac{\left(108\ (\text{volts}) \times 1{,}000\right)}{(\ I(\text{ma}))} - 2{,}000$$

c. Under the conditions given in subparagraph a (2) and (3) above, an indication is also produced on CURRENT meter M1, when RESTORE switch S5 is operated. This meter indication can be converted to the resistance of the power loop by the formula given in *b* above when the RESTORE switch is operated. In addition, the operating path of relay K7 is opened by operating the RESTORE switch (fig. 37). Relay K5 is not operated under the conditions given in a(2) and (3) above; therefore, the operation of the RESTORE switch has no effect on relay K5.

Section X. POWER SUPPLY PP 826/U

62. General

a. Power Supply PP-826/U provides a regulated current of .1-ampere dc at a nominal 600 volts, and can be used interchangeably with Power Supply PP-826A/U. It supplies power for one, two, or three Telephone Repeaters AN/TCC-11 (unattended repeaters). Dummy load resistors in the 600 VOLT POWER SUPPLY are used to compensate for a decrease in power loop resistance when less than three unattended repeaters are used.

b. Protective features include lamp and buzzer alarm indicators, and cutoff circuits which remove input power from the high-voltage transformers when abnormal operating conditions are encountered. Power Supply PP-826/U consists of a main chassis and a plug-in assembly contained in the same transmit case.

c. The circuits that are identical in both the PP-826/U and the PP-826A/U power supplies are referenced in (1) through (7) below:

(1) Block diagram (par. 42).

(2) Input power circuit (par. 43).

(3) High-voltage rectifier circuit (par. 44).

(4) Reference voltage rectifier circuit (par. 45).

(5) Current regulator circuit (par. 46).

(6) Regulating action (par. 47).

(7) REPEATER switch S6 (par. 48).

63. Low-Voltage Rectifier and Alarm Unit Z1, General

(fig. 34)

Note. Some low-voltage rectifier and alarm units Z1 are different from others. In this manual, some units have been arbitrarily designated original units, and others revised units. For specific differences between the original and revised units, refer to the equipment differences chart (par. 2). Paragraphs 63 through 74 apply to both original and revised low-voltage rectifier and alarm units Z1 unless otherwise specified.

a. Low-voltage rectifier and alarm unit Z1 consists of the following subcircuits and relays:

(1) *Low-voltage rectifier circuit.* The low-voltage rectifier circuit consists

of power transformer T1 and rectifiers CR1 and CR2. Rectifier CR1 supplies 24 volts dc for the operation of all relays except K2, K3, and K6. Rectifier CR2 in conjunction with voltage-regulator tube V1, supplies 108-volts dc for the initial starting action of resistance check and starting relay K6.

(2) *Initial starting circuit*. The initial starting circuit energizes relays K6, K7, K8, K9, and K1 in sequence. When relay K1 energizes, ac input power is applied to the high-voltage rectifier circuit (main chassis). A detailed description of this starting action appears in paragraph 65.

(3) *Relay-control circuit*. The relay-control circuit is a conventional control amplifier circuit used to energize the low- and high-voltage alarm circuits during abnormally high- or low-voltage output conditions. A detailed description of the relay-control circuit is given in paragraph 66.

(4) *Low-voltage relay and Alaskan circuit*. The low-voltage relay and alarm circuit removes ac input power from the high-voltage rectifier circuit when the high-voltage output falls to 535 volts or lower, and provides visual and audible alarm indications. A detailed description of the low-voltage relay and alarm circuit is given in paragraph 67.

(5) *High-voltage relay and Alarm circuit*. The high-voltage relay and alarm circuit removes ac input power from the high-voltage rectifier circuit when the high-voltage output rises to 670 volts or higher, and provides visual and audible alarm indications. A detailed description of the high-voltage relay and alarm circuit is given in paragraph 70.

(6) Low line-voltage protective circuit. The low line-voltage protective circuit removes ac input power from the high-voltage rectifier circuit when input voltage falls to 93 volts during 115-volt operation, or 186 volts during 230-volt operation, and provides visual and audible alarm indications. A detailed description of the low line voltage protective circuit is given in paragraph 72.

(7) *Restore circuit*. The restore circuit reapplies ac input power to the high-voltage rectifier circuit when the abnormally high or low-voltage output conditions have been corrected. A detailed description of the restore circuit is given in paragraph 73.

b. A list of all relays on low-voltage rectifier and alarm unit Z1 and their functions is given in the following chart:

Relay	Name	Function
K1	Power-cutoff relay..................................	Completes the ac input circuit to transformers T1 and T2 on the main chassis.
K2	Low-voltage control relay.......................	Actuates low-voltage alarm relay during low-voltage trouble conditions.
K3	High-voltage control relay......................	Actuates high-voltage alarm relay during high-voltage trouble conditions.
K4	Low-voltage alarm relay	Releases power-cutoff relay K1 during low-voltage trouble conditions.
K5	High-voltage alarm relay........................	Releases power-cutoff relay K1 during high-voltage trouble conditions.
K6	Resistance check and starting relay	Actuates power-cutoff relay K1 when line load conditions are normal. Under abnormal conditions, K6 will not actuate K1.
K7	Starting-power relay	Actuates relay K8 during the starting cycle. During normal operating conditions, relay K7 releases, buzzer I4 is silenced, and LOAD ALARM lamp I1 is extinguished.
K8	Operating-power relay	Actuates relay K9 during the starting cycle.
K9	Power-holding relay...............................	Holds relay K1 operated during normal operating and line-voltage conditions. Deenergizes relay K1 during low line-voltage conditions.

64. Starting-Relay Circuit, General

(figs. 39 and 41 (original units) or figs. 40 and 42 (revised units))

a. Relay K6 functions as a starting relay to actuate relays K7, K8 K9, and K1 in turn. The operation of relay K1 applies ac input power to transformers T1 and T2 in the voltage rectifier circuit.

b. The energizing path for starting relay K6 consists of two parallel paths to contacts 6 and 11 of deenergized relay K5.

(1) One path from the-108-volt dc side of rectifier CR2 is through the voltage-divider network consisting of resistors R11, R13, and R10 to contacts 6 and 11 of relay K5.

(2) The other path is from the-108-volt dc side of rectifier C2 through terminal 32 of connectors P11 and J11, the external power loop (including resistors R13 through R15 (main chassis), depending on the position of REPEATER switch S6, variable resistor R12, and milliameter M1), terminal 29 of connectors J11 and P11, to contacts 6 and 11 of relay K5.

c. Resistance-Check Circuit. Both of these paths are in series with the winding of starting relay K6. Thus, the combined resistance in the two paths controls the current flow through starting relay K6. Relay K6 will operate when the resistance of the second path (*b* (2) above) is between 0 and 100,000 ohms. If the second path is open, or higher than 100,000 ohms, starting relay K6 will not operate.

65. Relay Starting Action

(figs. 39 and 41 (original units) or figs. 40 and 42 (revised units))

When AC POWER switch S1 is operated to the ON position, voltage is applied through transformer T1 on the subchassis to rectifiers CR1 and CR2, the filaments of V6, LOAD ALARM lamp I 1, and buzzer I 4. LOAD ALARM lamp I 1 will light and buzzer I 4 will sound.

a. Operation of Starting Relay K6. Under normal starting conditions (0 to 100,000 ohms in the load) the 108-volt dc regulated output from voltage regulator V1 will energize starting relay K6. When relay K6 energizes, its 2 and 3 contacts apply the-24-volt dc output of rectifier CR1 through current-limiting resistor R23 to the winding of starting-power relay K7. From the winding of K7 the current returns to the +24-volt dc.

b. Operation of Starting-Power Relay K7. The current from rectifier CR1 energizes relay K7. When the relay energizes, the following actions occur:

(1) Contacts 3 and 10 break, connecting potentiometer R16 and resistor R17 in series with the winding of starting relay K6. Potentiometer R16 is adjusted during manufacture to permit relay K6 to deenergize when the load is approximately 4,800 ohms. When the load is less than 4,800 ohms, relay K6 will not deenergize. Under normal operating conditions, relay K6 deenergizes.

(2) Contacts 9 and 2 of relay K7 close; the relay is held operated by current flow through contacts 3 and 10 of deenergized relay K2.

(3) Contacts 4 and 10 or relay K7 close, connecting resistor R22 in parallel with that part of the voltage-divider network composed of resistor R10 and potentiometer R13 which connects to the grids of amplifier tube V6. This parallel combination reduces the bias, so that the high-voltage output of tube V6 will be 445 volts.

(4) Contacts 5 and 11 close, and the operating path for LOAD ALARM lamp I 1 and buzzer I 4 in the alarm circuit

Figure 39. Power Supply PP-826/U, schematic diagram (original units).

Figure 40. Power Supply PP-826/U, schematic diagram (revised units).

Figure 41. Power Supply PP-826/U, starting action, schematic diagram (original units).

Figure 42. Power Supply PP-826/U, starting action, schematic diagram (revised unite).

(Contained in separate envelope)

cult is transferred from contacts 6 and 11.

(5) Contacts 7 and 12 of relay K7 close; the 24-volt dc output from rectifier CR1 energizes relay K8. This circuit is from the –24-volt dc terminal of rectifier CR1, through contacts 3 and 1 of deenergized relay K6, contacts 12 and 7 of energized relay K7, RESTORE switch S5 (located on the main chassis), the winding of relay K8, and resistor R15 to the +24-volt dc.

c. Operation of Operating-Power Relay K8. When relay K8 is energized (*b* (5) above), the following actions occur:

(1) Contacts 3 and 10 open to prevent the output from the high-voltage rectifier circuit from appearing across starting relay K6, voltage-regulator tube V1, and rectifier CR2.

(2) Contacts 7 and 12 close to form part of the operating path of low-voltage alarm relay K4.

(3) Contacts 5 and 11 (original units only, fig. 41) close to transfer the operating path for LOAD ALARM lamp I 1 and buzzer I 4 in the alarm circuit from contacts 6 and 11.

(4) Contacts 5 and 11 (revised units only, fig. 42) close to supply 24-volt dc power from rectifier CR1 to energize power-holding relay K9. This circuit is from the−24-volt dc terminal of rectifier CR1 through contacts 3 and 1 of released relay K6, contacts 11 and 5 of operated relays K7 and K8, and the winding of relay K9 to the +2l-volt dc.

(5) Contacts 2 and 9 (original units only, fig. 41) close to supply the 24-volt dc output from rectifier CR1 to energize power-holding relay K9. This circuit is from the −24-volt dc terminal of rectifier CR1, through contacts 3 and 1 of released relay K6, and contacts 12 and 7 of energized relay K7, to RESTORE switch S5. From switch S5, through contacts 9 and 2 of energized relay K8, contacts 11 and 6 of released relay K2, and the winding of relay K9 to the +24-volt dc.

(6) Contacts 2 and 9 (revised units only, fig. 42) close to connect a short across potentiometer R20 and form part of the operating path for relay K8, established after the release of relay K7. Terminal 1 of potentiometer R20 is connected through contacts 2 and 9 of relay K8, RESTORE switch S5, contacts 7 and 12 of operated relay K7, and contacts 1 and 3 of released relay K6 to the −24-volt dc. Terminal 3 of potentiometer R20 is connected to the same potential as terminal 1 through contacts 5 and 11 of relays K8 and K7, and contacts 1 and 3 of released relay K6, thereby shorting potentiometer R20.

d. Operation *of Power-Holding Relay K9.* When relay K9 is energized, the following operations occur:

(1) Contacts 2 and 3 (original units only, fig. 41) close to lock up relays K8 and K9 through contacts 3 and 10 of released relays K4 and K5. This circuit is from the- -24-volt dc terminal of rectifier CR1 through contacts 3 and 10 of released relays K4 and K5, contacts 3 and 2 of energized relay K9, contacts 11 and 6 of deenergized relay K2 and the winding of relay K9 to the +24-volt dc.

(2) Contacts 2 and 3 (revised units only, fig. 42) close to set up the path for energizing relays K8 and K9 when relay K7 releases. Relay K8 then will be operated by current flowing from the −24-volt dc terminal of rectifier CR1 through contacts 3 and 10 of released relays K4 and K5, contacts 3 and 2. of operated relay K9, contacts 2 and 9 of relay K8, and the winding of relay K8 to the +24-volt dc.

(3) Contacts 4 and 5 close to supply 24-volt dc power from rectifier CR1 to the winding of power-cutoff relay K1. Relay K1 is thus energized.

e. Operation of Power-Cutoff Relay A1. When relay K1 is energized, contacts 2 and 3 on one side of the ac input power line and contacts 4 and 5 on the other side of the ac input powerline close; this action causes primary input power to be applied to the windings of high-voltage rectifier transformers T1 and T2 on the main chassis. Power is also applied to blower motor B1 if thermostatic switch S3 is closed.

f. Compensating Resistor, Function. Resistor R17 is a special resistor used to compensate for small changes in the release current of starting relay K6 due to changes in ambient temperature. In some 600 VOLT POWER SUPPLY units, resistor R23 is in series with the winding of relay K7 to prevent overheating of the relay if relay K6 does not release. In other 600 VOLT POWER SUPPLY units, a different type of relay has been substituted for relay K7. The latter type relay prevents possible chattering of relays K6 and K7. When the latter type relay is used, resistor R23 is replaced by a strap.

66. Relay-Control Circuit

(figs. 39 and 43 (original units) or figs. 40 and 44 (revised units)).

a. General. The relay-control circuit operates the low- and high-voltage alarm and cutoff relays during abnormal low- or high-voltage operations. This circuit is a conventional control amplifier circuit in which variations in the high-voltage or load circuit are compared with a reference voltage developed by a voltage-regulator and voltage-divider network. The difference is applied to the grid of control-amplifier tube V6, and the amplified difference is used to operate the protective relays. In addition, a time-delay network is incorporated to prevent high-voltage cutoff and alarm indications during starting, when the output voltage is above high-voltage cutoff value.

b. Control-Amplifier Circuit. The relay-control circuit consists of control-amplifier tube V6, voltage-regulator tube V5, and a voltage-divider network consisting of resistors R10 and R11, and potentiometer R13. The filament supply for control-amplifier tube V6 is obtained from a 6.4-volt step-down winding on power transformer T1. Resistor R6, between the plate of voltage-regulator tube V5 and the cathodes of control-amplifier tube V6, stabilizes the operating conditions of amplifier tube V6 during variations in filament voltage. Plate voltage for amplifier tube V6 is obtained from the cathodes of current regulator tubes V3 and V4 on the main chassis.

(1) A constant potential of 150 volts dc is maintained across voltage-regulator tube V5 in conjunction with current-limiting resistor R7. This current potential is independent of variations in the high-voltage output and is impressed on the cathodes of control-amplifier tube V6. The two sections of this tube are connected in parallel.

(2) The voltage-divider network, consisting of resistors R10 and R11 and LOW-VOLT ALARM potentiometer R13, is connected to both the output of the high-voltage rectifier circuit and the grids of control-amplifier tube V6. Thus, any variations in the high-voltage output circuit will cause the bias to vary on amplifier tube V6. The variations in the high-voltage output circuit are amplified by control amplifier tube V6 and are used to operate low- and high-voltage cutoff and alarm relays K2 and K3 respectively. A detailed description of the operation of the low- and the high-voltage relay and alarm circuits is given in paragraphs 67 through 73.

c. Time-Delay Circuit. A time-delay circuit, consisting of resistors R8 and R9 capacitor C5, prevents the high-voltage surge from operating the high-voltage cutoff and alarm circuit when the tube filaments of the unattended repeaters are warming up. Resistors R8 and R9 are connected to the grid of amplifier tube V6. Capacitor C5 is connected from the grid of amplifier V6 to the negative side of the high-voltage rectifier output.

(1) When the output voltage rises across voltage-regulator tube V5, a potential of 150 volts dc is applied to the cathodes of control-amplifier tube V6. The time-delay network maintains the grids of control-amplifier tube V6 at −150-volt. dc potential in respect to the cathodes. This voltage cuts off the tube.

(2) At the end of 20 seconds, capacitor C5 is charged fully and the abnormal bias is removed from the tube, causing

it to conduct. This delay is to allow the initial voltage in the high-voltage rectifier circuit to subside while tile tube filaments of the unattended repeaters are warming up. The 20-second time delay prevents this voltage peak from causing excessive current flow in control-amplifier tube V6, which would otherwise operate high-voltage cutoff and alarm relays K2 and K3.

67. Low-Voltage Relay and Alarm Circuit

(figs. 39 and 43 (original units) or figs. 40 and 44 (revised units))

a. General. The low-voltage relay and alarm circuit removes primary power from the high-voltage rectifier circuit when the high-voltage output falls to 535 volts dc. In addition, the alarm lamp and a buzzer operate to alert the operator in case of trouble. The low-voltage relay and alarm circuit consists of the relay control circuit (par. 66), low-voltage relay K2, low-voltage alarm relay K4, LOW VOLTAGE indicator lamp I 2, ALARM CUTOFF switch S4, buzzer I 4, and RESTORE switch S5.

b. Energizing Circuit. From the plates of control-amplifier tube V6, the path of the low-voltage relay energizing circuit is through the series parallel combination of variable resistor R12 and resistor R21, the winding of high-voltage relay K3, and resistor R19, to the winding of low-voltage relay K2. From relay K2, the path is completed through resistor R8 on the main chassis to the cathodes of current regulator tubes V3 and V4.

c. Initial Action, Time Delay. When power-cutoff relay K1 applies power to the primaries of high-voltage transformers T1 and T2 on the main chassis, high voltage is developed in the high-voltage rectifier output circuit. This voltage is applied to the cathodes of control-amplifier tube V6 through voltage-regulator tube V5 in conjunction with current-limiting resistor R7. The application of this initial output voltage from the voltage-divider network, R10, R13, and R11, to the grids of amplifier tube V6 is delayed for approximately 20 seconds by the time-delay network, R8, R9, and C5 (par. 66*c*). At the end of 20 seconds, capacitor C5 is charged fully and control-amplifier tube V6 will conduct. Under normal operating conditions V6 will conduct enough current to energize low-voltage relay K2, but not enough to energize high-voltage relay K3. A detailed description of the operation of relay K2 is given in paragraph 68.

68. Low-Voltage Relay Operation

(figs. 39 and 43 (original units) or figs. 40 and 44 (revised units))

When energized, low-voltage relay K2 performs the following functions:

a. Release of Relay K7. Contacts 3 and 10 of relay K2 open, breaking the operating path of relay K7, and deenergizing it. When deenergized, relay K7 performs the following operations.

(1) When contacts 4 and 10 of relay K7 open, resistor R22 is removed from the grid circuit of control-amplifier tube V5. Initially, resistor R22 is connected in parallel with part of the voltage-divider formed by resistors R10 and R11 and LOW-VOLT ALARM potentiometer R13, in the grid circuit of control-amplifier tube V6. This allows the tube to conduct enough current to energize relay K2 when the high-voltage rectifier output has reached a value of 445 volts dc. Without resistor R22 in the grid circuit, the bias on control-amplifier tube V6 is made more negative, and current flow is decreased enough, so that relay K2 will deenergize when the high-voltage rectifier output has dropped to 530 volts dc, or less. This provides overlapping protection during low-voltage trouble conditions. For example, if the high-voltage output; falls to 460 volts dc (4,600-ohm power loop resistance), relay K2 will deenergize. When RESTORE switch S5 is operated, starting relay K6 should not deenergize. Relay K6 will not deenergize below 4,800-ohm

Figure 43. Power Supply PP-826/U, relays in normal operating condition, schematic diagram (original units).

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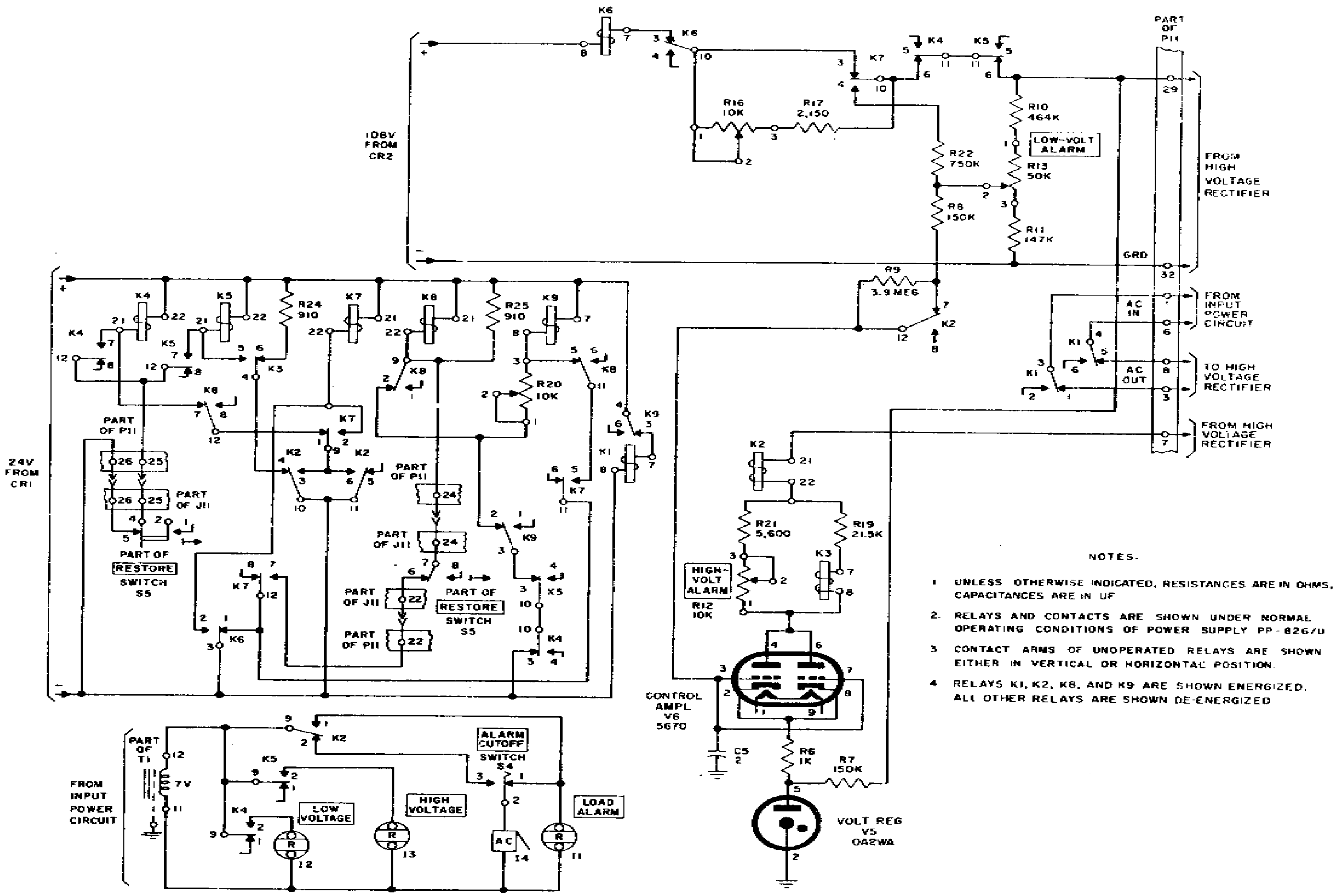


Figure 44. Power Supply PP-826/U, relays in normal operating condition, schematic diagram (revised units)

power loop resistance. If relay K6 does deenergize because of changes in ambient temperature not compensated by temperature-compensating resistor R17, resistor R22 will be reinserted in grid circuit and relay K2 will operate at 460 volts. When resistor R22 is removed from the grid circuit of control-amplifier tube V6, relay K2 will deenergize.

(2) Contacts 8 and 12 close to form part of the energizing path for low-voltage alarm relay K4.

(3) Contacts 3 and 10 close to place a short across resistors R16 and R17, in series with the winding of relay K6, and restore this circuit to starting condition.

(4) Contacts 5 and 11 (original units only, fig. 43) open to extinguish LOAD ALARM lamp I 1 and silence buzzer I 4, if ALARM CUTOFF switch S4 is not in the cutoff position. If the ALARM CUTOFF switch is in the cutoff position, buzzer I 4 will operate; the operating path is completed through contacts 5 and 11 of energized relay K8 and contacts 6 and 11 of released relay K7. This alarm is provided to prevent the operator from leaving switch S4 in the cutoff position during normal operation.

(5) Contacts 5 and 11 (revised units only, fig. 44) open to insert previously shorted variable resistor R20 (par. 65*c*(6)) into the operating path of relay K9. Potentiometer R20 is adjusted during manufacture or following repair of low-voltage rectifier and alarm Z1 to release relay K9 when the ac input voltage drops below 93 volts during 115-volt operation, or below 186 volts during 230-volt operation.

b. Operating Circuit, Original Units Only (fig. 43). Contacts 5 and 11 of relay K2 close to place resistor R24 in parallel with the energizing circuits of relays K8, K9, and K1 to replace the resistance formerly supplied by relay K7. Without resistor R24, relay K1 would overheat.

(l) Contacts 1 and 9 of relay K2 open to prevent the output of rectifier CR1 from being applied to the winding of low-voltage alarm relay K4 during normal operating conditions.

(2) Contacts 2 and 9 of relay K2 close to form part of the energizing path for high-voltage alarm relay K5.

(3) Contacts 6 and 11 of relay K2 open to place potentiometer R20 in series with the winding of power-holding relay K9. Potentiometer R20 is adjusted during manufacture to permit relay K9 to be deenergized when the ac input voltage drops below 93 volts during 115-volt operation or below 186 volts during 230-volt operation. When relay K9 deenergizes, relay K1 deenergizes and as a result, the primary power to the high-voltage circuit is removed.

(4) Contacts 7 and 12 of relay K2 close to short out resistor R9 in the time-delay network on the grids of control-amplifier tube V6. This reduces the 20-second time factor associated with control-amplifier tube V6 for starting to a 1-second time factor for alarm indications produced by variations in the high-voltage output circuit.

c. Opening Circuit, Revised Units Only (fig. 44). Contacts 4 and 10 of relay K2 close to place resistor R24 in parallel with the energizing circuits of relays K8, K9, and K1, and to replace the resistance formerly supplied by the winding of relay K7. Without resistor R24, relay K1 may overheat. Closed contacts 4 and 10 of relay K2 also form part of the operating path for high-voltage alarm relay K5.

(1) Contacts 1 and 9 of relay K2 open to extinguish LOAD ALARM lamp I 1 and to silence buzzer I 4 if ALARM CUTOFF switch S4 is not in the cutoff position. If ALARM CUTOFF switch S4 is in the cutoff position, buzzer I 4 is energized through contacts 2 and 9 of relay K2 and through the contacts of ALARM CUTOFF switch S4. This alarm is provided to prevent the operator from leaving

switch S4 in the cutoff position during normal *operation*.

(2) Contacts 7 and 12 of relay K2 close to short out resistor R9 in the time-delay network on the *grids* of control amplifier tube V6. This reduces the 20-second time factor associated with control-amplifier tube V6 for starting to a 1-second time factor for alarm indications produced by variations in the high-voltage output circuit.

(3) Paralleled contacts 11 and 6 and 10 and 3 of relay K2 open to prevent application of dc voltage from rectifier CR1 to low-voltage alarm relay K4.

69. Low-Voltage Alarm Operation

a. Deenergizing of Relay k2 Original Units Only (figs. 39 and 43). LOW-VOLT ALARM potentiometer R13 is adjusted so that relay K2 deenergizes at 530 volts. When the output in the high-voltage rectifier circuit drops to 530 volts or less, low-voltage relay K2 will deenergize. When relay K2 deenergizes, the following operations occur:

(1) Contacts 6 and 11 close to short out *potentiometer* R20 in series with the winding of power-holding relay K9.

(2) Contacts 3 and 10 close to prepare the lockup path of relay K7. Relay K7 does not operate, because contacts 2 and 9 of the relay are open.

(3) Contacts 7 and 12 open to remove the short from *resistor* R9 in the time-delay network in the grid circuit of control-amplifier tube V6.

(4) Contacts 1 and 9 close, supplying voltage from rectifier CR1 to energize low-voltage alarm relay K4. The energizing path of this circuit is traced from the negative terminal of rectifier CR1 through contacts 1 and 3 of deenergized relay K6, contacts 12 and 8 of deenergized. relay K7, contacts 7 and 12 of energized relay K8, and contacts 9 and 1 of deenergized relay X2. From contact 1 of relay K2, the path is completed through the winding of relay K4, resistor R15 to the positive side of rectifier CR1.

b. Deenergizing of Relay K2, Revised Units Only (figs. 40 and 44). LOW-VOLT ALARM potentiometer R13 is adjusted so that relay K2 deenergizes at 530 volts. When the output in the high-voltage rectifier circuit drops to 530 volts or less, low-voltage relay K2 will deenergize. When relay K2 deenergizes, the following operations occur:

(1) Parallel-connected contacts 3 and 10 and 6 and 11 close to operate low voltage alarm relay K4. This circuit is from the negative side of rectifier CR1 through parallel-connected contacts 3 and 10 and 6 and 11 of operated relay K2, contacts 1 and 9 of released relay K7, contacts 12 and 7 of operated relay K8, and through the winding of relay K4 to +24 volts dc.

(2) Contacts 4 and 10 open to disconnect resistor R24 from the negative side of CR1. Resistor R24 is no longer required to prevent overheating of relay K1 (par. 71*c*) because relay K1 is disconnected from the 24-volt dc source after relay K2 releases.

(3) Contacts 7 and 12 open to remove the short from *resistor* R9 in the time delay network on the grids of control amplifier tube V6.

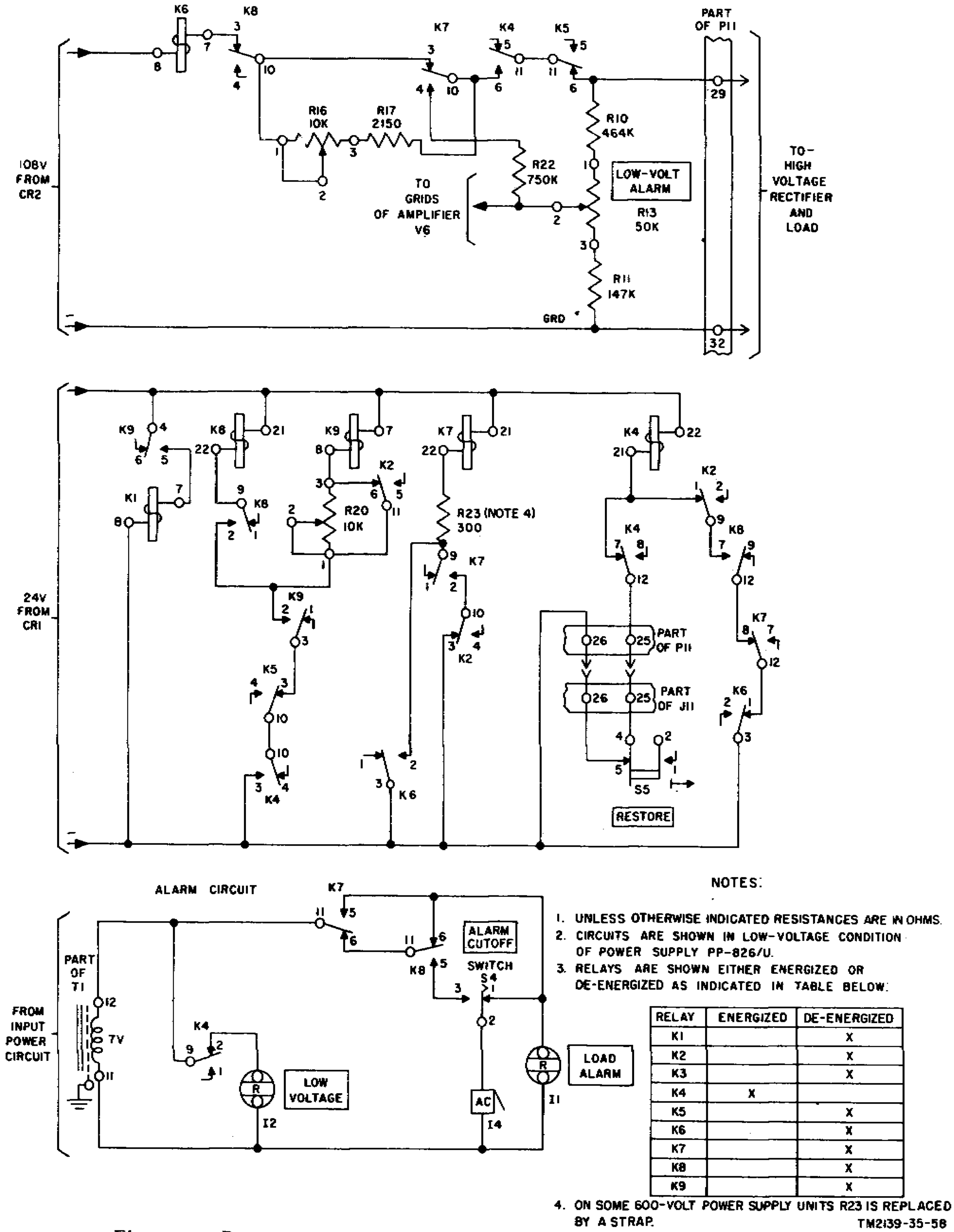
(4) Contacts 1 and 9 close to operate buzzer I 4 and LOAD ALARM lamp I 1. The buzzer may be silenced by operating ALARM CUTOFF switch S4.

c. Energizing of Low-Voltage Alarm Relay K4 (figs. 39 and 45 (original units) and figs. 40 and 46 (revised units)). When relay K4 is energized, the following operations occur:

(1) Contacts 2 and 9 close to light LOW VOLTAGE *indicator* lamp I 2.

(2) Contacts 7 and 12 close to lock the relay. The locking path of relay K4 is from the *negative* terminal of rectifier CR1 through RESTORE switch S5, contacts 12 and 7 of energized relay K4, and the winding of relay K4, to the +24 volts dc. Relay K4 will remain energized until RESTORE switch S5 is operated.

(3) Contacts 6 and 11 open to break the operating path *of* relay K6. This



RELAY	ENERGIZED	DE-ENERGIZED
K1		X
K2		X
K3		X
K4	X	
K5		X
K6		X
K7		X
K8		X
K9		X

Figure 45. Power Supply PP-826/U, low-voltage relay and alarm circuits in low-voltage condition, schematic diagram (original units).

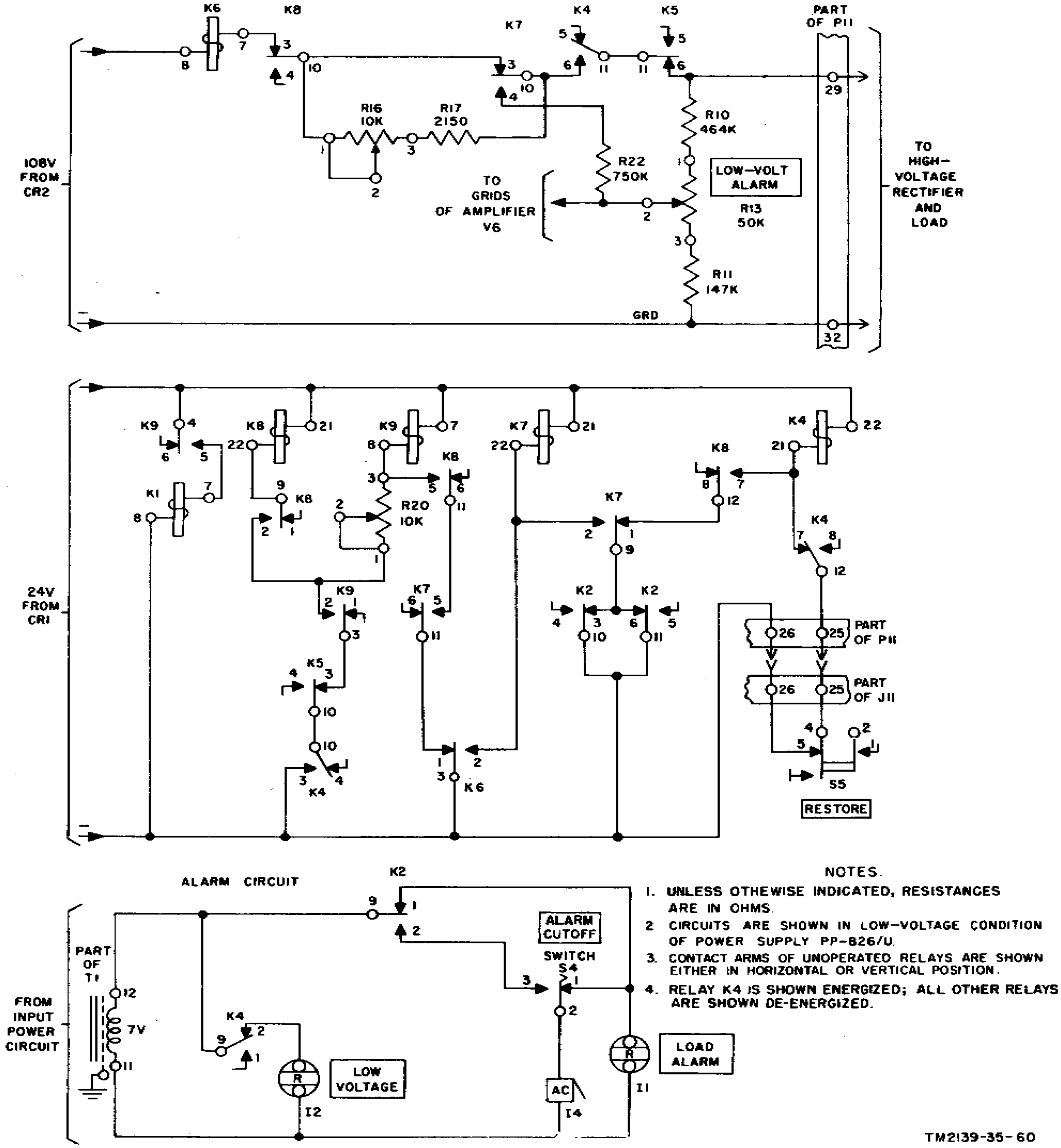
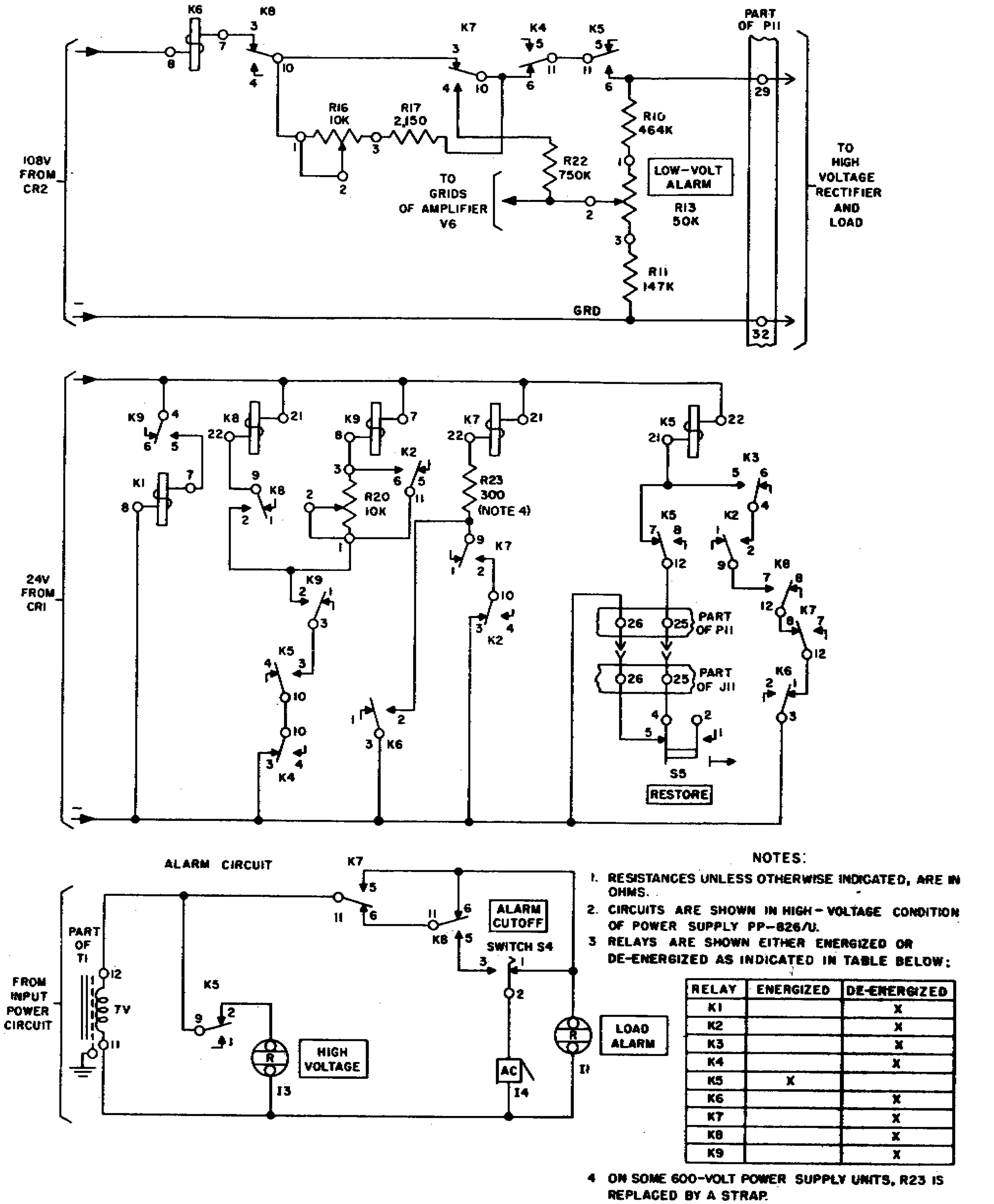


Figure 46. Power Supply PP-826/U, low-voltage relay and alarm circuits in low-voltage condition, schematic diagram (revised units).



NOTES:

1. RESISTANCES UNLESS OTHERWISE INDICATED, ARE IN OHMS.
2. CIRCUITS ARE SHOWN IN HIGH-VOLTAGE CONDITION OF POWER SUPPLY PP-826/U.
3. RELAYS ARE SHOWN EITHER ENERGIZED OR DE-ENERGIZED AS INDICATED IN TABLE BELOW:

RELAY	ENERGIZED	DE-ENERGIZED
K1		X
K2		X
K3		X
K4		X
K5	X	
K6		X
K7		X
K8		X
K9		X

4. ON SOME 600-VOLT POWER SUPPLY UNITS, R23 IS REPLACED BY A STRAP.

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Figure 47. Power Supply PP - 826/U, high-voltage relays and alarm circuits in high-voltage condition, schematic diagram (original units).

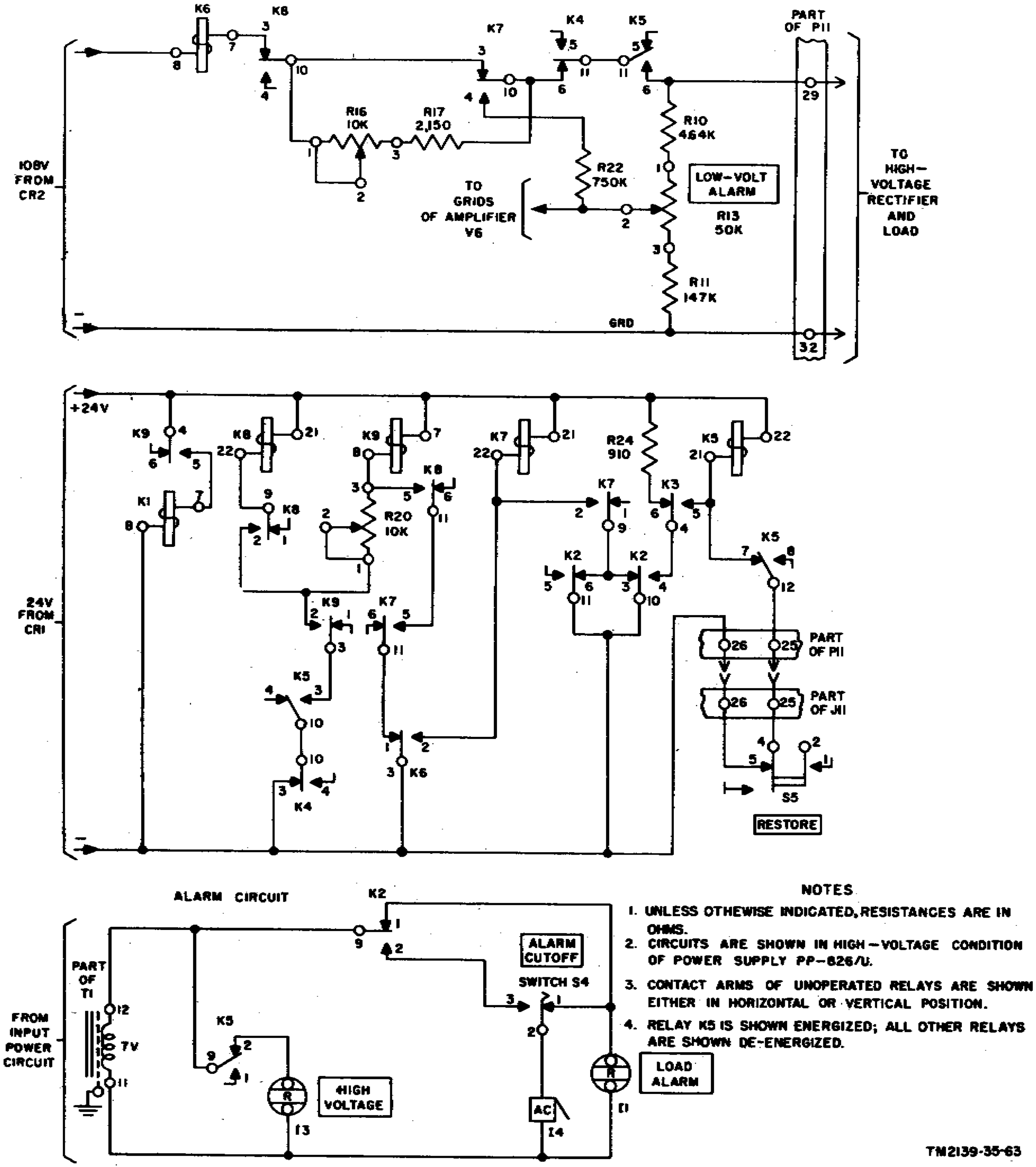

Figure 48. Power Supply PP-886/U, high-voltage relays and alarm circuits in high-voltage condition, schematic diagram (revised unite).

prevents the reenergizing of relay K6 and further relay operations.

(4) Contacts 3 and 10 open the locking path of power-holding relay K9; relay K9 deenergizes. When relay K9 deenergizes, contacts 4 and 5 open to break the energizing path of power-cutoff relay K1. When relay K1 deenergizes contacts 2, 3, 4, and 5 open. This removes the ac input power from the primaries of high-voltage transformers T1 and T2, and cuts off the

high-voltage rectifier output. Contacts 2 and 3 of relay K9 open locking path of relay K8; relay K8 deenergizes. Resistor R25, connected across the winding of relay KS, delays the deenergizing for a short time to insure the lockup of relay K4.

d. Deenergizinq of Relay KS (figs. 39 and 45 (original units) and figs. 40 and 46 (revised units)). When relay K8 deenergizes, the following operations occur:

(1) Contacts 6 and 11 close (original units only) to operate buzzer I 4 and LOAD ALARM lamp I 1. The buzzer may be silenced by operating ALARM CUTOFF switch S4.

(2) Contacts 7 and 12 open to break the initial energizing path of relay K4, but not before relay K4 is locked up by its own contacts 7 and 12 (*c* above).

(3) Contacts 2 and 9 open to break further the operating path of relay K8.

(4) Contacts 3 and 10 close to prepare the energizing path for starting relay K6. Relay K6 does not operate because this energizing path is broken by opened contacts 6 and 11 in energized low-voltage alarm relay K4.

70. High-Voltage Relay and Alarm Circuit

(figs. 39 and 43 (original units) or figs. 40 and 44 (revised units))

a. General. The high-voltage relay and alarm circuit removes primary power from the high-voltage rectifier circuit when the high-voltage output exceeds 670 volts. In addition, the buzzer and an alarm lamp operate to alert the operator in case of trouble. The high-voltage relay and alarm circuit consists of the relay-control circuit (par. 66), high-voltage relay K3, high-voltage alarm relay K5, HIGH-VOLTAGE indicator lamp I 3, ALARM CUTOFF switch S4, buzzer I 4, and RESTORE switch S5.

b. Energizing Circuit. From the plates of control-amplifier tube V6, the path of the high-voltage relay energizing circuit is through the series parallel circuit consisting of potentiometer R12 and resistor R21, the winding of relay K3 and resistor R19, and the winding of relay K2. From relay K2, the path is completed through resistor R8 (main chassis) to current regulator tubes V3 and V4. Resistor R19 has a negative temperature coefficient which compensates for the positive temperature coefficient of relay K3. This stabilizes the deenergizing point of relay K3 during changes in ambient temperature. Potentiometer R12 is adjusted, so that relay K3 will operate when the voltage in the high-voltage output reaches 670 volts. If variable resistor R12 is shorted accidentally or has been adjusted to a very low resistance, resistor R21 insures the operation of relay K3 when the high-voltage output reaches 800 volts.

71. High-Voltage Alarm Operation (figs. 39 and 43 (original units) or figs. 40 and 44 (revised units))

During normal operation, control-amplifier tube V6 conducts enough current to operate low-voltage relay K2, but not high-voltage relay K3. When the output voltage of the high-voltage rectifier circuit rises to 670 volts, the voltage applied to the control grids of tube V6 increases proportionately to cause the tube to conduct enough current to energize relay K3.

a. Energizing of High-Voltage Relay K3. When relay K3 is energized, the following operations occur:

(1) Contacts 3 and 1 of relay K3 (original units only, fig. 43) open to remove resistor R24 from its parallel connection with the operating circuits of relays K8, K9, and K1.

(2) Contacts 4 and 6 of relay K3 (revised units only, fig. 44) open to remove resistor R24 from its parallel connection with the operating circuits of relays K8, K9, and K1.

(3) Contacts 4 and 5 of relay K3 close, and high-voltage alarm relay K5 is energized.

b. Energizing of High-Voltage Alarm Relay K5, Original Units Only (fig. 43). The energizing path of high-voltage alarm relay K5 is from the negative terminal of rectifier CR1 through contacts 3 and 1 of deenergized relay K6, contacts 12 and 8 of deenergized relay K7, contacts 12 and 7 of energized relay K8, contacts 9 and 2 of energized relay K2, contacts 4 and 5 of energized relay K3, and through the winding of relay K5 to the +24 volts dc. Relay K5 operates (*d* below).

c. Energizing of High-Voltage Alarm Relay K5, Revised Units Only (fig; 44). The energizing path of high-voltage alarm relay K5 is from the negative terminal of rectifier CR1 through contacts 10 and 4 of energized relay K2, contacts 4 and 5 of energized relay KS, and the winding of relay K5 to the +24 volts dc. Relay K5 operates (*d* below).

d. Functions of High-Voltage Alarm Relay K5.

(1) Contacts 9 and 2 close to energize HIGH-VOLTAGE indicator lamp I 3.

(2) Contacts 7 and 12 close to lock the relay. The locking circuit is from the negative terminal of rectifier CR1 through RESTORE switch so, contacts 12 and 7 of energized relay K5, and the winding of relay K5 to the +24 volts dc. Relay K5 will remain energized until RESTORE switch S5 is operated to break the locking circuit.

(3) Contacts 6 and 11 of K5 open to break the operating path of relay K6. This prevents the reenergizing of relay K6 and further relay operations. In addition, contacts 6 and 11 open to prevent high voltage from appearing across relay K6 and rectifier CR2 when relay K8 deenergizes.

(4) Contacts 3 and 10 of relay K5 open to break the locking path of relay K9 and cutoff the high-voltage rectifier (par. 69*b* (4)).

72. Low Line-Voltage Protective Circuit

(figs. 39 and 43 (original units) or figs. 40 and 44 revised units))

The low line-voltage protective circuit removes power from the high-voltage rectifier circuit when the ac input voltage to the power supply falls below 93 volts on 115-volt operation, or 186 volts on 230-volt operation.

a. Functions of Potentiometer R20. Potentiometer R20, in series with the winding of power-holding relay K9, is adjusted during manufacture to permit relay K9 to deenergize when the ac input voltage falls to 93 volts on 115-volt operation or 186 volts on 230-volt operation. When relay K9 deenergizes, its 4 and 5 contacts open the energizing path of relay K1. When relay K1 deenergizes, its 4 and 6, and 2 and 3 contacts open to remove the ac input power from the primaries of high-voltage transformers T1 and T2.

b. Deenergizing of Relay K8. The locking path of relay K8 is from the negative terminal of rectifier CR1 through contacts 3 and 10 of deenergized relays K4 and K5, through contacts 3 and 2 of energized relay K9, contacts 2 and 9 of energized relay K8 and the winding of relay K8, to the +24 volts dc. When K9 deenergizes, contacts 2 and 3 open to break the locking path of relay K8.

c. Deenergizing of Relay K2. When relay K1 deenergizes and removes the ac input to the high-voltage transformers, the output voltage of the high-voltage circuit falls to zero. Filter capacitors C1 and C2 in the high-voltage circuit discharge enough current through the relay-control circuit and relay X2 to delay the deenergizing of K2 until relay K8 has deenergized. This prevents low-voltage alarm relay K4 from operating and locking. Relay K4 will not operate when relay K8 is deenergized because the energizing path is through contacts 7 and 12 of energized relay K8. Since contacts 7 and 12 are open on deenergized relay K8, relay K4 will not operate.

d. Recycling Actions. Because relay K2 is delayed in deenergizing, relay K4 is prevented from lockingup and the recycling of the starting action is allowed. Rectifier CR2 still has a sufficiently high output at 93-volt-ac input power to energize starting relay K6. Relay K6 will energize to cause relays K7, K8, K9, and K1 to energize as described in paragraph 64. After relay 7 energizes, relay K6 deenergizes since the starting action has been initiated. Relay K2 will then operate and insert variable resistor R20 in series with the winding of power-holding relay K9. Thus relay K9 will deenergize if the ac input voltage remains below 93 volts, and the circuit will recycle. Thus it is possible for the low-voltage input protection circuit to recycle continuously, when the input power is between 93 and 92 volts ac. When the input voltage returns to 97.5 volts or higher, the circuit will operate normally. If the ac input voltage drops below 92 volts, rectifier CR2 will not provide enough power to energize starting relay K6, and this starting and restoring action to the high-voltage rectifier circuit will not occur.

73. Restore Circuit

(fig. 39 (original units) or fig. 40 (revised units))

RESTORE switch S5 is provided to open the locking path of the low- and high-voltage alarm relays. These relays deenergize to extinguish the indicator lamps, silence the buzzer, restore power from rectifiers CR1 and CR2 to energize relays K6, K7, K8, K9, and K1, and restore ac input power to the primaries of high-voltage transformers T1 and T2.

74. Test Jacks

(fig. 39 (original units) or fig. 40 (revised units))

Jacks J1 and J3 through J5 (located on the main chassis) are test jacks provided for measuring the voltages in the main chassis of the 600 VOLT POWER SUPPLY. Jacks J1 through J10 (located on the subchassis) are test jacks provided for measuring voltages on low-voltage rectifier and alarm unit Z1.

CHAPTER 3
OPERATIONAL TESTS AND TROUBLESHOOTING

Section I. GENERAL TROUBLESHOOTING INFORMATION

Warning: **When troubleshooting or making repairs in this equipment, be extremely careful. Voltages as high as 1,000 volts are present internally. Use insulated test probes when making the required voltage measurements. Always disconnect the power cord from the equipment and short the suspected part to chassis ground before touching it.**

75. General Instructions

a. Troubleshooting at field and depot maintenance level includes all the techniques required to isolate a defective part. The field and depot maintenance procedures are not complete in themselves but supplement the procedures described in organizational maintenance. The systematic troubleshooting procedure, which begins with the operational and sectionalization checks performed at an organizational level, must be completed by further localizing and isolating techniques.

b. Troubleshooting may be performed while the equipment is operating as part of a system or, if necessary, after the equipment (or parts of it) have been removed from service. When trouble occurs, certain observations and measurements can be made which will help in determining whether the local equipment is at fault or if the trouble exists elsewhere in the system. Usually, when troubleshooting is performed while the equipment is operating as part of a system, it is done at the organizational level (TM 11-2139-20). Troubleshooting at the field level is usually done with the component removed from the equipment with which it is normally associated. Paragraph 76 describes the systematic procedures to be followed which will enable the repairman to isolate the cause of the trouble and correct the fault.

76. Troubleshooting Procedures

a. General. The first step in servicing a defective equipment is to s*ectionalize* the fault. Sectionalization means tracing the fault to the major component or circuit responsible for abnormal operation. The second step is to *localize* the fault. Localization means tracing the fault to the defective subchassis or stage. Refer to TM 11-2139-10 for sectionalization procedures and to TM 11-2139-20 for localization procedures. The third step, *isolation*, means tracing the fault to the defective part. Some faults, such as burned-out resistors, arching, or shorted transformers, can often be isolated by sight, smell, or hearing. The majority of faults, however, must be localized by checking voltages and resistances. Use resistor and capacitor color codes (figs. 137 and 136) to find the value of the components. Use tube socket voltage and resistance diagrams (TM 11-2139-20) to determine normal readings, and compare them with the readings taken. In all tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble often may be made to appear by tapping or j erring the equipment. Check the wiring and connection to the units of the set.

b. Procedure.

(1) If the trouble symptom, as reported by organizational maintenance personnel, is in terms of improper continuity or tube-socket voltage and resistance measurements, arrange the defective panel or pluck-out assembly in an operational test setup. Refer to the appropriate test setup schematic, wiring, and parts location diagrams and perform additional voltage

and resistance measurements to isolate the defective part.

(2) If the trouble symptom has not been localized to a suspected stage or circuit by organizational maintenance personnel, connect the defective panel or pluck-out assembly in an operational test setup and proceed to make tube-socket voltage, resistance, and continuity checks to localize the trouble. Refer to TM 11-2139-20 for tube socket voltage and resistance values. After localizing the trouble, perform additional voltage and resistance measurements to isolate the defective part. Refer to the appropriate test setup schematic, wiring, and parts location diagrams in this manual.

(3) If the trouble has not been isolated after performing the troubleshooting procedures in (1) or (2) above, perform an operational test on the defective panel or subassembly. The operational tests, in conjunction with their respective troubleshooting and signal substitution charts, should aid in further localizing and isolating the defective part.

77. Test Equipment, Tools, and Special Equipment Required

The chart in a below lists the test equipment required for troubleshooting Telephone Terminal AN/TCC-7. Tools and special equipment are listed in *b* below.

a. Test Equipment.

Item	Technical Manual	Common Name
Attenuator TS-402/U	TM 11-2044	Attenuator.
Audio Level Meter ME-71A/FCC or equal	TM 11-2151	Audio level meter.
Electron Tube Test Set TV-7/U or equal	TM 11-5083	Tube test set.
Frequency Meter AN/USM-26	TM 11-5057	Frequency meter.
Multimeter AN/URM-105 or equal	....	Multimeter.
Multirange Instrument Shunt MX-1471/U	....	Shunt.
Signal Generator SO-71/FCC or equal	TM 11-5088	Signal generator.
Voltmeter, Meter ME-30A/U or equal	TM 11-5132	Voltmeter.
Electronic Multimeter TS-505 or equal	TM 11-5511	Electronic multimeter

b. Tools and Special Equipment.

Tools and special equipment	Technical manual	Common name
Telephone Carrier System Test Facilities Kit MK-155/TCC	TB SIG 328	Test facilities kit.
Tool Equipment TE-123		
Tube Socket Adapter Kit MX-1258/U		Tube socket adapter
Power Supply PP-827/U or equal	TM 11-2139-35	200-VOLT POWER SUPPLY.
Variable Transformer TF-171/USM		Variable transformer.

78. Telephone Carrier System Test Facilities Kit MK-155/TCC

The test facilities kit contains test cable assemblies, impedance matching transformers and pads, assorted resistors and capacitors, and test leads. The components contained in the test facilities kit are used when performing operational troubleshooting and final-testing procedures on the panels and subassemblies. A complete description and detailed listing of the contents of the test facilities kit is covered in TB SIG 328.

79. Calibration of Audio Level Meter ME-71A/FCC

(fig. 49)

To calibrate the audio level meter with sufficient accuracy to perform the operational tests, follow the procedures given below before using the meter. Refer to TM 11-2151 for operating instructions of the audio level meter.

Note. For all tests described in this manual using the audio level meter, the selector switch on the front panel of the meter must be operated to the VMUNBAL 600 Ω BRG position. All connections to the audio level meter must be made to the unbalanced binding posts adjacent to the selector switch.

a. Connections. Connect the audio level meter to a circuit arranged as shown in figure 49. Be sure that all components have the proper values and are properly connected.

b. Calibration Test. Record the results of the following test on charts explained in *c* below, so that proper correction procedure (*d* below) can be applied to the audio level meter indications.

(1) Calibrate the audio level meter against its internal standard as described in TM 11-2151.

(2) Set Attenuator TS-402/U to provide 0-db attenuation.

(3) Adjust the output frequency of the signal generator to frequencies of 20 kc, 28 kc, 37 kc, 50 kc, 68 kc, and 100 kc for each of the nine tests listed in the chart in (8) below.

(4) Adjust the output level of the signal generator to provide the voltmeter indication given in the *voltmeter* indicatio*n* column.

(5) Set Attenuator TS-402/U as listed in the attenuator setting column.

(6) Set the ATTENUATOR DB switch on the audio level meter to the position indicated in the audio level meter ATTENUATOR DB switch column.

(7) Insert the test plug assembly into the test jack assembly.

(8) Set the frequency dial of the audio level meter to the same frequency as the signal generator. Adjust the frequency dial to obtain a maximum meter indication on the audio level meter. The indication should be approximately 0 db. Record the indication on the chart (*c* below).

Test No.	Voltmeter indication (ac volts)	Attenuator setting (db)	Audio level meter ATTENUATOR DB switch
1-----------	7.75	0	+20
2-----------	2.45	0	+10
3-----------	.775	0	0
4-----------	.775	10	-10
5-----------	.775	20	-20
6-----------	.775	30	-30
7-----------	.775	40	-40
8-----------	.775	50	-50
9-----------	.775	60	-60

c. Preparation of Calibration Charts. The calibration charts are used to record the response curves for each frequency and attenuator setting of the audio level meter being used. Prepare a calibration chart for each of the audio level meter ATTENUATOR DB switch settings except ±30 and ±40. Plot the audio level meter readings (*b* (8) above) against their respective frequencies for the setting of the ATTENUATOR DB switch setting. freq. see illustrates *sample* charts.

d. Test Measurement Correction Procedure. Use the following procedure to correct the indications given by the audio level meter:

(1) Determine the ATTENUATOR DB switch setting used to obtain the indication.

(2) Select the calibration chart corresponding to the ATTENUATOR DB switch setting.

(3) Determine the amount of deviation for the frequency that was measured and whether it is above the 0-db line (positive) or below the 0-db line (negative)

(4) If the response curve is above the 0-db line, subtract the deviation from the actual reading to obtain the corrected value.

(5) If the response curve is below the 0-db line, add the deviation to-the actual reading to obtain the corrected value.

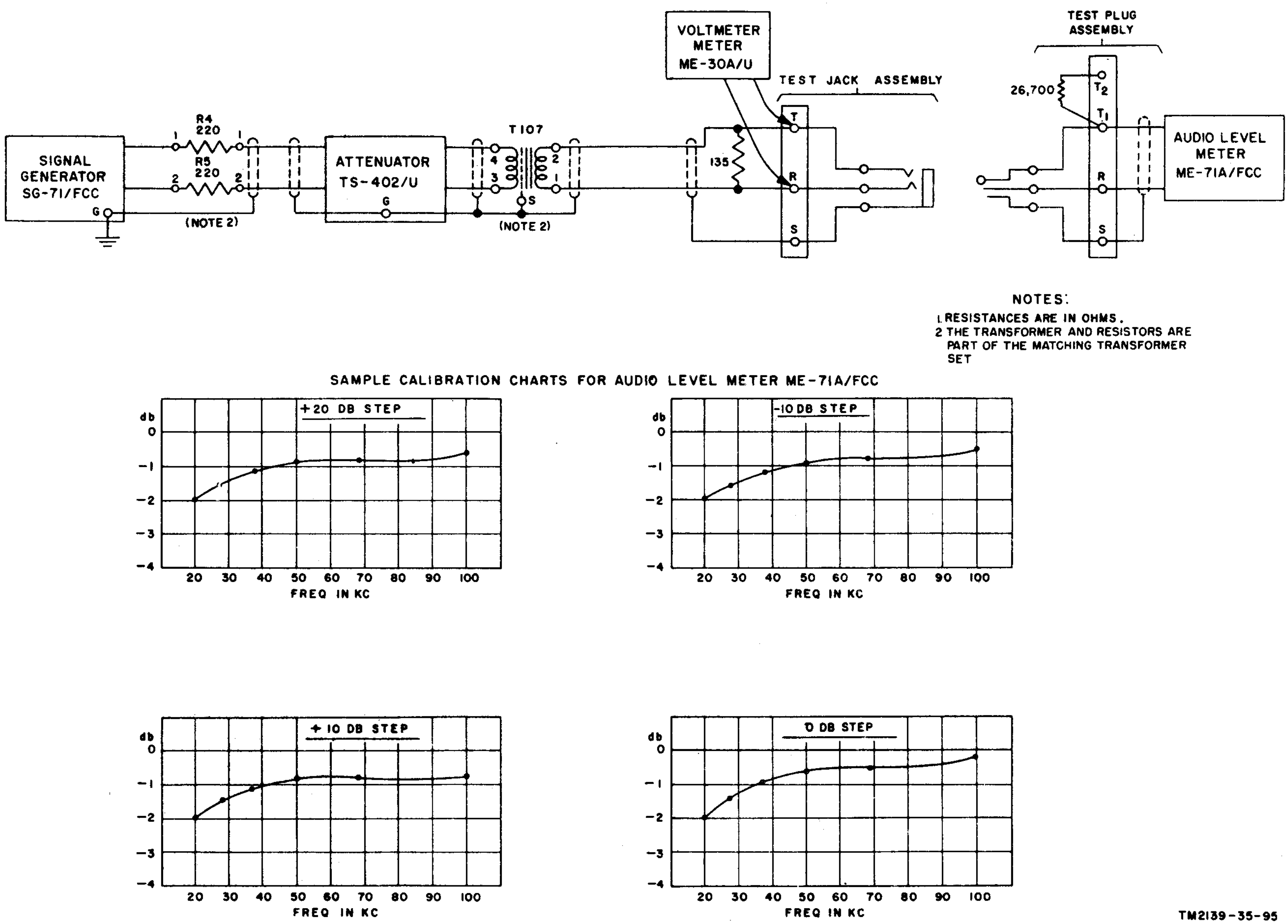

Figure 49. Calibration setup and sample calibration charts for Audio Level Meter ME-71A/FCC.

Section II. TELEPHONE MODEM TA-219/U

80. CHAN MODEM, Troubleshooting Data

Fig No.	Par. No.	Description
3 ----------------------	----------------------	Telephone Modem TA-291/U, main chassis, schematic diagram.
2 ----------------------	------------------------	Channel assembly, schematic diagram.
10, TM 11-2139-20.	------------------------	CHAN 1,2,3, and 4, tube socket voltage and resistance chart.
52---------------------	------------------------	CHAN MODEM top view, assemblies removed, location of parts.
53---------------------	------------------------	Channel assembly, bottom view, location of parts.
54---------------------	------------------------	Channel assembly, left side view, location of parts.
55---------------------	------------------------	Channel assembly, top view, location of parts.
138-------------------	------------------------	Telephone Modem TA-219/U, wiring diagram.
139-------------------	------------------------	CHAN 1, wiring diagram.
140-------------------	------------------------	CHAN 2, wiring diagram.
141-------------------	------------------------	CHAN 3, wiring diagram.
142-------------------	------------------------	CHAN 4, wiring diagram.
	88	CHAN MODEM, dc resistance of transformers.
	89	Channel Assemblies, thermistor resistance.

81. Channel Assemblies, Test Frequencies

Each channel assembly requires a different test frequency. The charts given in a and b below list the test frequencies and output levels for performing the operational tests given in paragraphs 82 and 83.

a. Carrier Test Frequencies.

Channel assembly under test	Signal generator output	
	Frequency (kc)	Output level (volt)
1 -------------------------------	8	.82
2 -------------------------------	12	.82
3 -------------------------------	16	.82
4 -------------------------------	20	.82

b.. Receive Circuit Test Frequencies.

Channel assembly under test	Signal generator output	
	Frequency (kc)	Output level (volt)
1 -------------------------------	7	.31
2 -------------------------------	11	.31
3 -------------------------------	15	.31
4 -------------------------------	19	.31

82. Channel Assembly, Transmitting Circuit Test

(fig. 50)

Perform the tests given in a through d below in sequence for each channel assembly.

a. Initial Procedures.

(1) Connect the test cable assemblies, 600-ohm resistors, power supply, and channel assembly being tested as shown in figure 50.

(2) Connect signal generator No. 1 to terminals 0 and 3 of the modem and amplifier test cable assembly; adjust the output frequency and the output level for the channel assembly being tested (par. 81a).

b. Two- and Four-wire Tests.

(1) Connect signal generator No. 2 to the 2W-4WT binding posts; adjust the output frequency to 1 kc and the output level to .49 volt.

(2) Operate the 4W-2W switch to the 4W position.

(3) Connect a voltmeter across terminals 16 and 19 of the test cable assembly terminal board. The voltmeter should indicate .014 $\pm$.002 volt.

(4) Readjust the output level of signal

(5) Operate the 4W-2W switch to the 2W

(6) The voltmeter should indicate .014 $\pm$.002 volt.

c. Order-Wire Circuit Tests.

(1) Connect signal generator No. 2 to terminals 9 and 12 of the modem and amplifier test cable assembly.

(2) Operate the TALK-MON switch to the TALK position.

(3) The voltmeter should indicate .014 volt ±.002 volt.

(4) Readjust the output level of signal generator No. 2 to 1.75 volts. Operate and hold the TALK-MON switch to the MON position.

(5) The voltmeter should indicate .0022 volt ±.0005 volt.

d. Test Signal Circuit Test.

(1) Operate the SEND-MEAS switch to the SEND position.

(2) Connect signal generator No. 2

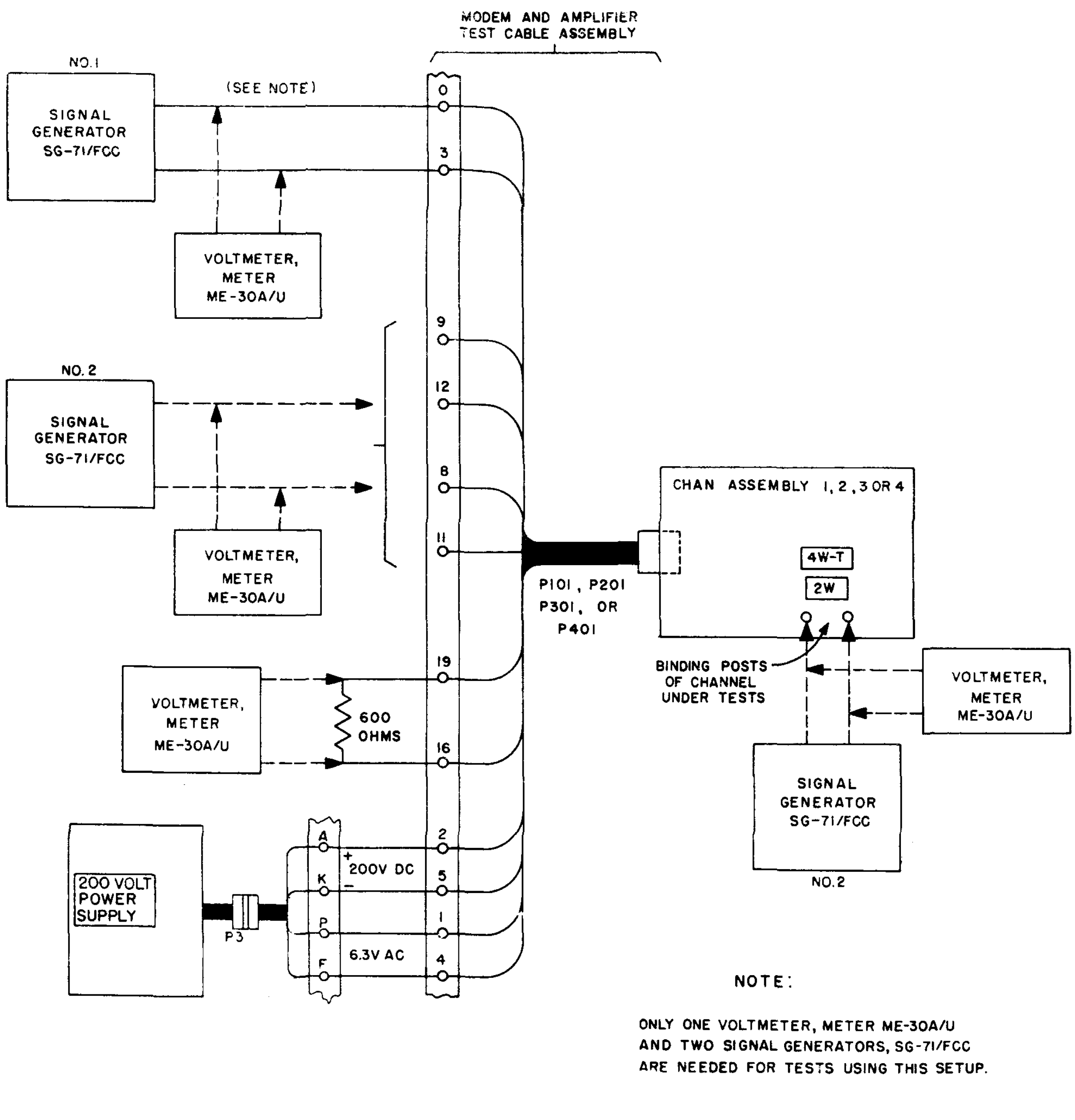

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Figure 50. Channel assembly, operational test setup, transmitting circuit.

across terminals 8 and 11 of the modem and amplifier test cable assembly and readjust the output level to .73 volt.

(3) The voltmeter should indicate .014 $\pm$.002 volt.

83. Channel Assembly, Receiving Circuit Test

(fig. 51)

Perform the tests given in *a* through *d* below in sequence for each channel assembly.

a. Initial Procedures.

(1) Connect the test cable assemblies, 600-ohm resistor, power supply, and channel assembly being tested as shown in figure 51.

(2) Connect signal generator No. 1 to terminals 0 and 3 of the modem and Figure 51. Channel assembly, operational test setup receiving circuit amplifier test cable assembly; adjust the output frequency and the output level for the channel assembly being tested (par. 81*a*).

b. Two- and Four-Wire Tests.

(1) Connect signal generator No. 2 to terminals 14 and 17 of the modem and amplifier test cable assembly; adjust the output frequency and the output level for the channel assembly being tested (par. 81*b*).

(2) Operate the 4W-2W switch to the 4W position.

(3) Connect the voltmeter across the 4WR binding posts. The voltmeter should indicate 2.45 $\pm$.8 volts.

(4) Operate the 4W-2W switch to the 2W position.

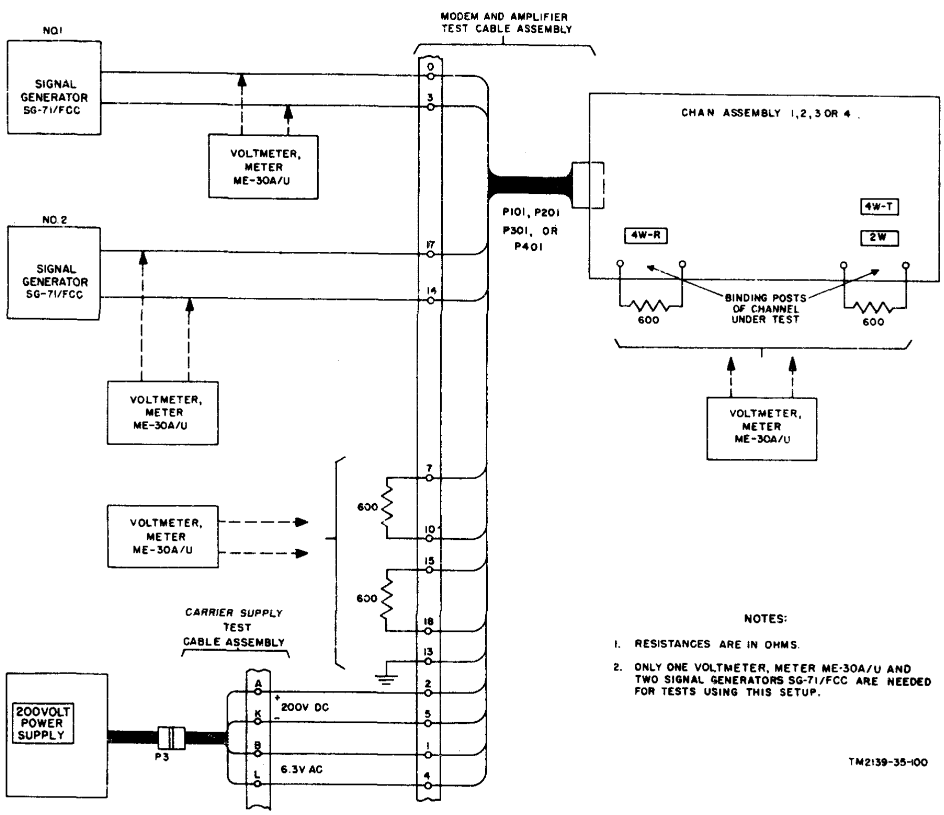

Figure 51. Channel assembly, operational test setup, receiving circuit.

(5) The voltmeter should indicate 1.55 ±.5 volts.

c. Order-Wire Circuit Tests.

(1) Operate the GAIN control on the channel assembly to the extreme clockwise position.

(2) Connect the voltmeter across terminals 7 and 10 of the modem and amplifier test cable assembly.

(3) Operate the TALK-MON switch to the TALK position.

(4) The voltmeter should indicate 2.45 ±.8 volts.

(5) Operate and hold the TALK-MON switch to the MON position.

(6) The voltmeter indication should be 2.45 ±.8 volts.

d. Test Signal Circuit Test.

(1) Operate the SEND-MEAS switch to the SEND position.

(2) Connect the voltmeter across terminals 15 and 18 of the modem and amplifier test cable assembly.

(3) The voltmeter indication should be 2.45 ±.8 volts.

84. Continuity Test

The continuity tests are for circuits in the CHAN MODEM not covered in the operational tests (par. 82 and 83). All power must be removed from the CHAN MODEM during this test. Use the multimeter to check the continuity of the CHAN MODEM (fig. 3). The CHAN MODEM should indicate zero resistance for each check except the following:

Connector J5 terminals	Connector J1, J2, J3, and J4 terminals	Multimeter indication (ohms)
E	17	532
P	17	823

85. Channel Assemblies, Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in individual channel assemblies. This chart lists the symptoms that may be reported on the equipment repair tag or observed when performing maintenance at the organizational level (TM 11-2139-20). When the trouble has been localized to a stage or circuit, a tube check and a voltage and resistance measurement of this stage or circuit ordinarily should be sufficient to isolate the defective part. Normal tube socket voltage and resistance measurements appear in TM 11-2139-20, figure 10.

Symptom	Probable trouble	Corrective measures
1. No transmission through a channel in transmitting and receiving directions.	Failure of carrier distribution circuit	Check carrier distribution circuits for open and short circuits (fig. 3).
2. Transmission through two-wire input of channel under test out of limits.	Failure of transmission circuits between 2W-4WT binding posts and terminals 16 and 19 of P101, P201, P301, or P401.	Use signal substitution procedure (par. 86, test No. 1 through 5) to localize trouble.
3. Transmission through four-wire input of channel under test out of limits.	Failure of transmission circuits between 2W-4WT binding post and terminals 16 and 19 of P101, P201, P301, or P401.	Use signal substitution procedure (par 86, test No. 1 through 5) to localize trouble.
4. Transmission through order wire talking and monitoring circuit in transmitting direction out of limits.	Failure of transmission circuits between terminals 9 and 12 and terminals 16 and 19 of P101, P201, P301, or P401.	*a.* Perform operational test (par. 82c). *b.* If normal output is obtained in correction *a* above, check contacts of TALK-MON lever switch (S101, S201, S301, or S401). *c.* Check order-wire talking circuits connections between TALK-MON lever switch and terminals 9 and 12 of P101, P201, P301, or P401 for open and short circuits (fig 2).

Symptom	Probable trouble	Corrective measures
5. Transmission through order-wire monitoring circuit out of limits.	Failure of TALK-MON lever switch contacts or connections.	*a*. Perform operational test (par. 82*c*). *b*. If normal output is obtained in correction *a* above, check contacts of TALK-MON lever switch and wiring and resistances associated with it (fig. 2).
6. Transmission through test signal circuit in transmitting direction out of limits.	Failure of SEND-MEAS lever switch contacts or of its connections to terminals 8 and 11 of connector P101, P201, P301, or P401.	*a*. Perform operational test (par. 82*d*). *b*. If normal output is obtained in correction *a* above, check contacts of SEND-MEAS lever switch *c*. Check test signal circuit connections between the SEND-MEAS lever switch and terminals 8 and 11 of connector P101, P201, P301, or P401 for open and short circuits (fig. 2).
7. Transmission through two-wire output of channel under test in receiving direction out of limits.	Failure of transmission circuits between terminals 14 and 17 of connector P101, P201, P301, or P401 and 4WR binding post.	*a*. Check tube socket voltages and resistances at XV101, XV201, XV301, or XV401 (fig. 10, TM 11-2139-20). Localize and remove fault. *b*. Use signal substitution procedures to localize the trouble (par.86, tests No. 1 through 5).
8. Transmission through four-wire output in receiving direction out of limits.	Failure of transmission circuits between terminals 9 and 12 of connector P101, P201, P301, or P401.	*a*. Perform operational test (par. 83*b*). *b*. If normal output is obtained in corrections *a* above, check contacts and wiring of the 4W-2W lever switch. Replace the switch if it is defective. *c*. Check the connections between the 4W-2W lever switch and the 4WR binding posts for open or short circuits and correct the fault.
9. Transmission through order wire talking and monitoring circuit in receiving direction out of limits.	Failure of transmission circuits between terminals 14 and 17 and terminals 7 and 10 of connector P101, P201, P301, or P401.	*a*. Perform operational test (par. 83*c*). *b*. If normal output is obtained in corrections *a* above, check contacts of the TALK-MON lever switch and wiring and resistance associated with it.
10. Transmission through test signal circuit in receiving direction out of limits.	Failure of SEND-MEAS lever switch contacts or of its connections to terminals 15 and 18 of connector P101, P201, P301, or P401.	*a*. Perform operational test (par. 83*d*). *b*. If normal output is obtained in correction *a* above, check contacts of SEND-MEAS lever switch *c*. Check test signal circuit connections between the SEND-MEAS lever switch and terminals 15 and 18 of connector P101, P201, P301, or P401 for open and short circuits (fig. 2).

86. Channel Assemblies, Transmitting Direction, Signal Substitution Charts

The signal substitution chart supplements the troubleshooting procedures (par. 85). This chart will help to determine the defective stage or circuit. Resistance and voltage measurements will isolate the defective part within the stage or circuit. Connect the channel assembly under test according to the procedures outlined in paragraphs 81 and 82. The signal substitution procedures at each step assume that all previous steps have -been completed satisfactorily. Small variations from the specified voltmeter readings do not necessarily indicate trouble. However, any marked variations from normal readings indicate the presence of trouble and may imply the nature of the trouble.

Note. Throughout the chart, reference symbols are or CHAN 1. Components of CHAN 2, CHAN3 and CHAN 4 are the same except that the reference designations are in a different hundred block as indicated below.

Channel No	*Hundred block*
2	201 to 299
3	301 to 399
4	401 to 499

Test No.	Voltmeter probe connections		Meter Indication (ac volt)	Corrective measures
	Positive	Negative		
1.	Standoff E107	Standoff E108	0.5	Check circuit between 2W-4Wt binding posts and standoffs E107 and E108 for opens and shorts (fig. 2). Operate the 4W-2W lever switch to 4W position. Check voltage across standoffs E107 and E108 and if normal voltage of .8 is obtained, it indicates trouble in transformer T101, capacitor C101, C102, C103, or C104, or resistor R101. Check these components.
2.	Terminal 3 of FL101	Ground	.17	Check circuit between standoffs E107, E108, and filter FL101 for open and shorts. Check resistors R106 through R109. Check capacitors C105 and C106. Check transformer T102. Check filter FL101.
3.	Terminal 3 of FL102	Ground	.10	Check circuit between filters FL101 and FL102 for opens and shorts. Perform test No. 5. Check thermistors RT103, RT104, RT107, and RT108. Check resistors R114 through R145. Check transformers T103 and T104. Check resistors R110 through R113. Check varistor CR101.
4.	Terminal 19 of modem and amplifier test cable assembly.	Terminal 1 of modem and amplifier test cable assembly.	.014	Check circuit between filter FL102 and connector P101. Check filter FL102.
5.	Terminal 2 of T104	Terminal 2 of T103	.4	Check circuit between terminals 0 and 3 of connector P101 and transformers T103 through T106 for opens and shorts. Check resistors R126 through R129. Check thermistors RT101 and RT102.

87. Channel Assemblies, Receiving Direction, Signal Substitution Chart

The receiving direction signal substitution chart is similar to the signal substitution chart for the transmitting direction (par. 86).

Perform the initial procedures described in paragraph 82.

Note. Throughout the chart, reference symbols are for CHAN 1. Components of CHAN 2, CHAN 3, and CHAN 4 are the same except that they are in a different hundred block (par. 86).

Test No.	Voltmeter probe connections		Meter Indication (ac volt)	Corrective measures
	Positive	Negative		
1.	Terminal 3 of FL103	Ground	0.14	Check circuit between terminals 14 and 17 of connector P101 and terminals 1 and 2 of filter FL103 for opens and shorts (fig. 2). Check filter FL103.
2.	Terminal 6 of T106	Ground	.04	Check circuit between FL103 and T106 for open and shorts. Check thermistors RT105, RT106, RT109, and RT110. Check resistors R119, R120, R121, R146, and R147.
3.	Terminal 6 of T105	Ground	.02	Check circuit between T106 and T105 for opens and shorts. Perform test No. 4. Check resistors R122 through R125. Check transformers T104 and T105 Check varistor CR102.
4.	Terminal 3 of T105.	Terminal 3 of T106.	.4	Check circuit between terminals 0 and 3 of connector P101 and transformer T103 through T106 for opens and shorts. Check resistors R126 through R129. Check thermistors RT101 and RT102.
5.	Terminal 3 of FL104	Ground	.02	Check circuit connections between T105 and FL104. Check filter FL104.
6.	Terminal 3 of T107	Ground	.02	Check circuit between filter FL104 and transformer T107 for opens and shorts. Check resistors R140, R141, and R138A and R138B.
7.	Terminal 1 of T108	Terminal 2 of T108	2	Check tube socket XV101 voltages (TM 11-2139-20, fig, 10). Check resistors and capacitors associated with the tube socket terminals that have abnormal dc voltages. Check tube socket XV101 resistances (TM 11-2139-20, fig. 10). Check resistors and associated with tube socket terminals that have abnormal resistance indications. Check resistors R130, R131, R134, and R137. Check capacitors C107 through C111. Check transformers R107 and T108.
8.	Binding Post E101	Binding Post E102	1.25	Check circuit between 2W-4WT binding posts and T108 for opens and shorts. Perform test No. 9. If normal voltage is obtained, it indicates trouble in transformer T101, capacitors C101, C102, C103, C104, or resistor R101. Check these components.
9.	Binding post E103	Binding post E104	2	Check circuit between 4WR binding posts and transformer T108 for opens and shorts.

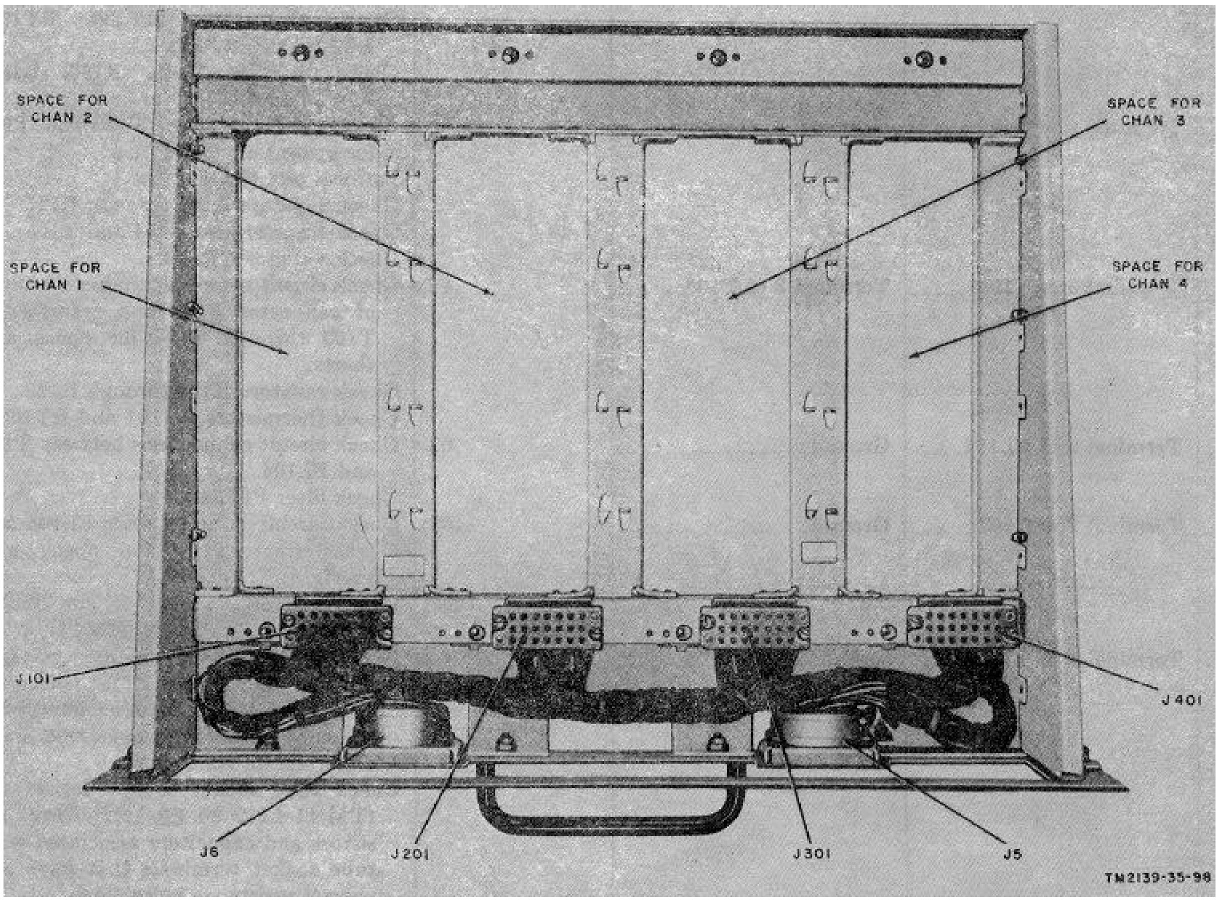

Figure 52. Telephone Modem TA-219/U, main chassis, channel assemblies removed, top view.

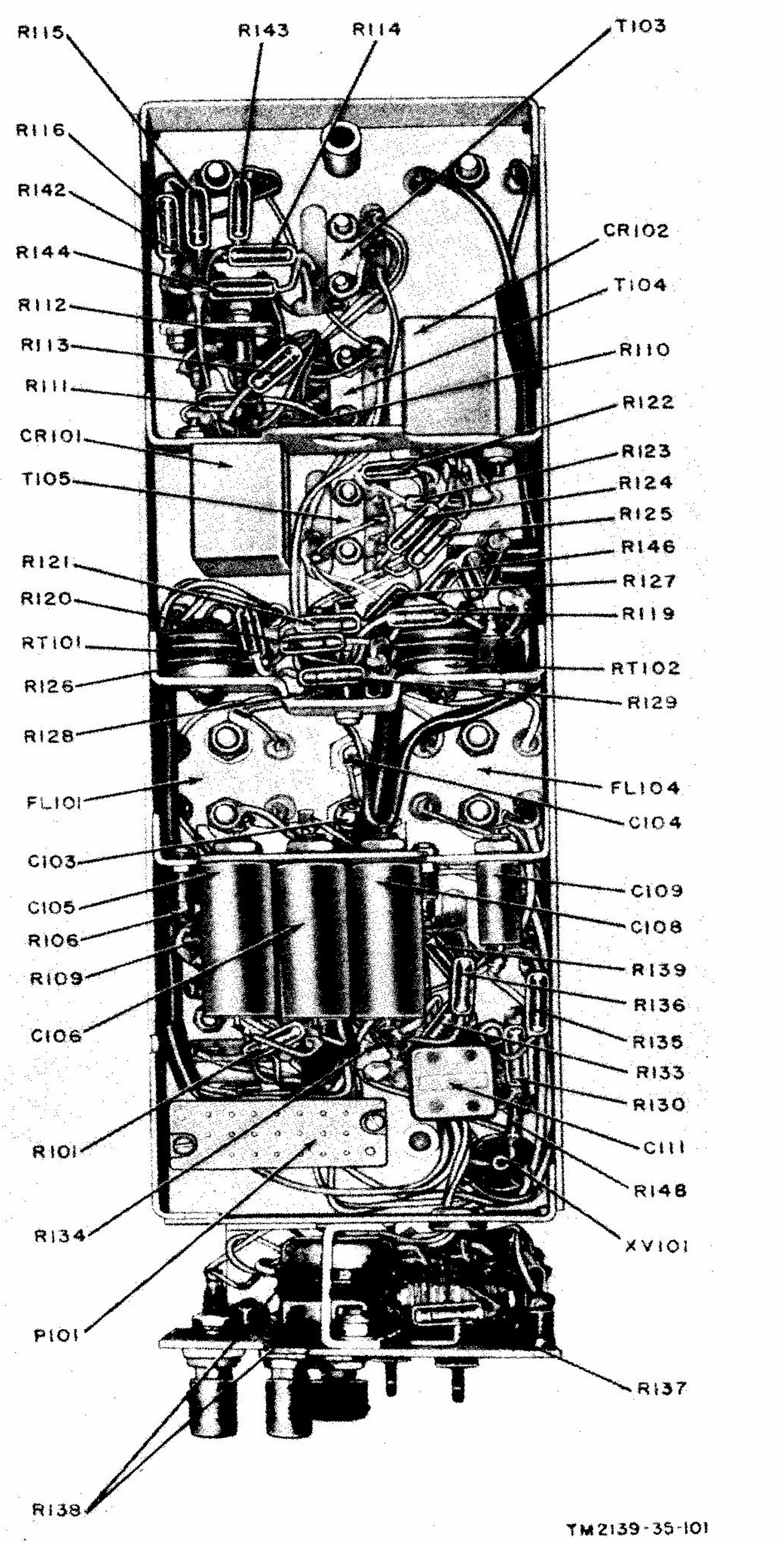

Figure 53. Channel assembly (part of Telephone Modem TA-219/U), bottom view, location of parts.

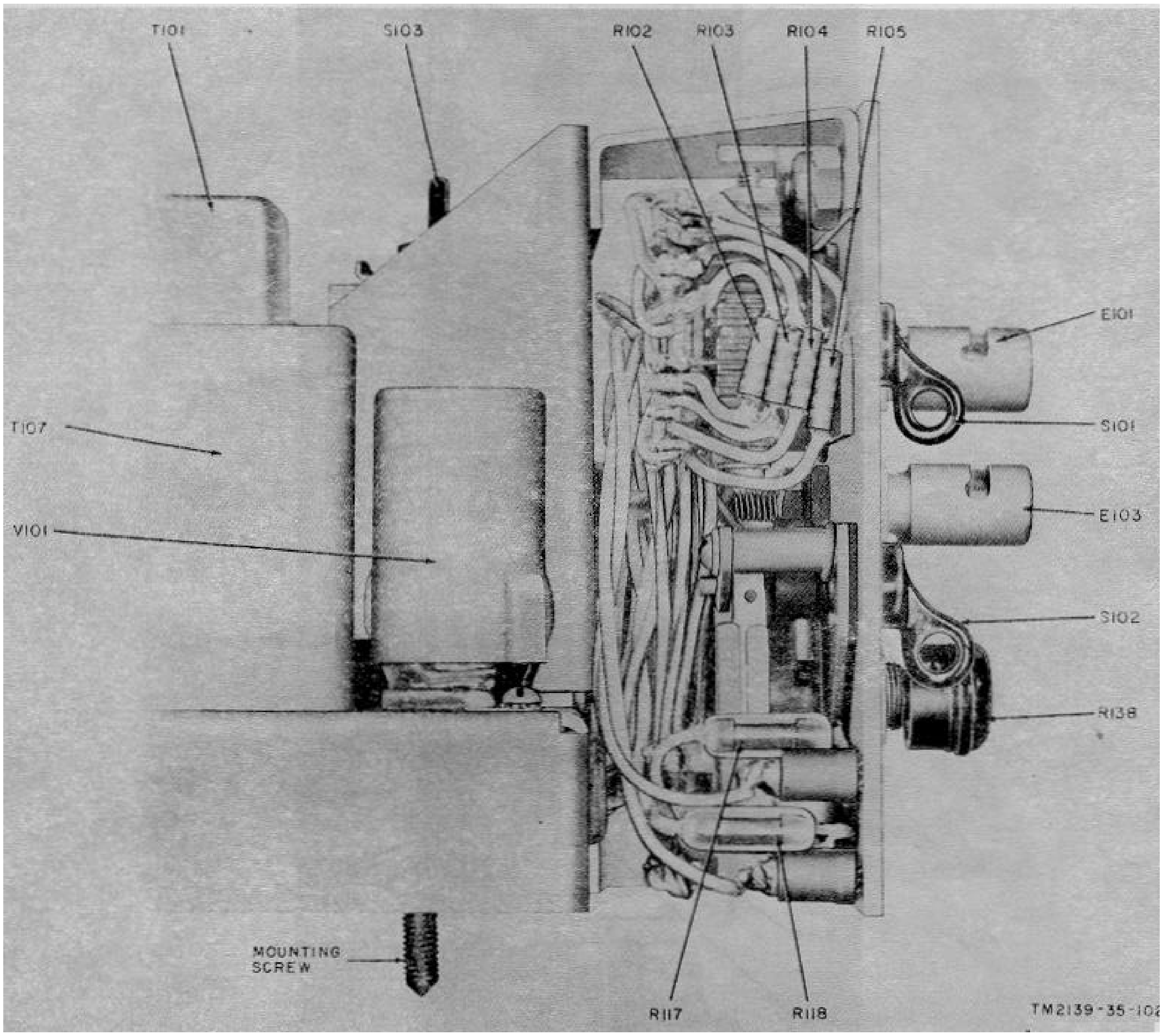

Figure 54. Channel assembly (part of Telephone Modem TA--219/U) left side view, location of panel-mounted parts.

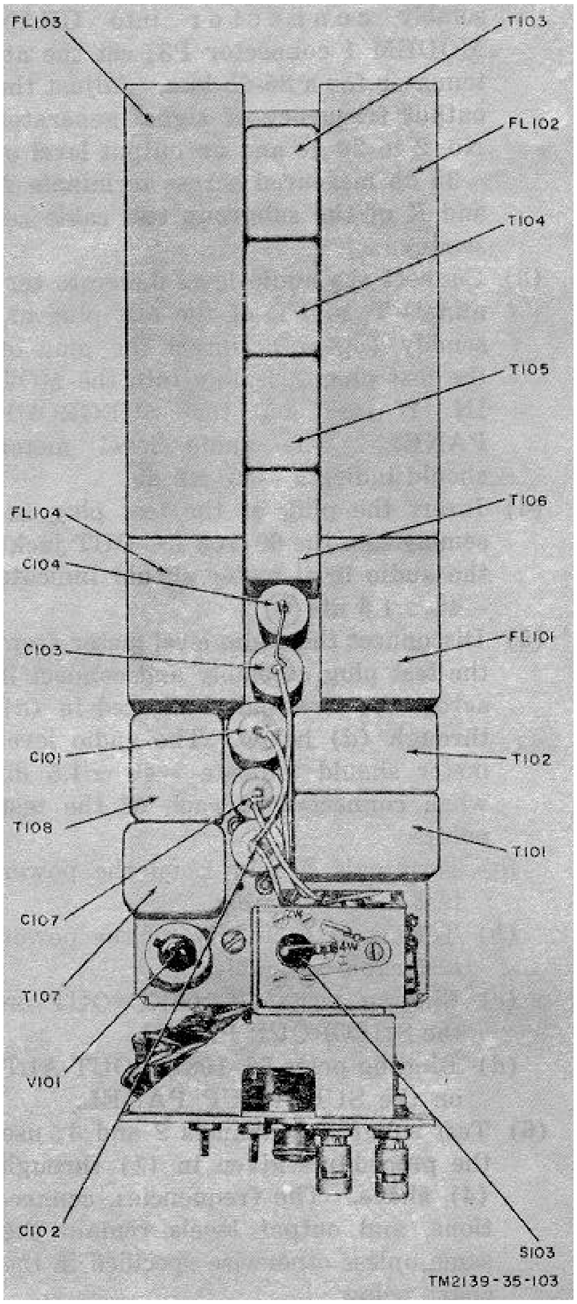

Figure 55. Channel assembly (part of Telephone Modem TA-219/U), top view, location of parts

88. CHAN MODEM, Dc Resistance of Transformers

Transformers	Terminals	Resistance (ohms)
T101, T201, T301, and T401	1-2	24
	2-3	27
	1-3	51
	4-5	24
	5-6	27
	4-6	51
	7-8	27
	9-10	27
T102, T202, T302, and T402	1-2	57
	3-4	34
	5-6	34
T103 through 106, T203 through T206, T303 through T306, and T403 through T406.	1-2	13
	3-4	13
	5-6	48 (115 for T103 through T106 only)
T107, T207, T307, and T407	1-3	20
	4-6	7,500
T108, T208, T308, and T408	1-2	100
	3-4	83
	5-6	1,720

89. Channel Assemblies, Thermistor Resistance

Test the thermistors with an ohmmeter. Because the resistance of the thermistor varies with temperature, check the thermistor at a room temperature between 70° and 80 F.

Thermistor	Approx. Resistance (ohms)
RT101 and RT102	31.5
RT201 and RT202	31.5
RT301 and RT302	31.5
RT401 and RT402	31.5
RT103 through RT110	1,000
RT203 through RT206	1,000
RT303 through RT306	1,000
RT403 through RT406	1,000

90. Troubleshooting Data

Fig. No.	Par. No.	Description
5 ------------	--------------	Schematic diagram.
12, TM 11-2139-20.	--------------	Tube socket voltage and resistance chart.
58, 59 ------	--------------	Bottom view, location of parts
60-----------	--------------	Top view, location of parts.
143 ---------	--------------	Wiring diagram.
	96	Dc resistance of transformers and coils

91. Transmitting Circuit, Test

(fig. 56)

a. Initial Procedures.

(1) Calibrate the audio level meter (par. 79).

(2) Connect the transmission, carrier supply and power test cable assemblies, two 135-ohm resistors, 200 VOLT POWER SUPPLY, and the SUBGROUP PANEL as shown in figure 56.

(3) Connect signal generator No. 2, resistors R1 through R3, attenuator, and transformer T108 as shown in figure 56. Connect the subgroup test cable assembly as specified in the following procedure.

(4) Adjust the TR AMP GAIN control on the SUBGROUP PANEL to the extreme clockwise position.

b. Subgroup Channel Test.

(1) Connect signal generator No. 1 to terminals C and L of the transmission test cable assembly (fig. 56); adjust the output frequency to 56 kc at an output level of --2.5 db.

(2) Connect the subgroup test cable assembly connector into CHAN MODEM 1 connector P3; set the attenuator for a 35-db loss. Adjust the output frequency of signal generator No. 2 to 20 kc and an output level of —35 db measured across terminals A and K of the subgroup test cable assembly.

(3) Connect the audio level meter to terminals T_1 and R of the test plug assembly (fig. 56); insert the plug of the test plug assembly into the MOD IN 1 jack on the SUBGROUP PANEL. The audio level meter should indicate--39 $\pm$2 db.

(4) Insert the plug of the test plug assembly into the 60-108 KC OUT jack; the audio level meter should indicate —48 $\pm$1.5 db.

(5) Disconnect the audio level meter from the test plug assembly and connect it across the terminals indicated in (a) through (d) below. The audio level meter should indicate —48 $\pm$ 1.5 db when connected to each of the test points.

(a) Terminals A and L on the power test cable assembly.

(b) Terminals K and W on the power test cable assembly.

(c) Binding posts 60-108KC OUT on the SUBGROUP PANEL.

(d) Binding posts 60-108KC OUT-ALT on the SUBGROUP PANEL.

(6) Test subgroup channels 2 and 3; use the procedures given in (1) through (4) above. The frequencies, connections, and output levels remain the same unless otherwise specified in the chart below

Subgroup channel	Subgroup test cable connection	Signal generator No. 1			Test plug assembly connection (jack)
		Connection	Frequency (kc)	Level (db)	
2 --------------	CHAN MODEM 2 P2	A and J	72	-2.5	MOD IN 2
3 --------------	CHAN MODEM 3 P1	D and E	88	-2.5	MOD IN 3

Figure 56. SUBGROUP PANEL, operational and final test setup, transmitting direction.
(Contained in separate envelope)

c. Special Service Test.

(1) Operate the SPECIAL SERVICE switch on each subgroup channel to the SPL SERV position.

(2) Connect signal generator No. 2, resistors R1 through R3, attenuator, and transformer T108 as shown in figure 56, to the SPECIAL SERVICE IN binding posts on the channel being tested; set the attenuator for 0-db loss. Adjust the frequency of signal generator No. 2 to 20 kc and the output level to 0 db measured at the SPECIAL SERVICE IN binding posts.

(3) Connect and adjust signal generator No. 1 as specified in the following chart.

Subgroup channel	Signal generator No. 1		
	Transmission test cable assembly connection	Frequency (kc)	Level (db)
1	C and L	56	-2.5
2	A and J	72	-2.5
3	D and E	88	-2.5

(4) Connect the audio level meter across terminals A and L of the power test cable assembly. The meter should indicate--48 ±1.5 db on each subgroup channel at frequencies of 76, 92, and 108 kc for channels 1, 2, and 3 respectively.

92. Receiving Circuit, Tests

(fig. 57)

a. Initial Procedure.

(1) Calibrate the audio level meter (par. 79).

(2) Connect the transmission, carrier supply, and power test cable assemblies, and SUBGROUP PANEL as shown in figure 57.

(3) Connect a 600-ohm resistor across each SPECIAL SERVICE OUT binding post.

(4) Connect signal generator No. 2, resistors R1 through R3, attenuator, and transformer T107 as shown in figure 57.

(5) Adjust the DEM 1 GAIN, DEM 2 GAIN, and DEM 3 GAIN controls to their extreme clockwise positions.

(6) Connect signal generator No. 2 and associated components ((3) above) to terminals H and R of the transmission test cable assembly. Set the attenuator for a 10-db loss.

b. Subgroup Channel 1 Test.

(1) Connect the subgroup test cable assembly and 600-ohm resistor to CHAN MODEM 1 connector P3.

(2) Connect signal generator No. 1 to terminals C and L of the transmission test cable assembly (fig. 57); adjust the output frequency to 56 kc at an output level of--2.5 db.

(3) Adjust the output frequency of signal generator No. 2 to 76 kc at an output level of 11.5 db as measured across terminals H and R of the transmission test cable assembly.

(4) Operate the SPECIAL SERVICE 1 switch to SPL SERV.

(5) Arrange the audio level meter to measure a frequency at 20 kc. Connect the audio level meter to the SPECIAL SERVICE 1 OUT binding posts. The audio level meter should indicate a level of 7.5 ±2 db at 20 kc.

(6) Operate the SPECIAL SERVICE 1 switch to CHAN MODEM.

(7) Connect the audio level meter to terminals P and E of the subgroup test cable assembly. The audio level meter should indicate a level of 7.5 ±2 db at 20 kc.

(8) Connect the audio level meter to terminals T. and R of the test plug assembly (fig. 57).

(9) Insert the plug of the test plug assembly into the DEM OUT 1 jack. The audio level meter should indicate 7.5 ±2 db.

c. Subgroup Channel 2 Test.

(1) Perform the initial procedures given in a above.

(2) Connect the subgroup test cable assembly and 600-ohm resistor to CHAN MODEM 2 connector P2.

(3) Connect signal generator No. 1 to terminals A and J of the transmission

test cable assembly (fig. 57); adjust the output frequency to 72 kc at an output level of--2.5 db.

(4) Adjust the output frequency of signal generator No. 2 to 92 kc at an output level of 11.5 db as measured across terminals H and R of the transmission test cable assembly.

(5) Operate the SPECIAL SERVICE 2 switch to SPL SERV.

(6) Arrange the audio level meter to measure a frequency of 20 kc. Connect the audio level meter to the SPECIAL SERVICE 2 OUT binding posts. The audio level meter should indicate a level of 6.5 $\pm$2 db at 20 kc.

(7) Operate the SPECIAL SERVICE 2 switch to CHAN MODEM.

(8) Connect the audio level meter to terminals P and E of the subgroup test cable assembly. The audio level meter should indicate a level of 6.5 $\pm$2 db at 20 kc.

(9) Connect the audio level meter to terminals T. and R of the test plug assembly (fig. 57).

(10) Insert the plug of the test plug assembly into the DEM OUT 2 jack. The audio level meter should indicate 6.5 $\pm$2 db at 20 kc.

d. Subgroup Channel 3 Test.

(1) Perform the initial procedures given in a above.

(2) Connect the subgroup test cable assembly and 600-ohm resistor to CHAN MODEM 3 connector P1.

(3) Connect signal generator No. 1 to terminals D and E of the transmission test cable assembly (fig. 57): adjust the output frequency to 88 kc at an output level of--2.5 db.

(4) Adjust the output frequency of signal generator No. 2 to 108 kc at an output level of 11.5 db as measured across terminals H and R of the transmission test cable assembly.

(5) Operate the SPECIAL SERVICE 3 switch to SPL SERV.

(6) Arrange the audio level meter to measure a frequency of 20 kc. Connect the audio level meter to the SPECIAL SERVICE 3 OUT binding posts. The audio level meter should indicate a level of 5.5 $\pm$2 db at 20 kc.

(7) Operate the SPECIAL SERVICE 3 switch to CHAN MODEM.

(8) Connect the audio level meter to terminals P and E of the subgroup test cable assembly. The audio level meter should indicate a level of 5.5 $\pm$2 db at 20 kc.

(9) Connect the audio level meter to terminals T_1 and R of the test plug assembly (fig. 57).

(10) Insert the plug of the test plug assembly into the DEM OUT 3 jack. The audio level meter should indicate 5.5 $\pm$2 db at 20 kc.

93. Miscellaneous Continuity Tests

(fig. 57)

The following continuity tests are for the circuits of the SUBGROUP PANEL not tested in previous operational tests (pars. 91 and 92). All power must be removed when performing these tests.

a. Connect the power test cable assembly to connector J9 on the SUBGROUP PANEL.

b. Connect the subgroup test cable assembly to connector P1, P2, or P3 on the SUBGROUP PANEL as shown in the chart (d below).

c. Use the multimeter to check continuity of the transmission circuits listed in the chart. Make the continuity checks between each subgroup test cable assembly terminal listed in the chart and the power test cable assembly terminal in the same horizontal row. The meter should indicate zero resistance for each check.

d. Use the multimeter to check for short circuits between the terminals listed in row a and those listed in row b for each path tested in the chart below. The multimeter should indicate infinite resistance between the terminals listed in row a and those listed in row b.

Figure 57. SUBGROUP PANEL, operational and Anal test setup, receiving direction.

(Contained in separate envelope)

Circuit Under Test		Subgroup test cable assembly connected to			Power test cable assembly terminals
		P1 terminals	P2 terminals	P3 terminals	
Send path between J9 and P1, P2, or P3	*a*	D	D	D	F
	b	N	N	N	S
Measure path between J9 and P1, P2, or P3	*a*	F	F	F	U
	b	R	R	R	H
Modulator talk path between J9 and P1, P2, or P3	*a*	C	C	C	P
	b	M	M	M	C
Demodulator talk path between J9 and P1, P2, or P3	*a*	B	B	B	R
	b	L	L	L	D

94. Subgroup Panel Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in the SUBGROUP PANEL. This chart lists tile symptoms that may be reported on the equipment repair tag or observed when performing maintenance at the organizational level (TM 11-2139-20). Normal tube socket voltage and resistance measurements appear in TM 11-2139-20.

Symptom	Probable trouble	Corrective measures
1. No transmission through sub-groups 1, 2, and 3 in transmitting and receiving directions	*a*. Failure of +200-volt dc distribution circuits	*a*. Check for presence of 200 volts dc from standoffs E12, E27, E42, and E50 to ground. If not present, refer to overall schematic diagram and locate open or short circuits.
	b. Failure of 6.3-volt ac distribution circuits.	*b*. Check for presence of 6.3 volts ac across terminals 3 and 4 of all tube sockets, with terminal 3 ground. If not present, check the 6.3-volt ac distributing circuits and locate open or short circuits.
2. No transmission through subgroup 1 in transmitting and receiving directions.	Failure of 56-kc carrier distribution circuit.	*a*. Check performance as given in operational tests (pars. 91 and 92). *b*. If normal output is obtained in cor-rection *a*, check the 56-kc carrier distribution circuit between terminals L and C of J10 and Tll, T12, T14, and T15, and locate open or short circuits.
3. No transmission through subgroup 2 in transmitting and receiving directions.	Failure of 72-kc carrier distribution circuit.	*a*. Check performance as given in opera tional tests (pars. 91 and 92).- b. If normal output is obtained in correction a, check the 72-kc carrier distribution circuit between terminals A and J of J10 and T6, T7, T9, and T10, and locate open or short circuits.
4. No transmission through subgroup 3 in transmitting and receiving. directions.	Failure of 88-kc carrier distribution circuit	*a*. Check performance as given in opera tional tests (pars. 91 and 92). *b*. If normal output is obtained in cor-rection a, check the 88-kc carrier distribution circuit between terminals D and E of J10 and T1, T2, T4, and T5, and locate open or short circuits.

Symptom	Probable trouble	Corrective measures
5 Transmission measurements through the message transmission path of subgroup 1 in the transmitting direction, out of limits.	Failure of transmission circuits between terminals A and K of P3, and A and L of J9.	*a.* Check performance as given in operational tests (par. 91b). *b.* If normal output is obtained in correction *a*, use signal substitution procedures given in paragraph *95a*, tests No. 1 through 6, to locate the trouble.
6. Transmission measurements through the special service transmission path of subgroup 1 in the transmitting direction, out of limits.	Failure of SPECIAL SERVICE 1 switch and associated circuits.	*a.* Check performance as given in operational tests (par. 91c). *b.* If normal output is obtained in correction a, check the contacts of the SPECIAL SERVICE 1 switch and the wiring and resistances between it and the SPECIAL SERVICE 1 IN binding posts.
7. Transmission measurements through the message transmission path of subgroup 2 in the transmitting direction, out of limits.	Failure of transmission circuits between terminals A and K of P2, between terminals A and L of J9 and terminals K and W of J9, between the transmission path and the 60-108 KC OUT or 60-108 KC OUT ALT binding posts, or between the transmission path and the 60-108 KC OUT test jack.	a. Check performance as given in operational tests (par. 91). If normal indication is obtained, proceed to correction d below. b. If normal output is not obtained in correction a, check tube socket XV7 voltages (TM 11-2139-20, fig. 12). c. If normal indications are obtained in correction b, use signal substitution procedures (par. 95b, tests No. 7 through 13) to localize the trouble. d. If normal output is obtained in correction *a*, use signal substitution procedures (par. 95b, tests No. 1 through 6) to localize the trouble.
8. Transmission measurements through the special service transmission path of subgroup 2 in the transmitting direction, out of limits.	Failure of SPECIAL SERVICE 2 switch and associated circuits.	a. Check performance as given in the operational tests (par. 91c). b. If normal output is obtained in correction a, check the contacts of the SPECIAL SERVICE 2 switch and the wiring and resistances between it and the SPECIAL SERVICE 2 IN binding posts.
9. Transmission measurements through the message transmission path of subgroup 3 in the transmitting direction, out of limits.	Failure of transmission circuits between terminals A and K ofP1 and A and L of J9.	a. Check performance as given in the operational tests (par. *91b).* *b.* If normal output is obtained in correction a, use signal substitution procedures (par. 95c, tests No. 1 through 6) to locate the trouble.
10. Transmission measurements through the special service transmission path of subgroup 3 in the transmitting direction, out-of limits.	Failure of SPECIAL SERVICE 3 switch and associated circuits.	a. Check performance as given in the operational tests (par. 91c). *b.* If normal output is obtained in correction a, check the contacts of the SPECIAL SERVICE 3 switch and the wiring and resistances between it and the SPECIAL SERVICE 3 IN binding posts.
11. Transmission measurements through the transmission path of subgroup 1 in the receiving direction, out of limits.	Failure of transmission circuits between terminals H and R of J10 and P and E of P3, between J10 and DEM OUT 1 jack, or between J10 and SPECIAL SERVICE1 OUT binding posts.	*a.* Check performance as given in the operational tests (par. 92b). *b.* If normal output is obtained in correction a, check tube socket XV5 and XV6 voltages (TM 11-213920, fig. 12).

Symptom	Probable trouble	Corrective measures
		c. If normal indications are obtained in correction b, use signal substitution procedures (par. 95d, tests No. 4 through 13) to localize the trouble.
12. Transmission measurements through the transmission path of subgroup 2 in the receiving direction, out of limits.	Failure of transmission circuits between terminals H and R of J10 and P and E of P2, between J10 and DEM OUT2 jack, or between J10 and SPECIAL SERVICE 2 OUT binding posts	*a*. Check performance as given in the operational tests (par. 92b). *b*. If normal output is not obtained in correction. a, use signal substitution procedures (par. 95e, tests No. 1 through 3) to localize the trouble. c. If normal output is obtained in correction a, check tube socket XV3 and XV4 voltages (TM 11-2139-20, fig. 12). d. If normal indications are obtained in correction c, use signal substitution procedures (par. 95e, tests No.4 through 13) to localize the trouble.
13. Transmission measurements through the transmission path of subgroup 3 in the receiving direction out of limits.	Failure of transmission circuits between terminals H and R of J10 and P and E of P1, between J10 and DEM OUT3 jack, or between J10 and SPECIAL SERVICE 3 OUT binding posts.	*a*. Check performance as given in the operational tests (par. 92b). *b*. If normal output is obtained in correction *a*, check tube socket XV1 and XV2 voltages (TM 11-2139-20, fig. 12). *c*. If normal indications are obtained in correction b, use signal substitution procedures (par. 95f, tests No.4 through 13) to localize thetrouble.
14. No transmission through test signal send path from P1, P2, or P3 to J9..	Failure of transmission circuit between P1, P2, or P3 and J9	Check for open or short circuits (par. 93).
15. No transmission through test signal measure path from P1, P2,.or P3 to J9.	Failure of transmission circuit between P1, P2, or P3 and J9	Check for open or short circuits (par. 93).
16. No transmission through modulator talk path from P1, P2, or P3 to J9.	Failure of transmission circuit between P1, P2, or P3 and J9.	Check for open or short circuits (par. 93).
16. No transmission through demodulator talk path from P1, P2, or P3 to J9.	Failure of transmission circuit between P1, P2, or P3 and J9.	Check for open or short circuits (par. 93).

95. Signal Substitution Charts

The signal substitution charts (a through f below) are used to supplement the troubleshooting procedures (par. 94). These charts will help isolate the defective stage or circuit. Voltage and resistance measurements taken at the defective stage or circuit will ordinarily isolate the defective part. The signal substitution charts are outlined for each subgroup channel transmitting and receiving circuit. The signal substitution procedures at each step are based on the assumption that all previous steps have been completed satisfactorily.

a. *Signal Substitution Chart for Subgroup 1, Transmitting Direction.*

Test No.	Audio level meter probe connections		Audio level meter indication		Corrective measures
	Positive	Negative	Frequency (kc)	Output (db)	
1	MOD IN 1 jack (tip)	MOD IN 1 jack ring	20	-39	*a.* Check circuit form terminals A and K of P3 to T11 and J5. *b.* Check resistors R69 through R71.
2	Terminal 4 of T11	Ground	20	-39	*a.* Check circuit from SPECIAL SERVICE 1 IN binding posts to T11. *b.* Check resistors R72 through R75.
3	Terminal 1 of T12	Ground	76	-53.5	*a.* Perform test No. 4. *b.* Check transformers T11 and T12. *c.* Check varistor CR5.
4	Terminal 2 of T11	Terminal 4 of T12	56	-2.5	Check circuit from terminals l and C of J10 to T11, T12, T14, and T15.
5	Terminal 3 of FL8	Ground	76	-61.5	*a.* Check circuit form T12 to FL8. *b.* Check resistors R76 through R85.
6	Terminal 1of T16	Ground	76	-65	*a.* Check circuit from FL8 to T16. *b.* Check filter FL8.
7	Terminal 1 of tube socket XV7.	Ground	76	-64.5	Perform test No. 7 (*b* below).
8	Terminal 6 of T17	Ground	76	-25	Perform test No. 8 (*b* below).
9	60-108 KC OUT jack (tip).	60-108 KC OUT jack (ring).	76	-48	Perform test No. 9 (*b* below).
10	Terminal A of J9	Terminal L of J9	76	-48	Perform test No. 10 (*b* below).

b. *Signal Substitution Chart for Subgroup 2, Transmitting direction.*

Test No.	Audio level meter probe connections		Audio level meter indication		Correction measures
	Positive	Negative	Frequency (kc)	Output (db)	
1	MOD IN 2 jack (tip)	MOD IN 2 jack (ring)	20	-39	a. Check circuit from terminal A and K of P2 to T6 and J3. b. Check resistors R35 through R37.

2	Terminal 4 of T6	Ground	20	-39	*a*. Check circuit form SPECIAL SERVICE 2 IN binding posts to T6. *b*. Check resistors R38 through R41.
3	Terminal 1 of T7	Ground	92	-53.5	*a*. Perform test No. 4. *b*. Check transformers T6 and T7.
4	Terminal 2 of T6	Terminal 4 of T7	72	-2.5	Check circuit from terminals A and J of J10 to T6, T7, T9, and T10.
5	Terminal 3 of FL6	Ground	92	-59.5	*a*. Check circuit from T7 to FL6. *b*. Check resistors R42 through R51.
6	Terminal 4 of T16	Ground	92	-65	a. Check circuit from FL6 to T16. b. Check filter FL6.
7	Terminal 1 of tube socket XV7.	Ground	92	-64.5	a. Check circuit from T16 to socket XV7 and to ground. b. Check resistors R103, through R107, and R127. c. Check capacitors C34, C35, and C42. d. Check transformer T16.
8	Terminal 6 of T17	Ground	92	-48	a. Check tube socket XV7 voltages (TM 11-2139-20, fig. 12). Check resistors and capacitors associated with tube socket terminals which have ab-normal dc voltages. b. Check tube socket XV7 re-sistances (TM 11-2139-20, fig. 12). Check resistors and capacitors associated with tube socket terminals which have abnormal resistance indications. c. Check resistors R109 through R112. d. Check capacitors C36, C37,C39, and C40.
9	60-108 KC OUT jack (tip).		92	-48	a. Check circuit from T17 to J7. b. Check resistor R115. c. Check trainsformer T17.
10	60-108 KC OUT binding post (E52).		92	-48	Check circuit from T17 to 60-108 KC OUT binding posts.
11	60-108 KC OUT ALT binding posts (E54).	60-108 KC OUT ALT binding posts (E55).	92	-48	Check circuit form T17 to 60-108 KC OUT ALT binding posts.
12	Terminal K of J9	Terminal W of J9	92	-48	Check circuit from T17 to J9.
13	Terminal A of J9	Terminal L of J9	92	-48	Check circuit from T17 to J9.

c. Signal Substitution Chart for Subgroup 3 Transmitting Direction.

Test No.	Audio level meter probe connections		Audio level meter indication		Correction measures
	Positive	Negative	Frequency (kc)	Output (db)	
1	MOD IN 3 jack (tip)	MOD IN 3 jack ring	20	-39	*a.* Check circuit from terminals A and K of P1 to J1 and T1. *b.* Check resistors R1 through R3.
2	Terminal 4 of T1	Ground	20	-39	*a.* Check circuit from SPECIAL SERVICE 3 IN binding posts to T1. *b.* Check resistors R4 through R7.
3	Terminal 1 of T2	Ground	108	-53	a. Perform test No. 4. b. Check transformers T1 and T2. c. Check varistor CR1.
4	Terminal 2 of T1	Terminal 4 of T2	88	-2.5	Check circuits from terminals D and E of J10 to T1, T2, T4, and T5.
5	Terminal 3 of FL4	Ground	108	-58.5	*a.* Check circuit from T2 to FL4. *b.* Check resistors R8 through R17.
6	Terminal 1 of T16	Ground	108	-64.5	*a.* Check circuit from FL4 to T16. *b.* Check filter FL4.
7	Terminal 1 of tube socket XV7.	Ground	108	-64.5	Perform corrective measures for test No. 7 (*b* above).
8	Terminal 6 of T17	Ground	108	-25	Perform corrective measures for test No. 8 (*b* above).
9	60-108 KC OUT jack (tip).	60-108 KC OUT jack (ring).	108	-48	Perform corrective measures for test No. 9 (*b* above).
10	Terminal A of J9	Terminal L of J9	108	-48	Perform corrective measures for test No. 10 (b above).

d. Signal Substitution Chart for Subgroup 1, Receiving Direction.

Test No.	Audio level meter probe connections		Audio level meter indication		Correction measures
	Positive	Negative	Frequency (kc)	Output (db)	
1	60-108 KC IN jack (tip).	60-108 KC IN jack (ring).	76	-11.5	Check circuit from terminals H and R of J10 to J8 and to 60-108 KC IN binding posts.
2	Terminal 4 of T18	Terminal 5 of T18	76	-28	*a* Check circuit from terminals H and R of J10 to T18. *b.* Check resistors R117 through R120. *c.* Check capacitor C41.
3	Terminal 1 of FL9	Ground	76	-30	*a.* Check circuit from T18 to FL9. *b.* Check resistors R116. *c* Check transformer T18.
4	Terminal 3 of FL9	Ground	76	-34	Check filter FL9.

5	Terminal 1 of T15	Ground	76	-39	*a*. Check circuit from FL9 to T15. *b*. Check resistors R100 through R102.
6	Terminal 4 of T14	Ground	20	-27	a. Perform test No. 7. b. Check transformers T14 and T15. c. Check varistor CR6.
7	Terminal 2 of T14	Terminal 4 of T15	56	-2.5	Check circuit from terminals L and C of J10 to T11, T12, T14, and T15.
8	Terminal 1 of FL3	Ground	20	-27.5	Check circuit from T14 to FL3.
9	Terminal 1 of tube socket XV5.	Ground	20	-11.5	a. Check tube socket XV6 voltages (TM 11-2139-20, fig. 12). Check resistors and capacitors associated with tube socket terminals which have abnormal dc voltages. b. Check tube socket XV6 resistances (TM 11-2139-20, fig. 12). Check resistors and capacitors associated with tube socket terminals which have abnormal resistance indications. c. Perform corrective meas-ures for test No. 10.
10	Terminal 5 of T13	Ground	20	+19.5	a. Check tube socket XV5 voltages (TM 11-2139-20, fig. 12). Check resistors and capacitors associated with tube socket terminals which have abnormal de voltages. b. Check tube socket XV5 resistances (TM 11-2139-20, fig. 12). Check resistors and capacitors associated with tube socket terminals, which have abnormal resistance indications. c. Check resistors R126, R125, R88, and R86. d. Check capacitors C23 through C33.
11	Terminal 1 of T13	Ground	20	+7.5	a. Check for proper termination of transformer T13. b. Check transformer T13.
12	DEM OUT 1 jack (tip)	DEM OUT 1 jack (ring)	20	+7.5	Check circuit from T13 to J6.
13	Terminal E of P3	Terminal P of P3	20	+7.5	Check circuit from T13 to terminals P and E of P3.

e. Signal Substitution Chart for Subgroup 2, Receiving Direction.

Test No.	Audio level meter probe connections		Audio level meter indication		Correction measures
	Positive	Negative	Frequency (kc)	Output (db)	
1	60-108 KC IN jack (tip).	60-108 KC IN jack (ring).	92	-11.5	Check circuit from terminals H and R of J10 to J8 and to 60-108 KC IN binding posts.
2	Terminal 4 of T18	Terminal 5 of T18	92	-28	*a* Check circuit from terminals H and R of J10 to T18. *b*. Check resistors R117 through R120. *c*. Check capacitor C41.
3	Terminal 1 of L7	Ground	92	-30	*a*. Check circuit from T18 to FL7 *b*. Check resistors R116. *c* Check transformer T18.
4	Terminal 3 of FL7	Ground	92	-35	Check filter FL7.
5	Terminal 1 of T10	Ground	92	-40	*a*. Check circuit from FL7 to T10. *b*. Check resistors R66 through R68.
6	Terminal 4 of T9	Ground	20	-28.5	a. Perform test No. 7. b. Check transformers T9 and T10. c. Check varistor CR4.
7	Terminal 2 of T9	Terminal 4 of T10	72	-2.5	Check circuit from terminals A and J of J10 to T6, T7, T9, and T10.
8	Terminal 1 of FL2	Ground	20	-28.5	Check circuit from T9 to FL2
9	Terminal 1 of tube socket XV3.	Ground	20	-12.5	a. Check tube socket XV4 voltages (TM 11-2139-20, fig. 12). Check resistors and capacitors associated with tube socket terminals which have abnormal dc voltages. b. Check tube socket XV4 resistances (TM 11-2139-20, fig. 12). Check resistors and capacitors associated with tube socket terminals which have abnormal resistance indications. c. Perform corrective meas-ures for test No. 10.
10	Terminal 5 of T8	Ground	20	+18.5	a. Check tube socket XV3 voltages (TM 11-2139-20, fig. 12). Check resistors and capacitors associated with tube socket terminals which have abnormal de voltages.

					b. Check tube socket XV3 resistances (TM 11-2139-20, fig. 12). Check resistors and capacitors associated with tube socket terminals, which have abnormal resistance indications. c. Check resistors R124, R123, R54, and R52. d. Check capacitors C12 through C22.
11	Terminal 1 of T8	Ground	20	+6.5	a. Check for proper termination of transformer T8. b. Check transformer T8.
12	DEM OUT 2 jack (tip)	DEM OUT 2 jack (ring)	20	+6.5	Check circuitT8 to J4.
13	Terminal E of P2	Terminal P of P2	20	+6.5	Check circuit from T8 to terminals P and E of P2.

f. Signal Substitution Chart for Subgroup 3, Receiving Direction.

Test No.	Audio level meter probe connections		Audio level meter indication		Correction measures
	Positive	Negative	Frequency (kc)	Output (db)	
1	60-108 KC IN jack (tip).	60-108 KC IN jack (ring).	108	-11.5	Check circuit from terminals H and R of J10 to J8 and to 60-108 KC IN binding posts.
2	Terminal 4 of T18	Terminal 5 of T18	108	-28	*a* Check circuit from terminals H and R of J10 to T18. *b.* Check resistors R117 through R120. *c.* Check capacitor C41.
3	Terminal 1 of FL5	Ground	108	-30	*a.* Check circuit from T18 to FL5 *b.* Check resistors R116. *c* Check transformer T18.
4	Terminal 3 of FL5	Ground	108	-36	Check filter FL5.
5	Terminal 1 of T5	Ground	108	-42	*a.* Check circuit from FL5 to T5. *b.* Check resistors R32 through R34.
6	Terminal 4 of T4	Ground	20	-29	a. Perform test No. 7. b. Check transformers T4 and T5. c. Check varistor CR2.
7	Terminal 2 of T4	Terminal 5 of T7	88	-2.5	Check circuit from terminals D and E of J10 to T1, T2, T4, and T5.
8	Terminal 1 of FL1	Ground	20	-29	Check circuit from T4 to FL1
9	Terminal 1 of tube socket XV1.	Ground	20	-14	a. Check tube socket XV2 voltages (TM 11-2139-20, fig. 12). Check resistors and capacitors associated with tube socket terminals which have abnormal dc voltages.

					b. Check tube socket XV2 resistances (TM 11-2139-20, fig. 12). Check resistors and capacitors associated with tube socket terminals which have abnormal resistance indications. c. Perform corrective meas-ures for test No. 10.
10	Terminal 5 of T3	Ground	20	+17.5	a. Check tube socket XV1 voltages (TM 11-2139-20, fig. 12). Check resistors and capacitors associated with tube socket terminals which have abnormal de voltages. b. Check tube socket XV1 resistances (TM 11-2139-20, fig. 12). Check resistors and capacitors associated with tube socket terminals, which have abnormal resistance indications. c. Check resistors R121, R122, R18, and R20. d. Check capacitors C1 through C11.
11	Terminal 1 of T3	Ground	20	+5.5	a. Check for proper termination of transformer T3. b. Check transformer T3
12	DEM OUT 3 jack (tip)	DEM OUT 3 jack (ring)	20	+5.5	Check circuitT3 to J2.
13	Terminal E of P2	Terminal P of P2	20	+5.5	Check circuit from T3 to terminals P and E of P1.

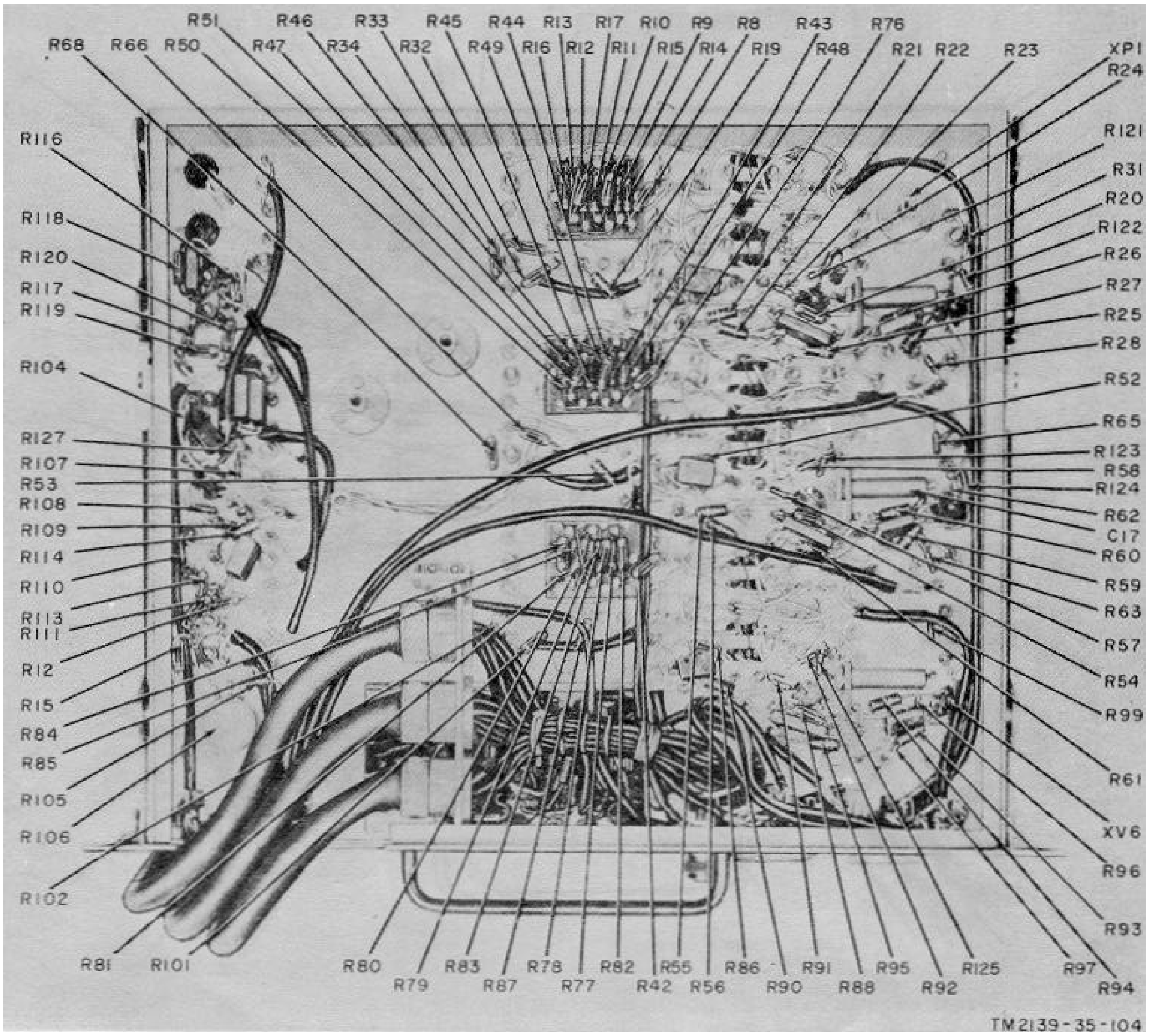

Figure *58. Telephone Modem TA-227/U, bottom view with covers removed, showing resistors.*

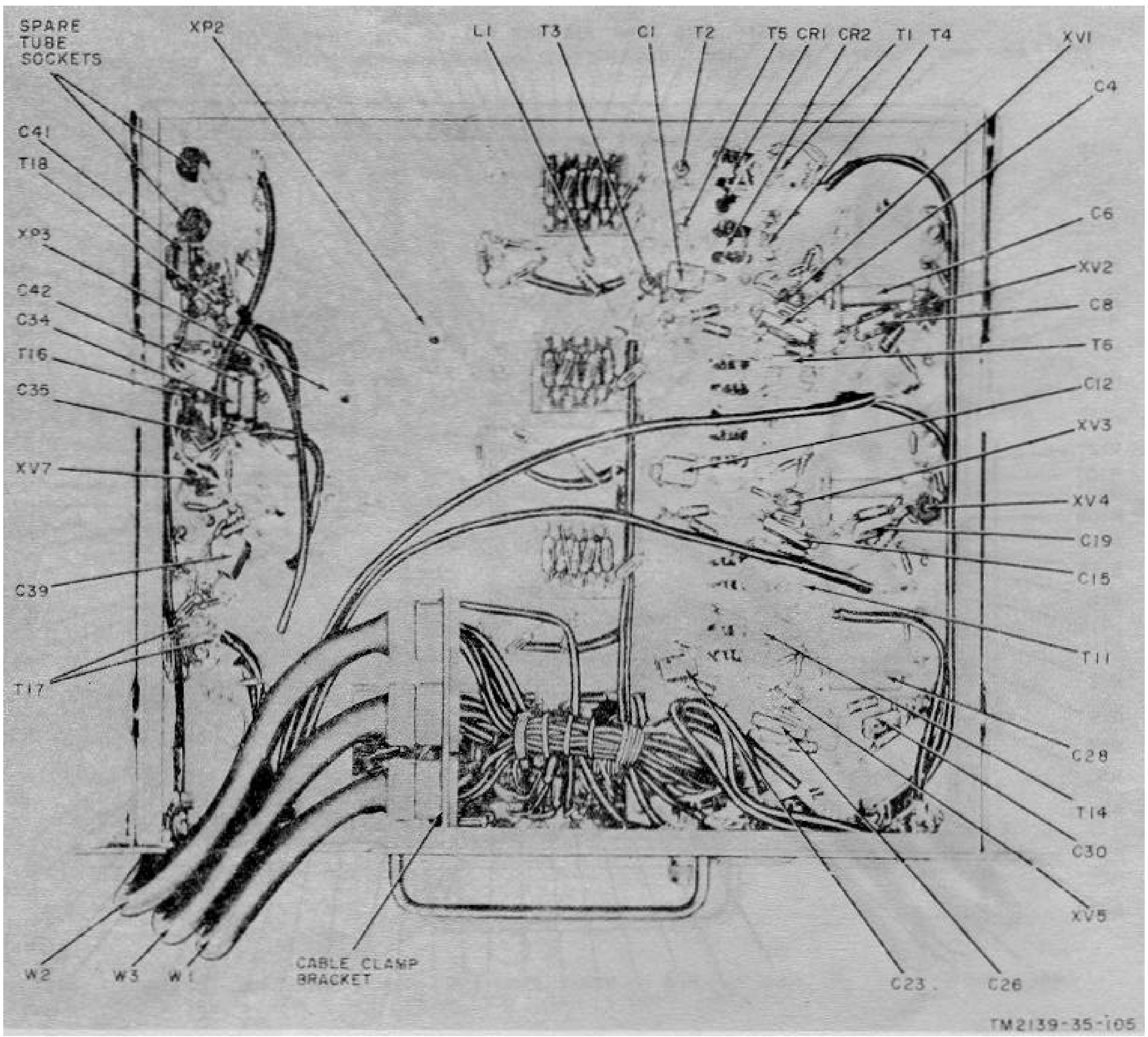

Figure 59. Telephone Modem TA--227/U bottom view with covers removed, showing capacitors and transformers.

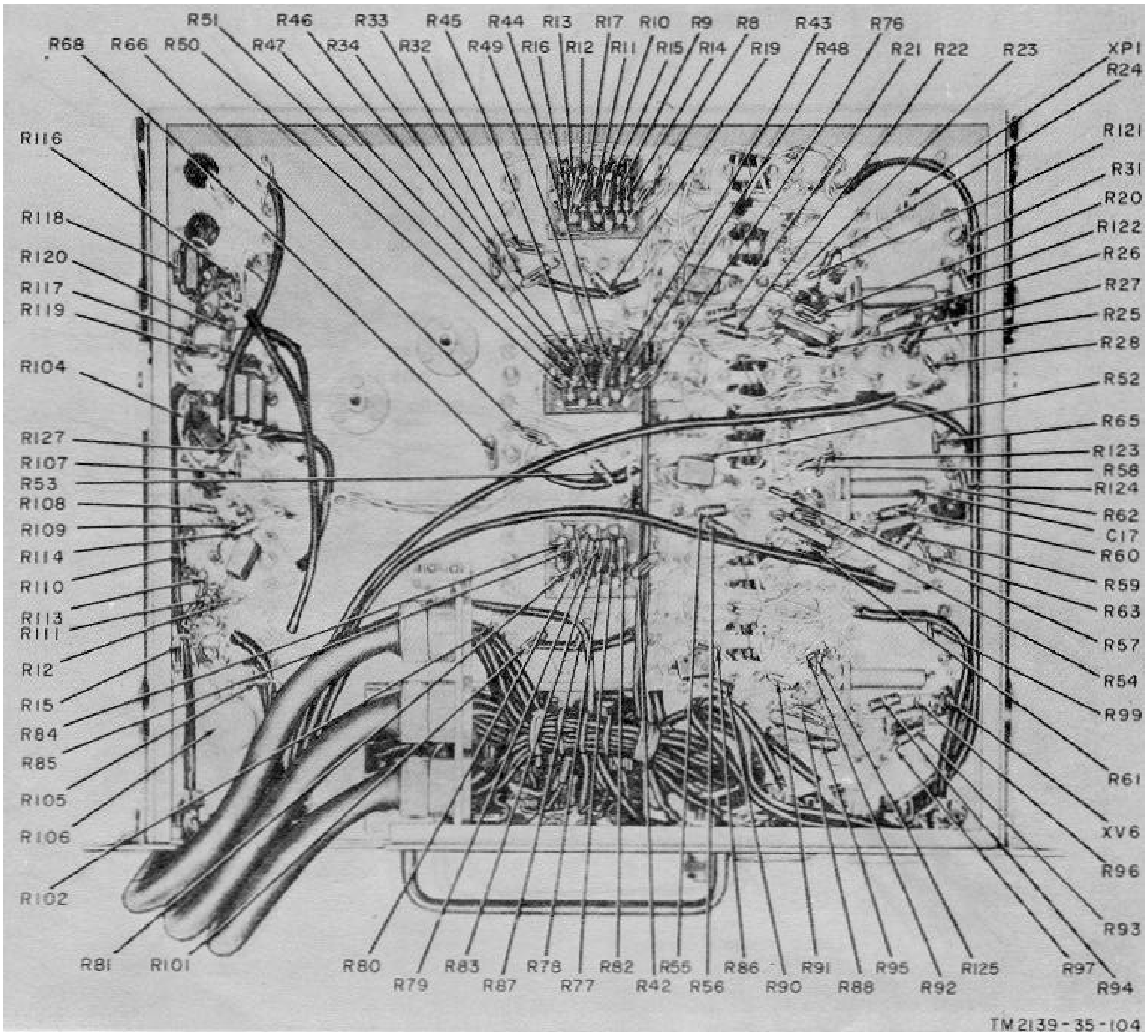

Figure 60. Telephone Modem TA-227/U, top view.

96. Dc Resistance of Transformers and Coils

Transformer or Coil	Terminals	Resistance (ohms)
T1, T6, and T11	**1-3**	**1.7**
	4-5	**.622**
T2, T7, and T12	**1-2**	**1.16**
	3-5	**2.85**
T3, T8, and T13	**1-2**	**39.6**
	3-4	**17.6**
	4-5	**7.4**
	3-5	**25**
T4, T9, and T14	**1-3**	**3.32**
	4-5	**1.72**
T5, T10, and T15	**1-2**	**1.16**
	3-5	**2.85**
T16 and T17	**1-2**	**2.47**
	3-4	**2.47**
T18	**1-3**	**1.7**
	4-5	**.622**
L1, L2, L3		**295**

Section IV. GROUP PANEL (PART OF AMPLIFIER-PILOT REGULATOR AM--707/TCC-7)

97. GROUP PANEL, Troubleshooting Data

Fig. No.	Par. No.	Description
		GROUP PANEL, schematic diagram.
9		12-68 kc amplifier, schematic diagram.
15		Regulator and alarm unit Z6, schematic diagram.
8		Modem and amplifier unit AR4, schematic diagram.
TM 11-2139-20, fig. 13.		GROUP PANEL, tube socket voltage and resistance chart.
TM 11-2139-20, fig. 14.		12-68 kc amplifier, tube socket voltage and resistance chart.
TM 11-2139-20, fig.15.		Regulator and alarm unit Z6, tube socket voltage and resistance chart.
TM 11-2139-20, fig.16.		Modem and amplifier unit AR4 tube socket voltage and resistance chart
74		GROUP PANEL, B+ distribution diagram.
62		GROUP PANEL, assemblies removed, top panel raised, top view.
63		GROUP PANEL, cover removed, bottom view.
65		12-68 kc amplifier, top view
66		12-68 kc amplifier, bottom view.
68		Regulator and alarm unit Z6, top view.
69		Regulator and alarm unit Z6, bottom view.
70		Regulator and alarm unit Z6, side view.
72		Modem and amplifier unit AR4, top view.
73		Modem and amplifier unit AR4, bottom view.
144		GROUP PANEL, wiring diagram.
145		12-68 kc amplifier, wiring diagram
146		Regulator and alarm unit Z6, wiring diagram.
147		Modem and amplifier unit AR4 wiring diagram.
	111*a*	GROUP PANEL, main chassis, dc resistance of transformers, coils, and thermistor.
	111*b*	12-68 kc amplifier, dc resistance of transformers and coil.
	111c	Regulator and alarm unit Z6, dc resistance of transformers and coil.
	111*d*	Modem and amplifier unit AR4, dc resistance of transformers and coil.

98. Transmitting Circuit Tests

(fig. 61)

a. Initial Procedures.

(1) Calibrate the audio level meter (par. 79).

(2) Connect the power, subgroup, and carrier supply test cable assemblies, 10-ohm resistor, 135-ohm resistor, 600-ohm resistor, 200 VOLT POWER SUPPLY, and GROUP PANEL as shown in figure 61.

(3) Connect signal generator No. 1 across terminals H and R of the subgroup test cable assembly; adjust signal generator No. 1 for an output frequency of 120 kc at an output level of —2.5 db as measured across terminals H and R with the audio level meter.

(4) Connect signal generator No. 2,resistors R1 through R3, attenuator, and transformer T107 together as shown in figure 61.

(5) Connect a 135-ohm across DEM OUT binding posts E9 and E10 and E13 and E14.

(6) Connect the audio level meter across the 600-ohm resistor connected to terminals F and S of the power test cable assembly. Arrange the meter to measure a frequency of 37 kc at a level of ±.5 db.

b. Message Transmitting Circuit Test. Per-form the initial procedures given in a above before performing steps (1) through (4) below.

(1) Operate the 12-60KC and 60-108KC switches to REGULAR and operate the TR CABLE REELS TO FIRST

AN/TCC-11 switch to the extreme clockwise position.

(2) Connect signal generator No. 2 and the associated components (*a* (4) above) across terminals A and L of the power test cable assembly. Set the attenuator for a 30-db loss and adjust the output frequency of the signal generator to 83 kc at an output level of -48.5 db measured across terminals A and L.

(3) The audio level meter (*a* (6) above) should indicate +.5 ±1.5 db.

(4) Operate the TR CABLE REELS TO FIRST AN/TCC-11 switch through one position at a time to the extreme counterclockwise position; the audio level meter indication should decrease about 3 db for each position of the switch.

c. 60-108KC Special Service Transmitting Test.

(1) Operate the 60-108KC and the 12-60KC switches to SPL SERV and REGULAR, respectively. The SPL SERV lamp should light.

(2) Connect signal generator No. 2 with associated components (*a* (4) above) across the SPECIAL SERVICE 60-108KC IN binding posts. Adjust the output frequency of the signal generator to 83 kc at an output level of. -6.5 db measured across the binding posts; adjust the attenuator for a 0-db loss.

(3) The audio level meter connected across terminals F and S of the power test cable indicate +.5 db ± 2 db.

d. 12-60KC Special Service Transmitting

(1) Operate the 12-60 KC switch to the SPL SERV position-The SPL SERV lamp should light.

(2) Connect signal generator No. 2 with associated components (*a* (4) above) across the SPECIAL SERVICE 12-60KC IN binding posts and readjust the output frequency of the signal generator to 37 kc at an output level of. -6.5 db measured across the binding posts. The audio level meter (*a* (6) above) should indicate +.5 db ±1.5 db.

e. Pilot Transmission Circuit Test.

(1) Connect signal generator No. 2 with associated components (*a* (4) above) across terminals K and W of the power test cable assembly; set the attenuator for a 30-db loss and readjust the signal generator for an output frequency of 68 kc at an output level of. -42 db measured across terminals K and W with the audio level meter.

(2) Connect the audio level meter across terminals T_1 and R of the test plug assembly; arrange the audio level meter to measure a frequency of 68 kc at a level of -38.5 db.

(3) Insert the plug of the test plug assembly into the TR AMP OUT jack; the audio level meter should indicate -38.5 ±1 db.

(4) Reinsert the plug of the test plug assembly into the TR 62 KC jack; the audio level meter should indicate. -1 ±1 db.

99. Receiving Circuit Tests

(fig. 61)

a. Initial Procedures.

(1) Calibrate the audio level meter (par. 79).

(2) Connect the power and subgroup test cable assemblies, 10-, 135-, and 600-ohm resistors, 200 VOLT POWER SUPPLY, and GROUP PANEL as shown in figure 61.

(3) Connect signal generator No. 1 across terminals H and R of the subgroup test cable assembly; adjust signal generator No. 1 for a frequency of 120 kc at a level of -2.5 db.

(4) Connect signal generator No. 2 resistors R1 through R3, attenuator, and transformer T107 as shown in figure 61.

(5) Connect a 135-ohm resistor across DEM OUT binding posts E9 and E10 and E13 and E14 on the GROUP PANEL.

(6) Set the BULGE ADJ 28 KC and

SLOPE ADJ 12 KC controls to position 0 and the TR and REC CABLE REELS TO FIRST AN/TCC-11 to position 23 for all tests unless otherwise specified.

b. Pilot and Message Receiving Circuit Test. Perform the initial procedures given in *a* above.

(1) Connect signal generator No. 2 and the associated components across terminals C and P of the power test cable assembly; set the attenuator for a 10-db loss and adjust the signal generator for a frequency of 68 kc at an output level of -23 db measured across terminals C and P.

(2) Connect the audio level meter across binding posts T_1 and R on the test plug assembly and arrange the audio level meter to measure a frequency of 68 kc at the levels indicated in the chart in (3) below.

(3) The following chart lists the test jack into which the plug of the test plug assembly must be inserted for each test, the GROUP PANEL control adjustments necessary, and the meter indication which should be obtained on the audio level meter.

Test plug assembly connection	Test and adjustment procedure	Audio level meter indication
1. REC IN--------------------------	Set FLAT ADJ 68 KC control on position 3 ---------------	-28.5± 3 db
2. REC AMP 1 OUT ------------	*a.* Set FLAT ADJ 68 KC control at maximum ---------	-28.5± 3 db
	b. Set FLAT ADJ 68 KC control at minimum----------	-54.5± 3 db
	c. Adjust FLAT ADJ 68 KC for a reading of -----------	-38.5 db
3. REC AMP 2 OUT ------------	*a.* Operate REGULATOR switch to MAN.	
	b. Set MAN REG control at maximum ------------------	-25.5± 4 db
	c. Set MAN REG control at minimum-------------------	-45± 4 db
	d. Adjust MAN REG control for a reading of ----------	-38.5 db
4. REC AMP 2 OUT ------------	*a.* Operate REGULATOR switch to AUTO.	
	b. Set AUTO REG control at maximum-----------------	-33± 3 db
	c. Set AUTO REG control at minimum -----------------	-47± 3 db
	d. Adjust AUTO REG control for a reading of---------	-38.5
	(After adjustments, do not disturb the control until all tests are completed.)	

(4) To test the automatic regulation of the pilot receiving circuit, perform the tests listed in the chart below. The chart lists the jack into which the test plug of the test plug assembly must be inserted for each test, the group panel control adjustments necessary, and the meter indication which should be obtained on the audio level meter.

Test plug assembly connection	Test and adjustment procedure	Audio level meter indication
1. REC AMP 1 OUT ----------------	Adjust FLAT ADJ 68 KC control for a reading of ------------------	-44.5 db
2. REC AMP 2 OUT ----------------	Controls as set in test 4*d* of the chart in *b(3)* above-----------------	Should stabilize between -39 and -38.5 db.
3. REC AMP 1 OUT ----------------	Adjust FLAT ADJ 68 KC control for a reading of ------------------	-32.5 db.
4. REC AMP 2 OUT ----------------	Controls as set in test 4*d* of the chart in *b(3)* above-----------------	Should stabilize between -39 and -38.5 db.
5. REC 62 KC -----------------------	Controls as set in tests 2 and 4 of the chart in *b(3)* above ---------	+3.5± 2db.

c. *Pilot Transmission Alarm Circuit Test.*

(1) Connect signal generator No. 2 and the associated components (*a* (4) above) across terminals C and P of the power test cable assembly; set the attenuator for a 10-db loss and adjust the output frequency of the signal generator to 68 kc at a level of -23 db measured across terminals C and P.

(2) Adjust the MAN REG control to the position given in test 3*d* of the chart in *b* (3) above.

(3) Connect the multimeter to the REG VOLTS jacks on regulator and alarm unit Z6.

(4) Operate the ALARM TEST switch to the 1 HIGH position and adjust the ADJ HIGH control to the position at which the HIGH alarm lamp lights and the alarm buzzer sounds. The multimeter should indicate 3.5 ±1 volt dc.

(5) Operate the ALARM TEST switch to the 2 LOW position and adjust the ADJ LOW control to the position at which the LOW alarm lamp lights and the alarm buzzer sounds. The multimeter should indicate 3.5 ±1 volt dc

d. Synchronizing Signal Receiving Circuit Test. Perform the initial procedures given in *a* above.

(1) Connect signal generator No. 2 and the associated components *a* (4) above across terminals C and P of the power test cable assembly with terminal P ground. Set the attenuator for a 10-db loss and adjust the output frequency of the signal generator to 68 kc at a level of-23 db measured across terminals C and P.

(2) Arrange the audio level meter to measure 68 kc at a level of 0 db. Connect the audio level meter to terminals P and F of the subgroup test cable assembly.

(3) Adjust signal generator No. 2 and the audio level meter to obtain a maximum indication on the audio level meter; the maximum indication should be 0 ±3 db.

e. 28 Kc Test Signal. Perform the initial procedure given in *a* above.

(1) Connect signal generator No. 2 and the associated components (*a* (4) above) to terminals C and P of the power test cable assembly. Set the attenuator for a 20-db loss and adjust the output frequency of the signal generator to 28 kc at an output level of -30 db measured across terminals C and P.

(2) Connect the audio level meter across terminals T_1 and R of the test plug assembly. Arrange the audio level meter to measure 28 kc at a -38.5-db level.

(3) Insert the plug of the test plug assembly into the REC AMP 2 OUT jack. The audio level meter should indicate -38.5 ±2 db.

(4) Adjust the SLOPE ADJ 12 KC control to the extreme counterclockwise position (-5). Turn the control one step at a time, to the extreme clockwise position (+5); the indication on the audio level meter should increase 1 db for each step of the SLOPE ADJ 12 KC control. Return the SLOPE ADJ 12 KC control to the 0 position.

(5) Operate the BULGE ADJ 28 KC control to the extreme counterclockwise position (-5). Turn the control, one step at a time, to the extreme clockwise position (+5); the indication on the audio level meter should increase .75 db for each step of the BULGE ADJ 28 KC control. Return the BULGE ADJ 28 KC control to the 0 position.

(6) Adjust the REC CABLE REELS TO FIRST AN/TCC-11 switch to the extreme counterclockwise position (2). Turn the switch, one step at a time, to the extreme clockwise position (23). The audio level meter indication should increase 3 db for each step of the switch.

f. 65 Kc Test Signal Receiving Circuit Test.

(1) Connect signal generator No. 2 and the associated components (*a* (4) above) to terminals D and R of the power test cable assembly. Set the attenuator for 0-db loss and adjust the output frequency of the signal generator to 65 kc at a level of -10.5 db.

(2) Connect the audio level meter across terminals T_1 and R of the test plug assembly; arrange the audio level meter to measure 65 kc at a level of -38.5 db.

(3) Insert the plug of the test plug assembly into the REC AMP 1 OUT

jack The audio level meter should indicate -38.5 ±1.5 db.

g. Message Circuit Receiving Test.

(1) Connect signal generator No. 2 and the associated components (*a* (4) above) to terminals C and P of the power test cable assembly.

(2) Set the attenuator for 10-db loss and adjust the signal generator for an output frequency of 68 kc at a level of -23 db.

(3) Connect the audio level meter to terminals T and R of the test cable assembly (with terminal R to ground).

(4) Insert the plug of the test plug assembly into the REC AMP 1 OUT jack-Adjust FLAT ADJ 68 KC control for a reading of -38.5 db on the audio level meter.

(5) Insert the plug of the test plug assembly into the REC AMP 2 OUT jack. Operate the REGULATOR switch to MAN and adjust the MAN REG control for an audio level meter indication of. -38.5 db.

(6) Operate the REGULATOR switch to AUTO and adjust the AUTO REG control for an audio level meter indication of -38.5 db.

(7) Adjust the DEM GAIN control to the extreme clockwise position.

(8) Operate the 60-108KC and 12-60KC switches to REGULAR.

(9) Readjust the output frequency of signal generator No. 2 to 37 kc.

(10) Arrange the audio level meter to measure a frequency of 83 kc at a level of -35 db. Connect the audio level meter to terminals H and R of the subgroup test cable assembly. The meter should indicate -35 ±2 db.

(11) Insert the plug of the test plug assembly into the DEM OUT jack; the audio level meter should indicate. -35 ±2 db.

(12) Reconnect the audio level meter to the SPECIAL SERVICE 60-108KC OUT binding posts; and operate the 60-108KC switch to the SPL SERV. The audio level meter should indicate . 35 db +2 db.

(13) Readjust the audio level meter to measure 37 kc. Connect the meter to the SPECIAL SERVICE 12-60KC OUT binding posts. Operate the 12-60KC switch to SPL SERV. The audio level meter should indicate -9 ±1 db.

100. Miscellaneous Continuity Tests

a. Initial Procedures. Connect one subgroup test cable assembly to connector P1 and another subgroup test cable assembly to connector P2 on the GROUP PANEL.

b. Cable Continuity and Short Circuit Tests. Use the multimeter to check the transmission circuits listed in the chart in *c* below. Make continuity tests between the subgroup test cable assembly terminals in the same horizontal row. The multimeter should indicate 0 ohms resistance for each check. Make short circuit checks between the terminals listed in row *a* and those listed in row *b* for each path in the chart. The multimeter should indicate infinite resistance for each check.

c. Cable Assembly Continuity Chart.

Circuit under test		Subgroup test cable assembly connected to P1	Subgroup test cable assembly connected to P2
56 KC path between connectors P1 and P2	a	C	C
	b	L	L
72 kc path between connectors P1 and P2	a	J	J
	b	A	A
88 kc path between connectors P1 and P2	a	E	E
	b	D	D

101. GROUP PANEL Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in the GROUP PANEL. This chart lists the symptoms that may be reported on the equipment repair tag or observed when performing maintenance at the organizational level (TM 11-2139-20). Once the trouble has been localized to a stage or circuit, a tube

Figure 61. GROUP PANEL, operational test setup

(Contained in separate envelope)

check and voltage resistance measurements of this stage or circuit will usually be sufficient to isolate the defective part. Normal tube socket voltage and resistance measurements are provided in TM 11-2139-20, figures 13 through 16.

Symptom	Probable trouble	Corrective measures
1. No transmission through GROUP PANEL IN BOTH transmitting and receiving directions.	*a*. Failure of 200-volt dc distribution circuits.	*a*. Check for presence of 200 volts dc between standoff E52 and ground. If not present, refer to B + distribution diagram (fig. 74) and locate open and short circuits.
	b. Failure of 6.3-volt ac distribution circuits.	*b*. Check for presence of 6.3 volts ac across standoffs E54 and E55 and across terminals 7 and 8 of connector J2 (fig. 7). If not present, check the 6.3-volt ac distribution circuits and locate open and short circuits.
	c. Failure of 120-kc carrier distribution circuits.	*c*. Use signal substitution procedures (par. 102*a*, test No. 3) to localize the trouble.
2. Transmission through normal transmitting circuit from terminals A and L to terminals F and S of connector J1, out of limits.	Failure of a component between terminals A and L, and F and S of connector J1.	*a*. Replace 12-68 kc amplifier AR3. *b*. If normal output is not obtained in correction *a*, use signal substitution procedures (par. 102*a*, tests No. 1 through 12) to localize trouble.
3. Transmission through 60-108 kc special service transmitting circuits from SPECIAL SERVICE 60-108 kc IN binding posts to terminals F and S of connector J1, out of limits.	Failure of a component between SPECIAL SERVICE 60-108 kc IN binding posts and connector J2 of modem and amplifier AR4.	*a*. Check performance (par. 98*c*). *b*. If normal output is obtained in correction *a*, use signal substitution procedures (par. 102*a*, tests No. 13 and 14) to localize trouble.
4. Transmission through 12-60 kc special service transmitting circuit from SPECIAL SERVICE 12-60KC IN binding posts to terminals F and S of connector J1 out of limits.	Failure of a component between SPECIAL SERVICE 12-60KC IN binding posts and terminals 3 and 4 of filter FL3.	*a*. Check performance (par. 98*d*). *b*. If normal output is obtained in correction *a*, use signal substitution procedures (par. 102*a*, tests No. 15 and 16) to localize trouble.
5. 68 kc pilot transmission from terminals K and W of connector J1, through 12-68 kc amplifier AR3, to the TR AMP OUT jack, or the TR 62 KC jack, out of limits.	Failure of a component between terminals K and W of connector J1 and output of 12-68 kc amplifier AR3.	Use signal substitution procedures (par. 102*a*, test No. 17) to locate trouble.
6. Transmission through receiving circuit from terminals C and P of connector J1 to terminals H and R of connector P1, out of limits.	Failure of a component between C and P of connector J1 and terminals H and R of connector P1.	*a*. Check performance (par. 99*b*). *b*. If normal output is obtained in correction *a*, use signal substitution procedures (par. 102*b*, test No. 18) to localize trouble.
7. Pilot transmission out of limits at REC IN jack.	Failure of cable building-out network Z5 and associated circuits.	Check performance of REC CABLE REELS TO FIRST AN/TCC-11 switch as outlined in paragraph 99*b*.
8. Pilot transmission out of limits at REC AMP 1 OUT jack.	Failure of a component between cable building-out network Z1 and output of 12-68 kc amplifier AR1.	a. Check performance (par. 99*b*). b. Replace 12-68 kc amplifier AR1. c. If normal output is not obtained in corrections *a* and *b*, use signal substitution procedures (par. 102*b*, tests No. 1 through 11) to localize trouble.
9. Pilot transmission out of limits at REC AMP 2 OUT jack, REGULATOR switch in MAN position.	Failure of a component between cable of 12-68 kc amplifier AR1 and output of 12-68 kc amplifier AR2.	*a*. Check performance (par. 99b) *b*. Replace 12-68 kc amplifier AR2. *c*. If normal output is not obtained in corrections a and l', use signal substitution procedures (par. 102b tests No. 1 through 11) to localize trouble.

Symptom	Probable trouble	Corrective measures
10. Test signal transmission out of limits at REC AMP 2 OUT jack.	Failure of a component between terminals C and P of connector J1 and output of 12-68 kc amplifier AR2.	Use signal substitution procedures (par. 102*b*, tests No. 32 through 40) to localize trouble.
11. Pilot transmission output too low at REC AMP 2 OUT jack (par. 99*b*, test No. 4). Normal reading at REC AMP l OUT jack. LOW alarm indication on GROUP PANEL. Connect the multimeter to REG VOLTS jacks on regulator and alarm Z6. Arrange the multimeter to read dc volts. The multimeter reads 6 volts dc or higher (normal reading is 3.5 volts dc).	Failure of a component between output of 12-68 kc amplifier AR1 and 12-68 kc amplifier AR2.	*a*. Operate REGULATOR switch to MAN position and check performance (par. 99). If out of limits, proceed as in symptom 9. *b*. If normal output is obtained in correction *a*, check capacitors C1 through C4 for short circuits. Check the wiring to thermistor RT1; check thermistor for open circuit between terminals l and 2.
12. Pilot transmission output too low at REC AMP 2 OUT jack (par. 99*b*, test No. 4). Normal reading at REC AMP 1 OUT jack. LOW alarm indication on GROUP PANEL. Connect the multimeter to REG VOLTS jacks on regulator and alarm Z6. Arrange the multimeter to measure dc volts. The multimeter reads less than 1 volt dc (normal reading is 3.5 volts dc).	Failure of a component in automatic regulation loop.	*a*. Operate REGULATOR switch to MAN position and check performance (par. 99). If out of limits, proceed as in symptom 9. *b*. If normal output reading is obtained in correction a, replace regulator and alarm Z6. *c*. If procedure in correction does not clear trouble, check for presence of +200 volts dc between terminal 19 of connector J6 and ground. Operate the AUTO REG OUTPUT control to the extreme clockwise position and check for +140 volts dc between terminal 14 of connector J6 and ground. If not present, refer to B+ distribution diagram (fig. 74 and locate open and short circuits.
13. Pilot transmission output too high at REC AMP 2 OUT jack (par. 99*b*, test No. 4). Normal reading at REC AMP 1 OUT jack. LOW alarm indication on GROUP PANEL. Connect the multimeter to terminal 14 of connector P1 on regulator and alarm Z6 and to chassis ground. Arrange the multimeter to measure 70 volts dc. Adjust AUTO REG OUTPUT control for a reading of 70 volts on the multimeter. Connect the multimeter to the REG VOLTS jacks on the regulator and alarm Z6. Arrange the multimeter to measure dc volts. The multimeter reads 10 volts dc or higher (normal reading is 3.5 volts dc.	*a*. Failure of regulator and alarm unit Z6 or 16-28 kc amplifier AR2. *b*. Failure of connections between connectors J3 and J6.	*a*. Replace regulator and alarm unit Z6 and 12-68 kc amplifier AR2, one at a time. *b*. If procedures in correction a do not clear trouble, use signal substitution procedures (par. 102*b*, test No l9).to locate trouble.

Symptom	Probable trouble	Corrective measures
14. Pilot transmission output too high at R3C AMP 2 OUT jack (par. 99b, test No. 4). Normal reading at REC AMP 1 OUT jack. HIGH alarm indication on GROUP PANEL. Connect the multimeter to REG VOLTS jacks on regulator and alarm Z6. Arrange the multimeter to measure dc volts. The multimeter reads less than 1 volt dc (normal reading is 3.5 volts dc).	Failure of component in automatic regulation loop.	*a*. Operate REGULATOR switch to MAN position and check performance (par. 99~. If out of limits, proceed as in symptom 9. *b*. If normal output reading is obtained in correction a, check thermistor RT1 for short circuit between terminals 1 and 2.
15. Pilot transmission output too high at REC AMP 2 OUT jack (par. 99*b* test No. 4). Normal reading at REC AMP 1 OUT jack. HIGH alarm indication on GROUP PANEL. Connect the multimeter to REG VOLTS jacks on regulator and alarm Z6. Arrange the multimeter to measure dc volts. The multimeter reads 6 volts dc or higher (normal reading is 3.5 volts dc).	*a*. Failure of regulator and alarm Z6.	a. Operate REGULATOR switch to MAN position and check performance (par. 99) of operational test. If normal, replace regulator and alarm Z6
	b. Failure of AUTO REG OUTPUT control and associated circuits.	b. If procedure in correction a does not clear trouble, check voltage between terminal 14 of connector J6 and ground. Adjust the AUTO PING OUTPUT control to its extreme counterclockwise position. The voltage at the REG VOLTS jacks (as checked with the multimeter) on the regulator and alarm Z6 should be less than 1 volt dc. Check AUTO REG OUTPUT variable resistor and associated circuits for opens and shorts.
16. Pilot transmission output out of | limits at REC 62 KC jack. HIGH alarm indication on GROUP PANEL that cannot be removed by adjustment. REGULATOR switch in MAN or AUTO position. | Normal reading at REC AMP 2 OUT jack.	Open circuit at output of 12-68 kc amplifier AR2.	Use signal substitution procedures (par. 102b, test No. 20) to locate trouble.
17. Pilot transmission output out of limits at REC 62 KC jack. HIGH alarm indication on GROUP PANEL that cannot be removed by adjustment. REGULATOR switch in MAN or AUTO position. Normal reading at REC AMP 2 OUT jack.	Short circuit at output of 12-68 kc amplifier AR2.	Use signal substitution procedures (par. 102*b*, test No. 20) to locate trouble.
18. Incorrect alarm indications for corresponding output reading of REC AMP 2 OUT jack; or permanent HIGH or LOW alarm; no visual and/or audible HIGH or LOW alarm indication on GROUP PANEL.	*a*. Failure of regulator and alarm unit Z6. *b*. Failure of alarm voltage distribution paths.	*a*. Replace regulator and alarm unit Z6. *b*. If procedure in correction a does not clear trouble, check for open and short circuits in alarm voltage distribution paths.

Symptom	Probable trouble	Corrective measures
19. Synchronizing signal at terminals P and F of connector P2 out of limits.	Failure of a component between 12-68 kc amplifier AR2 output and terminals P and F of connector P2.	*a*. Check performance (par. 99). *b*. If normal output is obtained (par. 99), replace tube V1. *c*. If procedure in correction *b* does not clear trouble, use signal substitution (par. 102*b*, tests No. 41 through 44) to localize trouble.
20. Transmission through 60-108 kc special service receiving circuits, from terminals C and P of connector J1 to SPECIAL SERVICE 60-108KC OUT binding posts, out of limits.	Failure of special service switch and associated circuits.	Check performance (par. 99*e*) of operational tests; if normal, check for shorts and open circuit between terminals 14 and 17 of connector J2 and SPECIAL SERVICE 60-108KC OUT binding posts.
21. Transmission through 12-60 kc special service receiving circuit, from terminals C and P of connector J1 to SPECIAL SERVICE 12-60KC OUT binding posts. out of limits.	Failure of special service switch, transformer T2, or associated circuits.	*a*. Check performance (par. 99*b* and e). *b*. If normal output, is obtained in correction *a*, use signal substitution procedures (par. 102*b*, test No. 31) to localize trouble.
22. 65 kc modulation test signal through REC AMP 1 from terminals D and R of connector J1 to REC AMP 1 OUT jack, out of limits.	Failure of a component between terminals D and R of connector J1 and out put of 12-68 kc amplifier AR1.	*a*. Check circuits from terminal D of connector J1 to terminals 0 or 3 of connector J3. Check circuits from terminal R of connector J1 to ground. *b*. Check resistors R32 and R33.

102 GROUP PANEL Signal Substitution Chart

Separate GROUP PANEL signal substitution charts are provided for the transmitting direction (*a* below) and the receiving direction (*b* below). Use the signal substitution charts to supplement the troubleshooting procedures outlined in paragraph 101. These charts will help determine the defective stage or circuit. Voltage and resistance measurements taken at the defective stage or circuit will ordinarily isolate the defective part. The signal substitution procedures at any step assumes that all previous steps have been satisfactorily completed. Use the same equipment arrangements in the signal substitution tests as were used in the operational tests.

a. Signal Substitution Chart, Transmitting Direction.

Test No.	Signal generator (for hookup in circuit, see par.)	Audio level meter probe connections: Positive	Audio level meter probe connections: Negative	Audio level meter normal indication: Frequency (kc)	Audio level meter normal indication: Output (db)	Corrective measures
1	98*b*	Terminal 4 of P1 on modem and amplifier of AR4.	Terminal 5 of P1 on modem and amplifier AR4.	83	-48.5	Check circuit from terminals A and L of J1 to terminals 4 and 5 of J2.
2	98*b*	Terminal 2 of P1 on modem and amplifier of AR4.	Terminal 1 of P1 on modem and amplifier AR4.	37	-46.5	a. Perform test No. 3. b. If normal indication is obtained in step a, check modem and amplifier AR4
	98*b*	Terminal 11 of P1 on modem and amplifier AR4.	Terminal 1 of P1 on modem and amplifier AR4.	120	-2.5	Check circuit from terminals H and R of P2, to terminals 10 and 11 of J2.
	98*b*	Terminal 1 of FL3 .	Ground	37	-50	*a*. Check. circuit from terminals 1 and 2 of J2 to FL3. *b*. Check resistors R11 through R13.
	98*b*	Terminal 3 of FL3 .	Ground	37	-53	*a*. Check circuit from FL3 to J4. *b*. Check filter FL.3.
	98*b*	Terminal 0 or 3 of P1 on 12-68kc amplifier AR3.	Ground	37	-54	*a*. Check circuit from FL3 to J4. *b*. Check resistor R14. *c*. Check capacitor C3.
	98*b*	Terminal 14 or 17 of P1 on 12-68 kc amplifier AR3.	Ground	37	.5	a. Replace 12-68 kc amplifier AR1 or AR2 and repeat test No. 2. *b*. If normal indication is not obtained in step *a*, check for +200 volts dc from terminal 9 to terminal 12 of J4. *c*. If normal indication in step *b* is not obtained, check the +200-volt distribution circuit (fig. 74). *d*. Check for 6.3 volts ac between terminals 10 and 11 of J4. *e*. If normal indication in step *d* is not obtained, check the 6.3-volt ac distribution circuit (fig. 7). *f*. Check the circuit from terminal 7 of J4 to terminal 6 of J4.

Test No.	Signal generator (for hookup in circuit, see par.)	Audio level meter probe connections: Positive	Audio level meter probe connections: Negative	Audio level meter normal indication: Frequency (kc)	Audio level meter normal indication: Output (db)	Corrective measures
						g Check resistors R15 and R16. *h*. Check capacitor C6.
8	98*b*	TR AMP OUT jack (tip).	TR AMP OUT jack (ring).	37	-38.5	*a*. Replace 12-68 kc amplifier AR3 with a spare 12-68 kc amplifier or the AR1 or AR2 12-68 kc amplifier, and repeat test No. 8. *b*. If normal indication is not obtained in step *a*, check circuit from J4 to J12. *c*. Check resistors R17 and R18.
9	98*b*	TR 62 KC jack I (tip).	TR 62 KC jack (ring).	37	-1	*a*. Check circuit from J4 to J13. *b*. Check resistor R19.
10	98*b*	Terminal 3 of Z1	Ground	37	+.5	Check circuit from J4 to Z1.
11	98b TR CABLE REELS TO FIRST AN/TCC-11 in position 23.	Terminal 1 of Z1	Ground	37		
	20					
	17					
	14	---------------------------	---------------------------	-----------	+.5	*a*. Check circuits between Z1 and S6.
	11	---------------------------	---------------------------	-----------	-2.5	
	8	---------------------------	---------------------------	-----------	-5.5	*b*. Check TR CABLE REELS TO FIRST AN/TCC-11 switch S6.
	5	---------------------------	---------------------------	-----------	-8.5	
	2	---------------------------	---------------------------	-----------	-11.5	
	Return switch to position 23.	---------------------------	---------------------------	-----------	-14.5	*c*. Check cable building-out network Z1.
		---------------------------	---------------------------	-----------	-17.5	
		---------------------------	---------------------------	-----------	-20.5	
		---------------------------	---------------------------	-----------	+.5	
12	98*b*	Terminal F of J1	Terminal S of J1	37	+.5	Check circuit from Z1 to J1.
13	98c	SPL SERV 60 108 KC IN jack (tip).	SPL SERV 60-108 KC IN jack (ring).	83	-11	*a*. Check circuit from SPECIAL SERVICE 60-108KC IN binding posts to J7. *b*. Check resistors R2 and R3.
14	98c	Terminal 4 of P1 on modem and amplifier AR4.	Terminal 5 of P1 on modem and amplifier AR4.	83	-48.5	*a*. Check circuit from SPECIAL SERVICE 60-108KC IN binding posts to J2. *b*. Check resistors R2 through R6.
15	98d	SPL SERV 12 60 KC IN jack (tip).	SPL SERV 12-60 KC IN jack (ring).	37	0	Check circuit from SPECIAL SERVICE 12-60KC IN binding posts to J9.

Test No.	Signal generator (for hookup in circuit, see par.)	Audio level meter probe connections		Audio level meter normal indication		Corrective measures
		Positive	Negative	Frequency (kc)	Output (db)	
16	98d	Terminal 1 of FL3	Ground	37	-50	*a*. Check circuit from SPECIAL SERVINCE 12-60KC IN binding posts to FL3. *b*. Check resistors R8 through R10.
17	98e	TR AMP OUT jack (tip).	TR AMP OUT jack (ring).	68	-38.5	*a*. Replace 12-69 kc amplifier AR3. Repeat test 17. *b*. If normal indication is not obtained in step *a*, check circuit from terminal K and W of J1 to J4. *c*. Check resistors R46 through R48.

b. Signal Substitution Chart, Receiving Direction.

Test No.	Signal generator (for hookup in circuit, see par.)	Audio level meter probe connections		Audio level meter normal indication		Corrective measures
		Positive	Negative	Frequency (kc)	Output (db)	
1	98*a* and b and test No. 1 of *b*(3).	Terminal 1 of Z5	Ground	68	-23	Check circuit from terminals C and P of J1 to Z5.
2	99*a* and *b* and test No. 1 of *b*(3).	Terminal 3 of Z5	Ground	68	---------	*a*. Check circuits from Z5 to S5. b. Check REC CABLE REELS TO FIRST AN/TCC-11 switch S5. c. Check cable building-out network Z5.
	REC CABLE REELS TO FIRST AN/TCC-11 switch in positions:					
	23	----------------------------	----------------------------	-----------	-23	
	20	----------------------------	----------------------------	-----------	-26	
	17	----------------------------	----------------------------	-----------	-29	
	14	----------------------------	----------------------------	-----------	-32	
	11	----------------------------	----------------------------	-----------	-35	
	8	----------------------------	----------------------------	-----------	-38	
	5	----------------------------	----------------------------	-----------	-41	
	2	----------------------------	----------------------------	-----------	-44	
	Return switch to position 23.	----------------------------	----------------------------	-----------	-23	
3	99a and b and test No. 2 of b(3).	REC IN jack (tip)	REC IN jack (ring)	68	-28.5	a. Check circuits from Z5 to J15 and Z4. b. Check resistors R52 and R53.

Test No.	Signal generator (for hookup in circuit, see par.)	Audio level meter probe connections		Audio level meter normal indication		Corrective measures
		Positive	Negative	Frequency (kc)	Output (db)	
4	99*a* and *b* and test No. 2 of *b*(3).	Terminal 1 of Z4	Ground -----------------	68	----------	a. Check circuits from Z5 to Z4.
	FLAT ADJ 68 KC GAIN control in extreme clockwise position.	---------------------------	---------------------------	----------	-23.5	b. Check resistors R36 through R38.
	In extreme counterclockwise position.	---------------------------	---------------------------	----------	-50.0	
	Adjust FLAT ADJ 68 KC gain control for normal.	---------------------------	---------------------------	----------	-34	
5	99*a* and *b* and test No. 2 of *b*(3).	Terminal 3 of Z4	Ground -----------------	68	-41	Perform test No. 32.
6	99*a* and *b* and test No. 2 of *b*(3).	Terminal 3 of Z3	Ground -----------------	68	-45	*a*. Check circuit from Z4 to Z3. *b*. Perform test No. 33.
7	99*a* and *b* and test No. 2 of *b*(3).	Terminal 3 of delay equalizer EQ3.	Ground -----------------	68	-45	*a*. Check circuit from Z3 to delay equalizer EQ3. *b*. Check delay equalizer EQ3.
8	99*a* and *b* and test No. 2 of *b*(3).	Terminal 3 of basic equalizer EQ2.	Ground -----------------	68	-50	*a*. Check circuit from delay equalizer EQ3 to basic equalizer EQ2. *b*. Cheek basic equalizer EQ2.
9	99*a* and *b* and test No. 2 of *b*(3).	Terminal 0 or 3 of P1 on 12-68 kc amplifier AR1.	Ground -----------------	68	-50	Check circuit from basic equalizer EQ2 to J5.
10	99*a* and *b* and test No. 2 of *b*(3).	REC AMP 1 OUT jack (tip).	REC AMP ! OUT jack (ring)	68	-38.5	*a*. Perform test No. 11. *b*. If normal indication is obtained in step a, cheek circuit from J5 to J14. c. Check resistors R29 and R30.
11	99*a* and *b* and test No. 2 of *b*(3).	Terminal 14 or 17 of P1 on 12-68 kc amplifier AR1.	Ground -----------------	68	-5	*a*. Replace 12-68 kc amplifier ART. Repeat test No. 11. *b*. If normal indication is not obtained in step a, cheek for +200 volts dc from terminal 9 to terminal 124f J5. c. If normal indication in step b is not obtained, cheek the +200-volt distribution circuit (fig. 74).

Test No.	Signal generator (for hookup in circuit, see par.)	Audio level meter probe connections		Audio level meter normal indication		Corrective measures
		Positive	Negative	Frequency (kc)	Output (db)	
						d. Check for 6.3 volts ac between terminals 10 and 11 of J5. *e*. If normal indication in step *d* is not obtained, check the 6.3-volt ac distribution circuit (fig. 7).
12	99*a* and *b* and test No. 2 of *b*(3).	Terminal 1 of T3----	Ground--------------	68	-14	*a*. Check circuit from J5 to T3. *b*. Check resistors R45, R49, R50, and R51. *c*. Check capacitor C14.
13	99*a* and *b* and test No. 2 of *b*(3).	Terminal 3 of T3----	Ground--------------	68	-28	*a*. Check circuit from T3 to Z2 and C7. *b*. Check resistor R27. *c*. Check transformer T3.
14	99*a* and *b* and test No. 3 of *b*(3).	Terminal 2 of Z2----	Ground--------------	68	-------	*a*. Check circuit from T3 to J3. *b*. Check resistor R28. *c*. Check capacitors C4, C5, and C7 through C10. *d*. Check regulator network Z2.
	MAN REG OUTPUT control in extreme clockwise position.	--------------------------	--------------------------	----------	-43	
	In extreme counterclockwise position	--------------------------	--------------------------	----------	-62.5	
15	99*a* and *b* and test No. 3*d* of *b*(3).	Terminal 1 or 4 of P1 on 12-68 kc amplifier AR2.	Ground--------------	68	-43	*a*. Check circuit from T3 to J3. *b*. Check resistor R28. *c*. Check capacitors C4, C5, and C7 through C10. *d*. Check regulator network Z2.
16	99*a* and *b* and test No. 3*d* of *b*(3).	REC AMP 2 OUT jack (tip).	REC AMP 2 OUT jack (ring)	68	-38.5	*a*. Perform test No. 17. *b*. If normal indication is obtained in step a, check resistors R22 and R23.
17	99*a* and *b* and test No. 3*d* of *b*(3).	Terminal 14 or 17 of P1 on 12-68 kc amplifier AR2.	Ground--------------	68	+5	*a*. Replace 12-68 kc amplifier AR2 with a spare 12-68 kc amplifier or the AR3 12-68 kc amplifier and repeat this test.

Test No.	Signal generator (for hookup in circuit, see par.)	Audio level meter probe connections		Audio level meter normal indication		Corrective measures
		Positive	Negative	Frequency (kc)	Output (db)	
						b. If normal indication is not obtained in step *a*, check for +200 volts dc from terminal 9 to terminal 12 of J3. *c*. If normal indication in step *b* is not obtained, check the +200-volt distribution circuit (fig. 74). *d*. Check for 6.3 volts ac between terminals 10 and 11 of J3. *e*. If normal indication in step *d* is not obtained, check the 6.3-volt ac distribution circuit. *f*. Check circuit from terminal 13 to terminals 19 and 16 of J3. *g*. Check resistor R26. *h*. Check capacitor C12.
18	99a and b and test No. ad of b(3).	REC 62 KC jack (tip).	REC 62 KC jack (ring).	68	+3.5	a. Check circuit from J3 to J10. b. Check resistor R20.
19	Connect regulator and alarm unit Z6 to GROUP PANEL with extension cable 99a and b and test No. 3 of b(3).	Terminal 6 of T1 on regulator and alarm unit Z6.	Ground --------------	68	-3	Check resistors R12, R13 and R34.
20	99a and b and test No. 3d of b(3).	Terminal 1 of FL1	Ground --------------	68	+5	Check circuit from J3 to FL1.
21	99g	Terminal 1 of FL1	Ground --------------	37	0	Perform tests No. 20 and 32 through 40.
22	99g	Terminal 3 of FL1	Ground --------------	37	-2	Check filter FL1.
23	99g	Terminal 19 of P1 on modem and amplifier AR4.	Ground --------------	37	-2	Check circuit from FL1 to terminals 16 and 19 of J2.
24	99g	Terminal 17 of P1 on modem and amplifier AR4.	Terminal 14 of P1 on modem and amplifier AR4.	83	-11.6	*a*. Replace modem and amplifier AR4. Repeat test No. 24. b. Perform test No. 25 if normal indication is not obtained in step *a*.

Test No.	Signal generator (for hookup in circuit, see par.)	Audio level meter probe connections: Positive	Negative	Audio level meter normal indication: Frequency (kc)	Output (db)	Corrective measures
						c. If normal indication is obtained in step *b*, and is not obtained in step *a*, check for +200 volts dc from terminal 3 to terminal 6 of J2. *d*. If normal indication in step *c* is not obtained, check the +200-volt distribution circuit (fig. 74). *e*. Check for 6.3 volts ac between terminals 7 and 8 of J2. *f*. If normal indication in step *e* is not obtained, check the 6.3-volt ac distribution circuit.
25	99a	Terminal 10 of P1 on modem and amplifier AR4	Terminal 11 of P1 on modem and amplifier AR4	120	-2.5	Check circuit from terminals H and R of P2 to terminals 10 and 11 of J2.
26	99g	DEM OUT jack (tip),	DEM OUT jack (ring),	83	-11.5	Check circuit from terminals 14 and 17 of J2 to DEM OUT binding posts.
27	99g	DEM OUT binding post E3	DEM OUT binding post E4	83	-11.5	Check circuit from terminals 14 and 17 of J2 to DEM OUT binding posts.
28	99g	DEM OUT ALT binding post E5	DEM OUT ALT binding post E5	83	-11.5	*a*. Check circuit, from terminals 15 and 18 of J2 to DEM OUT ALT binding posts. *b*. Check resistor R1
29	99g	Terminal H of P1	Terminal R of P1	83	-11.5	Check circuit from terminals 15 and 18 of J2 to terminals H and R of P1.
30	99g	SPECIAL SERVICE 60-108KC OUT binding post E9.	SPECIAL SERVICE 60-108KC OUT binding post E10.	83	-11.5	Check circuit from terminals 14 and 17 of J3 to SPECIAL SERVICE 60-108KC OUT binding posts.
31	99g	SPECIAL SERVICE 12-60KC OUT binding post E13	SPECIAL SERVICE 12-60KC OUT binding post E14	37	-9	*a*. Check circuit from FL1 to SPECIAL SERVICE 1260KC OUT binding posts. *b*. Check transformer T2.

Test No.	Signal generator (for hookup in circuit, see par.)	Audio level meter probe connections: Positive	Audio level meter probe connections: Negative	Audio level meter normal indication: Frequency (kc)	Audio level meter normal indication: Output (db)	Corrective measures
32	99e SLOPE ADJ 12 KC control position:	Terminal 3 of Z4	Ground	28	--------	a. Perform test No. 5 and if normal indication is not obtained, check circuit form Z4 to R35. b. Check R35. c. Check slope network Z4.
	+5	---------------------------	--------------------------	------------	-44	
	+4	---------------------------	--------------------------	------------	-45	
	+3	---------------------------	--------------------------	------------	-46	
	+2	---------------------------	--------------------------	------------	-47	
	+1	---------------------------	--------------------------	------------	-48	
	0	---------------------------	--------------------------	------------	-49	
	-1	---------------------------	--------------------------	------------	-50	
	-2	---------------------------	--------------------------	------------	-51	
	-3	---------------------------	--------------------------	------------	-52	
	-4	---------------------------	--------------------------	------------	-53	
	-5	---------------------------	--------------------------	------------	-54	
	Return to position 0					
33	99*e* BULGE ADJ 28 KC control position:	Terminal 3 of Z3	Ground ----------------	28	--------	a. Perform test No. 6 and if normal indication is not obtained, check circuit from Z3 to R34. b. Check R34. c. Check bulge network Z3.
	-5	---------------------------	--------------------------	------------	-48	
	+4	---------------------------	--------------------------	------------	-48.75	
	+3	---------------------------	--------------------------	------------	-49.5	
	+2	---------------------------	--------------------------	------------	-50.25	
	+1	---------------------------	--------------------------	------------	-51	
	0	---------------------------	--------------------------	------------	-51.75	
	-1	---------------------------	--------------------------	------------	-52.5	
	-2	---------------------------	--------------------------	------------	-53.25	
	-3	---------------------------	--------------------------	------------	-54	
	-4	---------------------------	--------------------------	------------	-54.75	
	-5	---------------------------	--------------------------	------------	-55.5	
	Return to position 0	---------------------------	--------------------------	------------	-51.75	
34	99e	Terminal 3 of delay equalizer EQ3.	Ground ----------------	28	-51	Perform tests No. 7, 32, and 33.
35	99e	Terminal 3 of basic equalizer EQ2.	Ground ----------------			Perform tests No. 8, 32, and 33.
36	99e	Terminal 14 or 17 of P1 on 12-68 kc amplifier AR1.	Ground ----------------			Perform tests No.11, 32, and 33.
37	99e	Terminal 1 of T3	Ground ----------------			Perform tests No. 12, 32, and 33.
38	99e	Terminal 1 or 4 of P1 on 12-68 kc amplifier AR2	Ground ----------------			Perform tests No. 15, 32, and 33.
39	99e	Terminal 14 or 17 of P1 on 12-68 kc amplifier AR2	Ground ----------------			Perform tests No. 17, 32, and 33.
40	99e	REC AMP 2 OUT (tip).	Ground ----------------			Perform tests No. 16, 32, and 33.
41	99d	Terminal 1 of FL2	Ground ----------------			a. Check circuit from J3 to FL2. b. Check resistor R2.
42	99d	Terminal 3 of FL2	Ground			Check filter FL2.
43	99d	Terminal 6 of T4	Ground ----------------			a. Check circuit from FL2 to T4.

Test No.	Signal generator (for hookup in circuit, see par.)	Audio level meter probe connections		Audio level meter normal indication		Corrective measures
		Positive	Negative	Frequency (kc)	Output (db)	
						b. Check tube socket XV1 voltages (TM 11-2130-20, fig. 13). Check resistors and capaacitors associtated with the tube socket terminals whech have abnormal dc voltages. c. Check tube socket XV1 resistances (TM 11-2139-20, fig. 13). Check resistors and acapaacitors associated with the tube socket terminals whech hve abnormal rsitance indications. d. Check capacitors C11 and C13.
44	99d	Terminal F of P2	Terminal P of P2	68	0	a. Check circuit from T4 to P2. b. Check transformer T4.

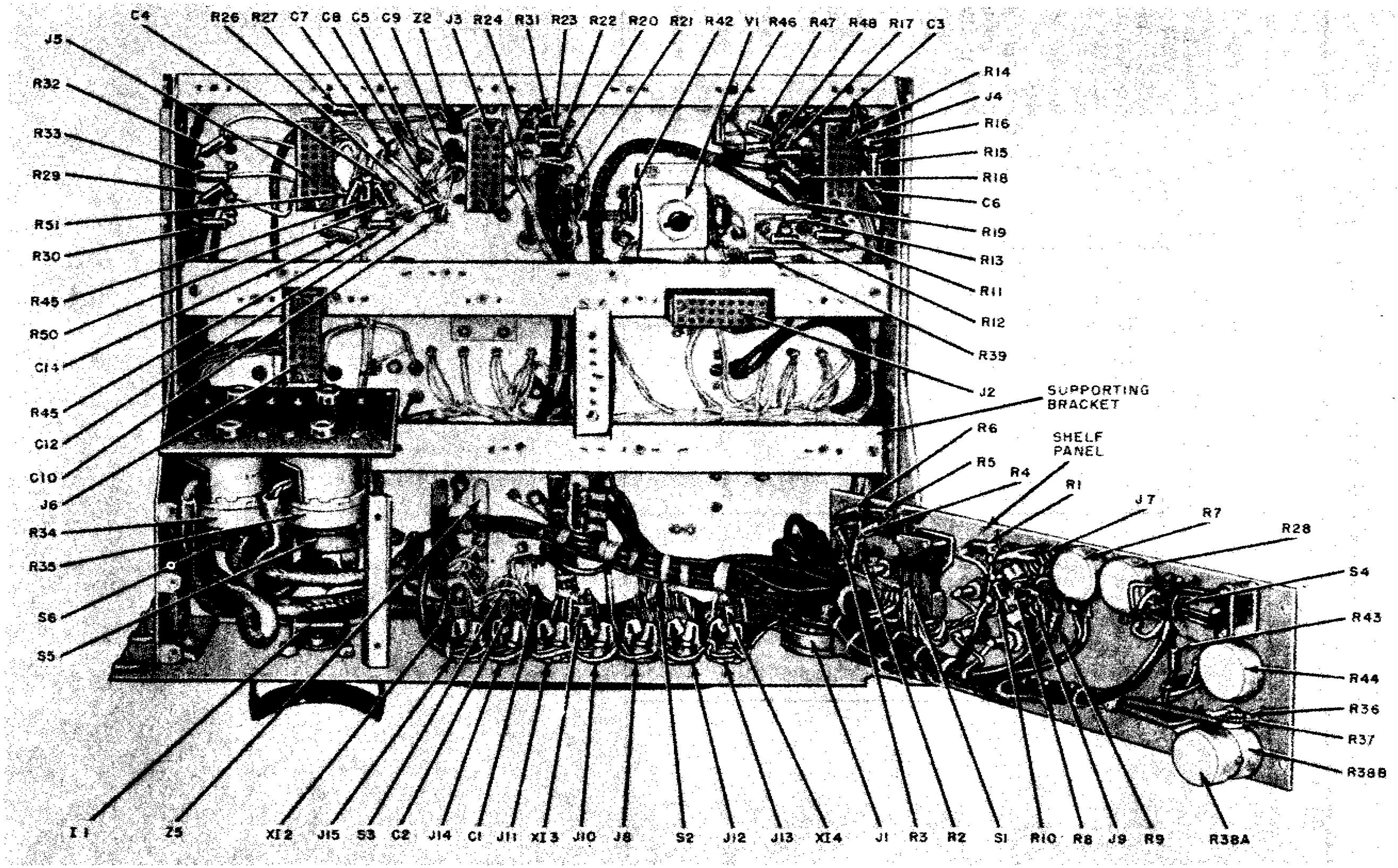

Figure 62. GROUP PANEL, pluck-out assemblies removed and top panel raised.

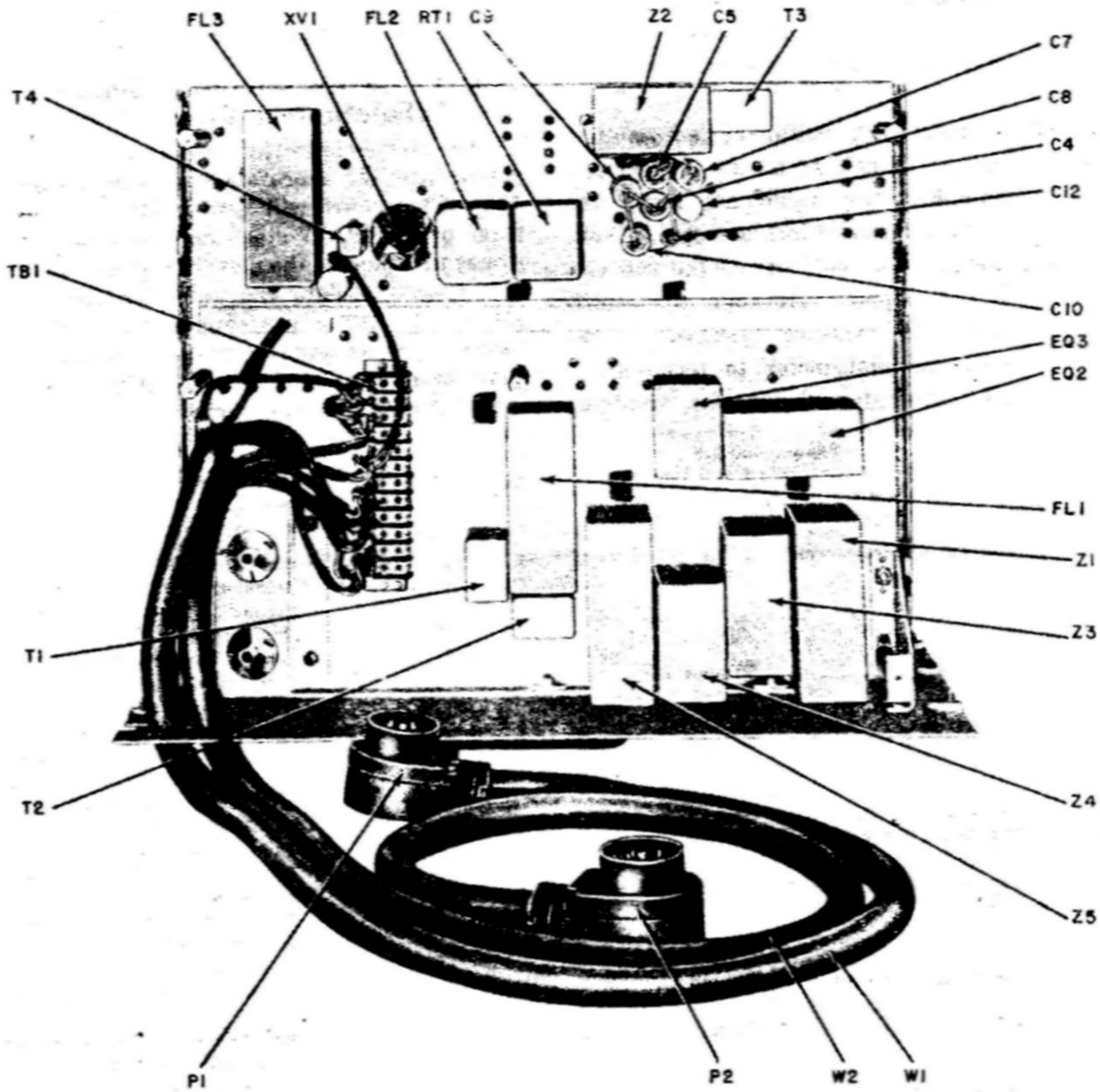

Figure 63. GROUP PANEL, bottom view with cover removed.

103. 12-68 Kc Amplifier Test

(fig-64)

a. Initial Procedures.

(1) Connect the 600-ohm resistor, modem and amplifier and carrier supply test cable assemblies, 200 VOLT POWER SUPPLY, and 12-68 kc amplifier as shown in figure 64.

(2) Connect the signal generator, resistors R1 through R3, attenuator, and transformer T108 to terminals 0 and 2 of the modem and amplifier test cable assembly. Adjust the signal generator for an output frequency of 68 kc at a voltage of .0022 volt measured across terminals 0 and 2 of the modem and amplifier test cable assembly.

b. 12-68 Kc Amplifier Gain Test.

(1) Connect the voltmeter across terminals 17 and 19 of the modem and amplifier test

assembly; the voltmeter should indicate 3.25 ±.5 volts.

(2) Connect the voltmeter across terminals 15 and 18 of the modem and amplifier test cable assembly; the voltmeter should indicate .1 ±.02 volt.

(3) Remove the power from the 200 volt power supply. Arrange the multimeter to measure resistance; connect the multimeter to terminals 1 and 2 of the modem and amplifier test cable assembly. The multimeter should indicate zero resistance.

104. 12-68 Kc Amplifier, Signal Substitution Chart

The signal substitution chart is used to supplement the operational tests in paragraph 103. This chart will help isolate a defective stage or circuit. Voltage and resistance measurements taken at the defective stage or circuit will usually isolate the defective part. The signal substitution procedures at each step are based on the assumption that all previous steps have been completed satisfactorily. Use the initial procedures (par. 98*a*).

Test No.	Voltmeter connections		Meter indication (ac)	Corrective measures
	High side probe	Ground probe		
1 --------	Terminal 4 of transformer T1.	Terminal 1 of transformer T1.	0.0022	Check wiring from connector P1 to transformer T1. Check transformer T1 for short circuits. Measure dc resistance of transformer T1 primary (par. 111*b*).
2 --------	E3 ------------------------------	Ground ---------------------	.015	Check transformer T1 and wiring. Check capacitors C3 and C11. Check resistors R13 and Rl4.
3 --------	Terminal 5 of tube socket XV1.	Ground ---------------------	.4	Check tube V1. Check network Z1. Check capacitors C5 through C7. Check resistors R8 and R7.
4 --------	Terminal 3 of Z1 -------------	Ground ---------------------	.4	Check network Z1.
5 --------	Terminal 1 of tube socket XV2.	Ground ---------------------	.4	Check wiring from network Z1 to tube V2. Check resistor R10
6 --------	Terminal 5 of tube socket XV2.	Ground ---------------------	2.0	Check tube V1. Check capacitors C8 through C10. Check resistors R11 and R15. Check transformer T2. Check transformer T2.
7 --------	Terminal 4 of transformer T2.	Ground ---------------------	3.25	Check transformer T2 and wiring.
8 --------	E7 ------------------------------	Ground ---------------------	3.25	Check inductor L1. Check resistors R16, R19, and R18. Check capacitor C13.
9 --------	Terminal 14 of modem and amplifier test cable assembly.	Ground ---------------------	3.25	Check wiring from E7 to connector P1.
10-------	Terminal 1 of transformer T2.	Ground ---------------------	.1	Check transformer T2 and wiring.
11-------	Terminal 15 of modem and amplifier test cable assembly.	Ground ---------------------	.1	Check wiring to connector P1. Check capacitor C12.
12-------	E5 ------------------------------	Ground ---------------------	.015	Check capacitor C11 and resistors R14 and R13. Check wiring.

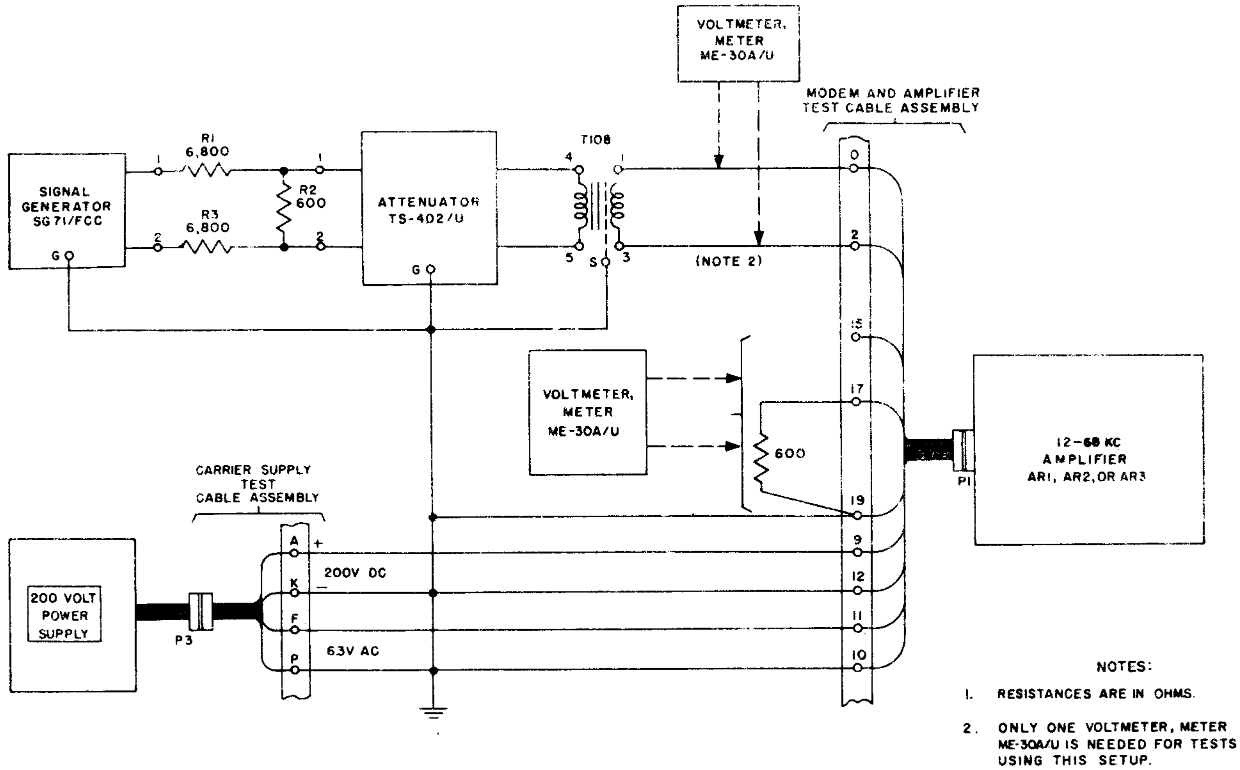

Figure 64. 12-68 kc amplifier, operational test setup.

105. Regulator and Alarm Unit Z6 Tests

(fig. 67)

a. Initial Procedures.

(1) Connect the 200 VOLT POWER SUPPLY, 10K-, 20K-, and 1,500-ohm resistors, modem and amplifier and carrier supply test cable assemblies, and regulator and alarm unit Z6 as shown in figure 67.

(2) Connect the signal generator, resistors R1 through R3, attenuator, and transformer T108 across terminals 0 and 3 of the modem and amplifier test cable assembly. Set the attenuator for a 3-db loss and adjust the output frequency of the signal generator to 68 kc at a voltage of .25 volt measured across terminals 0 and 3 of the modem and amplifier test cable assembly.

(3) Adjust the ADJ HIGH and ADJ LOW alarm controls to the extreme counterclockwise position.

b. Regulator and Alarm Unit Z6, Regulator Test.

(1) Connect the multimeter to REG VOLTS jacks J1 and J2 and adjust the 20K-ohm resistor until the multimeter indicates 3.5 volts dc.

(2) Set the attenuator for a 4-db loss. The multimeter indication should be greater than 5 volts dc.

(3) Set the attenuator for a 2-db loss. The multimeter indication should be less than 2 volts dc

(4) Set the attenuator for a 3-db loss. The multimeter indication should return to about 3.5 volts dc.

c. Regulator and Alarm Unit Z6, Alarm Test. Arrange the regulator and alarm circuit for testing as described in *a* above.

(1) Connect the multimeter to terminals 1 and 16 of the modem and amplifier test cable assembly. Operate and hold the ALARM TEST switch to the 1 HIGH position; adjust the ADJ HIGH control until the multimeter

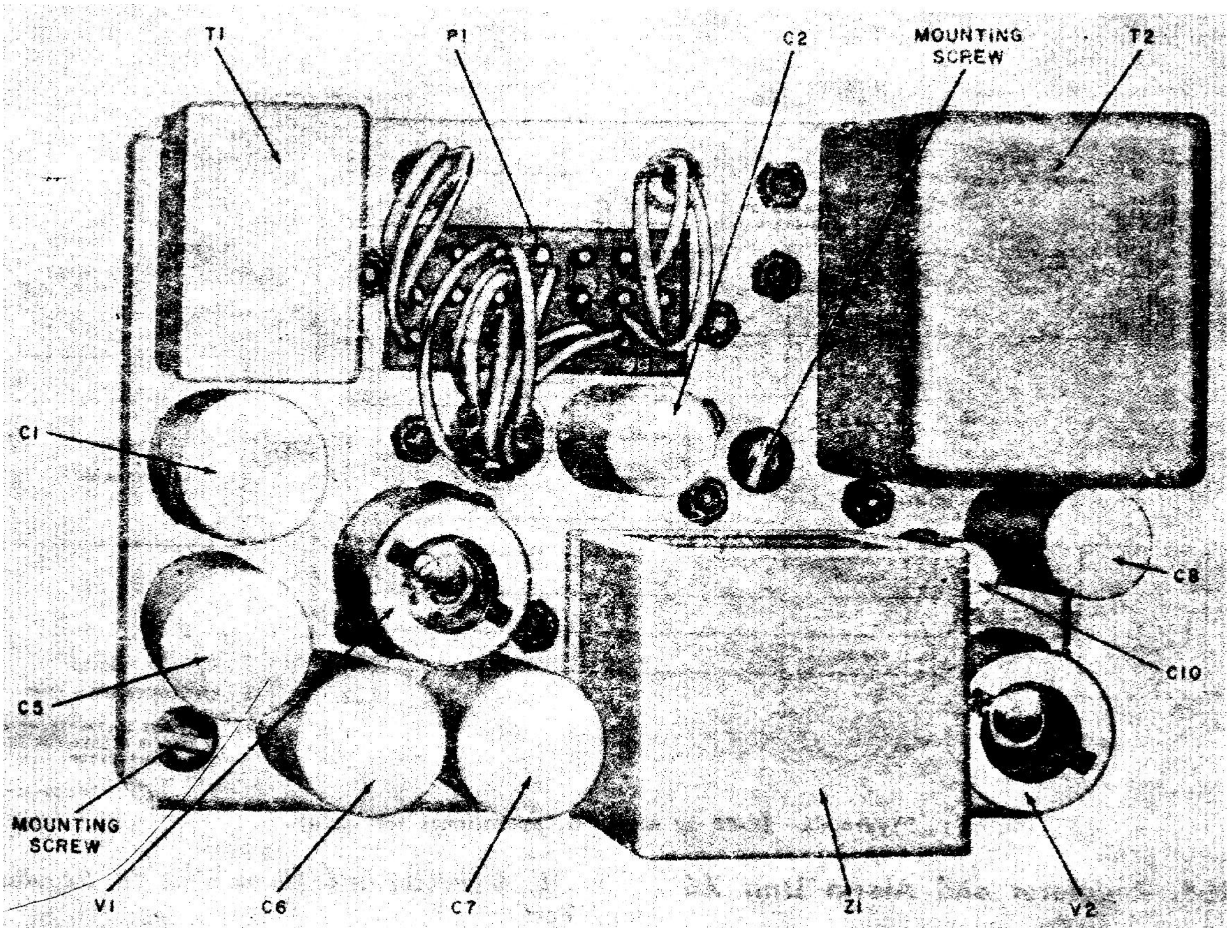

Figure 65. 12-68 kc amplifier (part of GROUP PANEL), top view.

indicates zero resistance. Release the ALARM TEST switch; the multimeter should indicate infinite resistance.

(2) Connect the multimeter to terminals 1 and 13 of the modem and amplifier test cable assembly. Operate and hold the ALARM TEST switch to the 2 LOW position; adjust the ADJ LOW control until the multimeter indicates zero resistance. Release the ALARM TEST switch; the multimeter should indicate infinite resistance.

(3) Set the attenuator for a 5-db loss. Connect the multimeter to terminals 1 and 2 and then to terminals 1 and 11 of the modem and amplifier test cable assembly; the multimeter should indicate zero resistance for both connections.

(4) Set the attenuator for a 3-db loss. Connect the multimeter to terminals 1 and 13 of the modem and amplifier test cable assembly; the multimeter should indicate infinite resistance.

(5) Set the attenuator for a 1-db loss. Connect the multimeter to terminals 1 and 16, then 1 and 5, and then 1 and 8 of the modem and amplifier test cable assembly; the multimeter should indicate zero resistance in each test.

(6) Set the attenuator for a 3-db loss. Connect the multimeter across terminals 1 and 16 of the modem and amplifier test cable assembly; the

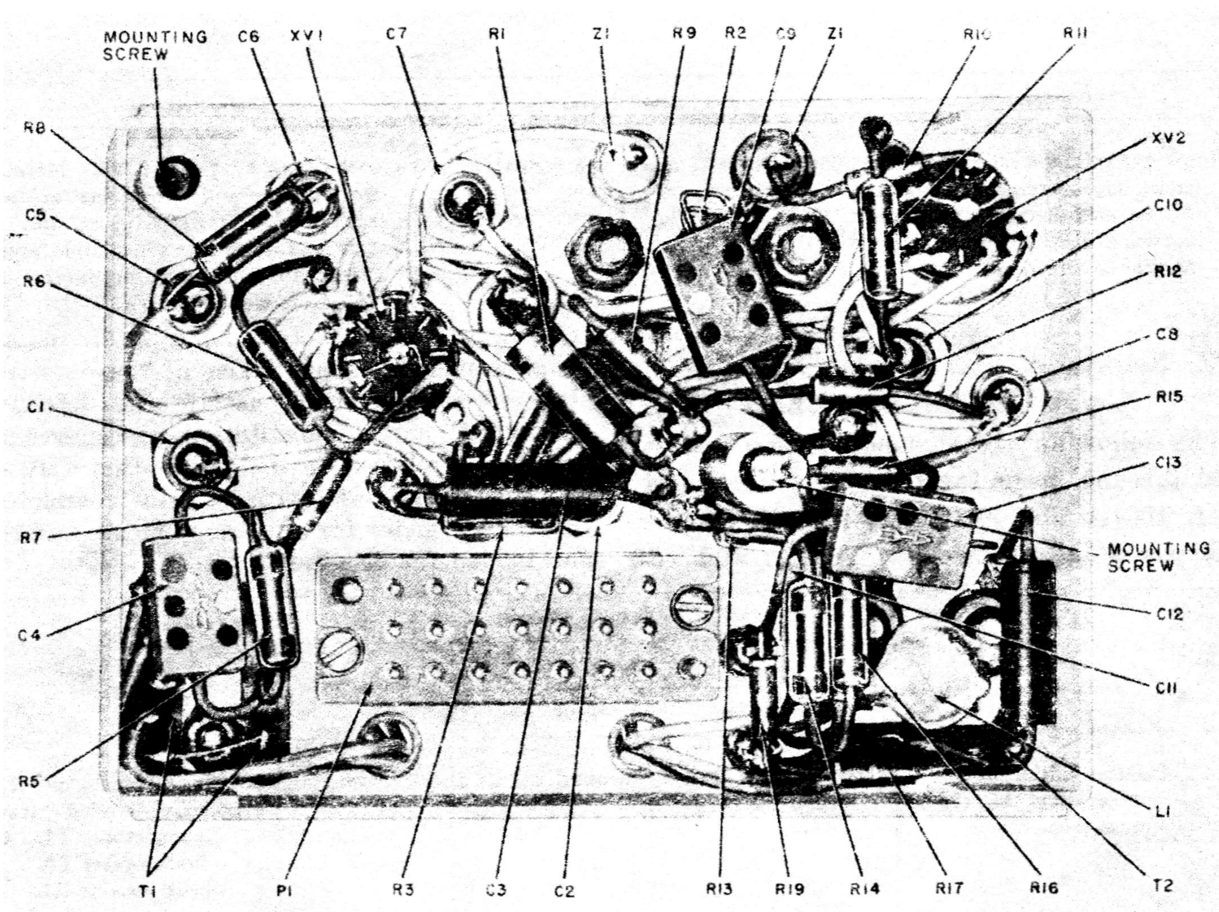

Figure 66. 12-68 kc amplifier (part of GROUP PANEL), bottom view.

multimeter should indicate infinite resistance.

106. Regulator and Alarm Unit Z6 Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in regulator and alarm unit Z6. This chart lists the symptoms that may be reported on the equipment repair tag or observed when performing maintenance at the organizational level (TM 11-2139-20). Normal tube socket voltage and resistance measurements are provided in TM 11-2139-20, figure 15. Prepare regulator and alarm unit Z6 for troubleshooting tests as described in paragraph 105*a*.

Symptom	Probable trouble	Corrective measures
l. Improper voltage at REG VOLTS jacks. All dc and ac power voltages normal at P1, and the ac input voltage normal at T1.	Defect in regulator circuit. -------------------	Check tubes V1 through V5. Measure dc voltages and resistances at tube sockets XV1 through XV3 (TM 11-2139-20, fig. 15). If this does not locate the trouble, apply signal substitution procedures (par. 107, tests No.1 through 5 and 9).
2. Proper voltage at REG VOLTS jacks, improper alarm circuit behavior. All dc and ac power voltages are normal at P1, and ac input voltage normal at T1.	Defect in alarm circuit ------------------------	Check tubes V1 through V5. Measure dc voltages and resistances at tube sockets XV1, XV4, and XV5 (TM 11-2139-20, fig. 15). If this does not locate the trouble, apply signal substitution procedures (par. 107, tests No.6 through 8 and l0 through l3).

Symptom	Probable trouble	Corrective measures
3. Improper voltage at REG VOLTS jacks, improper alarm behavior. All dc and ac power voltages normal at P1. Ac input voltage normal at T1.	Defect in both alarm and regulator circuits.	Check tubes V1 through V5. Measure dc voltages and resistances at tube socket (TM 11-2139-20, fig. 15). If this does not locate the trouble, apply signal substitution procedures (par. 107, tests No.1 through 13).

107. Regulator and Alarm Unit Z6 Signal Substitution Chart

The following signal substitution chart is used to supplement the troubleshooting chart (par. 106). This chart will help isolate the defective stage or circuit. Voltage and resistance measurements taken at the defective stage or circuit should isolate the defective part. The signal substitution procedures at any step are based on the assumption that all previous steps were satisfactorily completed. Use the voltmeter for ac measurements and the multimeter for dc measurements.

Test No.	Conditions	Voltmeter or multimeter			Corrective measures
		Connections		Indications (volts)	
		Positive probe	Negative probe		
1 --------	Perform initial procedures (par. 105) for ac measurements	Terminal 6 of transformer T1.	Ground ------------	.35 ac -----	*a.* Check transformer T1. *b.* Check wiring from connector P1 to transformer T1. *c.* Check resistor R1. *d.* Check wiring from transformer T1 to filter FL1
2 --------	Same as for test No.1	Terminal 3 of filter FL1.	Ground ------------	.35 ac -----	Same as d above.
3 --------	Same as for test No.1	Terminal 1 of filter FLI.	Ground ------------	.55 ac -----	*a.* Check filter FL1. *b.* Check resistor R2. *c.* Check wiring for short circuits.
4 --------	Same as for test No.1	Terminal 1 of tube socket XV1.	Ground ------------	.55 ac -----	Check resistor R3 and wiring.
5 --------	Same as for test No.1	Terminal 5 of tube socket XV1.	Ground ------------	24 ac ---------	Check resistors R5 and R4 and capacitor C2.
6 --------	Same as for test No.1	E8	Ground ------------	23 ac ---------	Check capacitor C8 and wiring.
7 --------	Same as for test No.1	Terminal 3 of tube socket XV4.	Ground ------------	9 ac ---------	Check resistor R16.
8 --------	Same as for test No.1	Terminal 4 of tube socket XV4.	Ground ------------	7.5 ac -------	Check resistors R22 and R21, and capacitors C9 and C10.
9 --------	Same as for test No.1, except measurement is dc.	Terminal 2 or 8 of tube socket XV3.	Ground ------------	3.5 dc -------	Check resistors R9 and R33 and capacitors C5 and C6.
10 -------	Same as for test No-9, with HIGH and LOW alarm controls in extreme counterclockwise position and switch S1 in normal position.	Terminal 4 of tube socket XV5.	Ground ------------	110 dc ---------	Check resistor R26, and capacitors C9, C11, C12, and C15.

Test No.	Conditions	Voltmeter or multimeter			Corrective measures
		Connections		Indications (volts)	
		Positive probe	Negative probe		
11	Same as for test No.10, with switch S1 depressed to test HIGH position.	Terminal 4 of tube socket XV5.	Ground -----------	115 dc or slight increase relative to reading in test No. 10.	Check switch S1 and wiring.
12	Same as for test No.10	Terminal 6 of tube socket XV5.	Ground -----------	102 dc -------------	Check capacitor C13 and wiring tube socket XV5.
13	Same as for test No.10, with switch S1 depressed to test LOW position.	Terminal 6 of tube socket XV5.	Ground -----------	105 dc or slight increase relative to reading in test No. 12.	a. Check switch S1. b. Check resistor R14. c. Check wiring to switch S1.

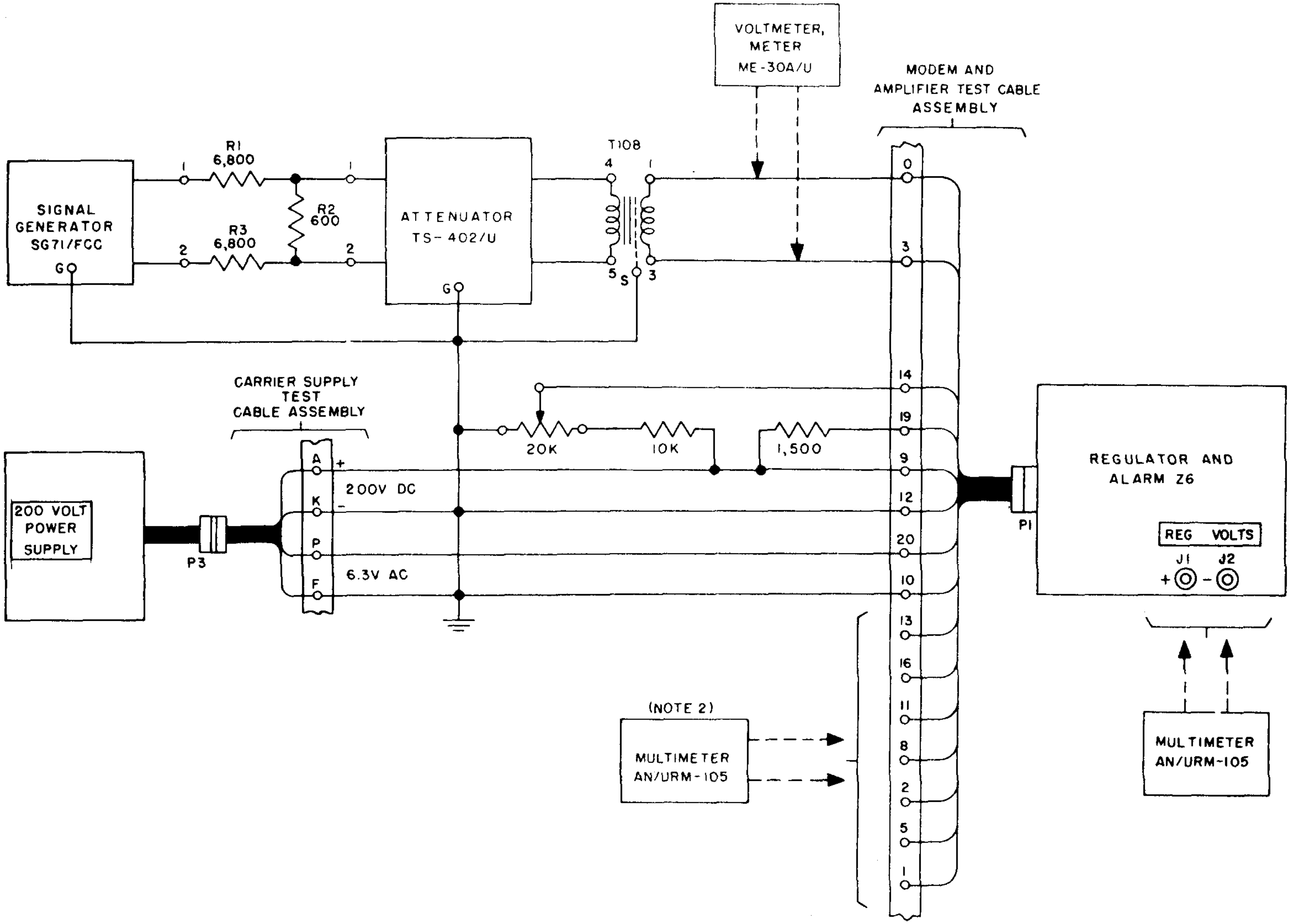

Figure 67. Regulator and alarm unit Z6 operational and final test setup

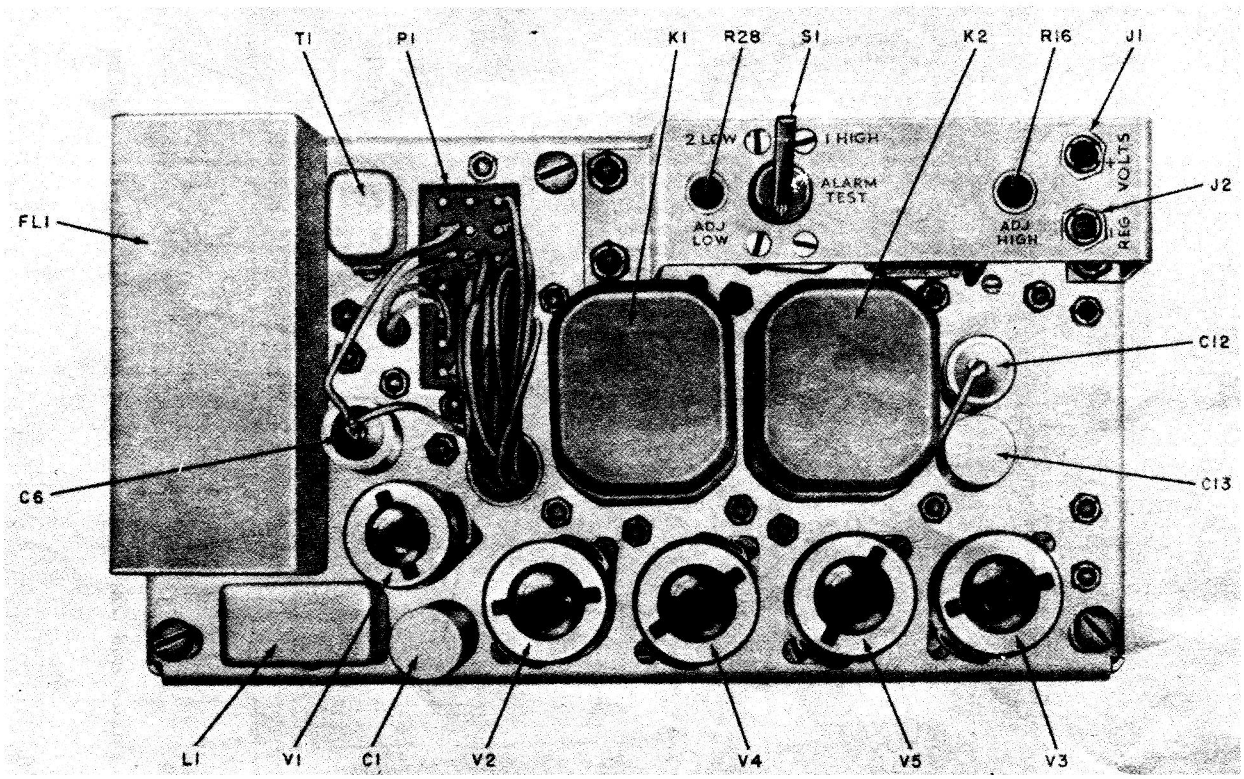

Figure 68-Regulator and alarm unit Z6 (part of GROUP PANEL), top view.

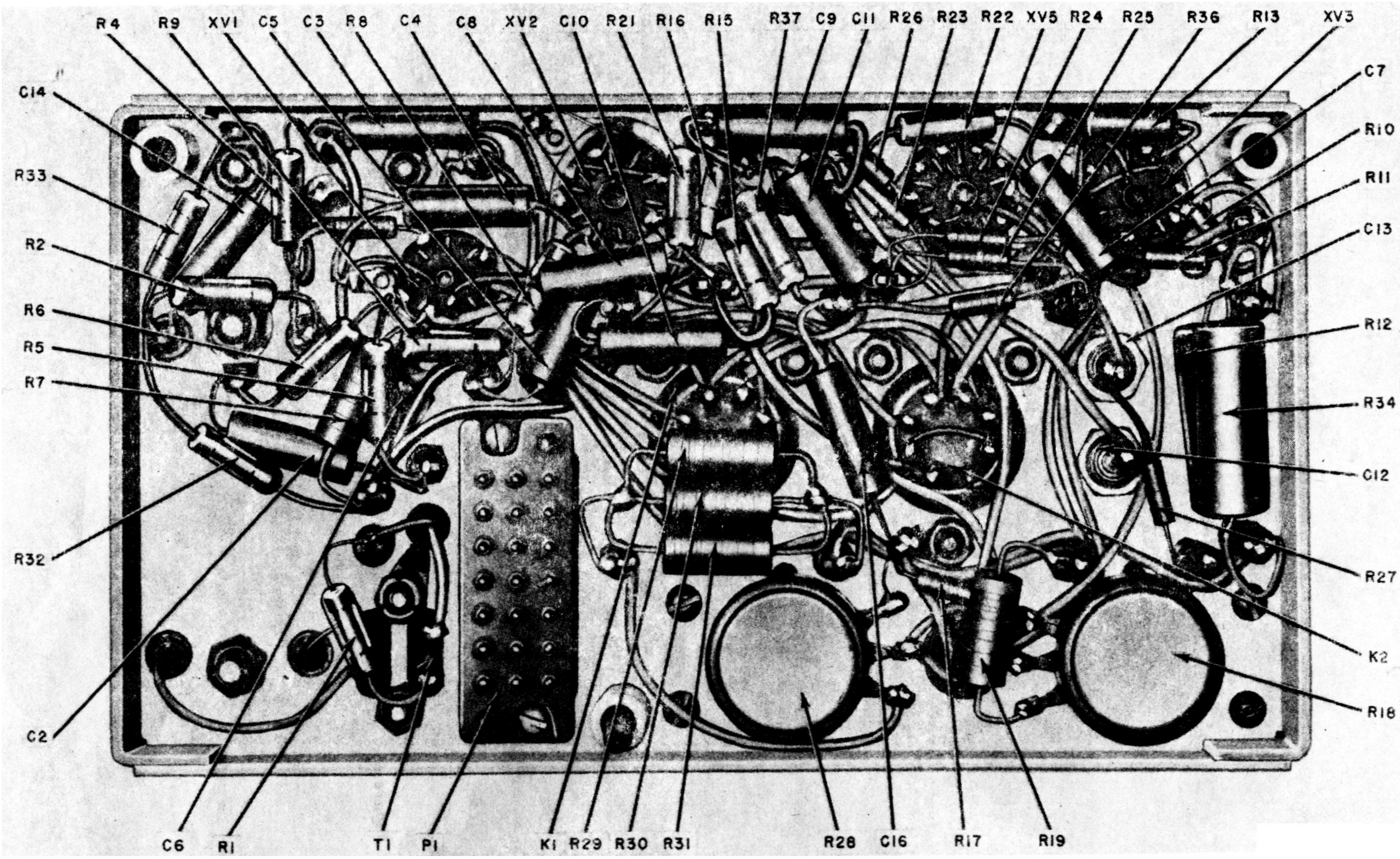

Figure 69. Regulator and alarm unit Z6 (part of GROUP PANEL), bottom view.

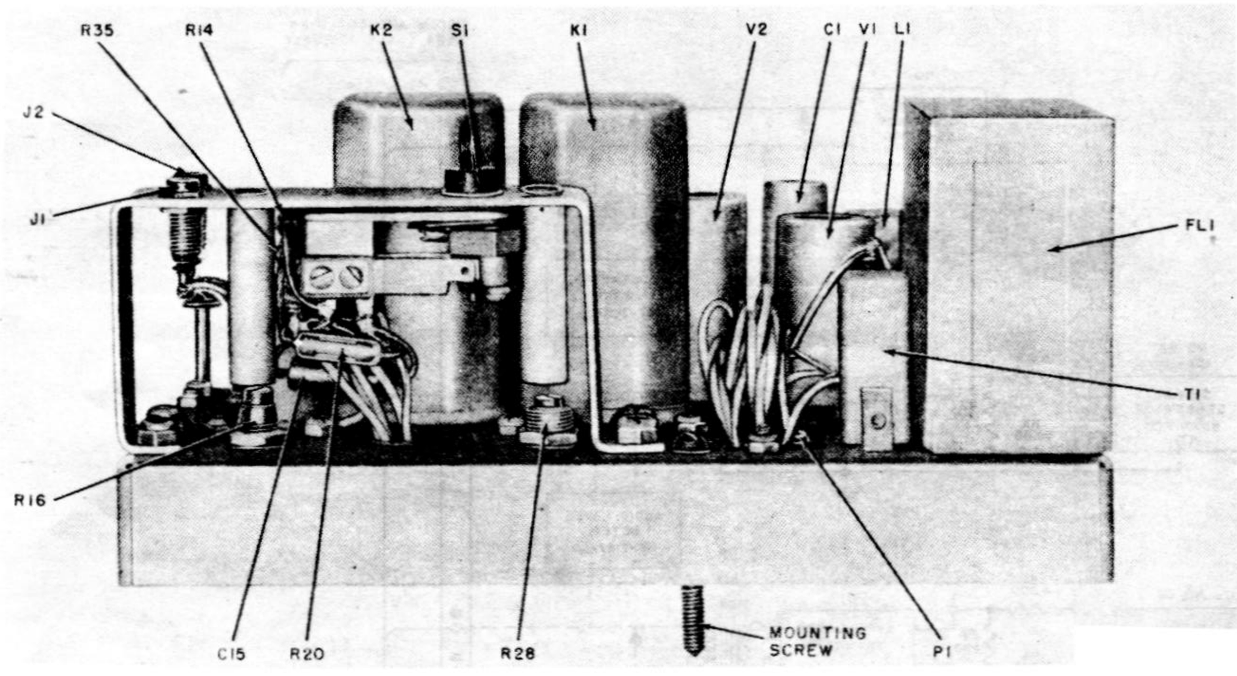

Figure 70. Regulator and alarm Z6 (part of GROUP PANEL), side view.

108. Modem and Amplifier Unit AR4 Tests

(fig-71)

a. Initial Procedures.

(1) Connect the two 135- and one 600 ohm resistors, 200-ohm variable resistor, modem and amplifier and carrier supply test cable assembly, modem and amplifier unit AR4, and the 200 VOLT POWER SUPPLY as shown in figure 71.

(2) Connect signal generator No. 1 to terminals 10 and 11 of the modem and amplifier test cable assembly. Adjust the signal generator for an output frequency of 120 kc at an output level of. -2.5 db measured across terminals 10 and 11.

(3) Connect signal generator No. 2, resistors R1 through R3, attenuator, and transformer T107 as shown in figure 71.

b. Modem and Amplifier Unit AR4, Transmitting Test.

(1) Set the attenuator for a 40-db loss. Connect signal generator No. 2 with associated components (*a* (3) above) to terminals 4 and 5 of the modem and amplifier test cable assembly. Adjust the signal generator for an output frequency of 83 kc at an output level of. -48.5 db measured across terminals 4 and 5.

(2) Connect the audio level meter across terminals 1 and 2 of the modem and amplifier test cable assembly. Arrange the audio level meter to measure a frequency of 37 kc at a level of -46.5 ±1 db.

c. Modem and Amplifier Unit AR4, Receiving Test.

(1) Replace transformer T107 (*a*(3) above) with transformer T108.

(2) Connect signal generator No. 2 with associated components to terminals 19 and 16 of the modem and amplifier test cable assembly. Set the attenuator for a 0-db loss. Adjust the signal generator for an output frequency of 37 kc at output level of. -10 db measured across terminals 19 and 16.

(3) Arrange the audio level meter to measure a frequency of 83 kc at a level of. -3.5 db. Connect the audio level meter across terminals 14 and 17, and then 15 and 18 of the modem and amplifier test cable assembly. The audio level meter should indicate -3.5 ±1.5 db for each measurement.

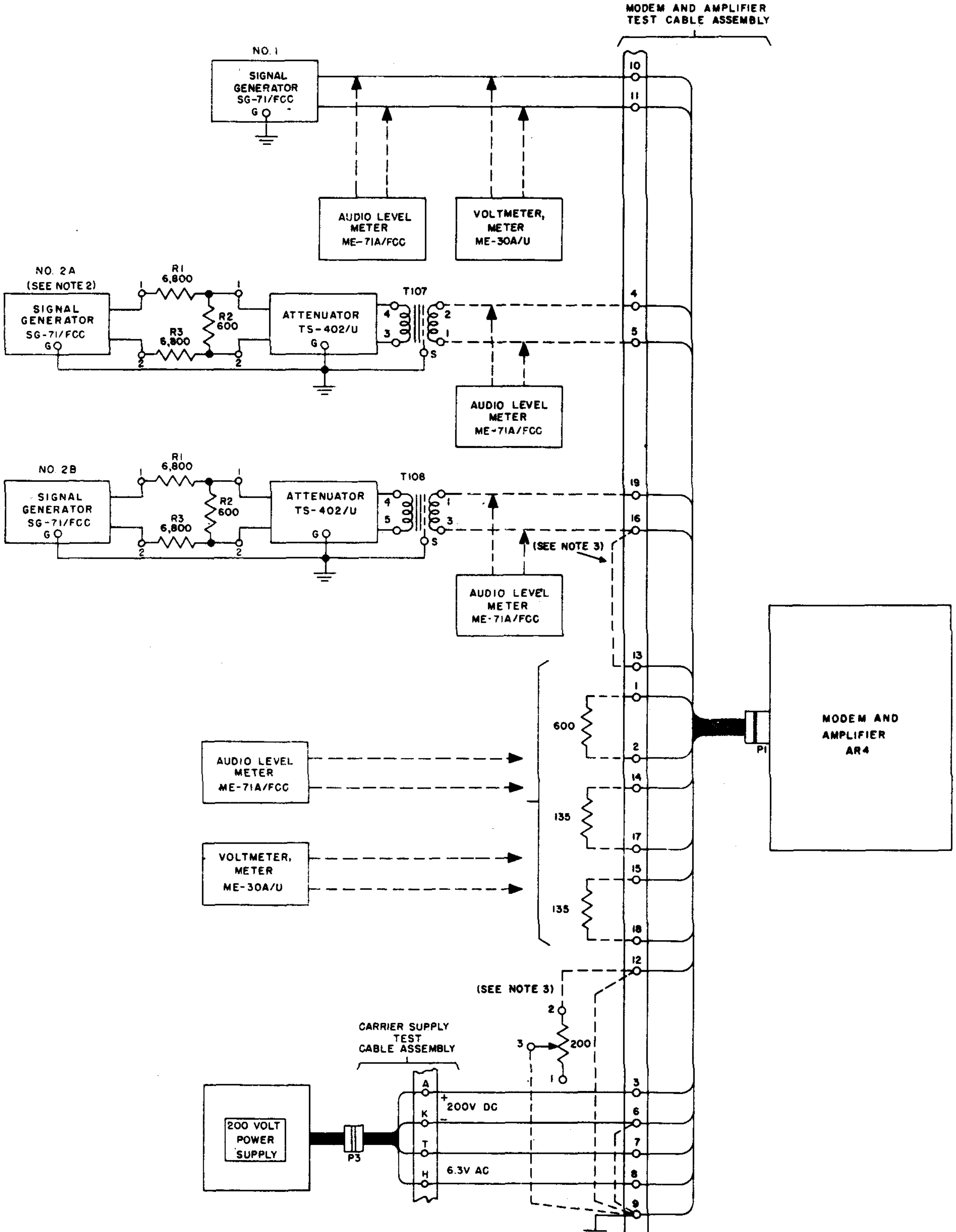

Figure 71. Modem and amplifier unit AR4 (part of GROUP PANEL), operational and final test setup.

109. Modem and Amplifier Unit AR4 Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in modem and amplifier unit AR4. This chart lists the symptoms that may be reported on the equipment repair tag or observed when performing maintenance at the organizational level (TM 11-2139-20). Voltage and resistance measurements of this stage or circuit should isolate the defective part. Normal tube socket voltage and resistance measurements appear in TM 11-2139-20, figure 16

Symptom	Probable trouble	Corrective measures
1. No transmission through modem |and amplifier AR4 in transmitting and receiving directions.	Failure of 120-kc carrier distribution circuits.	Use signal substitution procedures (par. 110, tests No. 2 and 5) to localize trouble.
2. No transmission through modem and amplifier AR4 in transmitting direction.	Failure of transmission circuits between terminals 4 and 5 and terminals 1 and 2 of connector P1.	Use signal substitution procedures (par. 110, test No. 1) to localize trouble.
3. No transmission through modem and amplifier AR4 in receiving direction.	Failure of transmission circuits between terminals 16 and 19, and terminals 14 and 17 of connector P1.	Check tube socket XVI and XV2 voltages. Use signal substitution procedures (par. 110, tests No. 3 through 14) to localize trouble.

110. Modem and Amplifier Unit AR4, Signal Substitution Chart

The following signal substitution chart is used to supplement the troubleshooting procedures in paragraph 109. This chart will help isolate the defective stage or circuit.

Voltage and resistance measurements taken at the defective stage or circuit should isolate the defective part. Follow the signal substitution procedures in the order given. These tests require the same equipment test setup as the operational tests (par. 108).

Test No.	Audio level meter probe connections		Audio level meter indication		Corrective measures
	Positive	Negative	Frequency (kc)	Output (db)	
1 ------	Terminal 2 of connector P1	Terminal 1 of connector P1 .	37	-46.5	*a*. Check circuit from terminals 10 and 11 of connector P1 to transformers T3 through T6. *b*. Check circuit from terminals 4 and 5 of connector P1 to terminals 1 and 2 of connector P1 (fig. 8). *c*. Check transformers T3 and T4. *d*. Check varistor CR1.
2 ------	Terminal 2 of transformer T3	Terminal 2 of transformer T4.	120	-2.5	Check circuit from terminals 10 and 11 of connector P1 to transformers T3 through T6 (fig. 8).
3 ------	Terminal 4 of transformer T6.	Ground ---------------	37	-36	Check circuit from terminals 16 and 19 of connector P1 to transformer T6 (fig. 8).
4 ------	Terminal 4 of transformer T5.	Ground ---------------	83	-44	*a*. Perform test No. la. *b*. Check circuit from transformer T6 to transformer T5 (fig. 8). *c*. Check transformers T5 and T6. *d*. Check varistor CR2.
5 ------	Terminal 2 of transformer T6.	Terminal 2 of transformer T5.	120	-2.5	Check circuit from terminals 10 and 11 of connector P1 to transformers T3 through T6 (fig. 8).

Test No.	Audio level meter probe connections		Audio level meter indication		Corrective measures
	Positive	Negative	Frequency (kc)	Output (db)	
6 ------	Terminal 3 of filter FL1	Ground------	83	-48.5	*a*. Check circuit from transformer T5 to filter FL1 (fig. 8). *b*. Check resistors R13 and R14.
7 ------	Terminal 1 of filter FL	Ground------	83	-51	*a*. Check circuit from filter FL1 to transformer T2 (fig. 8). b. Check inductor L1. c. Check capacitor C10. *b*. Check filter FL1.
8 ------	Terminal 1 of transformer T2	Ground------	83	-51.5	*a*. Check circuit from filter FL1 to transformer T2 (fig. 8). *b*. Check inductor L1. *c* Check capacitor C10.
9 ------	Terminal 6 of transformer T2	Ground------	83	-37	*a*. Check circuits associated with terminals 5 and 6 of transformer T2 (fig. 8). *b*. Check resistor R12. *c*. Check transformer T2.
10-----	Terminal 1 of network Z1.	Ground------	83	-14	*a*. Check voltages at tube socket XV2 (TM 11-2139-20, fig. 16). Check resistors and capacitors associated with tube socket terminals that have abnormal dc voltages. *b*. Check resistances at tube socket XV2 (TM 11-2139-20, fig. 11). Check resistors and capacitors associated with the tube socket terminals that have abnormal resistance indications. *c*. Perform test No. 12.
11-----	Terminal 3 of network Z1.	Ground------	83	-14	*a*. Perform tests No. 10 and 12. *b*. Check network Z1. .
12-----	Terminal 6 of transformer T1	Ground------	83	+22	*a*. Check voltages at tube socket XV1 (TM 11-2139-20, fig. 16). Check resistors and capacitors associated with tube socket terminals that have abnormal dc voltage. *b*. Check resistances at tube socket XV1 (TM 11-2139-20, fig. 16). Check resistors and capacitors associated with tube socket terminals that have abnormal resistance indications.

Test	Audio level meter probe connections		Audio level meter indication		Corrective
No.	Positive	Negative	Frequency (kc)	Output (db)	measures
					c. Check resistors R1, R2, R3, R12, and R18 (fig.8). *d*. Check capacitors C1 through C9.
13 ----	Terminal 14 of connector P1	Terminal 17 of connector P1.	83	-3.5	*a*. Check circuit from transformer T1 to terminals 14 and 17 of connector P1. *b*. Check transformer T1.
14 ----	Terminal 15 of connector P1.	Terminal 18 of connector P1.	83	-3.5	*a*. Check circuit from transformer T1 to terminals 15 and 18 of connector P1. *b*. Check transformer T1.

111. GROUP PANEL, Dc Resistance of Transformers, Coils and Thermistor

Note Test the thermistor with an ohmmeter. Because the resistance of the thermistor varies with temperature, check the thermistor at a room temperature between 70° and 80° F.

a. Main Chassis.

Item	Terminals	Resistance (ohms)
T1 and T2	1-2	1.15
	3-4	3.12
T3	1-2	2.98
	3-4	.41
T4	1-3	.81
	4-6	876
RT1		30K

b. 12-68 Kc Amplifier.

Item	Terminals	Resistance (ohms)
T1	1-2	7.8
	3-4	43
	5-6	241
T2	1-2	3.8
	3-4	12.4
	5-6	216
L1		3.62

c. Regulator Alarm Unit Z6.

Item	Terminals	Resistance (ohms)
T1	1-3	32
	4-6	1,370
L1		21

d. Modem and Amplifier AR4.

Item	Terminals	Resistance (ohms)
T1 and T2 --------	1-2	2.47
	3-4	2.47
	5-6	140
T3------------------	1-2	.85
	2-3	.85
	4-5	.622
T4------------------	1-2	1.45
	2-3	1.45
	4-5	10.8
T5------------------	1-2	.88
	3-4	.88
	4-5	1.37
T6------------------	1-2	1.45
	3-4	1.45
	4-5	10.8
L1------------------	------------------	4.8

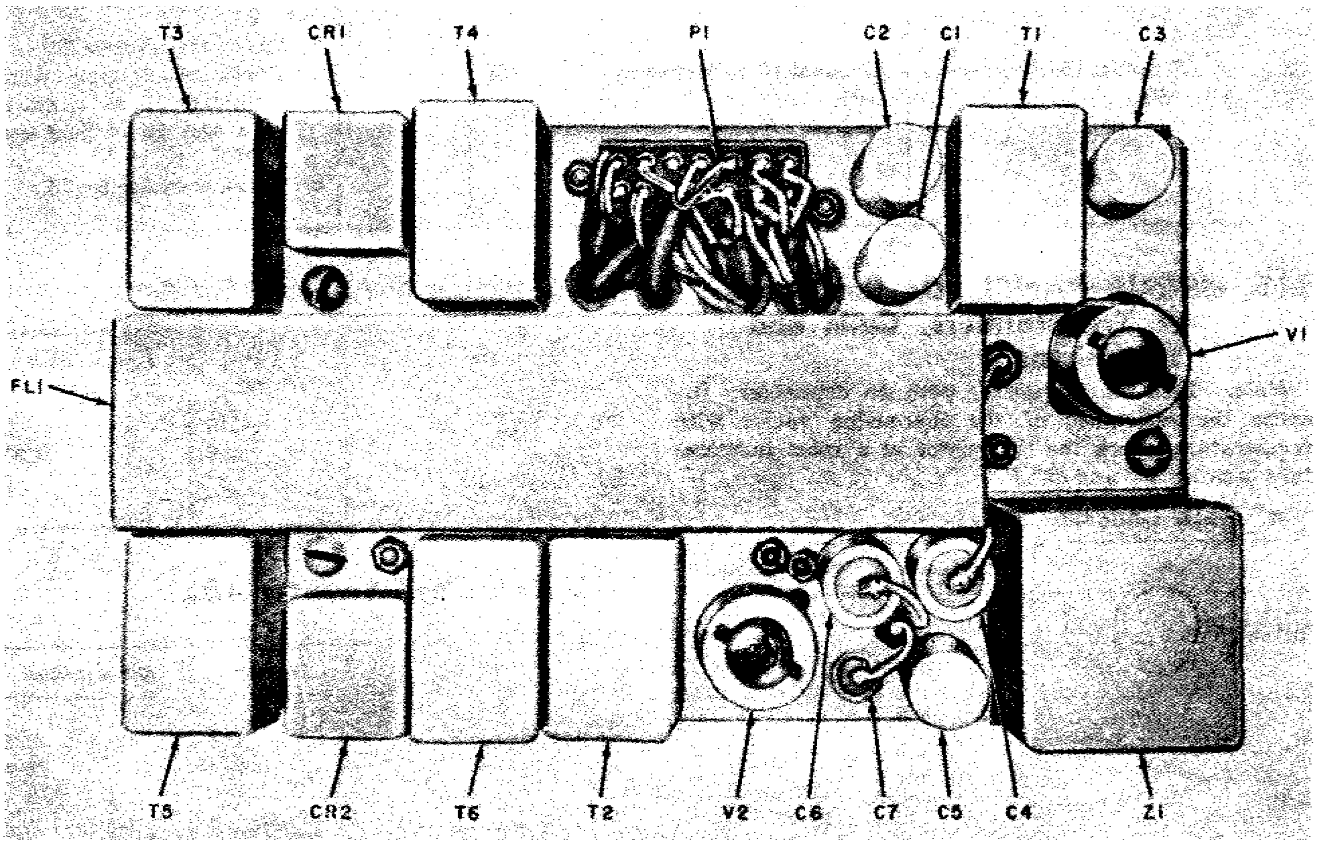

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Figure 72. Modem and amplifier unit AR4 (part of GROUP PANEL), top view

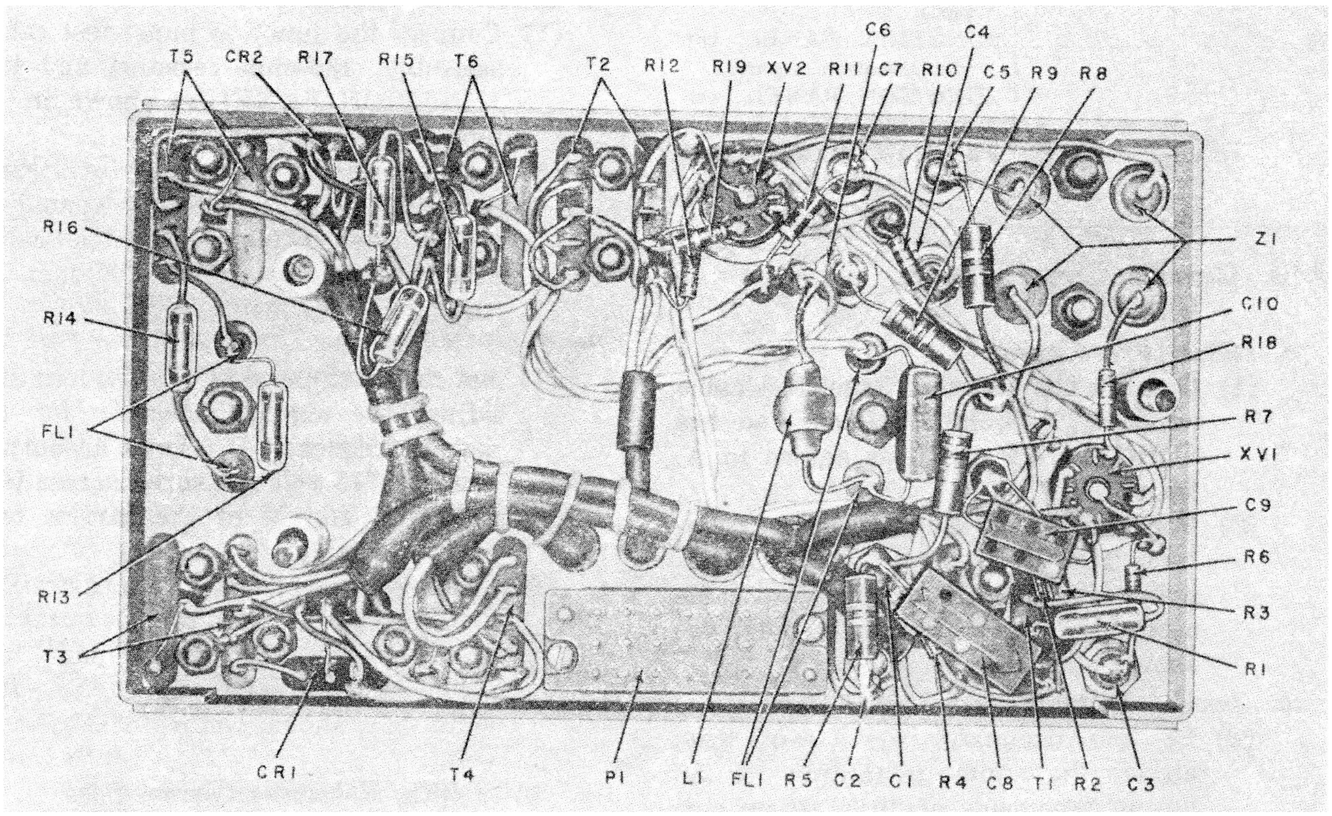

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Figure 73. Modem and amplifier unit AR4 (part of GROUP PANEL), bottom view.

Figure 74. GROUP PANEL, B+ distribution diagram.

(Contained in separate envelope)

Section V. JUNCTION PANEL (PART OF AMPLIFIER PILOT REGULATOR AM-707/TCC-7)

112. JUNCTION PANEL Troubleshooting Data

Fig. No.	Par. No.	Description
18		JUNCTION PANEL, schematic diagram
76		JUNCTION PANEL, bottom view, location of parts.
77		JUNCTION PANEL, top view, location of parts.
		JUNCTION PANEL, wiring diagram.
	116	JUNCTION PANEL, dc resistance of transformer.

113. Carrier Circuit

(fig. 75)

a. Initial Procedures.

(1) Connect the junction panel test cable assembly, 135-ohm resistor, and the JUNCTION PANEL as shown in A, figure 75.

(2) Connect the signal generator, resistors R1 through R3, attenuator, transformer T108, carrier test cable assembly, and 600-ohm resistor as shown in B, figure 75.

b. Carrier Transmitting Circuit Test.

(1) Set the attenuator for a 0-db loss; adjust the signal generator for an output frequency of 30 kc at an output level of .755 volt measured across terminals F and S with terminal S as ground.

(2) Connect the voltmeter across terminals 1 and 2 of the junction panel test cable assembly (A, fig. 75). The voltmeter should indicate .34 +.05 volt.

c. Carrier Receiving Circuit Test.

(1) Replace transformer T108 (a(2) above) with transformer T107.

(2) Connect the signal generator and the associated components across terminals 3 and 4 of the junction panel test cable assembly as shown in A, figure 75. Adjust the signal generator for an output frequency of 37 kc at an output level of .185 volt as measured across terminals 3 and G (ground).

(3) Connect the voltmeter across terminals C and P of the carrier test cable assembly (B. fig. 75); the meter should indicate .7 +.1 volt.

114. Order Wire Circuit Tests

a. Initial Procedures.

(1) Connect the junction panel test cable assembly, 135-ohm resistor, and the JUNCTION PANEL as shown in A, figure 75.

(2) Connect the signal generator, resistors R1 through R3, attenuator, transformer T108, carrier test cable assembly, and 301-and 1,300-ohm resistors as shown in C, figure 75.

b. Order Wire Transmitting Circuit Test.

(1) Set the attenuator for a 0-db loss and adjust the signal generator for an output frequency of 3 kc at an output level of .775 volt measured across terminals L and M of the carrier test cable assembly.

(2) Arrange the voltmeter to measure .25 volt. Connect the voltmeter to terminals 1 and 2 of the junction panel test cable assembly (A, fig. 75). The voltmeter should indicate .25 +.05 volt.

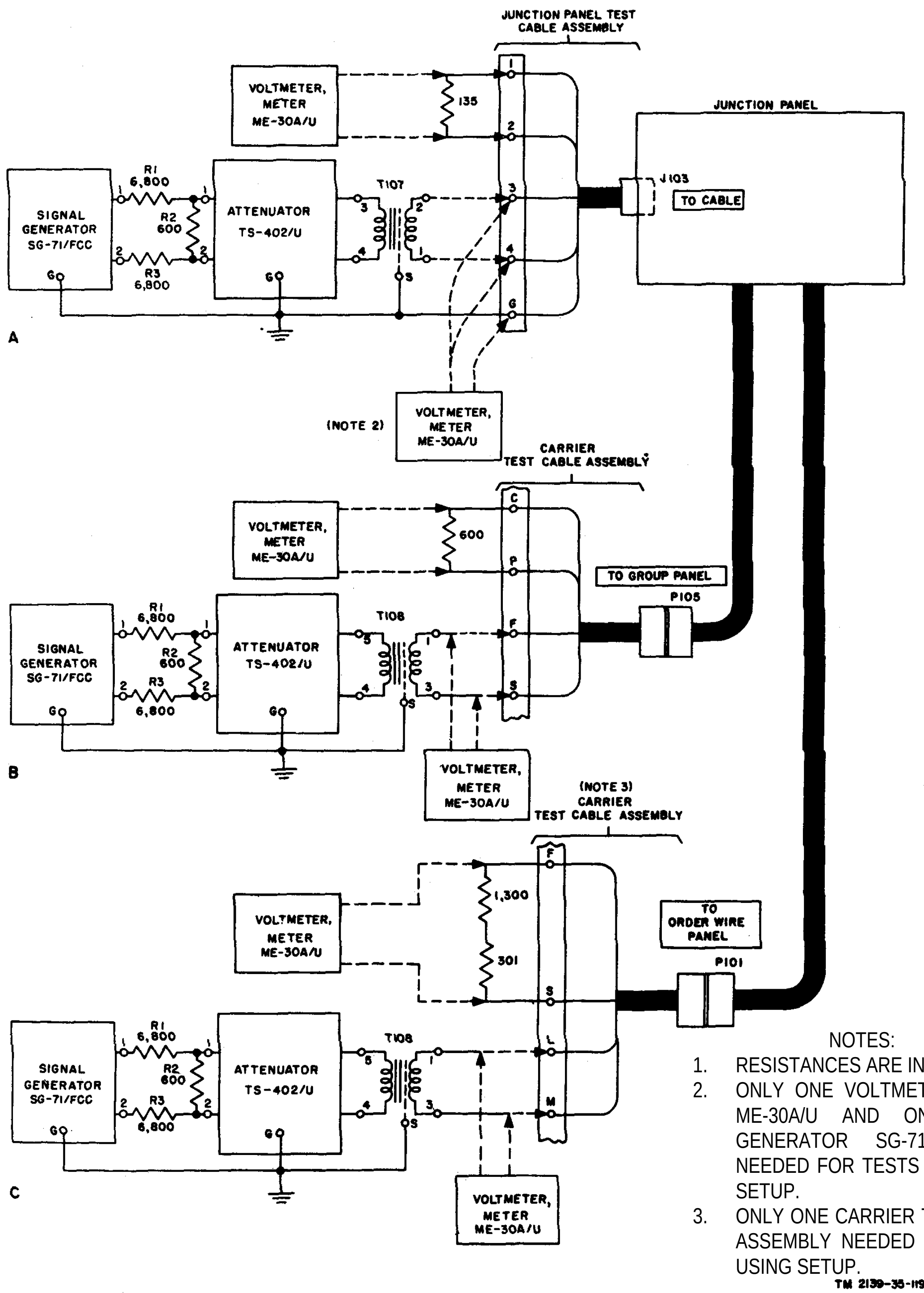
c. Order Wire Receiving Circuit Test.

(1) Connect the signal generator, resistors R1 through R3, attenuator, and transformer T107 to terminals 3 and 4 of the junction panel test cable assembly (A, fig. 75). Adjust the output level of the signal generator to .185 volt measured across terminals 3 or 4 and G (ground).

(2) Adjust the voltmeter to measure .57 volt. Connect the voltmeter across terminals F and S of the carrier test cable assembly (B. fig. 75) with terminal S as ground. The voltmeter should indicate .57 +.07 volt.

115. Miscellaneous Continuity Tests

a. Use the chart in *b* (3) below to check the continuity of the circuits not checked when



NOTES:

1. RESISTANCES ARE IN OHMS
2. ONLY ONE VOLTMETER, METER ME-30A/U AND ONE SIGNAL GENERATOR SG-71/FCC ARE NEEDED FOR TESTS USING THIS SETUP.
3. ONLY ONE CARRIER TEST CABLE ASSEMBLY NEEDED FOR TESTS USING SETUP.

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Figure 75. JUNCTION PANEL operational test setup.

performing the carrier and order wire circuit tests (pars. 113 and 114). The procedure for checking the 200-volt distribution circuit is covered in *c* below. To make the continuity tests, connect the test cable assemblies to the JUNCTION PANEL as indicated in (1) through (4) below. Refer to the JUNCTION PANEL schematic diagram (fig. 18).

(1) Connect the supply test cable assembly to connector J101.

(2) Connect the connector test cable assembly to connector J102.

(3) Connect the carrier test cable assemblies to connector P101, P102, P104, or P105, as required during the tests.

(4) Connect the carrier supply test cable assembly to connector P103.

b. The chart in (3) below outlines the continuity measurements. Use the multimeter to make these measurements as follows:

(1) Measure the resistance between all the terminals in a horizontal row. The multimeter should read zero resistance. An asterisk in the ground column indicates that a measurement must also be made between the terminals and chassis ground. The multimeter should read zero resistance.

(2) Measure the resistance, where applicable, between the a and b lead for each test. The multimeter should read infinite resistance for measurement except for test No. 14, K and W of the carrier test cable assembly connected to P104, which should indicate 135 ohms.

(3) Measure the resistance between the terminals of one test number and the terminals of the other test numbers. The multimeter should read infinite resistance except in cases where both terminals being measured are connected to chassis ground. Ground connections are indicated by an asterisk in the ground column.

Test No.	Circuit	Supply Test cable assembly (J101)	Connector test cable assembly (J102)	Carrier test cable assemblies				Carrier supply test cable assembly (P103)	Ground
				(P101)	(P102)	(P104)	(P105)		
1*a* ----	Filament -----	L	---	---	B				
b ----	Ground -------	B	---	---	N	---	---	---	(*)
2*a* ----	Filament -----	P	---	---	---	---	B		
b ----	Ground -------	F	---	---	---	---	N	---	(*)
3 ----	Ground -------	R	---	---	---	---		---	(*)
4*a* ----	Filament -----	M	---	B	---	---	---	M and C.	
b ----	Filament -----	N	---	N	---	---	---	N and D.	
5*a* ----	Filament -----	J	---	---	---	B	H	P and E.	
b ----	Ground -------	E	---	---	---	---	---	---	(*)
6*a* ----	-10 -----------	D	---	A					
b ----	Ground -------	H	---	---	---	---	---	---	(*)
7*a* ----	600 V meas -	---	D	---	A				
b ----	Ground -------	---	C	---	---	---	---	---	(*)
8*a* ----	Mod talk -----	---	---	C	---	C			
b ----	Mod talk -----	---	---	P	---	P			
9*a* ----	Dem talk ----	---	---	D	---	D			
b ----	Dem talk ----	---	---	R	---	R			
10 ----	Ground -------	---	---	E	---	---	---	---	(*)
11*a* ----	1 KC ---------	---	---	K	C		K	H	
b ----	1 KC ---------	---	---	W	P		W	J	
12*a* ----	Meas ---------	---	---	---	U	U			
b ----	Meas ---------	---	---	---	H	H			
13*a* ----	Send ---------	---	---	---	S	S			
b ----	Send ---------	---	---	---	F	F			
14*a* ----	Pilot ---------	---	---	---	K	---	K	H	
b ----	Pilot ---------	---	---	---	W	---	W	J	
15*a* ----	Ground -------	---	---	---	J and E. E.	---	---	---	(*)
16 ----	Shield --------	---	---	---	T	T		---	

Test No.	Circuit	Supply Test cable assembly (J101)	Connector test cable assembly (J102)	Carrier test cable assemblies (P101)	(P102)	(P104)	(P105)	Carrier supply test cable assembly (P103)	Ground
17*a* ---	65 KC------------	--------------------	--------------------	----------	D	---------	D		
b ---	65 KC------------	--------------------	--------------------	----------	R	---------	R		
18*a* ---	Buzzer -----------	--------------------	--------------------	----------	---------	---------	U	B	
b ---	Ground ----------	--------------------	--------------------	----------	---------	---------	---------	F	(*)
19 ---	Ground ----------	--------------------	--------------------	----------	---------	---------	---------	F	(*)
20*a* ---	60-108 KC TR -	--------------------	--------------------	----------	---------	A	A	---------------------	
b ---	60-108 KC TR -	--------------------	--------------------	----------	---------	L	L	---------------------	
21 ---	Shield------------	--------------------	--------------------	----------	---------	M	M	---------------------	
22 ---	Ground ----------	--------------------	--------------------	----------	---------	J, N and E.	---------	---------------------	(*)
23 ---	Ground ----------	--------------------	--------------------	----------	---------	---------	J, T and E.	---------------------	(*)

c. Use the following procedure to check the 200-volt circuit in the JUNCTION PANEL.

(1) Connect the supply test cable assembly to connector J101.

(2) Connect a carrier test cable assembly to connector P101.

(3) Connect the multimeter between terminal A of the supply test cable assembly and terminal V of the carrier test cable assembly. The multimeter should read zero resistance.

(4) Repeat (1) through (3) above with the carrier test cable assembly connected to P102, P104, and P105. The multimeter should read zero resistance for each test.

(5) Connect the multimeter between terminal K of the supply test cable assembly and chassis ground. The multimeter should read zero resistance.

(6) Connect the multimeter between terminals A and K of the supply test cable assembly. The multimeter should read infinite resistance.

116. JUNCTION PANEL, Dc Resistance of Transformers

Transformers	Terminals	Resistance (ohms)
T101 and T102	1-2	2.27
	3-4	2.27
	5-6	11.1
	7-8	11.1

117. JUNCTION PANEL Troubleshooting Chart

The chart below is supplied as an aid in locating trouble in the JUNCTION PANEL. This chart lists the symptoms that may be reported on the equipment repair tag or observed when performing maintenance at the organizational level (TM 11-2139-20). Once the trouble has been localized to a defective circuit, continuity and resistance measurements of the circuit should ordinarily be sufficient to isolate the defective part.

Symptom	Probable trouble	Corrective measures
1. Short circuit or open circuit through distribution paths.	Failure of circuit in distribution path.	Check for open or short circuit to localize faulty distribution path.
2. Improper 37-kc test signal level at terminals 1 and 2 of junction panel test cable assembly.	Failure in circuit between terminals F and S of connector P105 and spiral-four connector J103 female terminals.	Use signal substitution procedures (par. 118, tests No. 1 through 3) to localize trouble.
3. Improper 37-kc test signal level at terminals 3 and 4 of junction panel test cable assembly.	Failure in circuit between spiral-four connector J103 male terminals and terminals C and P of connector P105.	Use signal substitution procedures (par. 118, tests No. 4 through 8) to localize trouble.
4. Improper 3-kc test signal level at terminals 1 and 2 of junction panel test cable assembly.	Failure in circuit between terminals L and M of connector P101 and spiral-four connector J103 female terminals.	Use signal substitution procedures (par. 118, tests No. 9 through 11) to localize trouble.
5. Improper 3-kc test signal level at terminals 3 and 4 of junction panel test cable assembly	Failure in circuit between spiral-four connector J103 male terminals and terminals F and S of connector P101.	Use signal substitution procedures (par. 118, tests No. 12 through 14) to localize trouble.

118. JUNCTION PANEL Signal Substitution Chart

Use the signal substitution chart below to supplement the troubleshooting chart outlined in paragraph 117. This chart will help to determine the defective circuit in the JUNCTION PANEL. Continuity and resistance measurements should then be sufficient to isolate the defective part. Follow the signal substitution procedures in the order given. For location of parts on the JUNCTION PANEL, refer to figures 76 and 77. These tests are set up in the same manner as the operational tests (pars. 113 and 114).

Test No.	For SG, 71/FCC hookup in circuit see par.	Voltmeter connections		Meter indication	Corrective measures
		Positive Probe	Negative Probe		
1 -----	113*b* -------------------------	Terminal 5 of filter FL101.	Ground ------------------	.775	Check circuit from terminals F and S of connector P105 to filter FL101.
2 -----	113*b* -------------------------	Terminal 1 of filter FL101	Ground ------------------	.83	*a.* Check protector E101. *b.* Check filter FL101.
3 -----	113*b* -------------------------	Terminal 1 of the junction panel test cable assembly.	Terminal 2 of the junction panel test cable assembly.	.34	*a.* Check circuit from filter FL101 to connector J103. *b.* Check protector E103. *c.* Check transformer T101.
4 -----	113*c* -------------------------	Terminal 1 of transformer T102.	Ground ------------------	.185	Check circuit from connector J103 to transformer T102.
5 -----	113*c* -------------------------	Terminal 4 of trance former T102.	Ground ------------------	.185	Check circuit from connector J103 to transformer T102.
6 -----	113*c* -------------------------	Terminal 5 of filter FL 102.	Ground ------------------	.72	*a.* Check circuit from transformer T102 to filter FL102. *b.* Check protector E102.
7 -----	113*c* -------------------------	Terminal 5 of filter FL102.	Ground ------------------	.7	Check filter FL102.
8 -----	113*c* -------------------------	Terminal C of the carrier test cable assembly.	Terminal P of the carrier test cable assembly.	.7	Check circuit from filter FL102 to terminals C and P of connector P105.

Test No.	For SG, 71/FCC hookup in circuit see par.	Voltmeter connections		Meter indication	Corrective measures
		Positive Probe	Negative Probe		
10 ---	114*b*-------------------	Terminal 1 of filter FL101.	Ground	.58	*a.* Check protector E101. *b.* Check filter FL101.
11 ---	114*b*-------------------	Terminal 1 of the junction panel test cable assembly.	Terminal 2 of the junction panel test cable assembly.	.25	*a.* Check circuit from filter FL101 to connector J103. *b.* Check protector E103. *c.* Check transformer T101.
12 ---	114*c* -------------------	Terminal 1 of transformer T102.	Ground ----------------	.185	Check circuit from connector J103 to transformer T102.
13 ---	114*c* -------------------	Terminal 4 of transformer T102.	Ground ----------------	.185	Check circuit from connector J103 to transformer T102.
14 ---	114*c* -------------------	Terminal 1 of filter FL102.	Ground ----------------	.78	*a.* Check filter from transformer T102 to filter FL102. *b.* Check protector E102.
15 ---	114*c* -------------------	Terminal 3 of filter FL102 .	Ground ----------------	.84	Check filter FL102.
16 ---	114*c* -------------------	Terminal F of the carrier test cable assembly.	Terminal S of the carrier test assembly.	.57	Check circuit from filter FL102 to connector P105.

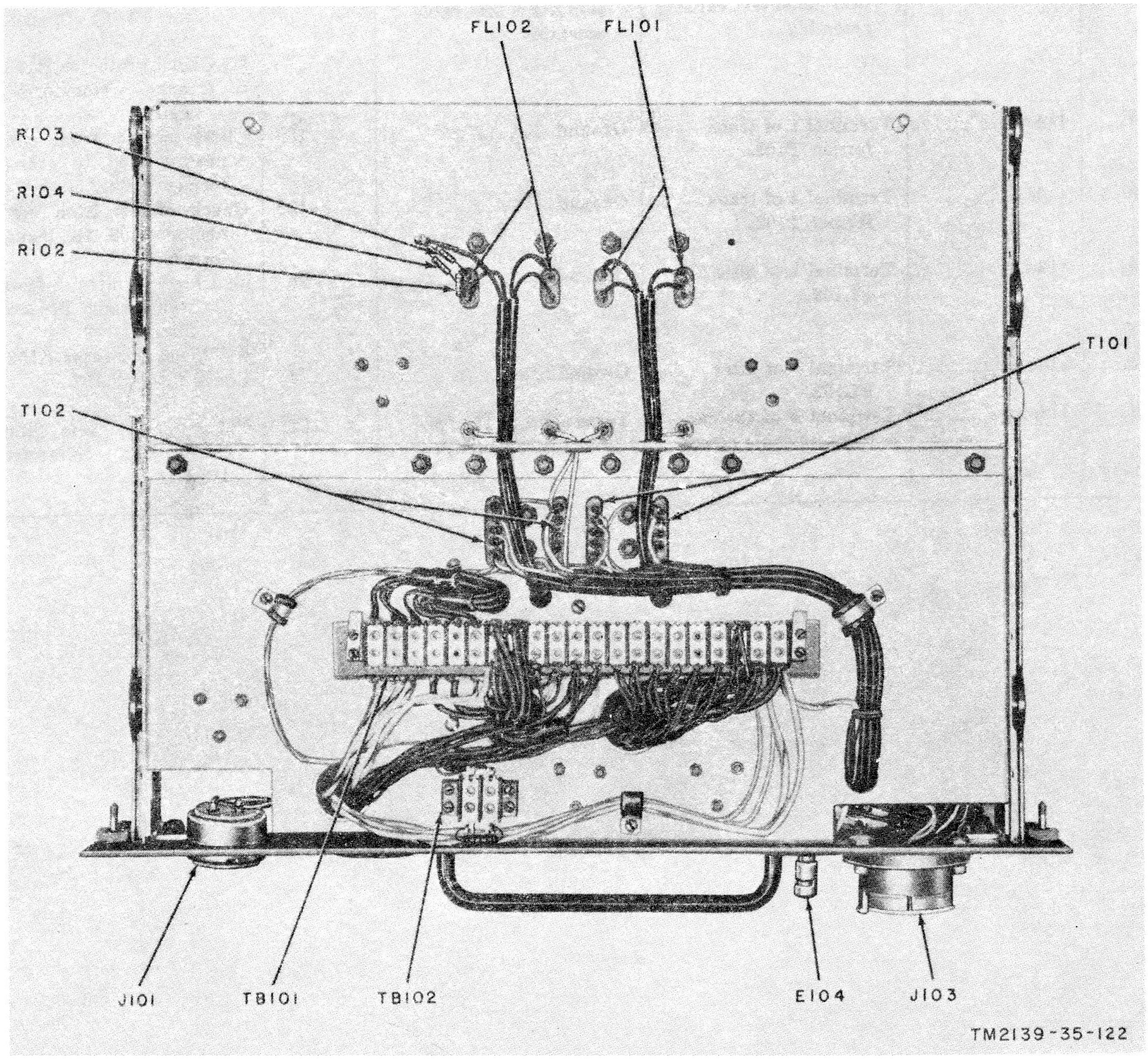

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Figure 76. JUNCTION PANEL, bottom view.

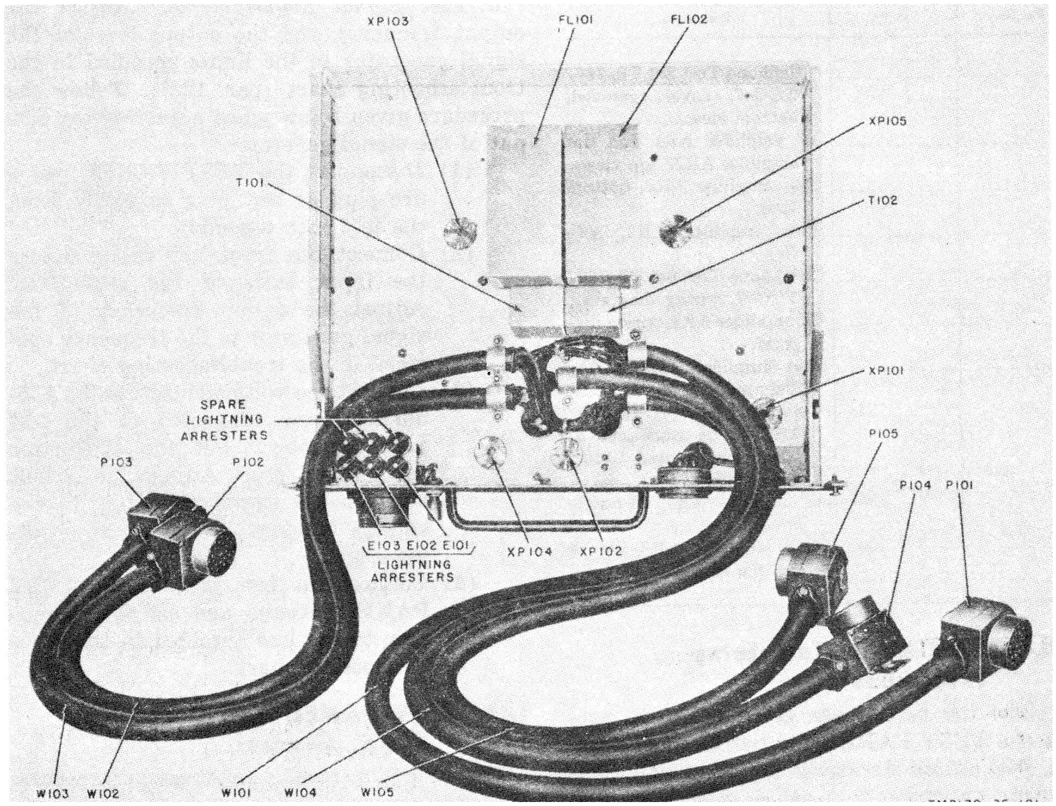

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Figure 77. JUNCTION PANEL, top view.

Section VI. TELEPHONE TEST SET TS-760/TCC-7 (PART OF RECEIVER-TRANSMITTER TEST SET GROUP OA-443/TCC-7)

119. TEST PANEL Troubleshooting Data

Fig No.	Par No.	Description
29 ---------	---------	Telephone Test Sets TS-760/ TCC-7, schematic diagram
79 ---------	---------	Switch S2, wiring diagram.
80 ---------	---------	Switch S3, wiring diagram.
81 ---------	---------	Switch S4, wiring diagram.
82 ---------	---------	Switch S5, wiring diagram.
83 ---------	---------	Switch S6, wiring diagram.
30 ---------	---------	If amplifier AR1, schematic diagram.
31 ---------	---------	Flat amplifier AR2, schematic diagram.

Fig No.	Par No.	Description
(TM 11-2139-20,fig. 7)	------	Telephone Test Set TS-760/TCC-7, tube socket voltage and resistance diagram
(TM 11-2139-20,fig. 8)	------	IF amplifier AR1, tube socket voltage and resistance diagram.
(TM 11-2139-20,fig. 9)	------	Flat amplifier AR2, tube socket voltage and resistance diagram.
84	------	Telephone Test Set TS-760/TCC-7, covers removed, top view.
(TM 11-2139-20,fig. 3)	------	Telephone Test Set TS-760/TCC-7, plug-in assemblies removed but shown, top view.

Fig No.	Par.No.	Description
85 ---------	----------	Telephone Test Set TS-760/ TCC-7, cover removed, bottom view.
87 ---------	----------	IF amplifier AR1 and flat amplifier AR22 top view.
88 ---------	----------	Flat amplifier AR2, bottom view.
89 ---------	----------	Flat amplifier AR2, side view.
155--------	----------	Telephone Test Set TS-760/ TCC-7, wiring diagram.
156--------	----------	IF amplifier AR1, wiring diagram.
157--------	----------	Flat amplifier AR2, wiring diagram.
	134a	Telephone Test Set TS-760/ TCC-7, dc resistance of transformers and coils, main chassis.
	134b	IF amplifier AR1, dc resistance of coil.
	134c	Flat amplifier AR2, de resistance of coil.

120. TEST PANEL Test Setup Procedures

Follow the procedures given below to prepare the TEST PANEL for troubleshooting.

a. Test Cable Assembly Connection. Connect the resistors, test cable assemblies, 200 VOLT POWER SUPPLY, and TEST PANEL as shown in figure 78.

b. Test Signal Source Connections. Connect the signal generator, resistors RI through R3, attenuator, transformer T107, and the I35-ohm resistor to terminals T and R of the test jack assembly as shown in figure 78.

c. Test Lead Connections. Connect test leads A and B to the test plug assembly as shown in figure 78.

d. Test Signal Requirements. Adjust the output frequency and the output level of the signal generator to the limits specified in the troubleshooting chart (par. 122). Follow the procedure given below when adjusting the output of the signal generator.

(1) Disconnect the TEST PANEL measure plug or test plug assembly from the test jack assembly.

(2) Connect the frequency meter across the input leads of the attenuator. Adjust the output frequency of the signal generator to the frequency specified in the troubleshooting chart.

(3) Connect the voltmeter across the 135ohm resistor connected to the test jack assembly. Set the attenuator for a 0-db loss. Adjust the output level of the signal generator to the voltage specified in the troubleshooting chart.

(4) Connect the test jack to the TEST PANEL circuits and set the attenuator to the loss specified in the troubleshooting chart.

121. TEST PANEL Troubleshooting Chart, General

The following troubleshooting charts (pars. 122-124) are supplied to aid in locating trouble in the TEST PANEL flat. amplifier AR2, and IF amplifier AR1. The charts list the symptoms which the repairman may observe while performing the tests listed in the test column. A tube check and voltage and resistance measurements at the defective stage or circuit will usually isolate the defective part. Normal tube socket voltage and resistance measurements appear in TM 11-2139-20, figures 7 through 9.

Figure 78. TEST PANEL operational and final test setup.
(Contained in separate envelope)

122. TEST PANEL Troubleshooting Chart

Test	Symptom	Probable Trouble	Corrective Measures
1. Operate MEASURE switch to 200 VOLTS and observe TEST PANEL meter indication (normal indication between -.5 db and +.5 db).	TEST PANEL meter M1 gives no indication	*a.* Open circuit in 200-volt wiring.	*a..* Check fir 200 volts between terminal 2, section 2, of MEASURE switch S1 and chassis ground (fig. 29). If no reading is obtained, check wiring.

Test	Symptom	Probable Trouble	Corrective measures
		b. MEASURE switch defective.	*b*. Check for 200 volts between terminal 11, section 2, and terminal 11, section 1, of MEASURE switch S1. If 200-volt reading is not obtained, check the MEASURE switch.
		c. Resistor R11 or R12 defective.	*c*. Check resistors R11 and R12 with an ohmmeter. Replace defective parts.
		d. Meter M1 defective	*d*. Check meter M1 by substituting meter known to be good; replace if defective.
2. Operate MEASURE switch to 200 VOLTS and observe TEST PANEL meter indication (normal indication between -5 db and +.5 db).	TEST PANEL meter gives an indication below -5db or above +.5 db scale markings.	*a*. Resistor R11 or R12 defective. *b*. Meter M1 defective.	*a*. Check resistors R11 and R12. Replace if defective. *b*. Check meter M1 by substituting meter known to be good; replace if defective.
3. Operate MEASURE switch to 600 VOLTS. Check to see that no voltage is applied to terminal A of power test cable assembly (fig. 78). Observe TEST PANEL meter indication. (No indication should be observed.)	TEST PANEL meter gives an indication with no voltage applied to terminal A of TO JUNCTION PANEL connector J2.	MEASURE switch defective.	Check for short circuit between terminals 2 and 4, section 2, of MEASURE switch S1. If short circuit exists, replace the switch.
4*a*. Operate MEASURE switch to 200 VOLTS and observe TEST PANEL meter indication (normal indication between -.5 db and +.5 db).	TEST PANEL meter M1 indicates between -5db and +.5 db scale markings for test a, but TEST PANEL meter gives no indication for test b.	*a*. Open circuit between terminal A of TO JUNCTION PANEL connector J2 and MEASURE switch	*a*. Check for 200 volts between terminal 4, section 2, of MEASURE switch S1 and ground. If 200-volt reading is not obtained, check wiring from terminal A of connector J2 and the switch.
b . Operate MEASURE switch to 600 VOLTS. Connect clip lead from terminal A to terminal V of power test cable assembly (fig. 78). Observe TEST PANEL meter indication (normal indication between -.5 db and +.5 db). Remove clip leads.		*b*. MEASURE switch defective	*b*. See correction lb.
5. Operate MEASURE switch to TRANSMISSION. Operate MEASURE SEL-ECTIVE switch to OFF. Operate MEASURE NON-SELECTIVE switch to CHECK 1 KC CHECK HF.	TEST PANEL meter indicates an output with no test input.	Flat amplifier AR2 oscillating.	Use troubleshooting chart (par. 123) to check flat amplifier AR2.

Test	Symptom	Probable trouble	Corrective measures
Make no connection to measure plug. Observe TEST PANEL meter indication. (No indication should be observed.)			
6. Operate MEASURE switch to TRANSMISSION. Operate MEASURE NON SELECTIVE switch to OFF. Operate MEASURE SELECTIVE switch to any position. Make no connection to measure plug. Observe TEST PANEL meter indication. (No meter indication should be observed.)	TEST PANEL meter indicates an output with no test input. The indication is not present when CARR OSC tube V2 is removed from its socket.	a. Shields missing or loose. b. Defect in carrier oscillator circuit. c. Defect in varistor CRT, filter FL2, or filter FL3.	a. Check to see that all shields are present and tightly connected. Check to see that IF amplifier AR1 and flat amplifier AR2 are securely in place. *b.* Use signal substitution test (par. 127) to isolate faulty part. *c.* Check varistor CR1 and filters FL2 and FL3 one at a time, rechecking each time for the trouble symptom. Replace defective part.
7*a*. Same as test 5----------------- *b*. Same as test 6-----------------	*a*. Indication for test 5 normal. *b*. Abnormal indication for test 6 persists after removal of CARR OSC tube V2.	IF amplifier AR1 oscillating.	Use troubleshooting chart (par. 124) to check IF amplifier ART.
8. Operate MEASURE switch to TRANSMISSION. Operate MEASURE SELECTIVE switch to OFF. Operate MEASURE NONSELECTIVE switch to CHECK 1 KC CHECK HF. Operate SEND switch to CHECK GAIN CHECK HF. *a*. Insert measure plug into CHECK HF jack. Operate HF control to obtain 0-db indication on TEST PANEL meter. *b*. Insert measure plug into CHECK 1 KC jack. Operate 1 KC control to obtain 0-db indication on TEST PANEL meter.	Inability to adjust HF control for 0-db indication on TEST PANEL meter for test a, and inability to adjust 1 KC control for 0-db indication on TEST PANEL meter for test b. If either part of test indicates normal operation, and other part indicates trouble, refer to tests 16 and 17.	Defect in rectifier circuit V3.	Use signal substitution procedures (par. 126) to localize trouble and to find the defective part. Replace defective part.
9. Same as test 8a. Measure the ac voltage across terminals R and D (ground) of transmission test cable assembly (fig. 78). (Normal indication should be between .049 and .062 volt.)	The HF control can be adjusted to obtain 0-db indication on TEST PANEL meter, but voltage measured is less than .049 volt or greater than .062 volt.	Defect between TO TS712/TCC-11 TEST SET connector J5 and CHECK HF jack J6.	Check resistors R45, R46, and R80 and wiring to terminal R of connector J5. Replace defective part.

Test	Symptom	Probable trouble	Corrective measures
10. Measure the resistance between terminals D and L and between D and A of transmission test cable assembly (fig. 78). (Normal indication should be between 612 and 748 ohms.)	Resistance measured is less than 612 ohms or greater than 748 ohms.	Resistor R24 defective	Check resistor R24 and replace if defective.
11. Adjust frequency and output of test jack (par. 120, fig. 78) to 68 kc and .775 volt. Set the attenuator for 46db loss. Operate the controls as outlined in test 8. Insert measure plug into test jack (fig. 78). Observe TEST PANEL meter indication (normal indication, 0 db ± 5 db).	TEST PANEL meter indicates less than -.5 db or more than +.5 db.	Defect in rectifier V3 circuit.	Use signal substitution procedures (par. 126) to localize trouble and to locate the defective part. Replace the defective part.
12. If test 11 is satisfactory (TEST PANEL meter indicates between -.5 and +.5 db), adjust the output of the signal generator to obtain a 0-db indication on the TEST PANEL meter. Check the attenuator loss to 41 db. Operate the 5db push button of the ATTENUATOR switch. Observe TEST PANEL meter indication (normal indication, 0 db ±.5 db).	TEST PANEL meter indicates less than -.5 db or more than +.5 db.	Defect in 5db section of ATTENUATOR switch.	Check resistors R25 through R27, wiring, and ATTENUATOR switch S2 (fig. 79). Replace defective part (par. 165).
13. If test 12 is satisfactory, change the attenuator loss to 36 db. Operate the 10db push button of the ATTENUATOR switch. Observe TEST PANEL meter indication (normal indication, 0 db ±.5 db).	TEST PANEL meter indicates less than -.5 or more than +.5 db.	Defect in 10db section of ATTENUATOR switch.	Check resistors R28 through R30, wiring, and ATTENUATOR switch S2 (fig. 79). Replace defective part (par. 165).
14. If test 13 is satisfactory, change the attenuator loss to 26 db. Operate the 20db push button of the ATTENUATOR switch. Observe TEST PANEL meter indication (normal indication, 0 db ±.5 db).	TEST PANEL meter indicates less than-.5 db or more than + .5 db.	Defect in 20db section of ATTENUATOR switch.	Check resistors R31 through R33, wiring, and ATTENUATOR switch S2 (fig. 79). Replace defective part (par. 165).

Test	Symptom	Probable trouble	Corrective measures
15. If test 11 is satisfactory (TEST PANEL meter indicates between -.5 and +.5 db), set the attenuator for 46-db loss. Adjust the output of the signal generator to obtain a 0-db indication on the TEST PANEL meter. Change the attenuator loss to the values indicated below. The TEST PANEL meter indication should be within the limits specified.	TEST PANEL meter indication is outside the limits given in the Test column.	*a.* Defective rectifier V3 circuit. *b.* Defective TEST PANEL meter M1.	*a.* Check tube V3 and make tube-socket voltage and resistance measurements. Check resistors R22 and R23 and capacitors C16 and C18. *b.* Check meter M1 by substituting a meter known to be good; replace ii defective.

ATTENUATOR setting (db)	***Meter reading limits (db)***
39	+7 ± .5
40	+6 ± .5
41	+5 ± .5
42	+4 ± .5
43	+3 ± .5
44	+2 ± .5
45	+1 ± 5
46	0
47	-1 ±.5
48	-2 ± 5
49	-3 ± .6
50	-41 ± .7
51	-5 ± .8
52	-6 ± .9
53	-7 ± 1.0

Test	Symptom	Probable trouble	Corrective measures
16. Same as test 8...............	The HF control can be adjusted to obtain a 0-db indication on TEST PANEL meter, but the 1 KC control cannot be adjusted to obtain a 0db indication.	Defect in 1-kc oscillator circuit.	Use signal substitution procedures (par. 131) to localize trouble and to find defective part. Replace the defective part.
17. Same as test 8...............	The 1 KC control can be adjusted to obtain a 0db indication on TEST PANEL meter, but HF control cannot be adjusted to obtain a 0-db indication.	Defect in hf oscillator circuit	Use signal substitution procedures (par. 132) to localize trouble and to find defective part. Replace the defective part.
18. Adjust the HF control as outlined in test 8. Adjust frequency and output at test jack (par. 120), to 1 kc and .870 volt. Set the attenuator for 0-db loss. Operate MEASURE switch to TRANSMISSION.	TEST PANEL meter indication other than 0 db ±1 db.	Defect between terminal 12, section 1, and terminal 12, section 2 of MEASURE NON-SELECTIVE switch in CHANNEL OUT position.	Check resistors R58 and R95 and continuity through MEASURE NONSELECTIVE switch S4 (fig. 81). Replace defective part (par. 165).

Test	Symptom	Probable trouble	Corrective measures
Operate MEASURE SELECTIVE switch to OFF. Operate MEASURE NONSELECTIVE switch to CHANNEL OUT. Insert measure plug into test jack (fig. 78). Observe TEST PANEL meter indication (normal indication, 0 db ±1 db).			
19. Adjust the HF control as outlined in test 8. Adjust frequency and output at test jack (par. 120, fig. 78) to 10 kc and .775 volt. Set the attenuator for 39db loss. Operate TEST PANEL controls as in test 18, except operate MEASURE NONSELECTIVE switch to SUB GRP MOD IN. Insert measure plug into test jack (fig. 78). Observe TEST PANEL meter indication (normal indication, 0 db ±1 db).	TEST PANEL meter indication other than 0 db ±1 db.	Defect between terminal 12, section 1, and terminal 12, section 2, of MEASURE NONSELECTIVE switch in SUB GRP MOD IN position.	Check resistors R60 through R62, filter FL4, and continuity through MEASURE NONSELECTIVE switch S4. Replace defective part (par. 165).
20. Adjust the HF control as outlined in test 8. Adjust frequency and output at test jack (par. 120, fig. 78) to 68 kc and.731 volt. Set the attenuator for 11db loss. Operate TEST PANEL controls as in test 18, except operate MEASURE NONSELECTIVE switch to GRP DEM OUT. Insert measure plug into test jack (fig. 78). Observe TEST PANEL meter indication (normal indication, 0 db ±1 db).	TEST PANEL meter indication other than 0 db ±1 db.	Defect between terminal 12, section 1, and terminal 12, section 2, of MEASURE NON SELECTIVE switch in GRP DEM OUT position.	Check resistors R63 and R64 and continuity through MEASURE NONSELECTIVE switch S4. Replace defective part (par. 165).
21. Adjust frequency and output at test Jack (par. 120) to 68 kc and .775 volt. Set the attenuator for 0-db loss.	TEST PANEL meter indication other than 0 db ± 1 db.	Defect between terminal 12, section 1, and terminal 12, section 2 of MEASURE NON SELECTIVE switch in SUB GRP DEM OUT position.	Check resistors R85 and R86 and continuity through MEASURE NONSELECTIVE switch S4. Replace defective part (par. 165)

Test	Symptom	Probable trouble	Corrective measures
Operate TEST PANEL controls as in test 18, except operate MEASURE NON-SELECTIVE switch to SUB GRP DEM OUT. Insert measure plug into test jack (fig. 78). Observe TEST PANEL meter indication (normal indication, 0 db ± 1 db).			
22. Adjust frequency and output at test jack (par. 120) to 1 kc and .699 volt. Set the attenuator for 13db loss. Operate TEST PANEL controls as outlined in test 18. Operate MEASURE NONSELECTIVE switch to OW TR AMP OUT. Insert measure plug into test jack (fig. 78). Observe TEST PANEL meter indication (normal indication, 0 db ± 1 db).	TEST PANEL meter indication other than 0 db ±1 db.	Defect between terminal 12, section 1, and terminal 12, section 2, of MEASURE NONSELECTIVE switch in OW TR AMP OUT position.	Check resistors R65 and R66 and continuity through MEASURE NON-SELECTIVE switch S4 (fig. 81). Replace defective part (par. 165).
23. Adjust frequency and output at test jack (par. 120), to 1 kc and .757 volt. Set the attenuator for 46db loss. Operate TEST PANEL controls as outlined in test 18. Operate MEASURE NON-SELECTIVE switch to OW REC AMP. Insert measure plug into test jack (fig. 78). Observe TEST PANEL meter indication (normal indication, 0 db ±1 db).	TEST PANEL meter indication other than 0 db ± 1 db.	Defect between terminal 12, section 1, and terminal 12, section 2 of MEASURE NONSELECTIVE switch in OW REC AMP position.	Check continuity through MEASURE NON-SELECTIVE switch S4. Replace defective part (par. 165).
24. Adjust frequency and output at test jack (par. 120, fig. 78) to 68 kc and .749 volt. Set the attenuator for 0-db loss. Operate TEST PANEL controls as outlined in test 18. Operate MEASURE NONSELECTIVE switch to CARR SUPPLY	TEST PANEL meter indication other than 0 db ±1 db.	Defect between terminal 12, section 1, and terminal 12, section 2, of MEASURE NONSELECTIVE switch in CARR SUPPLY position.	Check resistors R67 and R68 and continuity through MEASURE NON-SELECTIVE switch S4. Replace defective part (par. 165).

Test	Symptom	Probable trouble	Corrective measures
Insert measure plug into test jack (fig. 78). Observe TEST PANEL meter indication (normal indication, 0 db ±1 -db).			
25. Adjust frequency and output at test jack (par. 120) to 83 kc and .707 volt. Set the attenuator for 41db loss. Operate TEST PANEL controls as outlined in test 18. Operate MEASURE NONSELECTIVE switch to FAULT TEST. Insert measure plug into test jack (fig. 78). Observe TEST PANEL meter indication (normal indication, 0 db ±2 db). Repeat the above test at frequencies of 91 kc and 99 kc and .707 volt.	TEST PANEL meter indication below -2 db or above +2 db.	Defect between terminal 12, section 1, and terminal 12, section 2, of MEASURE NONSELECTIVE switch in FAULT TEST position.	Check filter FL5 and continuity through MEASURE NON-SELECTIVE switch S4. Replace defective part (par. 165).
26. If test 8a is satisfactory, operate MEASURE NON-SELECTIVE switch to OFF. Operate MEASURE SELECTIVE switch to CHECK GAIN. Operate COARSE TUNE and FINE TUNE controls to obtain a maximum indication on the TEST PANEL meter.	TEST PANEL meter gives no indication.	*a*. Hf oscillator off frequency. *b*. Defect in carrier oscillator, input circuit, modulator, or IF amplifier circuit of selective measurement circuit detector.	*a*. Realign hf oscillator for CHECK GAIN CHECK HF position of SEND switch S5 (par. 167*e*). If unable to align, check capacitors C23, C24, C49, C50, C51, and continuity through FAULT TEST switch S6 to terminal 3 of T5. Replace defective part (par. 165). *b*. Use signal substitution procedures (pars. 127 through 130) to localize the trouble and to isolate defective part. Replace defective part.
27. If test 26 is satisfactory, operate GAIN control, and AMP GAIN control of IF amplifier to obtain a 0-db indication on TEST PANEL meter.	TEST PANEL meter indication can be maximized by operation of COARSE TUNE and FINE TUNE controls, but the indication cannot be adjusted to 0 db by operation of the GAIN control and AMP GAIN control of IF amplifier.	Defect in carrier oscillator input circuit, modulator, or IF amplifier circuit of selective measurement circuit dictator	Use signal substitution procedures (pars. 127 through 130) to localize trouble and to isolate defective part. Replace defective part.

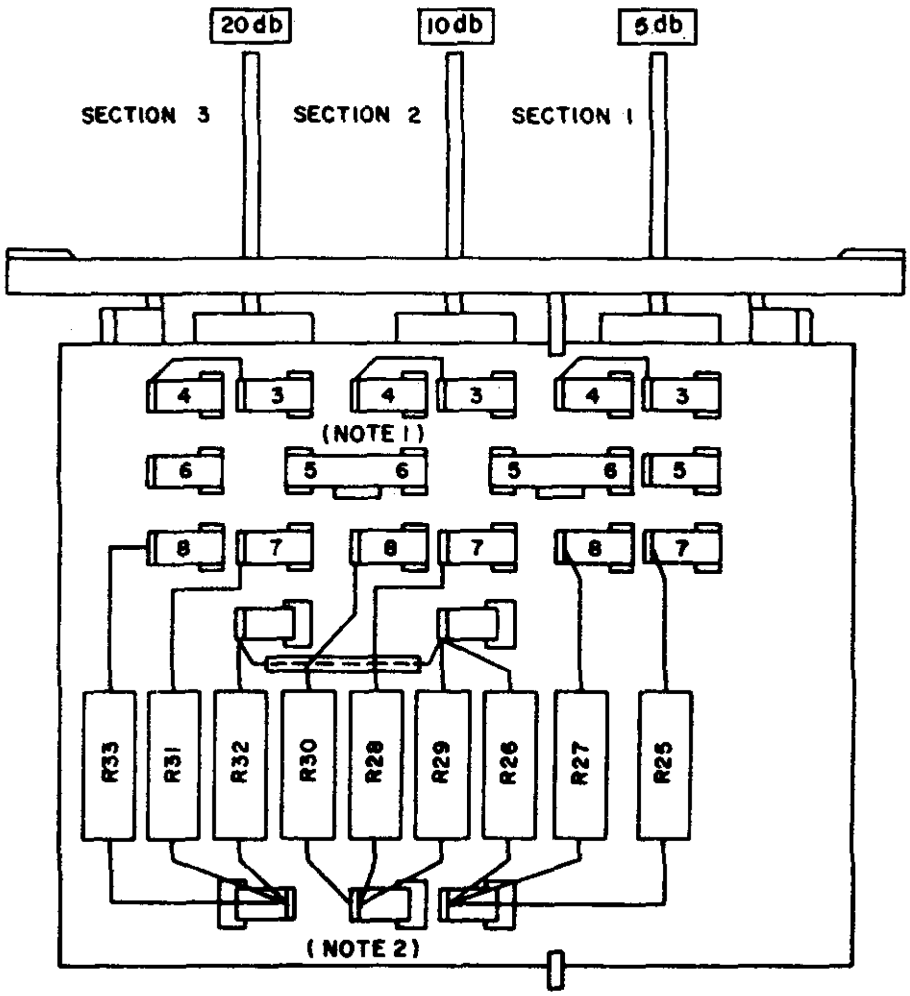
Test	Symptom	Probable trouble	Corrective measures
28. If test 27 is satisfactory, adjust frequency and output at test jack (par. 120, fig. 78) to 12 kc and .731 volt. Set the attenuator for 48db loss Operate MEASURE SELECTIVE switch to 12KC. Insert measure plug into test jack (fig. 78). Operate the COARSE TUNE and FINE TUNE controls to obtain a maximum indication on the TEST PANEL meter (normal indication, 0 db ±1 db).	TEST PANEL meter indication other than 0 db ±1 db.	*a*. Defect between terminal 1, section 3, and terminal 12, section 2, of MEASURE SELECTIVE switch. *b*. Defect in carrier oscillator circuit.	*a*. Check continuity through MEASURE SELECTIVE switch S3. Replace defective part (par. 165). *b*. Use signal substitution procedures (par. 127) to localize trouble and to isolate defective part. Replace defective part.
29. If test 27 is satisfactory, adjust frequency and output at test jack (par. 120, fig. 78) to 28 kc and .731 volt. Operate the COARSE TUNE and FINE TUNE controls to obtain a maximum indication on the TEST PANEL meter (normal indication, 0 db ±1 db).	TEST PANEL meter indication other than 0 db ±1 db.	Same as for test No. 28, except MEASURE SELECTIVE switch in 28KC position.	See corrective measures for test No. 28.
30. If test 27 is satisfactory, adjust frequency and output at test jack (par. 120), to 67 kc and .731 volt. Set the attenuator for 48db loss. Insert measure plug into test jack. Operate TEST PANEL controls as outlined in test 29. Operate MEASURE SELECTIVE switch to 67KC (normal indication, 0 db ±1 db).	TEST PANEL meter indication other than 0 db ±1 db.	Same as for test No. 28, except MEASURE SELECTIVE switch in 67KC position	See corrective measure for test No. 28

Test	Symptom	Probable trouble	Corrective measures
31. If test 27 is satisfactory, adjust frequency output at test jack (par. 120) to 83 kc and .731 volt. Set the attenuator for 48-db loss. Insert measure plug into test jack (fig. 78). Operate TEST PANEL controls as outlined in test 29. Operate MEASURE SELECTIVE switch to 83KC (normal indication, 0 db ±1 db).	TEST PANEL meter indication other than 0 db ±1 db.	Same as for test No. 28 except MEASURE SELECTIVE switch in 83KC position.	See corrective measure for test ho. 28.
32. If test 27 is satisfactory, adjust frequency and output at test jack (par. 120) to 99 kc and.731 volt. Set the attenuator for 48db loss. Insert measure plug into test jack (fig. 78). Operate TEST PANEL controls as outlined in test 29. Operate MEASURE SELECTIVE switch to 99KC (normal indication, 0 db ±1 db).	TEST PANEL meter indication other than 0 db ±1 db.	Same as for test No. 28, except MEASURE SELECTIVE switch in 99KC position.	See corrective measure for test No. 28.
33. If test 27 is satisfactory, adjust frequency and output at test jack (par. 120) to 68 kc and .731 volt. Set the attenuator for 38db loss. Operate TEST PANEL controls as outlined in test 29. Operate MEASURE SELECTIVE switch to 68KC (normal indication 0 db ±1 db).	TEST PANEL meter indication other than 0 db ±1 db.	Same as for test No. 28, except MEASURE SELECTIVE switch in 68KC position.	See corrective measure for test No. 28, and check resistors R40 through R42. Replace if defective.
34. If test 27 is satisfactory, adjust frequency and output at test jack (par. 120) to 65 kc and .731 volt. Set the attenuator for 38db loss. Insert measure plug into test jack (fig. 78). Operate TEST PANEL controls as outlined in test 29. Operate MEASURE SE`LECTIVE switch to 65KC (normal indication 0 db ±1 db).	TEST PANEL meter indication other than 0 db ±l db	Same as for test No. 28, except MEASURE SELECTIVE switch in 65KC position.	See corrective measure for test No. 28, and check resistors R40 through R42. Replace if defective.

Test	Symptom	Probable trouble	Corrective measures
35. If test 27 is satisfactory, adjust frequency output at test jack (par. 120) to 37 kc and .173 volt. Set the attenuator for 38db loss. Insert measure plug into test jack (fig. 78). Operate TEST PANEL controls as in test 29. Operate MEASURE SELECTIVE switch to 37KC (normal indication, 0 db ±1 db).	TEST PANEL meter indication other than 0 db +1 db.	Same as for test No. 28, except MEASURE SELECTIVE switch in 37KC position.	See corrective measure for test No. 28, and check resistors R40 through R42. Replace if defective.
36. If test 27 is satisfactory, adjust the frequency and output at the test jack to 62 kc ±100 cps and .775 volt (par. 120). Set the attenuator for 70db loss. Insert the measure plug into the test jack. Operate MEASURE NONSELECTIVE switch to GRP PANEL 62KC. Operate MEASURE SELECTIVE switch to GR PANEL 62KC. Operate the COARSE TUNE and FINE TUNE controls to obtain a maximum indication on the TEST PANEL meter (normal indication 0 db ±1 db).	TEST PANEL meter indication other than 0 db ±1 db.	Defect in selective circuit for 62-kc measurement.	Use signal substitution procedures (pars. 127 through 130) to localize trouble and to isolate defective part. Replace defective part.
37. If test 8*b* is satisfactory, connect the voltmeter from each of terminals C, F, P. and S of power test cable assembly (fig. 78), to chassis ground. Measure the voltage. (The voltage should be between 0.46 and 0.51 volt.)	The 1 KC control can be adjusted to obtain 0-db indication on TEST PANEL meter, but voltage measured is less than .46 volt or greater than .51 volt.	*a.* Defect in wiring between TO JUNCTION PANEL connector J2 terminals F and S and terminals E3 and E4. *b.* Defect between transformer T1 and CHECK 1 KC jack J1.	*a.* Check wiring. *b.* Check resistors R7 through R10, and R75. Replace defective part.
38. Measure the resistance between terminals H and U of power test cable assembly (fig. 78) and between tip and ring springs of CHANNEL OUT jack J7 (normal resistance between 594 ohms and 606 ohms).	Resistance measured is less than 594 ohms or greater than 606 ohms	Defect between TO JUNCTION PANEL connector J2 and CHANNEL OUT jack J7.	Check wiring and resistor R73. Replace defective part.

Test	Symptom	Probable trouble	Corrective measures
39. If test 8a is satisfactory, measure the frequency connected between terminal 6, section 1, of SEND switch, and chassis ground. (Frequency should be 68 kc ±200 cps.)	The frequency is less than 67.8 kc or greater than 68.2 kc.	HI oscillator out of alignment at 68 kc.	See corrective measure for test No. 26.
40. If test 39 is satisfactory, operate SEND switch to 65 KC TR OR FAULT TEST. Measure the frequency meter connected as in test 39. (Frequency should be 65 kc ±200 cps.)	The frequency measured with the SEND switch in 65 KC TR OR FAULT TEST position is less than 64.8 kc or greater than 65.2 kc.	HI oscillator out of alignment at 65 kc.	Realign hf oscillator for 68 kc (par. 167e). If unable to align at 65 kc, check capacitors C58 and C59 and continuity through section 2 of SEND switch S5 (fig. 82). Replace defective part (par. 165).
41. If test 40 is satisfactory, with same conditions as in test 40, operate REP 1 push button of FAULT TEST switch. (The frequency meter should indicate 99 kc ±400 cps.)	The frequency measured is less than 98.6 kc or greater than 99.4 kc.	HI oscillator out of alignment at 99 kc.	Realign hf oscillator for 99 kc (par. 167e). If unable to align, check capacitors C52 and C53 and continuity through FAULT TEST switch S6 (fig. 83). Replace defective part (par. 165).
42. If test No. 40 is satisfactory, with same conditions as in test 40, operate REP 2 push button of FAULT TEST switch. (Frequency meter should indicate 91 kc ±400 cps.)	The frequency measured is less than 90.6 kc or greater than 91.4 kc.	Hf oscillator out of alignment at 91 kc.	Realign hi oscillator for 91 kc (par. 167e). If unable to seine, check capacitors C54 and C55 and continuity through FAULT TEST switch S6 (fig. 83). Replace defective part (par. 165).
43. If test No. 40 is satisfactory, with same conditions as in test 40, operate REP 3 push button of FAULT TEST switch. (Frequency meter should indicate 83 kc ±400 cps.)	The frequency measured is less than 82.6 kc or greater than 83.4 kc.	HI oscillator out of alignment at 83 kc.	Realign hf oscillator for 83 kc (par. 167e). If unable to align, check capacitors C56 and C57 and continuity through FAULT TEST switch S6 (fig. 83). Replace defective part (par. 165).
44. If test No. 8*a* is satisfactory, operate SEND switch to 65KC REC. Operate 65 KC REC control to the extreme clockwise position. Connect the voltmeter between terminals D and R (ground) of power test cable assembly (fig. 78). Measure the voltage (normal voltage should be between limits of 0.32 volt and 42 volt)	The voltage measured with 65 KC REC control operated for maximum voltage is less than 0.32 volt or greater than 0.42 volt.	Defect between terminal 6, section 1, of SEND switch and TO JUNCTION PANEL connector J2, terminal D.	Check resistors R37 and R81 and continuity through SEND switch S5. Replace defective part (par. 165).

Test	Symptom	Probable trouble	Corrective measures
45. With other conditions the same as in test No. 44, adjust 65 KEC REC control to obtain a voltage of 0.12 volt.	It is not possible to adjust the 65 KC REC control to obtain a voltage of .12 volt.	See probable trouble for test No. 44.	See corrective measure for test No. 44.
46. If test No. 8*a* is satisfactory, operate SEND switch to 65 KC TR OR FAULT TEST. Connect the voltmeter between terminals K and W (ground) of power test cable assembly (fig. 78). Measure the voltage. Slowly operate the 65 KC TR OR FAULT TEST control from the extreme clockwise to the extreme counterclockwise positions. (Voltage should increase from .005 volt to .009 volt.)	Operation of the 65 KC TR OR FAULT TEST control does not enable adjustment of voltage over the range from .005 volt to .009 volt.	Defect between terminal 6, section 1, of SEND switch and TO JUNCTION PANEL connector J2, terminal K.	Check resistors R48 through R51 and continuity through SEND switch S5. Replace defective part (par. 165).
47. Use the test arrangement of test No. 46. Operate 65 KC TR OR FAULT TEST control to obtain a voltage of .007 volt. Operate, in turn, the REP 1, REP 2, and REP 3 push buttons of the FAULT TEST switch. Note the voltage as each push button is operated. (Normal voltage should be between limits of .0042 volt and .0054 volt.)	The operation of any FAULT TEST switch push button causes the voltage to drop to less than .0042 volt or to more than .0054 volt.	Resistor R38 out of adjustment.	Adjust resistor R38 in accordance with alignment procedure (par. 167). If unable to adjust, check resistors R38 and R79 and continuity through FAULT TEST switch S6. Replace defective part (par. 165).



NOTES:

1. **TERMINAL NUMBERS ARE ARBITRARILY ASSIGNED FOR REFERENCE PURPOSES ONLY.**
2. **TERMINALS WITHOUT\ REFERENCE NUMBERS ARE USED AS TIE POINTS.**

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Figure 79. ATTENUATOR switch S2 (part of TEST PANEL), circuit element location and wiring diagram.

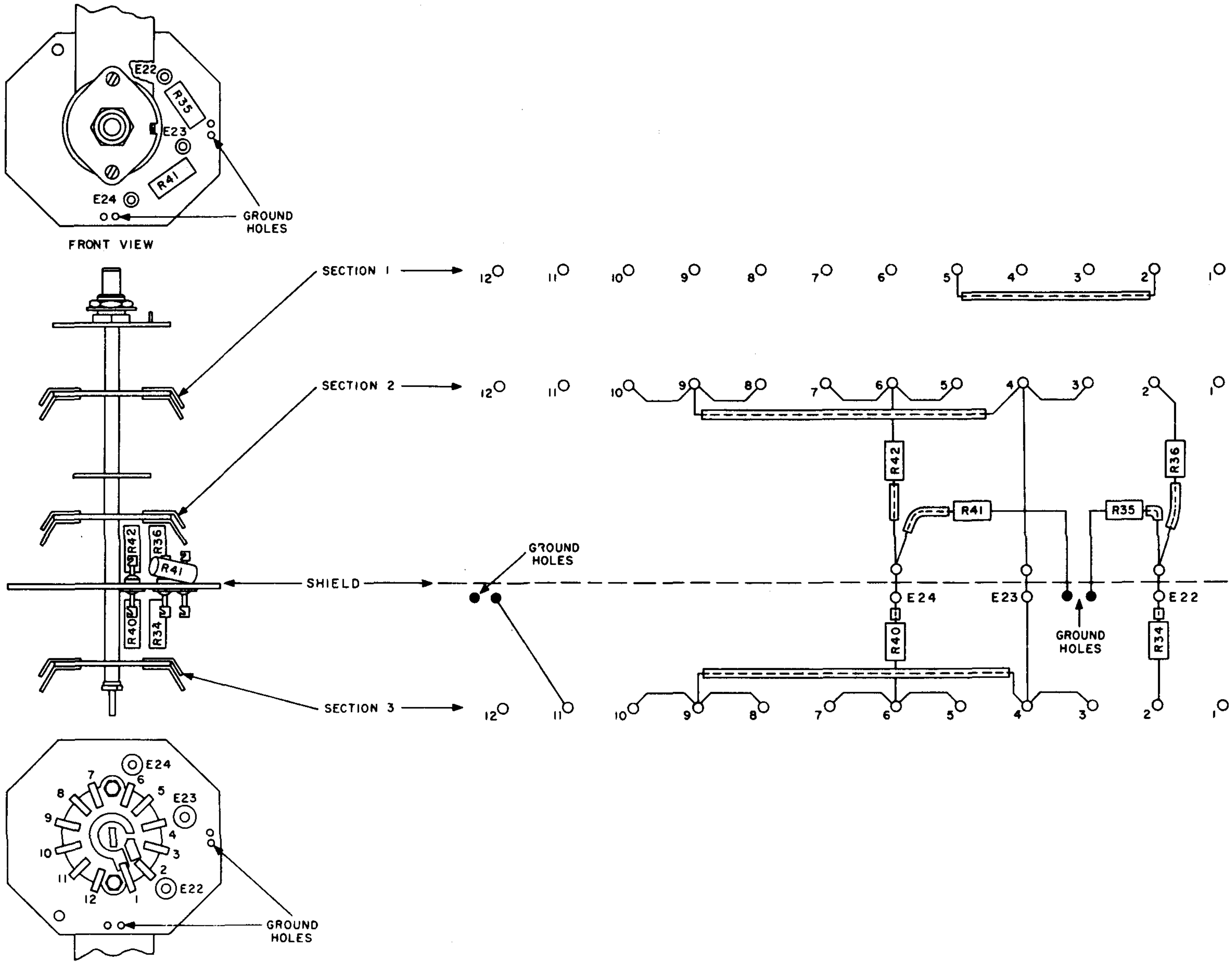

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Figure 80. MEASURE SELECTIVE switch S3 (part of TEST PANEL), circuit element location and wiring diagram.

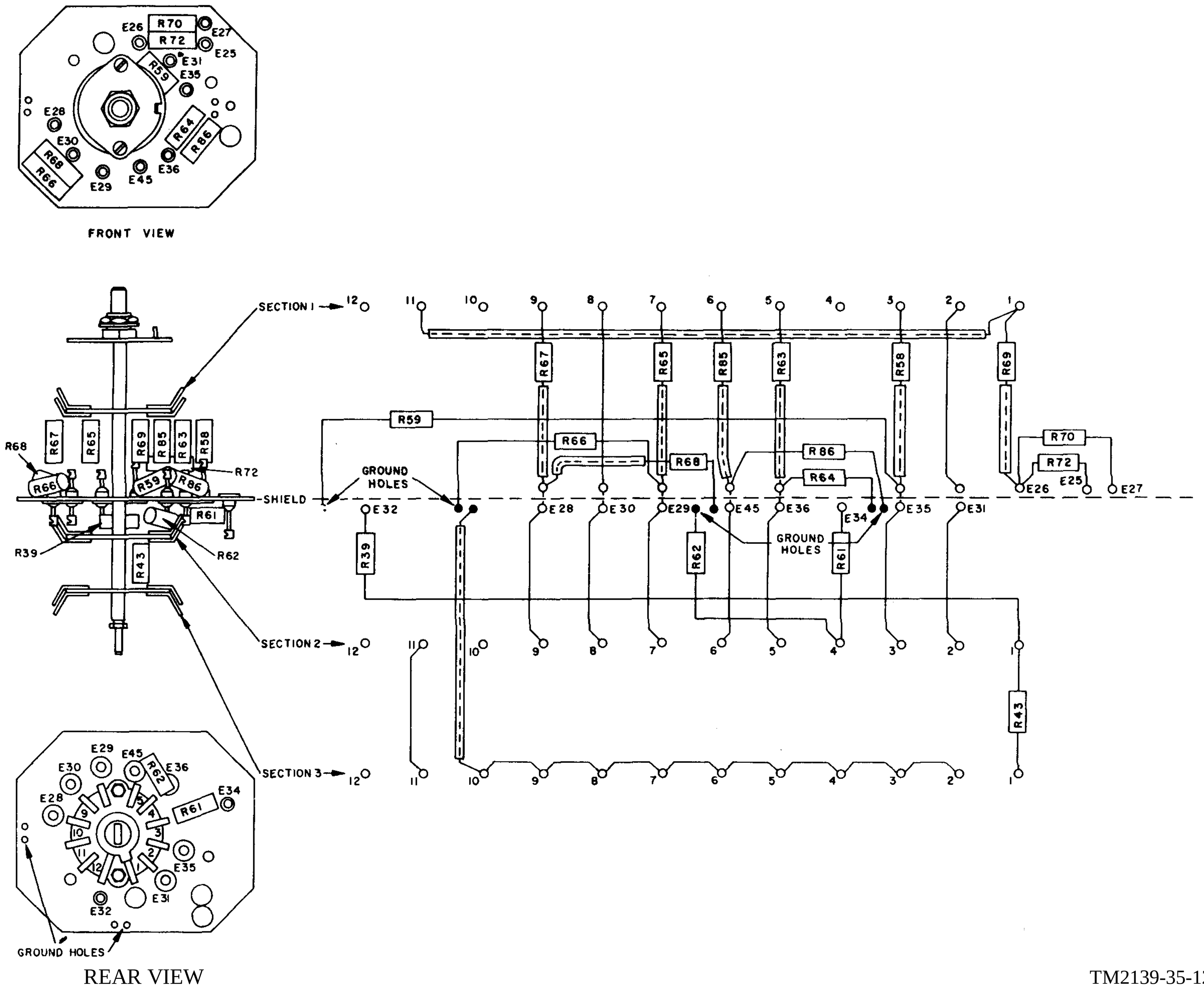
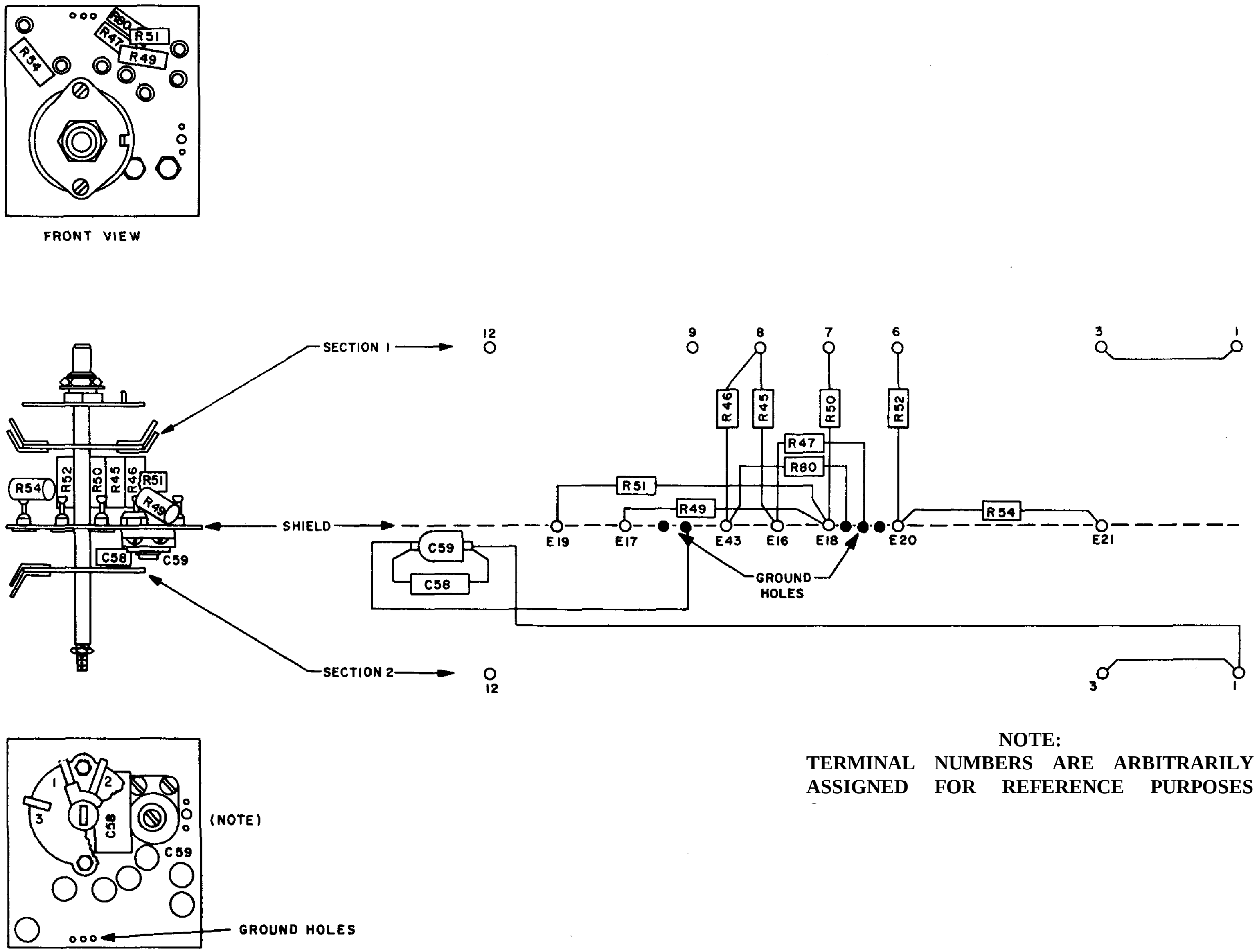


Figure 81. MEASURE NON-SELECTIVE switch S4 (part of TEST PANEL), circuit element location and wiring diagram.



REAR VIEW

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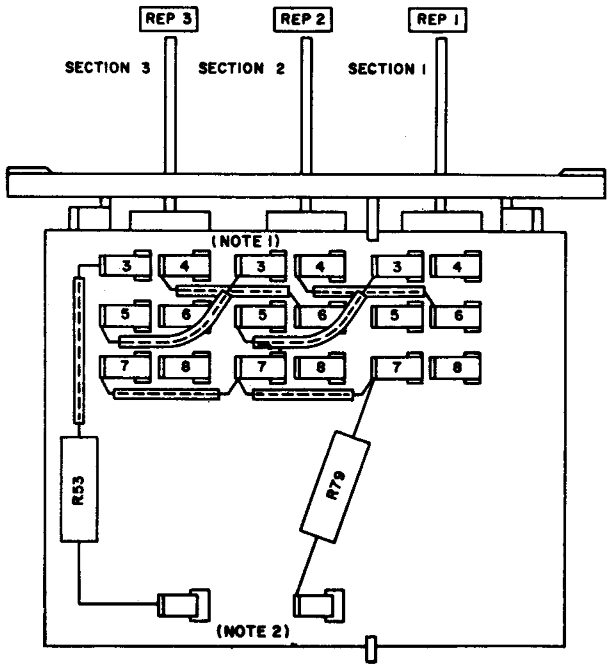
Figure 82. SEND switch S5 (part of TEST PANEL), circuit element location and wiring diagram.



NOTES

1 TERMINAL NUMBERS ARE ARBITRARILY ASSIGNED FOR REFERENCE PURPOSES ONLY.
2 TERMINALS THAT DO NOT BEAR REFERENCE NUMBERS ARE USED AS TIE POINTS

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Figure 83. FAULT TEST switch S6 (part of TEST PANEL), circuit element location and wiring diagram.

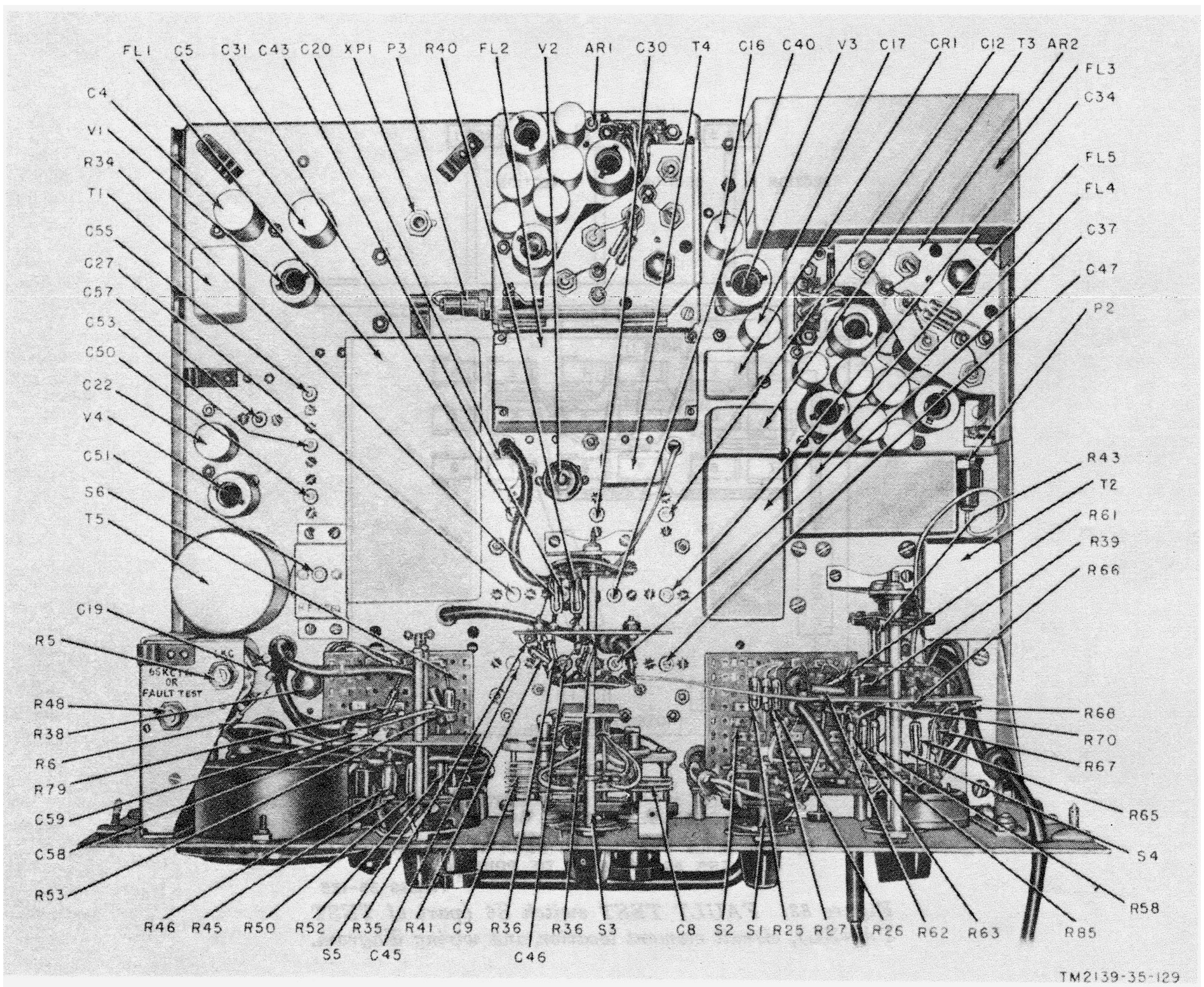


Figure 84. Telephone Test Set TS-760/TCC-7, top view of chassis, covers removed, parts location.

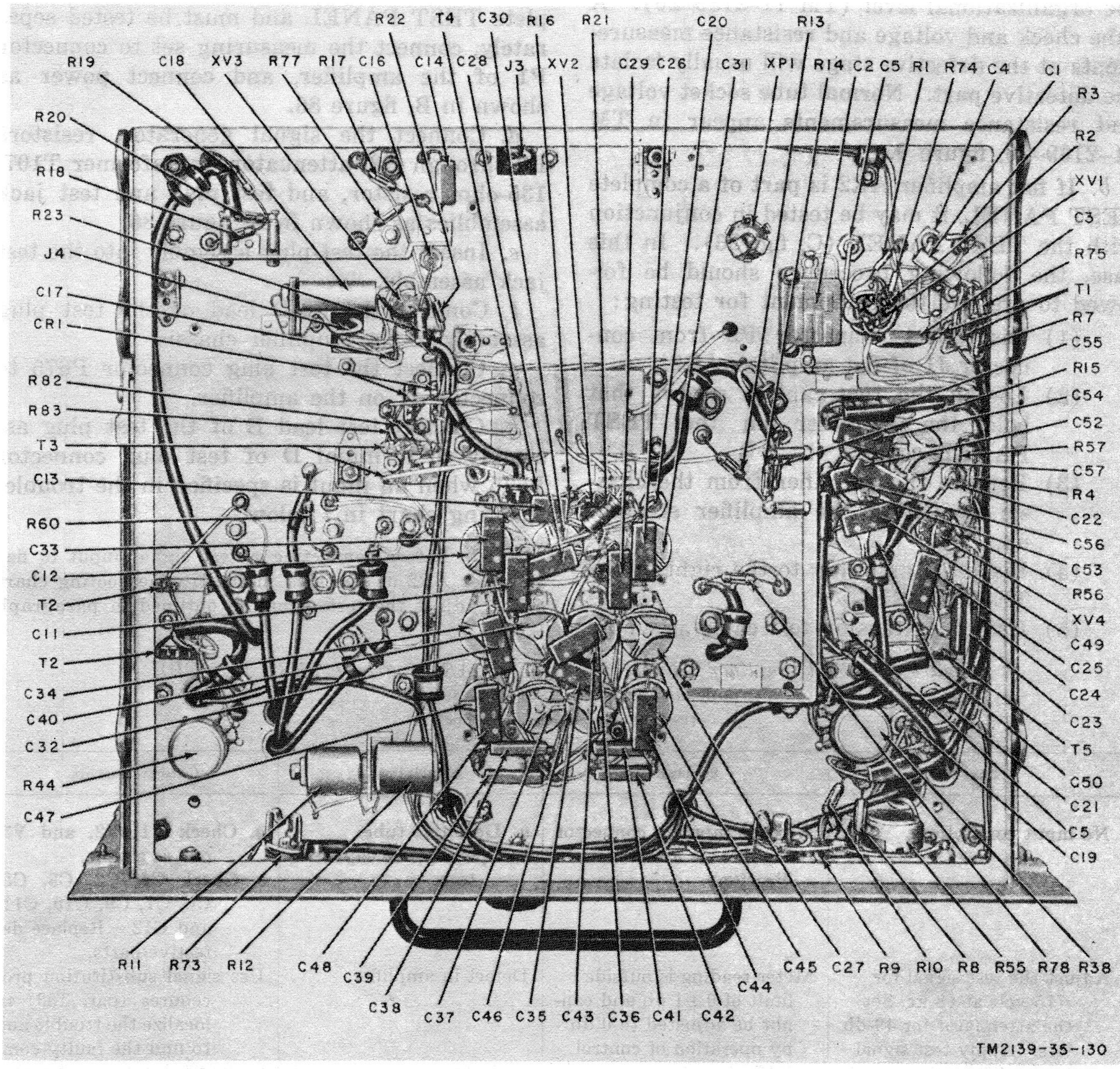


Figure 85. Telephone Test Set TS-760/TCC-7, bottom view of chassis, cover removed, parts location.

123. Flat Amplifier AR2 Troubleshooting Chart

a. The following troubleshooting chart is supplied to aid in locating trouble in flat amplifier AR2. The chart lists the symptoms that may be reported on the equipment repair tag or observed performing at the organizational level (TM 11-2139-20). A tube check and voltage and resistance measurements at the defective stage will usually isolate the defective part. Normal tube socket voltage and resistance measurements appear in TM 11-2139-20, figure 9.

b. If flat amplifier AR2 is part of a complete TEST PANEL, it may be tested in conjunction with the TEST PANEL (C, fig. 86). In this case, the following procedure should be followed to prepare the equipment or testing:

(1) Disconnect connector P2 from connector J1 of flat amplifier AR2.

(2) Loosen the two captive screws that hold the amplifier on the TEST PANEL chassis.

(3) Remove the amplifier from the chassis by lifting the amplifier straight up.

(4) Place the amplifier to the right of the TEST PANEL.

(5) Use the extension test cable assembly to connect connector J4 on the TEST PANEL to connector P1 on the amplifier.

(6) Connect power to the TEST PANEL as shown in figure 86.

(7) Operate the MEASURE switch to the TRANSMISSION position.

c. If flat amplifier AR2 is not part of a complete TEST PANEL and must be tested separately, connect the measuring set to Connector P1 of the amplifier, and connect power as shown in B. figure 86.

d. Connect the signal generator, resistors R6 through R8, attenuator, transformer T107, 135-ohm resistor, and test plug and test jack assemblies as shown in A, figure 86.

e. Insert the test plug assembly into the test jack assembly.

f . Connect the GRD lead of the test plug assembly to the amplifier chassis.

g. Connect the test plug connector P675 to connector J1 on the amplifier.

h. Connect test lead B of the test plug assembly to terminal D of test plug connector P675 when an input is specified in the troubleshooting chart in *i* below.

Note. Before connecting a test signal input to flat amplifier AR2 as specified in the troubleshooting chart below, adjust the test signal as outlined in paragraph 120*d*.

Figure 86. Flat amplifier AR2 or IF amplifier AR1 (part of TEST PANEL), operational and final test setup.
(Contained in separate envelope)

Test	Symptom	Probable trouble	Corrective measures
1. No input connection.	With no input to connector J1, there is a meter indication.	*a*. Defective tube. *b*. Open bypass capacitors.	*a*. Check V1, V2, and V3, one at a time. *b*. Check C1, C2, C3, C5, C6, C7, C9, C10, C11, and C12. Replace defective parts.
2. Adjust the test signal for 775 volt at 68 kc. Set the attenuator for 49-db loss. Apply test signal to amplifier.	Meter reading is outside limit of 0 ±1 db and cannot be adjusted to 0 db by operation of control R17.	Defect in amplifier.	Use signal substitution procedures (par. 133) to localize the trouble and find the faulty component.

124. IF Amplifier AR1 Troubleshooting Chart

a. The following troubleshooting chart is supplied to aid in locating trouble in IF amplifier AR1. The chart lists the symptoms that may be reported on the equipment repair tag or observed when performing maintenance at the organizational level (TM 11-2139-20). A tube check and voltage and resistance measurements at the defective stage will usually isolate the defective part. Normal tube socket voltage and resistance measurements appear in TM 11-2139-20, figure 8.

b. If IF amplifier AR1 is part of a complete TEST PANEL, it may be tested in conjunction with the TEST PANEL (C, fig. 86). In this case, use the procedure given in paragraph 123*b* to prepare the equipment for testing.

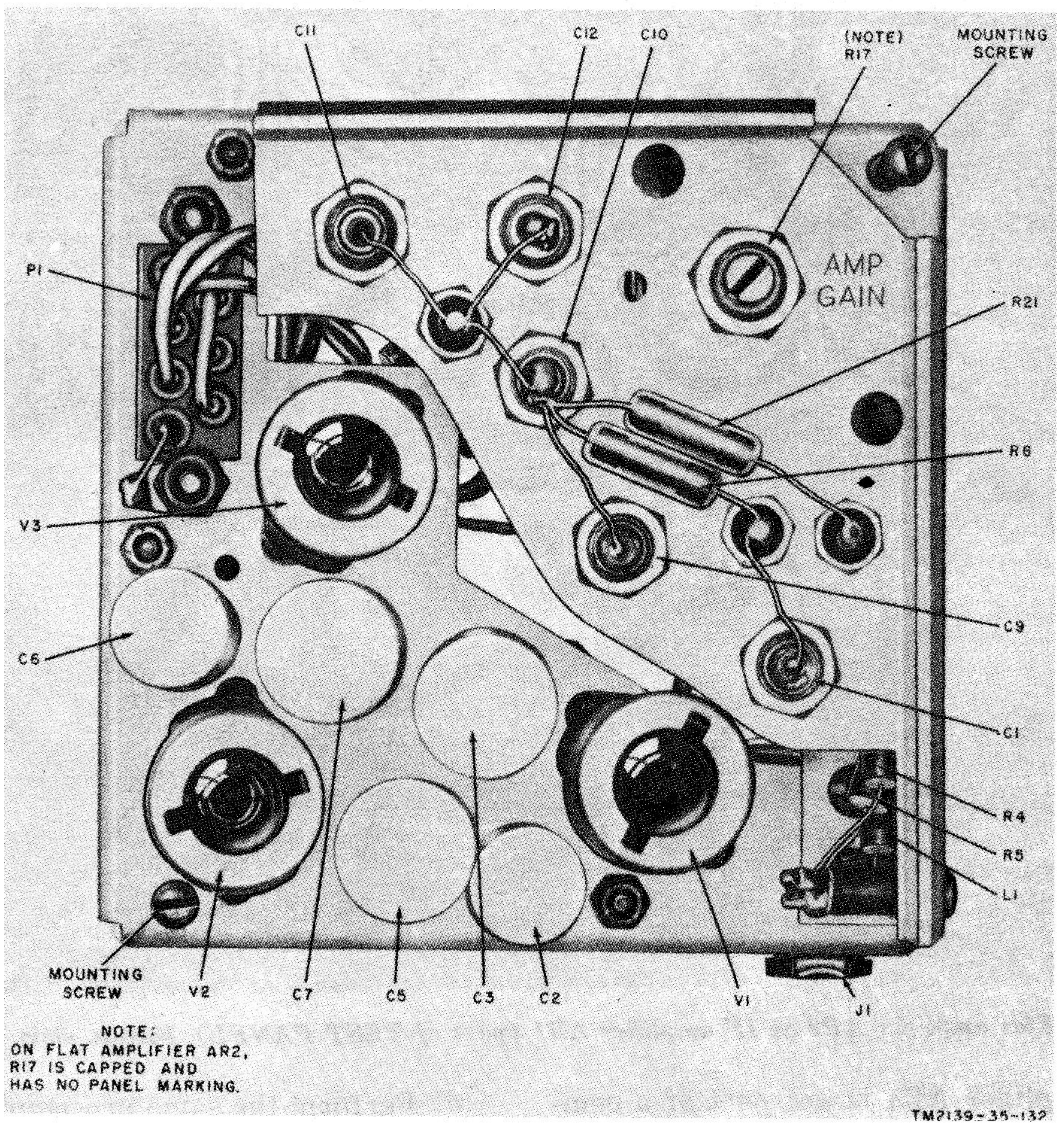


Figure 87. Flat amplifier AR2 or IF amplifier AR1 (part of TEST PANEL), top view

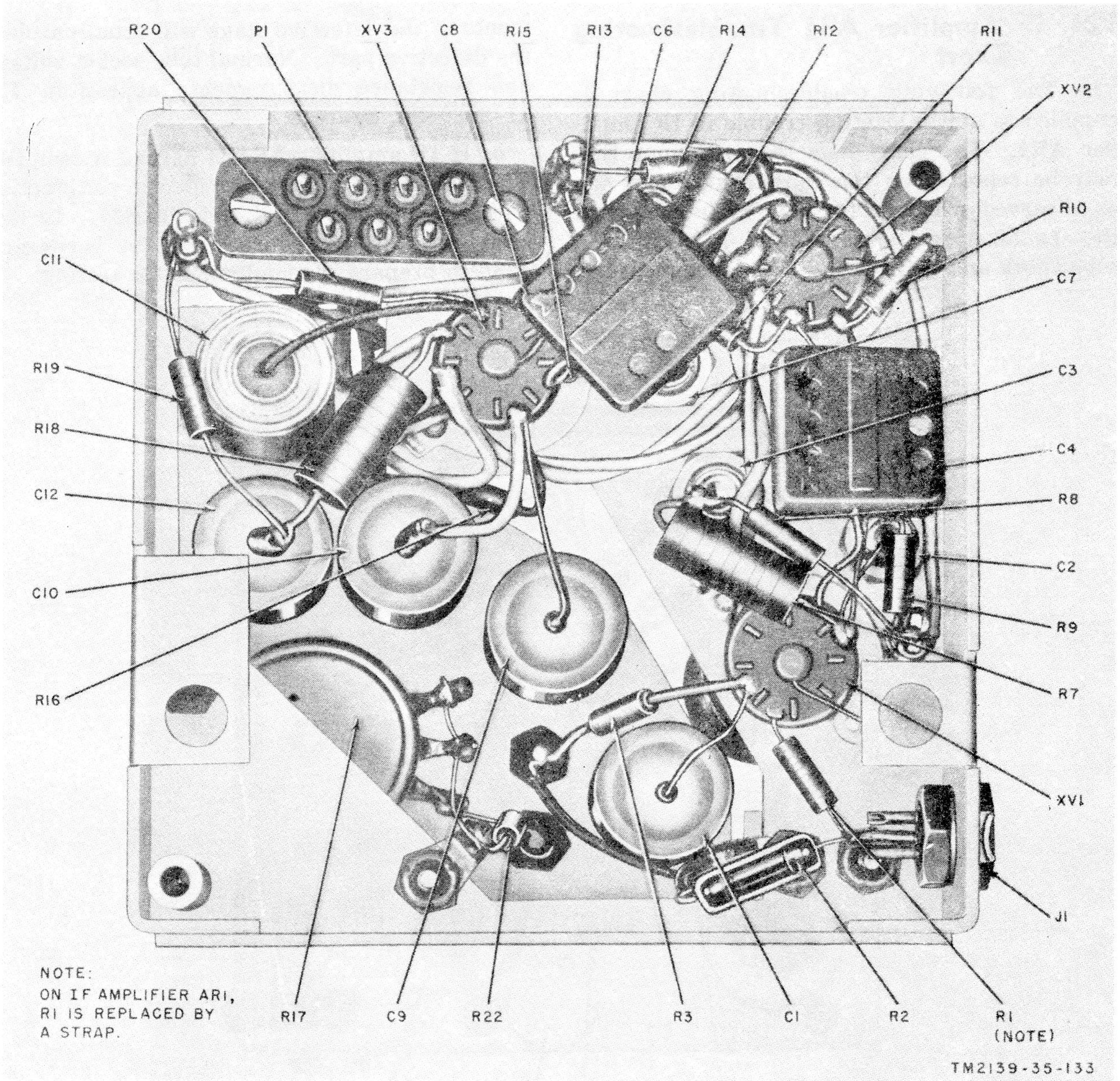


Figure 88. Flat amplifier AR2 or IF amplifier AR1 (part of TEST PANEL), bottom view, parts location.

c. If IF amplifier AR1 is not part of a complete TEST PANEL and must be tested separately, use the procedure given in paragraph 123*c* to prepare the equipment for testing.

d. Perform the same procedures as described in paragraph 123*d* through *h*.

Note. Before connecting a test signal input to IF amplifier AR1, as specified in the troubleshooting chart (*e* below), adjust the test signal source as outlined in paragraph 120*d*.

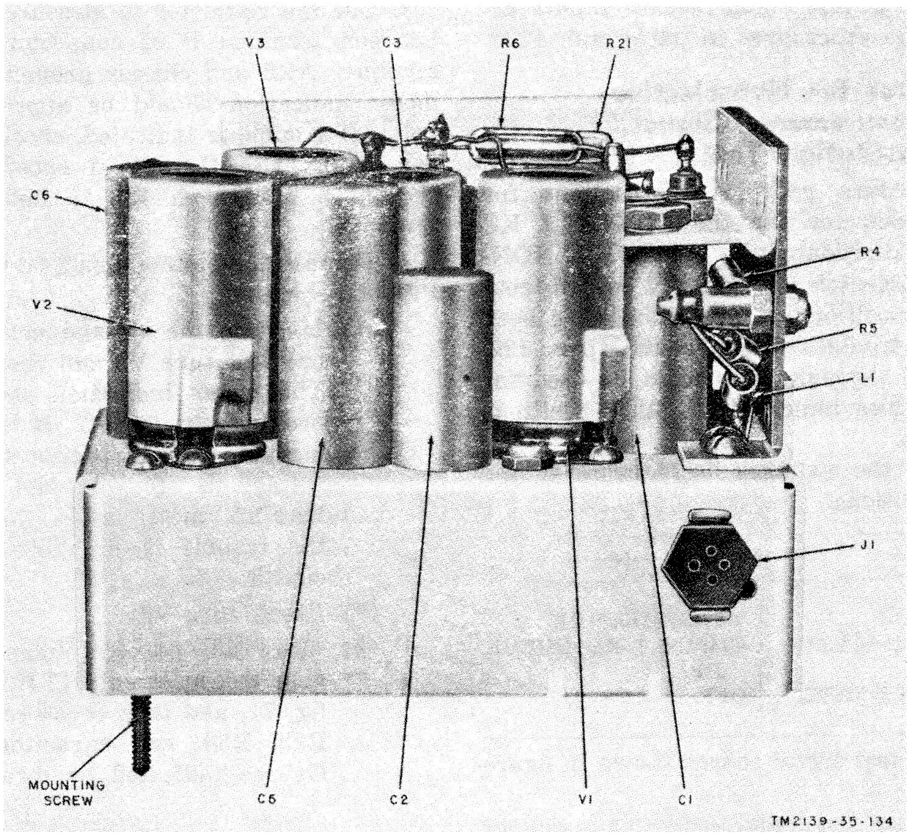


Figure 89. Flat amplifier AR2 or IF amplifier AR1 (part of TEST PANEL), side view, parts location.

Test	Symptom	Probable trouble	Corrective measures
1. No input connection.......	With no input to connector J1, there is a meter indication.	*c*. Defective tube.	*a*. Check V1, V2, and V3, one at a time. Replace defective tube.
		b. Open bypass capacitor.	*b*. Check C1, C2, C3, C5, C6, C7, C9, C10, C11, and C12. Replace defective part.
2. Adjust the test signal for 0.775 volt at 68 kc. Set the attenuator for 51-db loss. Apply test signal to amplifier.	Meter reading is outside limit of 0 ±1 db and cannot be adjusted to 0 db by operation of control R17.	Defect in amplifier.	Use signal substitution procedures (par. 134) to localize the trouble and find the defective component.

125. TEST PANEL Signal Substitution Setup

Use the following procedures to set up the TEST PANEL for the signal substitution

a. Arrange the TEST PANEL and the test signal source as shown in figure 78.

b. The measuring set and the test arrangement shown in figure 86 must be provided when complete TEST PANEL is not available for testing flat amplifier AR2 and IF amplifier AR1.

Note. Except where definite limits are given, the test values given in these procedures may vary somewhat from TEST PANEL to TEST PANEL. Sound judgment should be used in deciding when a trouble is indicated. After troubles have been cleared in a TEST PANEL, it is recommended the TEST PANEL be realigned completely as instructed in paragraph 167.

c. Adjust the test signal source inputs according to the procedures in paragraph 120*d*.

126. Detector for Nonselective Measurements, Signal Substitution Test

This procedure provides instructions for testing the detector for the CHECK 1 KC CHECK HF position of the MEASURE NONSELECTIVE switch (fig. 29). When all troubles in this position of the switch have been cleared, the troubleshooting chart (par. 122, symptoms 18 through 25) should be used for locating troubles indicated on other positions of the switch.

a. Operate the switches listed below to the indicated positions.

Switch	Position
MEASURE-------------------	TRANSMISSION.
MEASURE NON-SELECTIVE.	CHECK 1 KC CHECK HF.
MEASURE SELECTIVE--	OFF.

b. Use the test signal source shown in figure 78.

(1) Adjust the signal generator to deliver 68 kc ±100 cps as measured with the frequency meter.

(2) With no connection to the test jack, and with the attenuator set for 0 db, adjust the signal generator output for an indication of .775 volt as measured on the voltmeter.

c. Set the attenuator for a 46-db loss and insert the measure plug of the TEST PANEL into the test jack assembly.

d. Measure the voltage between terminal 6 of transformer T2 and chassis ground with the voltmeter. The voltmeter indication should be .00275 volt. If trouble is indicated, check transformer T2.

e. Measure the voltage between terminal D of connector P2 and chassis ground with the voltmeter. The indication on the voltmeter should be .00275 volt. If trouble is indicated, check the wiring from terminal 6 of transformer T2, through the ATTENUATOR and MEASURE NON-SELECTIVE switches to connector P2.

f. Use the voltmeter to measure the voltage between terminal B of connector P1 of flat amplifier AR2 and chassis ground. The voltmeter indication should be approximately .9 volt. If trouble is indicated, check flat amplifier AR2. Use the signal substitution procedure in paragraph 133 to find the faulty component.

g. Remove the bottom shield from the TEST PANEL chassis.

(1) Measure the voltage between terminal 3 of tube V3 and chassis ground. The meter indication should be approximately .9 volt. If trouble is indicated, check capacitor C18. If the voltage is .9 volt and the TEST PANEL meter gives no indication, the trouble is probably in rectifier circuit. V3.

(2) Check tube V3.

(3) Make tube-socket voltage and resistance measurements (TM 11-2139-20, fig. 7), and then check resistors R22, R23, R84, and capacitors C16 and C17 as indicated by measurements.

Note. The adjustment of potentiometer R17 is extremely important. Before making the adjustment, check to see that the input signal as set up in *b* and *c* above has not changed.

h. Remove the locking nut from potentiometer R17 on flat amplifier AR2 and adjust R17 for a 0-db indication on the TEST PANEL meter. Replace the locking nut after the adjustment has been made.

127. Detector and Carrier Oscillator Signal Substitution Test

The procedure outlined in a through h below provides information for testing the carrier oscillator in all positions of the MEASURE SELECTIVE switch.

a. Operate the MEASURE SELECTIVE switch to the OFF position. Disconnect the measure plug. Operate the COARSE TUNE and FINE TUNE controls to their midpositions. Remove the bottom shield plate from the TEST PANEL chassis.

b. Calibrate the audio level meter (par. 79) and set the controls as indicated in the chart below:

Switch	Position
INJECTOR-------------------	REC.
METER-----------------------	REC.
ATTENUATOR DB--------	0.
SELECTOR-----------------	VM-UNBAL 600 Ω BRG.

c. Connect the G binding post of the audio level meter to the TEST PANEL ground, and the unmarked binding post to terminal 2 of transformer T3. Adjust the audio level meter for maximum response in the vicinity of 304 kc. The reading on the audio level meter should be between -4 db and +4 db. If it is, note the reading and proceed to *f* below. If it is out of these limits, continue with *d* below.

d. Remove the small shield on the underside of the chassis. Measure the voltage from terminal 5 of carrier oscillator tube V2 to chassis ground with the voltmeter. The meter indication should be between 50 and 100 volts. (This reading may vary considerably with different meters as the frequency being measured is out of the normal frequency range of the meter.) If the meter indication appears reasonable, proceed to e below. If the meter indication is out of limits, or if there is no indication, check tube V2. Next, make tube socket voltage and resistance measurements (TM 11-2139-20, fig. 7) and check transformer T4, resistors R16, R21, and capacitors C7 through C11, C20, C12, and C13 as indicated by the measurements. To check some of these parts, remove the shield on the upper side of the chassis over the MEASURE SELECTIVE switch.

e. Replace the shields removed in *d* above and repeat the measurement described in *c* above. If the reading is still out of the limits, check resistors R82 and R83, and the output winding of transformer T4 (terminal 2 to terminal 1). Other possible sources of trouble are a defective modulator CR1 and a short to ground on the modulator side of transformer T3.

f. When the measurement of *c* above falls within the limits given, repeat the measurement for each of the other positions of the MEASURE SELECTIVE switch. As an aid in tuning the audio level meter, the frequencies for the various switch positions are given in the chart below. The audio level meter indications should be approximately the same for all positions of the MEASURE SELECTIVE switch (-4 db to +4 db). If there is no meter indication for any one switch position, a leaky or shorted capacitor associated with that switch position is the probable source of trouble. The chart also lists the capacitors that are associated with each switch position. To test these capacitors, remove the small shield on the under side of the chassis. The wiring through section 1 of the MEASURE SELECTIVE switch also should be checked. To do this, remove the shielding on the upper side of the chassis over the MEASURE SELECTIVE switch. When all switch positions have been cleared of trouble, remove the connections from the audio level meter to the TEST PANEL and replace any shields removed during test.

MEASURE SELECTIVE switch position	Audio level meter frequency (kc)	Associated capacitors	
		Fixed	Variable
CHECK GAIN----------	262	C35, C36--	C37.
12KC---------------------	206	C28, C29--	C30,C31.
28KC---------------------	22	C32, C33--	C34.
68KC---------------------	262	C35, C36--	C37.
65KC---------------------	259	C26---------	C27.
37KC---------------------	231	C38, C39--	C40.
67KC---------------------	261	C41, C42--	C43.
83KC---------------------	277	C44---------	C45.
99KC---------------------	293	--------------	C46.
62KC---------------------	256	C48---------	C47.

g. Connect the frequency meter between terminal 2 of transformer T3 and the TEST PANEL chassis ground. Operate the FINE TUNE control to its mid-range position and the MEASURE SELECTIVE switch to the OFF position. Adjust the COARSE TUNE control for a frequency reading of 304 kc ±100 cycles on the frequency meter. If this cannot be done, or if the COARSE TUNE control is close to either end of its range, set the COARSE TUNE control to its midrange and adjust capacitor C12 to meet the frequency requirement. If this cannot be done, check capacitors C7 through C12. To test these capacitors, remove the small shield on the underside of the chassis and the shield on the upper side of the chassis, over the MEASURE SELECTIVE switch.

Replace these shields after the trouble is cleared and before the final frequency adjustment is made.

Note. During the test below, do not disturb the setting of the COARSE TUNE control as adjusted in *g* above.

h. At each position of the MEASURE SELECTIVE switch, adjust the FINE TUNE control for a frequency meter indication of within 50 cycles of the frequencies listed in the chart (*f* above). If this cannot be done for any position of the switch, or if the setting of the FINE TUNE control is close to either end of its range, operate the FINE TUNE control to its mid-position and adjust the variable capacitor listed in the chart in *f* above associated with the defective switch position. If this does not correct the trouble, check the capacitors listed in the chart, which are associated with the defective switch position. To test these capacitors, remove the small shield on the underside of the chassis. Replace this shield after the trouble has been cleared and before the final frequency adjustment is made.

128. Detector Input Circuit Signal Substitution Test Selective Measurement

a. This procedure checks the detector input circuit for the CHECK GAIN and the GRP PANEL 62KC positions of the MEASURE SELECTIVE switch. When all troubles in these positions have been cleared, the troubleshooting chart (par. 122, symptoms 28 through 35) should be used for troubles on other positions of the switch.

(1) Remove tubes V1, V2, and V4 to reduce cross talk from the oscillator circuits during these measurements.

(2) Remove the bottom shield from the TEST PANEL chassis.

(3) Connect the test equipment as shown in figure 78.

(4) Adjust the frequency of the signal generator to 62 kc ± 50 cycles as measured with the frequency meter.

(5) With no connection to the test jack and with the attenuator set for 0 db, adjust the signal generator output for an indication of .5 volt on the voltmeter.

(6) Insert the TEST PANEL measure plug into the test jack.

(7) Operate the MEASURE SELECTIVE switch to the CHECK GAIN position, the MEASURE NONSELECTIVE switch to the OFF position, and the GAIN control to its approximate mid-position.

(8) Measure the voltages between chassis ground and the points indicated in the chart in *b* below.

b. The chart below lists the approximate voltage indications and the corrective measures to be applied.

Measuring point	Approximate voltage (ac)	Corrective measures
Terminal 4 of transformer T2----------------------	0.5	Check measure plug connections to T2.
Terminal 6 of transformer T2----------------------	.35	Check T2. Check wiring from T2 to R69 through switches S2 and S4. Repair defective wiring. Check R69.
Terminal E25---	.105*	Check wiring through switch S3 from E25 to R36. Check R69 through R72. Check R36, R35, and R34. Replace defective parts.
Terminal 5 of transformer T3----------------------	.09	Check R34 through r36. Check wiring through switch S3 from R34 to terminal 5 of T3. Check for short from terminal 5 of T3 to chassis ground.
Terminal 1 of T3 with terminal 2 grounded------	.0066	Check T3 and CR1. Replace defective parts.
Terminal 4 of T3 with terminal 2 grounded------	.0066	Check T3 and CR1.

c. Operate the MEASURE SELECTIVE switch to the GRP PANEL 62KC position. Leave the GAIN control adjustment as set in *a* (7) above. Make the measurements indicated in the following chart:

Measuring point	Approximate voltage (ac)	Corrective measures
Terminal 1 of filter FL1-----------------	.066	Check wiring through switch S3 from E25 to terminal 1 of FL1. Check R78. Check for a short circuit from terminal 1 of FL1 to chassis ground. Replace defective parts.
Terminal 3 of filter FL1-----------------	.048	Check FL1, R13 through R15. Replace defective parts
Terminal 5 of transformer T3----------	.034	Check R13 through R15 and wiring from R15 through switch S3 to terminal T3.

129. Modulator Signal Substitution Test

a. This procedure outlines the tests necessary to check the operation of modulator CRT. It is assumed that any troubles in the carrier oscillator and the input circuit have been cleared as indicated in paragraphs 127 and 128.

(1) Do NOT change the GAIN control setting as adjusted in paragraph 128*b*.

(2) Replace carrier oscillator tube V2.

(3) Operate the MEASURE SELECTIVE switch to the GRP PANEL 62KC position.

(4) Remove tube V1 from IF amplifier AR1 (fig. 87).

(5) Connect the test signal source as shown in figure 78. Insert the measure plug into the test jack assembly.

(6) Adjust the output of the signal generator for 62 kc ±50 cycles as measured with the frequency meter.

(7) Set the attenuator for 0 db.

(8) Adjust the signal generator output for a reading of .775 volt on the voltmeter.

(9) Reset the attenuator for 4-db loss.

b. Calibrate the audio level meter and operate its switches as given in the chart below.

Switch	Position
INJECTOR-------------------	REC.
METER-----------------------	REC.
ATTENUATOR DB--------	60.
SELECTOR------------------	VM-UNBAL 600 Ω BRG.

(1) Connect the G binding post of the audio level meter to the TEST PANEL chassis ground.

(2) Connect the unmarked binding post to terminal 4 of 194-kc crystal filter FL2.

(3) Operate the frequency dial of the audio level meter to 194 kc.

(4) Very slowly operate the FINE TUNE control on the TEST PANEL and look for a response on the audio level meter. It may be necessary to repeat this adjustment several times, each time changing the frequency setting of the audio level meter slightly over the range of 190 kc to 198 kc in steps of approximately .5 kc

c. If an indication can be obtained, carefully adjust the FINE TUNE control and the frequency dial for a maximum meter indication. The indication should be approximately -60 db.

(1) If there is no indication or if trouble is suspected, check modulator CR1.
(2) If the indication appears to be satisfactory, make the same measurement at terminal 1 of filter FL2. The meter indication should be approximately the same as that for *c* above.
(3) If the indication is out of limits, check modulator CRT. When all troubles are cleared in the modulator, remove the measure plug from the test jack assembly and replace tube V1 of the IF amplifier.

130. IF Circuit Signal Substitution Test

a. This procedure outlines the tests necessary to check the operation of the 194-kc IF circuit up to the input of flat amplifier AR2 for all selective measurements. It is assumed that flat amplifier AR2 and the rectifier circuits are operating properly. Connect the test equipment as shown in figure 78.

(1) Adjust the frequency of the signal generator to 194 kc ±200 cps as measured with the frequency meter.
(2) Set the attenuator for a 41-db loss.
(3) Remove connector P2 from connector J1 on flat amplifier AR2.
(4) Connect test plug connector P675 to connector J1 on flat amplifier AR2.
(5) Insert the test plug assembly into the test jack assembly and connect the GRD lead to the TEST PANEL chassis. Connect test lead A to terminal D on test plug connector P675.
(6) Operate the MEASURE switch to the TRANSMISSION position, and adjust the signal generator output for a 0-db reading on the TEST PANEL meter.
(7) Remove the test plug assembly from the test jack.
(8) Set the attenuator for 0 db.
(9) Note carefully the indication on the voltmeter connected across the 135 ohm resistor. *This is the reference voltage.* It should be maintained at this value by readjusting the signal generator output as necessary during the remainder of this procedure. The indication will be .4 to .8 volt, but may vary considerably with different meters as the frequency being measured is outside the normal frequency range of the voltmeter.

b. After the reference voltage has been determined, reset the attenuator for a 41-db loss and reconnect the test plug assembly to the test jack assembly.

(1) Remove the test plug assembly connections and test plug connector P675 from connector J1 of flat amplifier AR2.
(2) Reconnect P2 to connector J1.
(3) Operate the MEASURE NONSELECTIVE switch to the GRP PANEL 62KC position.
(4) Disconnect resistor R18 from terminal 3 of filter FL3.
(5) Connect test lead A of the test plug assembly (fig. 78) to the open end of resistor R18 and the GRD lead to the chassis.
(6) Adjust the attenuator for a meter reading as close to 0 db as possible. The attenuator setting should be approximately 34 db.
(7) If trouble is indicated, check resistors R18 through R20, and the wiring through switch S4 to connector P2 at flat amplifier AR2 input (fig. 81).

c. If no trouble is indicated, or after the trouble is found and cleared, proceed as follows:

(1) Operate the MEASURE NONSELECTIVE switch to the OFF position.
(2) Change the attenuator setting to -3 db.
(3) Remove the locking nut from potentiometer R44 and adjust R44 for a 0-db meter indication. The adjustment range should be at least ±2 db. If trouble is indicated, check R43, R39, R44, and the wiring through switch S4.
(5) Remove the test plug assembly connections, reconnect resistor R18 to terminal 3 of filter FL3, and replace the locking nut on potentiometer R44.

d. Additional checks to be made of the IF circuit are as follows:

(1) Disconnect resistor R77 from terminal 1 of filter FL3.

(2) Operate the MEASURE NON-SELECTIVE switch to the GRP PANEL 62KC position.
(3) Change the attenuator setting to-31 db.
(4) Connect test lead A of the test plug assembly to terminal 1 of filter FL3 and the GRD lead to the TEST PANEL chassis. The meter indication should be approximately 0 db. If it is not, check filter FL3. Remove the test plug assembly connections and reconnect resistor R77 to terminal 1 of filter FL3.
(5) Disconnect capacitor C14 from terminal E37.
(6) Connect test lead A of the test plug assembly to terminal E37 and the GRD lead to the TEST PANEL chassis.
(7) Change the attenuator setting to -22 db.
(8) The meter indication should be approximately 0 db. If it is not, check resistors R17 and R77.
(9) Remove the test plug assembly connections and reconnect capacitor C14 to terminal E37.

e. To check the adjustment of the AMP GAIN control, follow the procedure outlined in (1) through (8) below.

(1) Replace the bottom shield on the TEST PANEL chassis.
(2) Change the attenuator setting to -61 db.
(3) Operate the MEASURE NONSELECTIVE switch to the OFF position.
(4) Remove connector P3 from connector J1 of IF amplifier AR1.
(5) Connect test lead A of the test plug assembly to terminal D of test plug connector P675 and the GRD lead to the TEST PANEL chassis.
(6) Adjust AMP GAIN control R17 on IF amplifier AR1 for a meter indication of 0 db.
(7) If this cannot be done, test IF amplifier AR1 as instructed in paragraph 134.
(8) Remove the test plug assembly connections and plug connector P675 from connector J1 on IF amplifier AR1 and reconnect P3 to connector J1.

f. If the results of the test in *e* above and the tests in paragraph 134 are satisfactory, and trouble still exists in the circuit for selective measurements, the 194-kc crystal filter is probably faulty. Check filter FL2.

g. After all troubles have been cleared in the selective measurements circuit, realign the circuit as instructed in paragraph 167*a* through *d*.

131. 1-kc Oscillator Signal Substitution Test

a. The procedures below are for testing the output power and the frequency of the 1-kc oscillator circuit.

(1) Replace tube V1 (par. 128*a*(1)).
(2) Remove the bottom shield from the TEST PANEL chassis.
(3) Operate the 1 KC control to its extreme clockwise position.
(4) Use the voltmeter to measure the voltage from terminal 5 of tube V1 to chassis ground. The meter indication should exceed 50 volts.
(5) If the meter indication is less than 50 volts, check tube V1. Make tube socket voltage and resistance measurements (TM 11-2139-20, fig. 7). Check transformer T1, resistors R1 through R5 and R74, and capacitors C1 through C5 as indicated by the voltage and resistance measurements.

b. Measure the voltage from terminal 7 of T1 to chassis ground, and from terminal 6 of T1 to chassis ground. These voltages should be equal to, or greater than .4 volt. If trouble is indicated, check transformer T1, and resistors R7 and R75; check for a short between E3 or E4 and ground.

c. Operate the switches on the TEST PANEL to the positions given in the chart below.

Switch	Position
MEASURE	TRANSMISSION.
MEASURE SELECTIVE	OFF.
MEASURE NONSELECTIVE	CHECK 1 KC CHECK HF.

d. Insert the measure plug into the CHECK 1 KC jack. If the circuit for selective measurements has been properly adjusted (pars. 130 and 167*a-d*), the 1 KC control can be adjusted to obtain a TEST PANEL meter indication of 0 db indication cannot be obtained, check resistors R8 through R10. If the operation of the 1 KC control does not vary the reading, check resistors R3 through R6.

e. After making the adjustments described in *c* above, measure the voltage from terminal S, F, P, or C of the power test cable assembly (fig. 78) and from E3 or E4 to the chassis. Each meter indication should be approximately .5 volt. If trouble is indicated, check resistors R8 through R10, and the wiring to connector J2.

f. Check the frequency of the 1-kc oscillator by connecting the frequency meter to terminal E3 and the chassis. If the indication on the frequency meter is not 1 kc ±20 cps, check transformer T1 and capacitors C2 and C3.

132. HF Oscillator Signal Substitution Test

The procedures in this paragraph are for testing the output power of the hf oscillator with the SEND switch in the CHECK GAIN CHECK HF position. When all troubles for this switch position have been cleared, use the troubleshooting chart (par. 122, symptoms 26 and 39-47) for any other troubles in the hf oscillator circuit.

a. Replace tube V4 (par. 128*a*(1)). Operate the SEND switch to the CHECK GAIN CHECK HE position. Measure the voltages between the points specified in the chart below and the chassis. The position of the HF control should have very little effect on the readings. If trouble is indicated, check tube V4. Then make tube socket voltage and resistance measurements (TM 11-2139-20, fig. 7). Check resistors R56 and R57, transformer T5, and capacitors C22 through C25 and C49 through C51 as indicated by voltage and resistance measurements.

Measuring point on transformer T5	Approximately reading (ac volts)
Terminal 3----------------------	95
Terminal 2----------------------	65
Terminal 6----------------------	1.95
Terminal 5-----------------------	6.8

b. Use the voltmeter to measure the voltage between terminal 8 of section 1 of the SEND switch and the chassis. Adjust the HF control for an indication of 1.035 volts. If this indication cannot be obtained, check resistors R52 through R55, R45 through R47, and R80.

c. Connect the voltmeter between the tip and ring (ground) of the CHECK HF jack. The voltmeter indication should be approximately .004 volt. If it is not .004 volt, check resistors, R45 through R47, and R80.

d. If any of the parts have been changed or disturbed during the tests above, realine the hf oscillator (par. 167*e*).

133. Flat Amplifier AR2 or IF Amplifier AR1 Signal Substitution Test

a. If the amplifier is part of a complete TEST PANEL (C, fig. 86), use the procedure in (1) through (3) below to prepare the amplifier for testing, and perform the procedures in *c* through *g* below. Use the test signal source arrangement as shown in A, figure 86.

(1) Disconnect connector P2 from connector J1 of the amplifier and loosen the two captive screws that hold the amplifier on the TEST PANEL chassis. Remove the amplifier from the chassis by lifting it straight up. Place the amplifier to the right of the TEST PANEL.

(2) Use the extension test cable assembly to connect connector J4 on the TEST PANEL to connector P1 on the amplifier.

(3) Connect power to the TEST PANEL as shown in figure 86 and operate the MEASURE switch to the TRANSMISSION position.

b. If the amplifier is not part of a complete TEST PANEL and must be tested separately, connect the measuring set to connector P1 on the amplifier and connect power as shown in B, figure 86. Use the test signal source arrangement as shown in A, figure 86. Perform the procedures in *c* through *g* below.

c. Adjust the output frequency of the signal generator to 68 kc. See the attenuator for 0 db. Adjust the output of the signal generator for an indication of .775 volt on the voltmeter. Use test lead B of the test plug assembly to connect the test signal to the various test points. Insert the plug of the test plug assembly into the test jack assembly and connect the GRD lead to the amplifier chassis. Connect test lead B as indicated in *d* through *g* below.

d. Remove tubes V1 and V2 (fig. 87) and connect test lead B to terminal 1 of tube V3.

(1) Adjust the attenuator for an indication as close to 0 db as possible on the TEST PANEL meter or the meter of the measuring set.

(2) The approximate attenuator setting required is 15 db. If trouble is indicated, check tube V3 and make tube socket voltage and resistance measurements (TM 11-2139-20, fig. 8 or 9).

(3) Check resistors R15 through R22, and capacitors C9 through C12 as indicated by measurements.

e. Replace tube V2. Connect the T1 test lead to terminal 1 of V2 and adjust the attenuator for a meter reading as close to 0 db as possible. The approximate attenuator setting required is 51 db. If trouble is indicated, check tube V2 and make tube socket voltage and resistance measurements. Check resistors R10 through R14, and capacitors C5 through C8.

f. Replace tube V1 and connect the T test lead to terminal 1 of tube V1.

(1) Set the attenuator for a 49-db loss

(2) Remove the locking nut from potentiometer R17 and adjust R17 for a meter indication of 0 db.

(3) If this cannot be done and the meter indication is off scale (high), the feedback path is probably open.

(4) Check resistor R6, coil L1, and the connections.

(5) If the meter indication is on scale but cannot be adjusted to 0 db, check tube V1 and resistors R4, R5, R6, R17, R21, and R22.

(6) If trouble is still indicated, make tube-socket voltage and resistance measurements (TM 11-2139-20, fig. 8 or 9).

(7) Check resistors R1, R2, R3, R7, R8, and R9, and capacitors C1 through C4 as indicated by the measurements.

(8) After the trouble is cleared, adjust R17 for a 0-db meter indication and replace the locking nut.

g. Change test lead B connection to terminal D on plug connector P675 which is connected to connector J. The meter indication should be 0 db. If it is not, check resistors R1 and R2.

134. Dc Resistance of Transformers and Coils

a. Main Chassis.

Transformers	Terminals	Resistance (ohms)
T1.......................	1-3	290
	4-5	12.5
	6-7	.55
T2.......................	1-2	102
	3-4	104
	5-6	70.9
T3.......................	1-2	2.47
	3-4	2.4
	5-6	140
T4.......................	1-2	.05
	3-4	.075
	5-6	1.1

b. IF Amplifier AR1 or Flat Amplifier AR2.

Coil	Resistance (ohms)
Ll..	Less than 1.

Section VII. ORDER WIRE RECEIVER-TRANSMITTER RT-280/TCC-7 (PART OF RECEIVER-TRANSMITTER TEST SET GROUP OA-443/TCC-7)

135. Troubleshooting Data

Fig. No.	Par. No.	Description
23	-----------	Receiver-Transmitter Order Wire RT-280/TCC-7, schematic diagram.
92	-----------	Switch S103, wiring diagram.
24	-----------	Transmitting amplifier AR101, schematic diagram.
25	-----------	Receiving amplifier AR102, schematic diagram.
27	-----------	Ringer oscillator Y101, schematic diagram.
(TM 11 2139-20, fig. 17).	-----------	Transmitting amplifier AR101, tube socket voltage and resistance chart.
(TM 11 2139-20, fig. 18).	-----------	Receiving amplifier AR102, tube socket voltage and resistance chart.
(TM 11 2139-20, fig. 19).	-----------	Ringer oscillator Y101, tube socket voltage and resistance chart.
(TM 11 2139-20; fig. 4).	-----------	Receiver-Transmitter Order Wire RT-280/TCC-7, top view.
93	-----------	Receiver-Transmitter Order Wire RT-280/TCC-7, bottom view.
95	-----------	Transmitting amplifier AR101, top view.
96	-----------	Transmitting amplifier, AR101, bottom view.
98	-----------	Receiving amplifier, AR102, top view.
99	-----------	Receiving amplifier AR102, bottom view.
101	-----------	Ringer oscillator Y101, top view.
102	-----------	Ringer oscillator Y101, bottom view.
151	-----------	Receiver-Transmitter Order Wire RT-280/TCC-7, wiring diagram.
152	-----------	Transmitting amplifier AR101, wiring diagram.
153	-----------	Receiving amplifier AR102, wiring diagram.
154	-----------	Ringer oscillator Y101, wiring diagram.
	148*a*	ORDER WIRE PANEL, dc resistance of transformers and coils, main chassis.
	148*b*	Transmitting amplifier AR101, ORDER WIRE PANEL, dc resistance of transformers.
	148*c*	Receiving amplifier AR102, ORDER WIRE PANEL, dc resistance of transformers.
	148*d*	Ringer oscillator Y101, ORDER WIRE PANEL, dc resistance of transformers and coil.

136. Initial Procedures for Transmitting Tests

(fig. 90)

Perform the procedures below prior to making the transmitting tests (par. 137).

a. Connect the power and carrier supply test cable assemblies, 301- and 1,300-ohm resistors, 200 VOLT POWER SUPPLY; and ORDER WIRE PANEL as shown in figure 90.

b. Connect the signal generator, resistors R4 and R5, attenuator, and transformer T109 as shown in figure 90.

137. Transmitting Circuit Tests

a. Ringing Signal Transmitting Test.

(1) Connect the 10-volt dc source available at terminals D and H of the carrier supply test cable assembly to terminals A and T respectively, of the power test cable assembly.

(2) Connect the voltmeter arranged to measure 18 volts across terminals L and M on the power test cable assembly terminal board with terminal M as ground.

(3) Operate CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to the 0-11 position.

(4) Operate the TR GAIN control to the extreme clockwise position.

(5) Operate the ORDER WIRE switch to the RING position. The voltmeter should indicate 18 volts, the CALL lamp should light, and the buzzer should sound.

(6) Disconnect the 10-volt dc source from the power test cable assembly.

Figure 90. ORDER WIRE PANEL, operational test setup, transmitting direction.

(Contained in separate envelope)

b. Handset Transmitting Test.

(1) Strap terminals A and T on the power test cable assembly terminal board.

(2) Operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to the 0-11 position.

(3) Operate the TR GAIN control to the extreme clockwise position and the ORDER WIRE switch to the TALK position.

(4) Connect the signal generator and associated components (par. 136*b*) across terminals 1 and 3 of TB101 in the ORDER WIRE PANEL. Set the attenuator for a 0-db loss; arrange the signal generator for an output frequency of 1 kc at an output level of 1 volt measured across terminals 1 and 3 with terminal 3 as ground.

(5) Connect the voltmeter, arranged to measure 11 volts, across terminals L and M on the power test cable assembly terminal board with terminal M as ground; the voltmeter should indicate 11 volts ±1.5 volts.

(6) Connect the voltmeter, arranged to measure 11 volts, across terminals T1 and R of the test plug assembly with terminal R as ground. Insert the plug of the test plug assembly into the TR AMP OUT jack on the ORDER WIRE PANEL. The voltmeter should indicate 11 ±1.5 volts.

(7) Connect the voltmeter, arranged to measure .41 volt, across terminals C and P of the power test cable assembly terminal board; operate the CHANNEL TALK switch to the LINE position. The voltmeter should indicate .41 ±.04 volt. Operate the CHANNEL TALK switch to the TEST BD position; the voltmeter should indicate 0 volt.

(8) Connect the voltmeter across terminals D and R of the power test cable assembly terminal board. Operate the CHANNEL TALK switch to the TEST BD position; the voltmeter should indicate .41 ±.04 volt. Operate the CHANNEL TALK switch to the LINE position; the voltmeter should indicate 0 volt.

c. Test Signal Transmitting Test.

(1) Strap terminals A and T on the power test cable assembly terminal board.

(2) Operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to the 0-11 position.

(3) Operate the TR GAIN control to the extreme clockwise position.

(4) Connect the signal generator and associated components (par. 136*b*) across terminals K and W on the power test cable assembly terminal board. Adjust the attenuator for a 0-db loss; arrange the signal generator for an output frequency of 1 kc at an output level of .73 volt measured across terminals K and W.

(5) Connect the voltmeter across terminals L and M on the power test cable assembly terminal board with terminal M as ground. The voltmeter should indicate 11 volts ±.5 volt.

d. 2W EXT Binding Post Test.

(1) Strap terminals A and T on the power test cable terminal board.

(2) Connect the signal generator and the associated components (par. 136*b*) across the 2W EXT binding posts. Arrange the signal generator to supply 300, 1,000, or 1,700 cps, as required in (2), (5), and (6) below, at an output level of .55 volt measured across the 2W EXT binding posts.

(3) Connect the voltmeter across terminals L and M on the power test cable assembly terminal board.

(4) Operate the TR GAIN control to the extreme clockwise position. Adjust the signal generator for an output frequency of 300 cps. Set the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to the 104-126 position. The voltmeter should indicate 3.7 volts ±.8 volt.

(5) Readjust the signal generator for an output frequency of 1,000 cps. The voltmeter should indicate 11 ±2.5 volts.

(6) Readjust the signal generator for an output frequency of 1,700 cps. The voltmeter should indicate 12 ± 3 volts.

(7) Readjust the signal generator for an output frequency of 1,000 cps and reset the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to the 0-11 position. The voltmeter should indicate 11 ±1.5 volts.

(8) Readjust the TR GAIN control to the extreme counterclockwise position. The voltmeter should indicate .14 ±.08 volt.

138. Receiving Circuit Tests

(fig. 91)

a. Initial Procedures. Perform the following procedures prior to making the receiving circuit tests (*b* through *d* below).

(1) Connect the power and carrier supply test cable assemblies, 75-, 121-, 301-, and 600-ohm resistors, ORDER WIRE PANEL, and 200 VOLT POWER SUPPLY as shown in figure 91.

(2) Connect the signal generator, resistors R1 through R3, attenuator, and transformer T109, with the two 511-ohm resistors *not* strapped out, as shown in figure 91.

b. Ringing Signal Receiving Test.

(1) Connect the 10-volt dc from the 200 VOLT POWER SUPPLY across terminals A and T of the power test cable assembly with terminal T positive.

(2) Operate the REC GAIN control on the ORDER WIRE PANEL to the extreme clockwise position.

(3) Connect the signal generator and the associated components (*a*(2) above) across terminals F and S of the power test cable assembly; adjust the signal generator output frequency to 1,600 cps at an output level of .007 volt measured across terminals F and S with the voltmeter. The CALL lamp should light and the buzzer should sound.

c. Receiving Maximum Gain Test.

(1) Strap terminals A and T on the power test cable assembly terminal board. Operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to the 0-11 position.

(2) Operate the REC GAIN control on the ORDER WIRE PANEL to the extreme clockwise position.

(3) Connect a 600-ohm resistor across the 2W EXT binding posts.

(4) Connect the signal generator and associated components (*a* (2) above) across terminals F and S on the power test cable assembly. Set the attenuator for a 30-db loss and adjust the signal generator for an output frequency of 1 kc at an output level of .007 volt measured across terminals F and S.

(5) Connect the voltmeter to terminals T1 and R of the test plug assembly with terminal R as ground.

(6) Insert the plug of the test plug assembly into the REC AMP IN and REC AMP OUT jacks on the ORDER WIRE PANEL. The voltmeter should indicate .007 ±.003 volt at each jack.

Figure 91. ORDER WIRE PANEL, operational and final test setup, receiving direction.

(Contained in separate envelope)

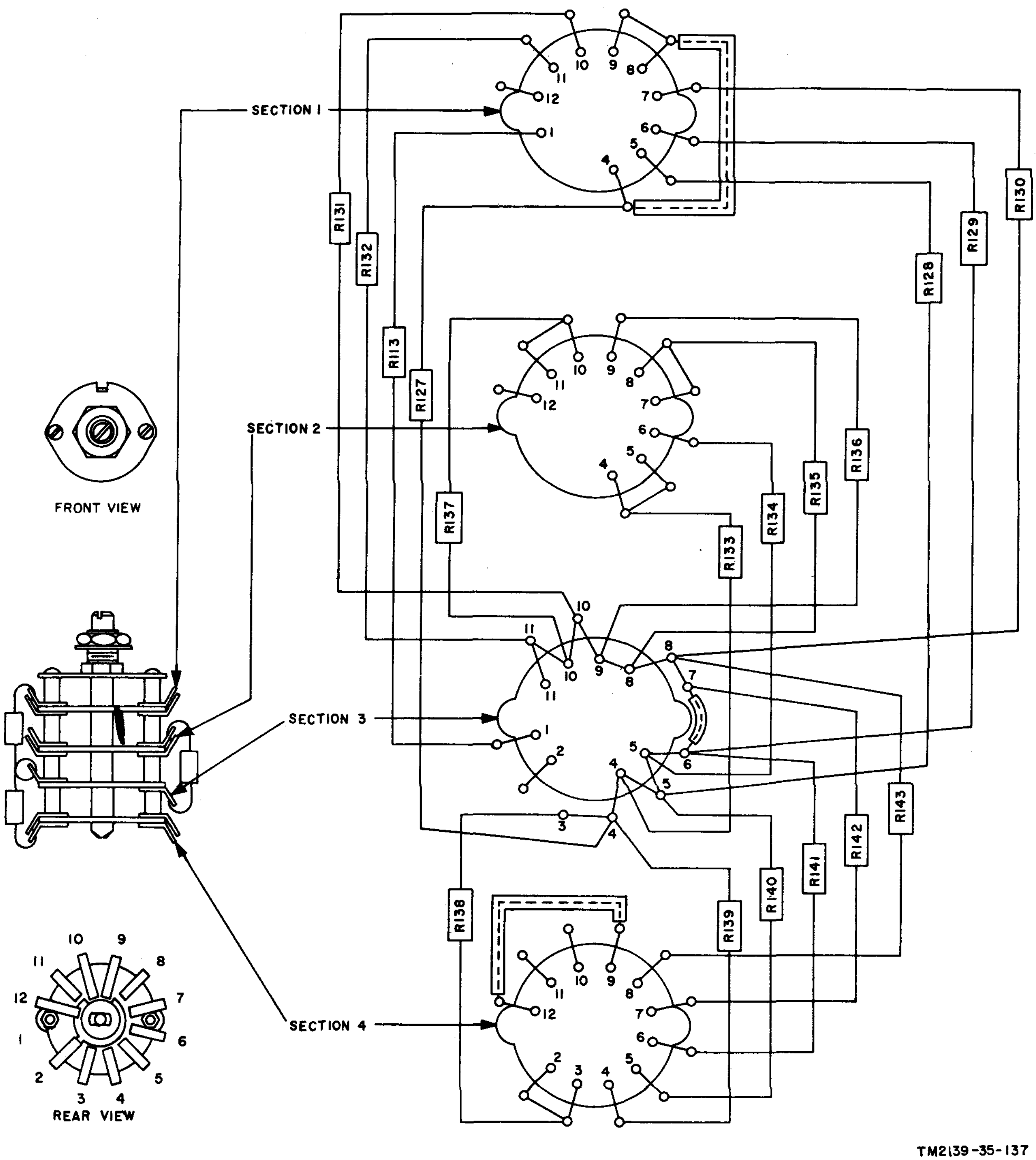


Figure 92. CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch S103, (part of ORDER WIRE PANEL) circuit element location and wiring diagram.

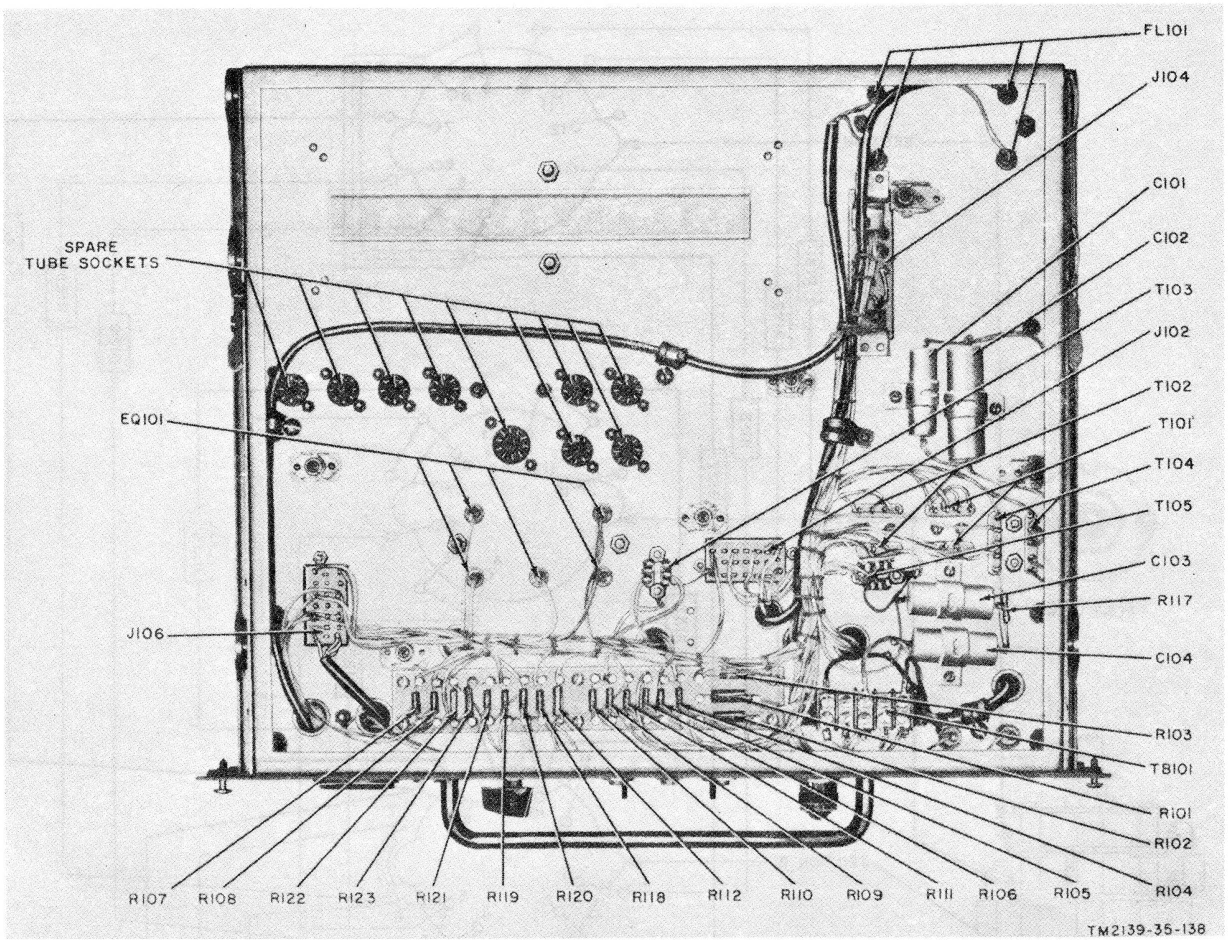


Figure 93. Receiver-Transmitter Order Wire RT-280/TCC-7, bottom view of chassis, parts location.

(7) Connect the voltmeter across terminals 3 and 5 of TB101 in the ORDER WIRE PANEL. The voltmeter should indicate .21 volt. Operate the ORDER WIRE switch to the TALK position; the voltmeter should indicate .21 volt ±.03 volt. Operate the CHANNEL TALK switch to the TEST BD position. There should be no change in the voltmeter indication.

(8) Connect the voltmeter across the 600 ohm resistor connected to the 2W EXT binding posts. Operate the ORDER WIRE switch to the normal position; the voltmeter should indicate .35 ±.05 volt.

d. Receiving Minimum Gain Test.

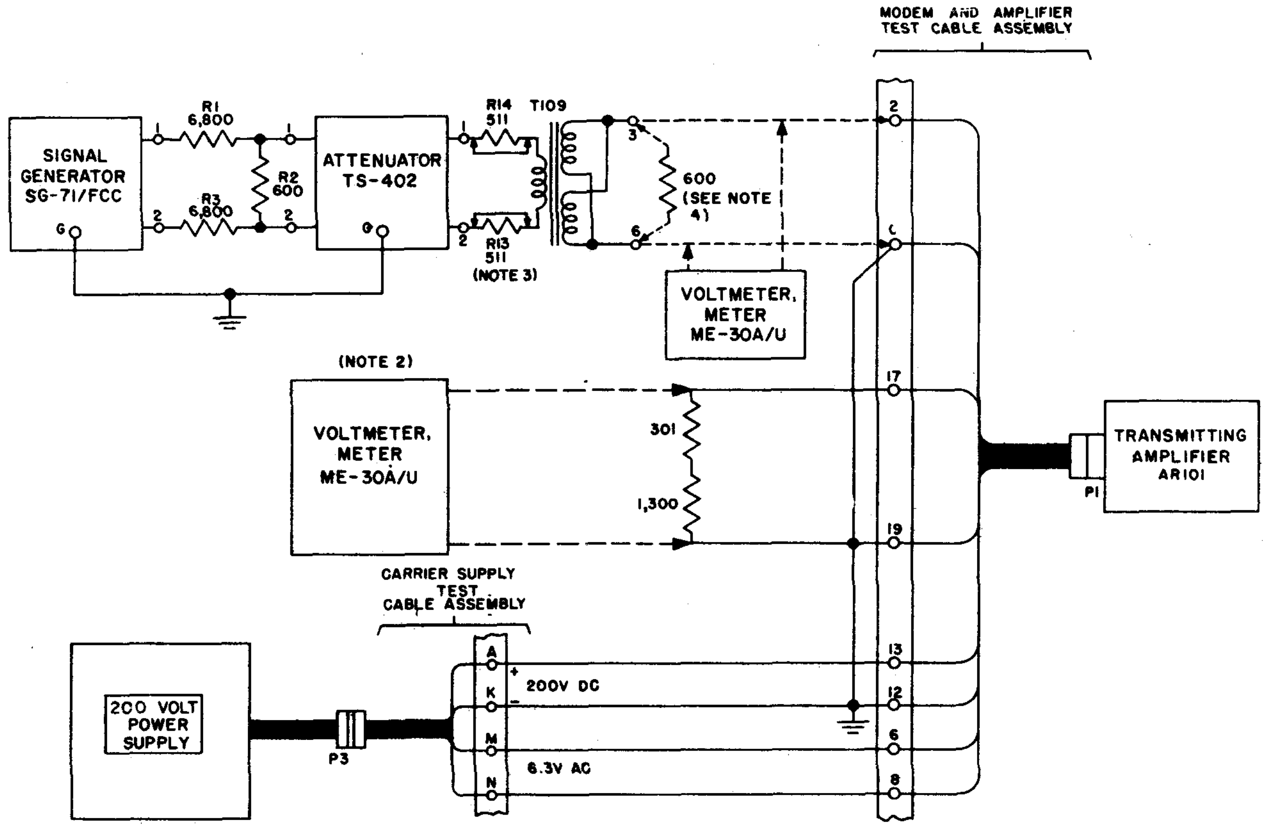
(1) Strap terminals A and T of the power test cable assembly.

(2) Adjust the REC GAIN control to the extreme counterclockwise position and operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to the 0-11 position.

(3) Connect the signal generator and associated components (*a* (2) above) across terminals F and S of the power test cable assembly. Set the attenuator for a 0-db loss and adjust the signal generator for an output frequency of 1 kc at an output level of .7 volt measured across terminals F and S.

(4) Connect the voltmeter across terminals T1 and R of the test plug assembly with terminal R as ground.

(5) Insert the plug of the test plug assembly into the REC AMP IN jack on the



NOTES:
1. RESISTANCES ARE IN OHMS.
2. ONLY ONE VOLTMETER, METER ME-30A/U IS NEEDED FOR TESTS USING THIS SETUP.
3. RESISTORS R13 AND R14 MUST BE STRAPPED OUT FOR THIS TEST SETUP.
4. CONNECT AS INDICATED IN FINAL TEST PROCEDURES.

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Figure 94. Transmitting amplifier AR101 (part of ORDER WIRE PANEL), operational and final test setup.

ORDER WIRE PANEL; the voltmeter should indicate .007 ±.003 volt.

139. ORDER WIRE PANEL, Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in the ORDER WIRE PANEL. This chart lists the symptoms that may be reported on the equipment repair tag or observed when performing maintenance at the organizational level (TM 11-2139-20). When the trouble has been localized to a stage or circuit, a tube check or a voltage and resistance measurement of this stage or circuit should be sufficient to isolate the defective part. Normal voltage and resistance measurements are given in TM 11-2139-20, figures 17 through 19.

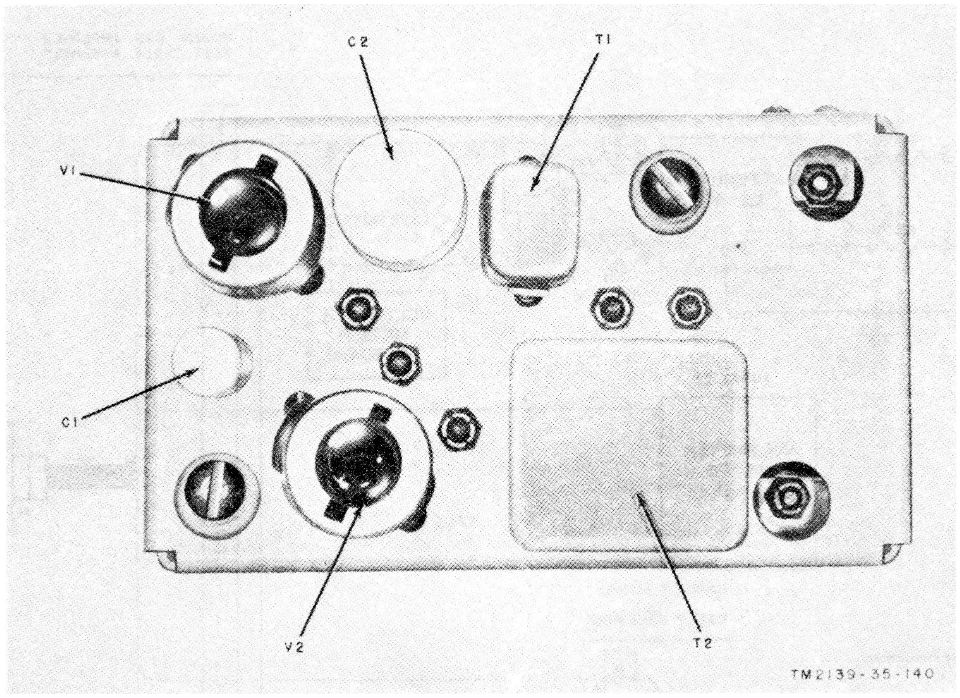

Figure 95. Transmitting amplifier AR101 (part of ORDER WIRE PANEL), top view, parts location.

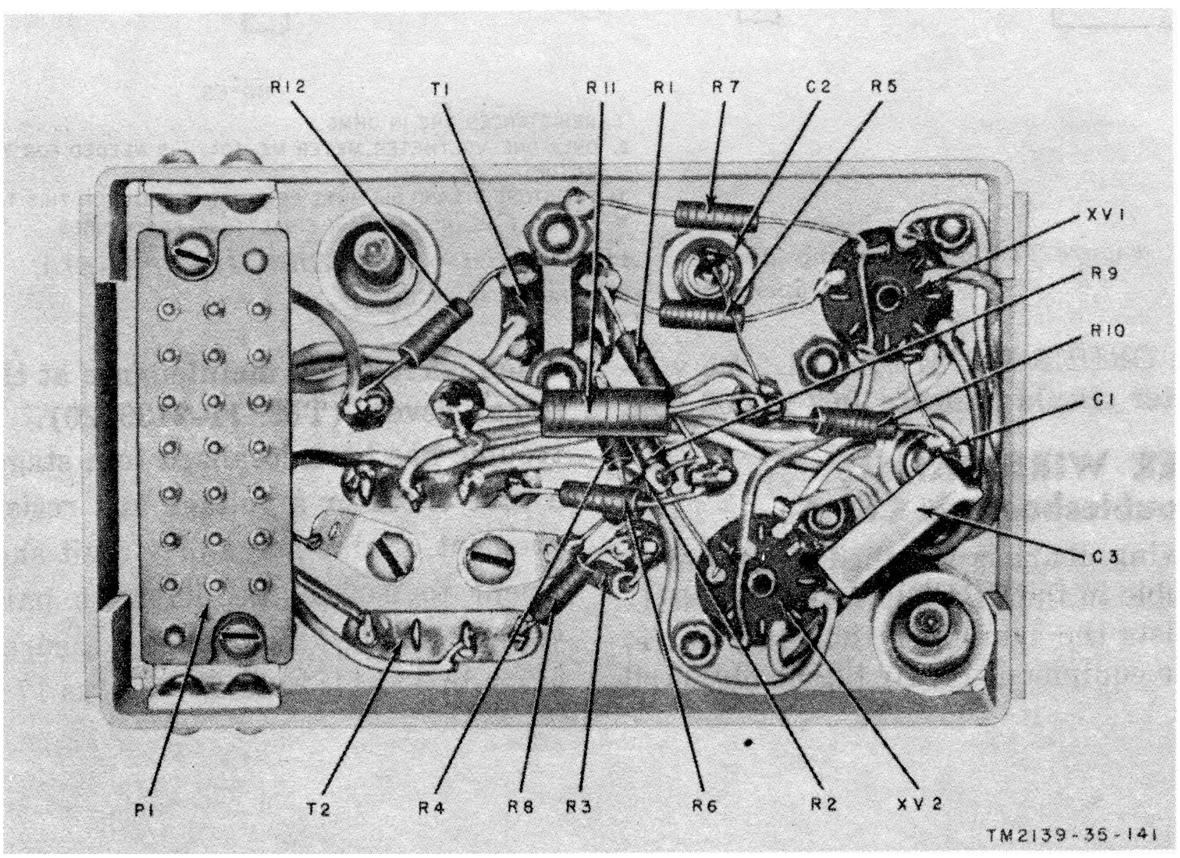

Figure 96. Transmitting amplifier AR101 (part of ORDER WIRE PANEL), bottom view, parts location.

Symptom	Probable trouble	Corrective measures
1. No transmission in either direction, no signal from ringer-oscillator Y101.	*a*. Failure of 200-volt dc distribution circuits.	*a*. Check for presence of 200 volts dc between terminals 13 of connector J102 or J106 and ground. If not present, check B + distribution circuit and locate open or short circuits (fig. 23).
	b. Failure of 6.3-volt ac distribution circuits.	*b*. Check for presence of 6.3 volts ac across terminals 6 and 8 of connector J102 or J106. If not present, check the 6.3-ac volt ac distribution circuits: and locate open or shorted circuits.
2. Transmission in transmitting direction from telephone handset, out of limits.		
a. Output at terminals L and M of connector J101 out of limits.	*a*. Failure of a component part between TR AMP OUT jack and terminals L and M of J101 connector.	*a*. Check output at TRAMP OUT jack (par. 137). If normal, use signal substitution procedures (par. 140*b*, test No. 13).
b. Output of TR AMP OUT jack, out of limits.	*b*. Failure of a component part between telephone handset and TR AMP OUT jack.	*b*. Proceed as in correction 2*a*. If signal is out of limits, replace AR101 amplifier. If still out of limits, use signal substitution procedures (par. 140*b*, tests No. 1 and 2 and 5 through 8).
c. Output at terminals C and P of connector J101, out of limits.	*c*. Failure of a component part between telephone handset and terminals C and P of connector J101.	*c*. Use signal substitution procedures (par. 140*b*, test No. 4).
d. Output at terminals D and R of connector J101, out of limits.	*d*. Failure of a component part between telephone handset and terminals D and R of J101.	*d*. Use signal substitution procedures (par. 140*b*, test No. 3).
3. Transmission in transmitting direction from test signal input, out of limits.	Failure of a component part between terminals K and W of connector J101 and terminals 3 and 4, and 5 and 6 of T103.	Proceed as in correction 2*a*. If signal is normal, use signal substitution procedures (par. 140*b*, test No. 14).
4. Transmission in transmitting direction from 2W EXT binding posts, out of limits.		
a. Output at terminals L and M of connector J101, out of limits.	*a*. Failure of a component part between 2W EXT binding posts and terminals L and M of connector J101.	*a*. Proceed as in correction 2*a*. If signal is normal, use signal substitution procedures (par. 140*b*, test No. 9).
b. Output at terminals L and M of connector J101 out of limits when transmitting a frequency of 300 cps or 1,000 cps; or 1,700 cps from 2W EXT binding posts through equalizer with CABLE REELS TO NEXT AN/TCC-7 or AN/TCC-8 switch in 104-126 position.	*b*. Failure of EQ101 or associated circuits.	*b*. Use signal substitution procedures (par. 140*b*, tests No.10, 11, and 12).
5*a*. Transmitting signal from ringer oscillator Y101 out of limits at terminals L and M of connector J101.	*a*. Failure of a component part between ringer oscillator Y101 output connection and terminal L and M of connector J101.	*a* . Proceed as in correction 2*a*. If signal is normal, replace ringer oscillator Y101 and perform corrective measure in test No. 5*b*. If normal, check for shorted or open circuits from terminals 0 and 1 of connector J104 through switch S104 to terminals 5 and 6 of T103. Check to see that terminal 2 is connected to terminal 6 and terminal 6 to 8 of connector J104

Symptom	Probable trouble	Corrective measures
b. Transmitting signal from ringer oscillator Y101 out of limits at terminals L and M of connector J101.	*b*. Failure of 10-volt dc distribution circuit.	*b*. Check for presence of 10 volts dc between terminals 13 and 11 of connector J104. If not present, check for open and short circuits from terminals 13 and 11 of J104 to terminals A and T of J101.
6. Transmission in receiving direction from terminals F and S of J101 connector, out of limits.		
a. Output at terminals 3 and 5 of TB101, out of limits.	*a*. Failure of a component part between REC AMP OUT jack and terminals 3 and 5 of TB101.	*a*. Check output at REC AMP IN jack (par. 138*c*). If normal, check out put at REC AMP OUT Jack. If normal, use signal substitution procedures (par. 140*a* tests No 6, 7, and 9).
b. Output at REC AMP OUT jack, out of limits.	*b*. Failure of amplifier AR102.................	*b*. Check output at REC AMP IN jack (par. 138*c*). If normal, replace amplifier AR102.
c. Output at REC AMP IN jack, out of limits.	*c*. Failure of a component part between REC AMP IN jack and terminals F and S of J101.	*c*. Use signal substitution procedures (par. 140*a*, tests No. 1 through 5).
d. Output at 2W EXT binding posts, out of limits.	*d*. Failure of a component part between 2W EXT binding posts and terminals F and S of connector J101.	*d*. Proceed as in correction 6*a*. If normal, use signal substitution (par. 140*a*, test No. 8).
7. Receiving signal to ringer-oscillator Y101 does not light call lamp or sound buzzer.	*a*. Failure of a component part between terminals F and S of connector J101 and ringer oscillator Y101 input connection.	*a*. Proceed as in correction 6*a*. If normal, replace ringer-oscillator Y101 and perform correction 5*b*. If normal, check for shorted or open circuits from terminals 1 and 2 of T105 to terminals O and 1 of connector J104. Check to see that terminal 5 is connected to terminal 2 of connector J104.
	b. Failure of 10-volts dc distribution circuit.	*b*. Proceed as in correction 5*b*.

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140. ORDER WIRE PANEL, Signal Substitution Charts

The following signal substitution charts (*a* and *b* below) are used to supplement the troubleshooting chart (par. 139). These charts will help to determine the defective stage or circuit. Voltage and resistance measurements taken at the defective stage should isolate the defective part. Normal voltage and resistance measurements appear in TM 11-2139-20, figures 17 through 19. The signal substitution procedures for each step assume that all previous steps have been satisfactorily completed. These tests use the same setup as the operational tests (pars. 136 and 138*a*). For the locations of the parts to be checked in the *Corrective measures* column of the following chart refer to figures 93 and 94. The schematic diagram is figure 23.

a. ORDER WIRE PANEL, Receiving Direction, Signal Substitution Chart (fig. 23).

Test No.	For hookup of signal in circuit, see paragraph	Voltmeter probe connections		Meter indication (volts ac)	Corrective measures
		Positive	Negative		
1	138*c* -------------	REC AMP IN jack (tip). --	REC AMP IN jack (ring).	.007	*a*. Check circuit from terminals F and S of J101 to J107. *b*. Check resistors R124 through R126.
2	138*c* -------------	Terminal 2 of J106 ---------	Ground --------------------	.007	*a*. Check circuit from terminals F and S of J101 to 2 and 0 of J106. *b*. Check resistors R124 through R126.
3	138*c*. Operate CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to RADIO position.	Terminal 2 of J106 ---------	Ground --------------------	.0015	*a*. Perform test No. 2. *b*. Check circuit from terminals F and S of J101 to S103. *c*. Check resistor R113.
4	138*c* -------------	Terminal 17 of J106--------	Ground --------------------	2.2	*a*. Replace receiving amplifier AR102 and repeat test No. 4. *b*. Check circuit associated with terminals 17 and 19 of J106 for opens and shorts if normal indications are not obtained in test No. 4*a*. *c*. Check for 200 volts DC between terminals 12 and 13 of J106. *d*. If normal indication is not obtained in test No. 4*c*, check the 200-volt distribution circuit (TM 11-2139-20, fig. 25). *e*. Check for 6.3 volts ac between terminals 6 and 8 of J106. *f*. If normal indication in test No. 4*e* is not obtained, check the 6.3 volt ac distribution circuit.
5	138*d* -------------	Terminal 17 of J106-------	Ground --------------------	.023	*a*. Check resistors R124 through R126. *b*. Perform test No. 4*a* through *f*.
6	138*c* -------------	REC AMP OUT jack (tip).	REC AMP OUT jack (ring).	.0075	*a*. Check circuit from J106 to T105. *b*. Check resistors R122 and R123.

Test No.	For hookup of signal in circuit, see paragraph	Voltmeter probe connections		Meter indication (volts ac)	Corrective measures
		Positive	Negative		
7	138*c* -------------	Terminal 2 of T105	Ground ------------------	.72	*a*. Check circuit between J106 and T105. *b*. Check resistors R119 through R121.
8	138*c* -------------	2W EXT binding post (E101).	2W EXT binding post (E102).	.35	*a*. Check circuits betweenT105 and 2W EXT binding posts. *b*. Check transformers T104 and T105. *c*. Check resistor R117. *d*. Check capacitors C101 through C104.
9	138*c* -------------	Terminal 5 of TB101	Terminal 3 of TB101	.21	*a*. Check circuits between T105 and TB101. *b*. Check resistors R104 through R106. *c*. Check transformer T102.

b. ORDER WIRE PANEL, Transmitting Direction, Signal Substitution Chart (fig. 23).

Test No.	For hookup of signal in circuit, see paragraph	Voltmeter probe connections		Meter Indication (volts ac)	Corrective measures
		Positive	Negative		
1	137*b*-------------	Terminal 1 of T101 -	Terminal 4 of T101		*a*. Check circuit from TB101 to T101. *b*. Check resistor R101.
2	137*b*-------------	Terminal 5 of T101	Terminal 6 of T101	.41	*a*. Check circuits associated with terminals 5 and 6 of T101. *b*. Check transformer T101.
3	137*b*-------------	Terminal D of J101	Terminal R of J101	.41	Check circuits from T101 to J101 terminals D and R.
4	137*b*-------------	Terminal C of J101	Terminal P of J101	.41	Check circuits from T101 to J101 terminals C and P.
5	137*b*-------------	Terminal 6 of T103 -	Terminal 5 of T103	.41	Check circuits from T101 to T103.
6	137*b*-------------	Terminal 2 of T103	Ground ---------------	.35	*a*. Check circuits associated with terminals 2 and 1 of T103. *b*. Check transformer T103.
7	137*b*-------------	Terminal 2 of EQ101 ----------------	Ground ---------------	.255	*a*. Check circuits from T103 to EQl01. *b*. Check resistors R109 through R111.
8	137*b*-------------	Terminal 2 of J102--	Ground ---------------	-------------------	*a*. Check circuits from EQ101 to J102. *b*. Check circuits from EQ101 to Sl03. *c*. Check resistors Rl27 through Rl43.

Test No.	For hookup of signal in circuit, see paragraph	Voltmeter probe connections: Positive	Voltmeter probe connections: Negative	Meter Indication (volts ac)	Corrective measures
					d. Check equalizer network EQ101.
	CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch position:				
	RADIO	----------------------------	---------------------------	.092	
	0-11	----------------------------	---------------------------	.092	
	12-13	----------------------------	---------------------------	.092	
	35-57	----------------------------	---------------------------	.084	
	58-80	----------------------------	---------------------------	.084	
	81-103	----------------------------	---------------------------	.088	
	104-126	----------------------------	---------------------------	.084	
	127-149	----------------------------	---------------------------	.084	
	150-160	----------------------------	---------------------------	.088	
	150-160 (Hot).	----------------------------	---------------------------	.175	
9	137*e*	Terminal 2 of J102----	Ground------------------	------------------	*a.* Perform corrective measures in test No. 8. *b.* Check circuit from 2W EXT binding posts to T103. *c.* Check transformer T104. *d.* Check resistor R117. e. Check capacitors C101 through C104.
	Operate CABLE REELS TO NEXT AN/TCC-7 OR AN-TCC-8 switch to 104-126 position.				
	Input frequency:				
	300 cps	----------------------------	---------------------------	.031	
	1,700 cps	----------------------------	---------------------------	.1	
10	137*e* -------------	Terminal 17 of J102 --	Ground------------------	11	*a.* Check circuit associated with terminals 17 and 19 of J102. *b.* Replace transmitting amplifier AR101, and repeat test No. 10*b*. *c.* If normal indications are not obtained in test No. 10*b*, check for 200 volts dc between terminals 12 and 13 of J102. *d.* If normal indication is not obtained in test No. 10*c*, check the 200-volt distribution circuit (TM-11-2139-20, fig. 25).

Test No.	For hookup of signal in circuit, see paragraph	Voltmeter probe connections		Meter indication (volts ac)	Corrective measures
		Positive	Negative		
					e. Check for 6.3 volts ac between terminals 6 and 8 of J102. *f*. If normal indication is not obtained in test No. 10*e*, check the 6.3-volt ac distribution circuit.
11	137*e* ----------------	TR AMP OUT jack (tip).	TR AMP OUT jack (ring).	11	*a*. Check circuit from J102 to J103. *b*. Check resistors R114 through R116.
12	137*e* ----------------	TR AMP OUT jack (tip).	TR AMP OUT jack (ring).	.136	Perform corrective measures in test No. 11.
13	137*e* ----------------	Terminal L of J101	Ground--------------------	11	*a*. Check circuit from terminal 17 of J102 and ground to terminals L and M of J101. *b*. Check filter FL101.
14	137*d* ----------------	Terminal L of J101	Ground--------------------	11	*a*. Check circuit from terminals K and W of J101 to T103. *b*. Check resistors R107 and R108.

141. Transmitting Amplifier AR101, Test

(fig. 94)

a. Connect the modem and amplifier and carrier supply test cable assemblies, 301- and 1,300-ohm resistors, 200 VOLT POWER SUPPLY, and transmitting amplifier as shown in figure 94.

b. Connect the signal generator, resistors R1 through R3, attenuator, and transformer T109 as shown in figure 94. Connect the output of the transformer across terminals 0 and 2 of the modem and amplifier test cable assembly.

c. Set the attenuator for a 0-db loss and adjust the signal generator for an output frequency of 1 kc at an output level of .077 volt across terminals 0 and 2 as measured with the voltmeter.

d. Connect the voltmeter across the 301- and 1,300-ohm resistors. The voltmeter indication should be 10 ± 1.25 volts.

142. Transmitting Amplifier AR101, Signal Substitution Tests

The setup for making signal substitution measurements is the same as that described for the operational test (par. 141). To perform the test outlined in the signal substitution chart below, use the same attenuator setting and signal generator frequency and output level as in paragraph 141*c*.

Test No.	Voltmeter probe connection Positive	Negative	Meter indication (ac)	Corrective measures
1 ---	Term. 1, T1	Term. 3, T1	.077	Check resistor R12 and wiring from connector P1 to transformer T1.
2 ---	Term. 1, V1	Ground	.30	Check resistor R5 and wiring to tube V1.
3 ---	Term. 1, V2	Ground	30	Check resistor R9 and wiring to tube V2.
4 ---	Term. 5, V1	Ground	40	Check capacitors C1 and C2 and connections to T2 and V1.
5 ---	Term. 5, V2	Ground	40	Check capacitors C1 and C2 and connections to T2 and V2.
6 ---	Term. E1	Ground	.8	Check resistors R6, R2, and wiring.
7 ---	Term. E2	Ground	.8	Check resistors R8, R3, and wiring.
8 ---	Term, 1, T2	Term. 3,T2	10	Check transformer T2.
9 ---	Term. 17, P1	Term. 19, T1	10	Check wiring from transformer T2 to connector P1.

143. Receiving Amplifier AR102, Test

(fig. 97)

a. Connect the carrier supply, and modem and amplifier test cable assemblies, 825-ohm resistor, 200 VOLT POWER SUPPLY and receiving amplifier as shown in figure 97.

b. Connect the signal generator, resistors R1 through R3, attenuator, and transformer T109 together as shown in figure 97. Connect the secondary output of the transformer across terminals 0 and 2 of the modem and amplifier test cable assembly.

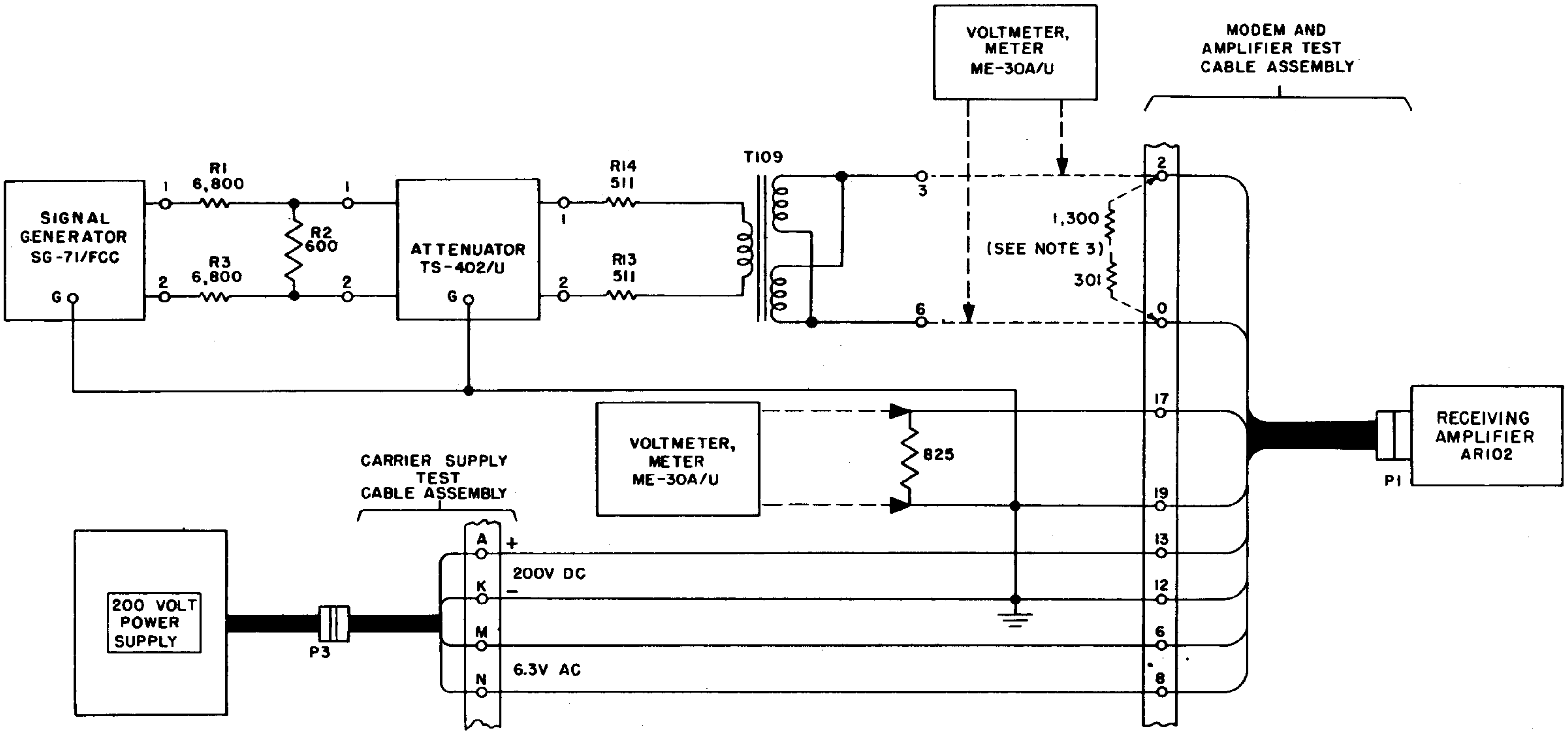
c. Set the attenuator for a 30-db loss and adjust the signal generator for an output frequency of 1 kc at an output level of .007 volt as measured across terminals 0 and 2 with the voltmeter.

d. Connect the voltmeter across the 825-ohm resistor. The voltmeter indication should be 2.2 ±.275 volt.

144. Receiving Amplifier AR102, Signal Substitution Tests

The procedure for making the signal substitution tests is the same as that described for the operational test (par. 143). To perform the tests outlined in the signal substitution chart below, use the same attenuator setting and signal generator frequency and output level as in paragraph 143*c*.

Test No	Voltmeter probe connections Positive	Negative	Meter indication (ac)	Corrective measures
1-----	Term. 1, T1	Term. 3, T1	0.007	Check wiring to transformer T1. If wiring is not defective, the trouble may be on the secondary side of T1.
2-----	Term. 4,T1	Ground	.06	Check transformer T1, the wiring, capacitor C1, and resistor R1.
3-----	Term. 1, V1	Ground	.06	Check wiring from transformer T1 to tube V1.
4-----	Term. 5,V1	Ground	.55	Check capacitor C2. Check to see that the tube is properly seated in its socket. Check R5 and wiring from T2 through R5 to E1.
5-----	Term. 1, V2	Ground	.45	Check capacitor C3 and wiring to tube V2.
6-----	Term. 6, T2	Ground	17	Check to see that tube V2 is properly seated in its socket. Check C4, C5, and T2.
7-----	Term. 3, T2	Term. 1, T2	2.2	Check transformer T2.
8-----	Term. 17, P1	Term. 19, P1	2.2	Check wiring to connector P1.



NOTES:
1. RESISTANCES ARE IN OHMS.
2. ONLY ONE VOLTMETER, METER ME-30A/U IS NEEDED FOR TESTS USING THIS SETUP.
3 CONNECT AS INDICATED IN FINAL TEST PROCEDURES.

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Figure 97. Receiving amplifier AR102 (part of ORDER WIRE PANEL), operational and final test setup.

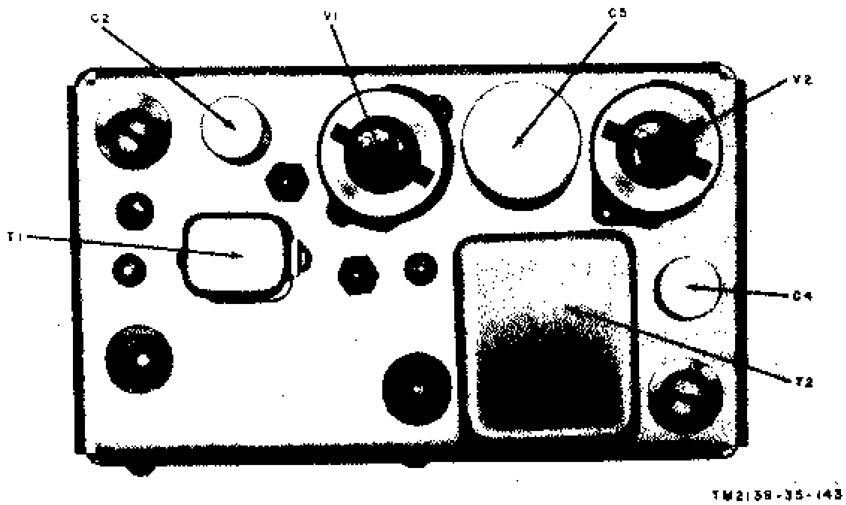


Figure 98. Receiving amplifier AR102 (part of ORDER WIRE PANEL), top view, parts location.

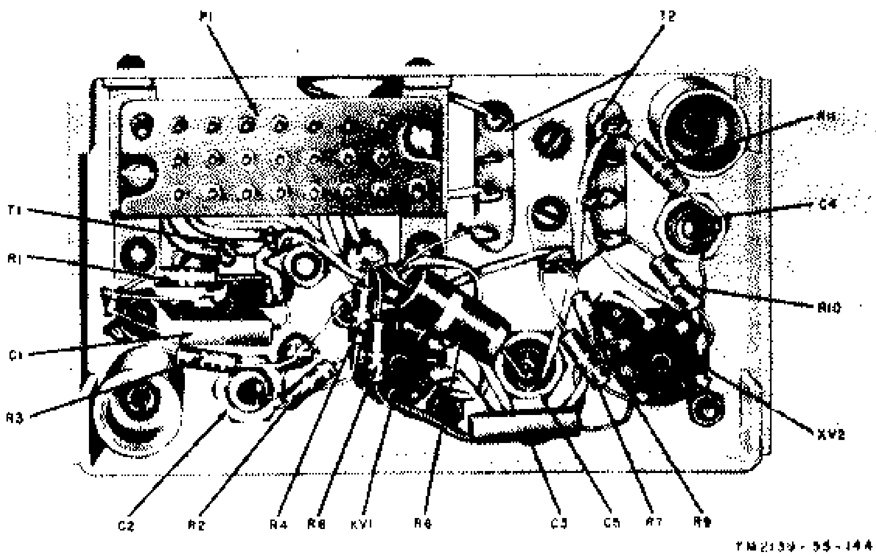


Figure 99. Receiving amplifier AR102 (part of ORDER WIRE PANEL), bottom view, parts location.

145. Ringer-Oscillator Y101, Test

(fig. 100)

a. Initial Procedures.

(1) Connect the carrier supply, and modem and amplifier test cable assemblies, *200* VOLT POWER SUPPLY, and ringer-oscillator as shown in figure 100.

(2) Connect the signal generator, resistors R1 through R3, attenuator, and (3) transformer T109 as shown in figure 100.

b. Receiving Test.

(1) Strap terminals *2* and 5 and connect the 600-ohm resistor across terminals 0 and 1 on the modem and amplifier test cable assembly.

(2) Set the attenuator for a 30-db loss and adjust the signal generator for an output frequency of 1.6 kc at an output level of .31 volt as measured with the voltmeter across the *input* to the attenuator.

(3) Connect the signal generator and associated components *(a(2)* above) across terminals 0 and 1 of the modem and amplifier test cable assembly. The buzzer should operate.

(4) Readjust the attenuator for a 0-db loss and readjust the signal generator for an output frequency 300 cps at an output level of .16 volt measured across terminals 0 and 1 of the modem and amplifier test cable assembly.

(5) Connect the *multimeter*, arranged as a dc voltmeter, across terminal E2 and ground; it should indicate between 5.5 and 13.5 volts dc.

(6) Remove the strap and the 600-ohm resistor ((1) above).

(7) Readjust the signal generator for an output frequency of 1 kc; the multimeter should indicate between 6 and 9 volts dc.

(8) Readjust the signal generator for an output frequency of 3 kc; the multimeter should indicate between 8.5 and 12.5 volts dc.

c. Oscillating Test.

(1) Connect the 600-ohm resistor across terminals 0 and 1 and strap terminals 2 and 6 and 5 and 8 on the modem and amplifier test cable assembly.

(2) Connect the frequency meter across terminals 0 and 1 of the modem and amplifier test cable assembly.

(3) The frequency meter indication should be 1.6 kc.

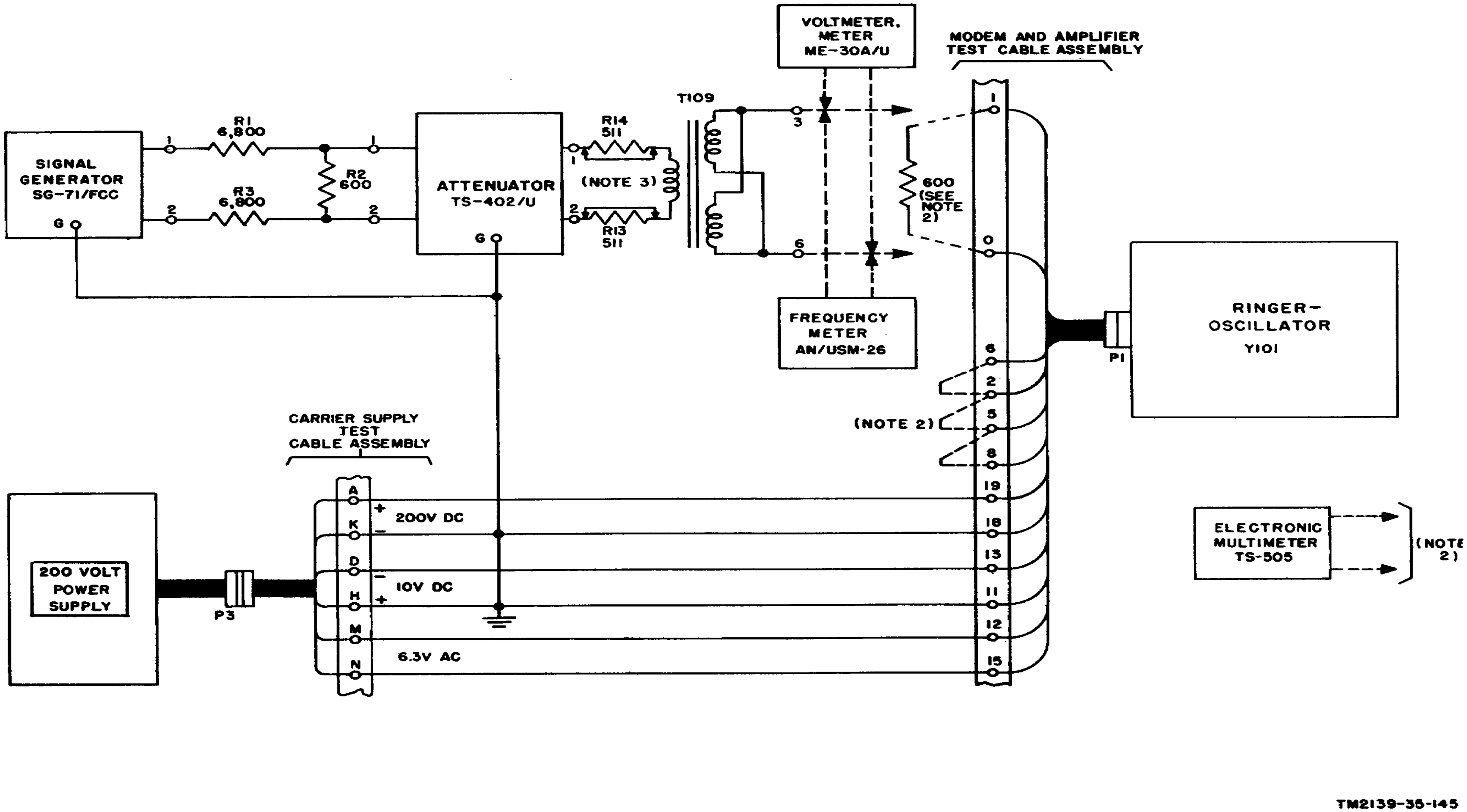
(4) Connect the voltmeter across terminals 0 and 1 of the modem and amplifier test cable assembly. The voltmeter should indicate .275 +.05 volt.

(5) Remove the 600-ohm resistor and the straps ((1) above).

146. Ringer-Oscillator Y101, Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in ringer-oscillator Y101. This chart lists the symptoms that may be reported on the equipment repair tag or observed when performing maintenance at the organizational level (TM 11-2139-20). Once the trouble has been localized to the proper circuit, a tube check and voltage and resistance measurements (TM 11-2139-20, fig. 19) of this circuit should be sufficient to isolate the defective part.

Item No.	Symptom	Probable trouble	Corrective measures
1	No ac voltage measured at terminals 1 and 0	Defective component part or wiring in in oscillator circuits.	Make operational tests in paragraph 145. If these checks indicate normal circuit behavior, check R11 and wiring from terminal 4 of T3 to terminals 6 of P1. Check wiring to terminals 1 and 0 of P1. Check T1 (measure primary and secondary resistances).
2	Voltage measured at terminals 1 and 0 out of limits	Feedback path of oscillator	Check CR3, CR4, R12, R13, and wiring. Replace defective parts.
3	Frequency measured at terminals1 and 0 incorrect (par. 145)	Tuned circuit of oscillator	Adjust capacitor C5 and attempt to bring frequency into correct range of 1.6 ± 4 cps. If adjustment is impossible, check C5 through C9, and wiring. Replace defective parts.
4	The buzzer does not operate when 1.6 kc is applied to the circuit under the conditions described in paragraph 145a through c (oscillator frequency and voltage normal as determined from previous tests).	Guard circuit of oscillator	Apply signal substitution tests (par. 147, tests No. 1 through 9).
5	Dc voltage at terminal E2 for 1-kc input incorrect (or excessive talk up reported from the field).	Defective component part in guard circuit transmission path.	Apply signal substitution tests (par. 147, tests No. 10 through 12).
6	Dc voltage at terminal E2 for 300 cps input incorrect.	Defective capacitor C12 in signal circuit transmission path.	Check capacitor C12. Replace if defective.
7	Dc voltage at terminal E2 for 3-kc input incorrect	Defective capacitor C13 in guard circuit transmission path.	Check capacitor C13. Replace if defective.



NOTES:

1. RESISTANCES ARE IN OHMS.
2. CONNECT AS INDICATED IN OPERATIONAL OR FINAL TEST PROCEDURES.
3. RESISTORS R13 AND R14 MUST BE STRAPPED OUT FOR THIS SETUP

Figure 100. Ringer oscillator Y101 (part of ORDER WIRE PANEL), operational and final test setup

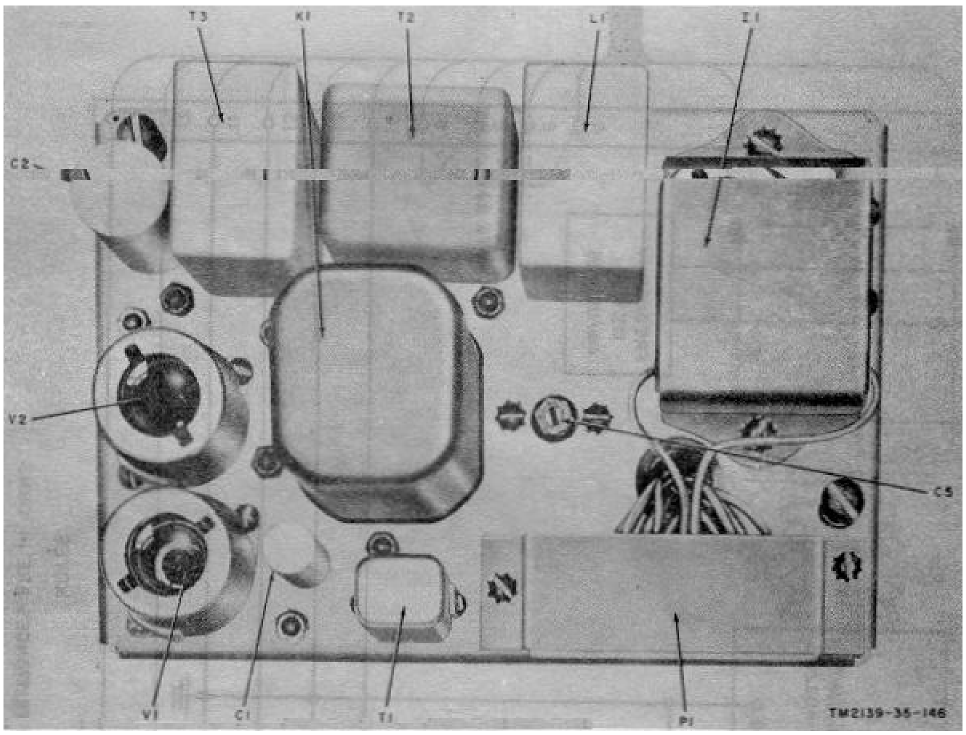


Figure 101. Ringer oscillator Y101 (part of ORDER WIRE PANEL), top view, parts location.

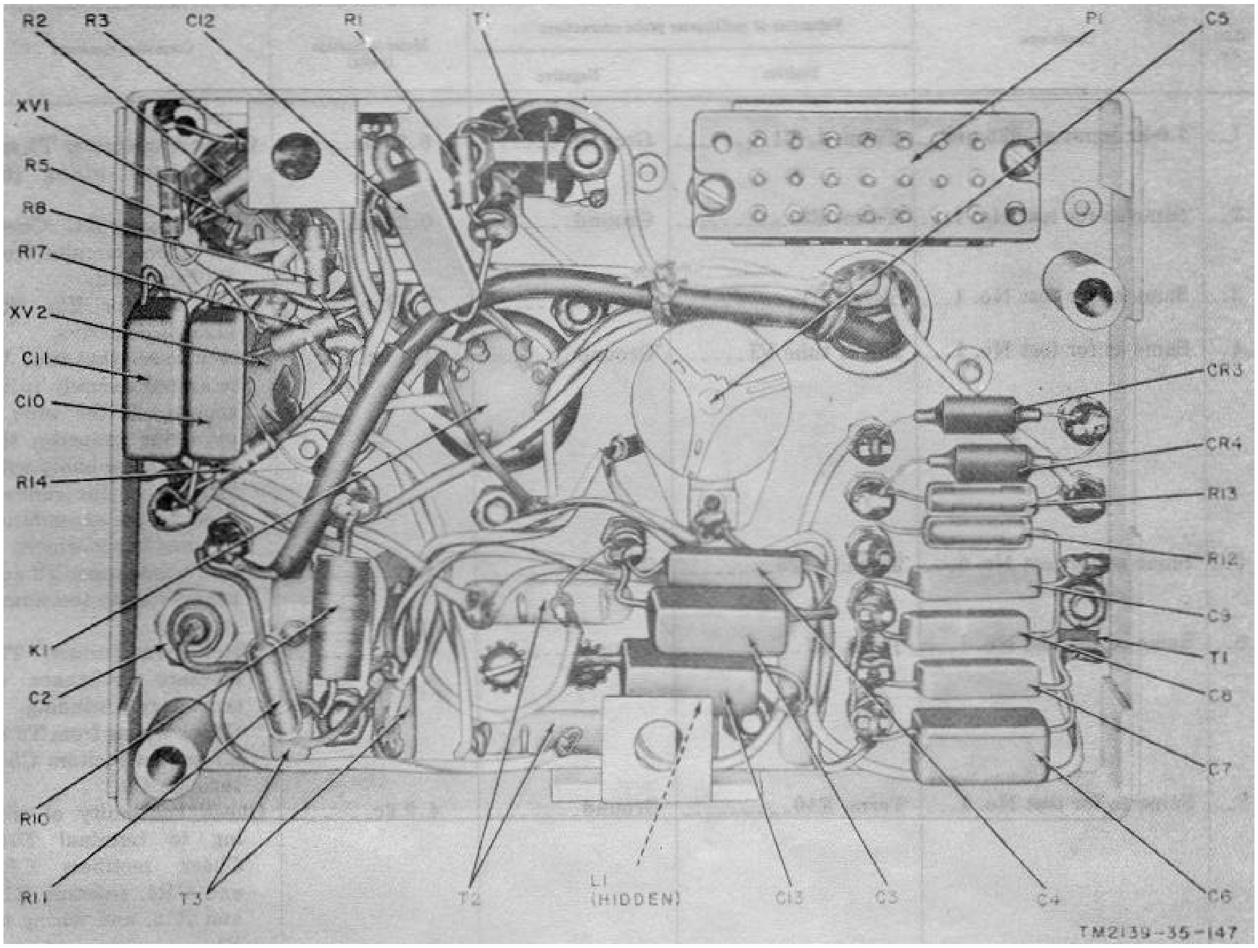


Figure 102. Ringer oscillator Y101 (part of ORDER WIRE PANEL), bottom view, parts location.

147. Ringer Oscillator Y101, Signal Substitution Tests

The signal substitution tests given in the following chart are used to supplement the troubleshooting chart in paragraph 146. Once the trouble has been localized to a specific stage, voltage and resistance measurements should be sufficient to isolate the defective part. The procedure for preparing ringer oscillator Y101 for the signal substitution tests is given in *a* through *e* below.

a. Follow the pretest setup procedure (par. 145*a*) and short terminal 2 to terminal 5 on the modem and amplifier test cable assembly (fig. 100).

b. Connect the signal generator to the attenuator through a protective pad consisting of one 600-ohm resistor and two 6,800-ohm resistors (fig. 100). Set the attenuator for 30-db loss.

c. Connect the output binding posts of the attenuator to the transformer primary winding. Connect the transformer secondary winding to terminals 0 and 1 of the modem and amplifier test cable assembly.

d. Connect the voltmeter to terminals 0 and 1 of the modem and amplifier test cable. Adjust the output of the signal generator for the proper frequency and adjust the voltmeter for an indication as determined by the *Conditions* column of the signal substitution chart.

e. Use the voltmeter for ac test measurements and the multimeter for dc test measurements.

Note. Adjust the attenuator to any setting necessary to obtain the required signal generator output reading as measured on the voltmeter.

Test No.	Conditions	Voltmeter or multimeter probe connections		Meter Indication (volts)	Corrective measures
		Positive	Negative		
1	1.6-kc input at .025 volt	Term. 4, T1	Ground	0.23 ac	Check transformer T1 and associated wiring (fig. 27).
2	Same as for test No. 1	Term. E3	Ground	0.20 ac	Check resistor R1. Check for short circuits from E3 to ground.
3	Same as for test No. 1	Term. E1	Ground	0.19 ac	Check resistor R3. Replace if defective.
4	Same as for test No. 1	Pin 4, tube V1	Ground	1.1 ac	Check to see that tube V1 is seated securely in its socket. If the tube is operating properly, the trouble is probably with T2, T3, or the connections to the secondaries of these transformers.
5	Same as for test No. 1	Pin 4, tube V1	Ground	1 ac	Check transformer T3 and connection to secondary winding.
6	Same as for test No. 1	Term. E7	Ground	8 ac	Check transformer T3; measure resistance of secondary winding. Check wiring from T3 to E7 and capacitors C5 through C9.
7	Same as for test No. 1	Term. E10	Ground	4.9 ac	Check continuity of wiring to terminal E10. Check rectifiers CR3 and CR4, resistors R12 and R13, and wiring to P1.
8	Same as for test No. 1	Term. E6	Ground	-6.1 dc	Check resistor R15 and capacitor C11. Replace if defective.
9	Same as for test No. 1	Term. E2	Ground	-6.1 dc	Check C10, R17, R14; check continuity of connection from E6 to C10, R14, C13, terminal 8 of T2, and terminal 1 of L1.
10	1-kc input at .1 volt	Pin 4, tube V1	Ground	1.5 ac	Check to see that tube V1 is seated securely in its socket. Check connections to primary of T2. If connections to primary are normal and primary is not short-circuited, proceed to next test.
11	1-kc input at .1 volt with external ground on terminal E6.	Term. E15	Term. E6	9.4 ac	Check T2, L1, C3, C4, C13, and associated wiring. Replace defective part.
12	Same as for test No. 11	Term. E2	Term. E6	3.8 dc	Check R17, R14, C10, and tube V2.

148. Dc Resistance of Transformers and Coil

a. Main Chassis.

Transformers	Terminals	Resistance (ohms)
T101 and T102.............	1-2	10
	3-4	11.5
	5-6	44.5
T103.............................	1-2	61.5
	3-4	75.5
	5-6	90
T104.............................	1-3	51.5
	4-6	51.5
	7-8	27.5
	9-10	27.5
T105.............................	1-2	61.5
	3-4	75.5
	5-6	90

b. Transmitting Amplifier AR101.

Transformers	Terminals	Resistance (ohms)
T1.................................	1-3	100
	4-6	4,300
T2.................................	1-3	57
	4-5	235
	6-8	2,850

c. Receiving Amplifier AR102.

Transformers	Terminals	Resistance (ohms)
T1.................................	1-3	100
	4-6	4-300
T2.................................	1-3	57
	4-5	235
	6-8	2,850

d. Ringer Oscillator Y101.

Transformers	Terminals	Resistance (ohms)
T1.................................	1-3	100
	4-6	4,300
T2.................................	1-3	54
	4-5	215
	6-8	2,570
T3.................................	1-2	25
	3-4	100
	4-5	210
	3-5	310
L1.................................		740

Section VIII. TELEPHONE CARRIER FREQUENCY SUPPLY TA-228/TCC-7

149. Troubleshooting. Data

Fig. No.	Par. No.	Description
20	....	Schematic diagram.
(TM 11-2139-20, fig. 11).	....	Tube socket voltage and resistance diagram.
104	....	Resistor board, physical and wiring diagram.
105 and 106	....	Top view, location of parts.
107,108, and 109.	....	Bottom view, location of parts.
150	....	Wiring diagram.
	153	Dc resistance of transformers and coils.

150. Carrier Supply Panel Tests

(fig. 103)

a. Initial Procedures.

(1) Connect the carrier supply transmission, and supply test cable assemblies to the CARRIER SUPPLY PANEL as shown in figure 103.

(2) Connect the resistors across the appropriate terminals of the test cable assemblies as shown in figure 103.

Note. Throughout the following tests, the CARR SYNC switch should be operated to the LOCAL position unless otherwise specified.

Figure 103. CARRIER SUPPLY PANEL, operational and final test setup.

(Contained in separate envelope)

b. Carrier Frequency Output Test.

(1) Connect the voltmeter to terminals C and L, A and J. D and E, and H and R on the transmission test cable assembly. The voltmeter should indicate .75 ± .25 volt for each test.

(2) Connect the voltmeter to terminals C and M, D and N. E and P and F and R on the carrier supply test cable assembly. The voltmeter should indicate .82 ± .25 volt for each test.

e. Pilot Frequency Output Test.

(1) Adjust the 68KC control to its extreme clockwise position.

(2) Connect the voltmeter across terminals H and J on the supply test cable assembly with terminal J as ground; the voltmeter should indicate at least .0075 volt.

d. 12 and 28 Kc Test Frequency Output Test.

(1) Operate the 12 & 28KC switch to the ON position and operate the 12KC control to its extreme clockwise position.

(2) Strap terminals 3 and 4 on filter FL4 and FL5 (fig. 105).

(3) Connect the voltmeter across terminals H and J on the supply test cable assembly (fig. 103) with terminal J as ground; the voltmeter should indicate at least .003 volt.

(4) Operate the 12KC control to its extreme counterclockwise position and adjust the 28KC control to its extreme clockwise position. The voltmeter ((3) above) should indicate at least .003 volt.

e. Test Jack Test.

(1) Connect the voltmeter across terminals T_1 and R of the test plug assembly with terminal R as ground.

(2) Insert the plug of the test plug assembly into each jack on the CARRIER SUPPLY PANEL except the SYNC jack. The voltmeter should indicate .75 ± .25 volt for each jack tested.

f. Local Oscillator Frequency Test.

(1) Connect the frequency meter across the T_1 and R terminals of the test plug assembly.

(2) Insert the plug of the test plug assembly into the 64KC LOCAL jack on the CARRIER SUPPLY PANEL. The frequency meter should indicate an output of 64 kc ± 5 cps.

g. Test Jack Test for Remote Control.

(1) Operate the CARR SYNC switch to the REMOTE position.

(2) Connect the signal generator across terminals F and P on the transmission test cable assembly. Adjust the signal generator for an output frequency of 68 kc at an output level of .75 volt measured across terminals F and P.

(3) Connect the voltmeter across terminals T_1 and R of the test plug assembly with terminal R as ground. Insert the plug of the test plug assembly into the jacks listed in the chart below. The voltmeter indication for each test jack is given in the following chart.

Test jack	Volts (ac)
64KC LOCAL....................	Less than .2
SYNC................................	.75 ± .25
64KC REM........................	.75 ± .25
DIV 1................................	.75 ± .25

h. Miscellaneous Continuity Tests.

(1) Remove power from the CARRIER SUPPLY PANEL.

(2) Use the multimeter arranged as an ohmmeter to perform the following tests.

(3) Connect the test leads of the multimeter between the supply test cable assembly terminals and the terminals of the other test cable assemblies. The multimeter should indicate zero resistance for each check.

Supply test test cable assembly	Carrier supply test cable assembly connected to		
	(P1)	(P2)	(P3)
C..................	....	....	B
D..................	....	....	L
A..................	A	A	A
K..................	K	K	K
M..................	B	B	
N..................	L	L	

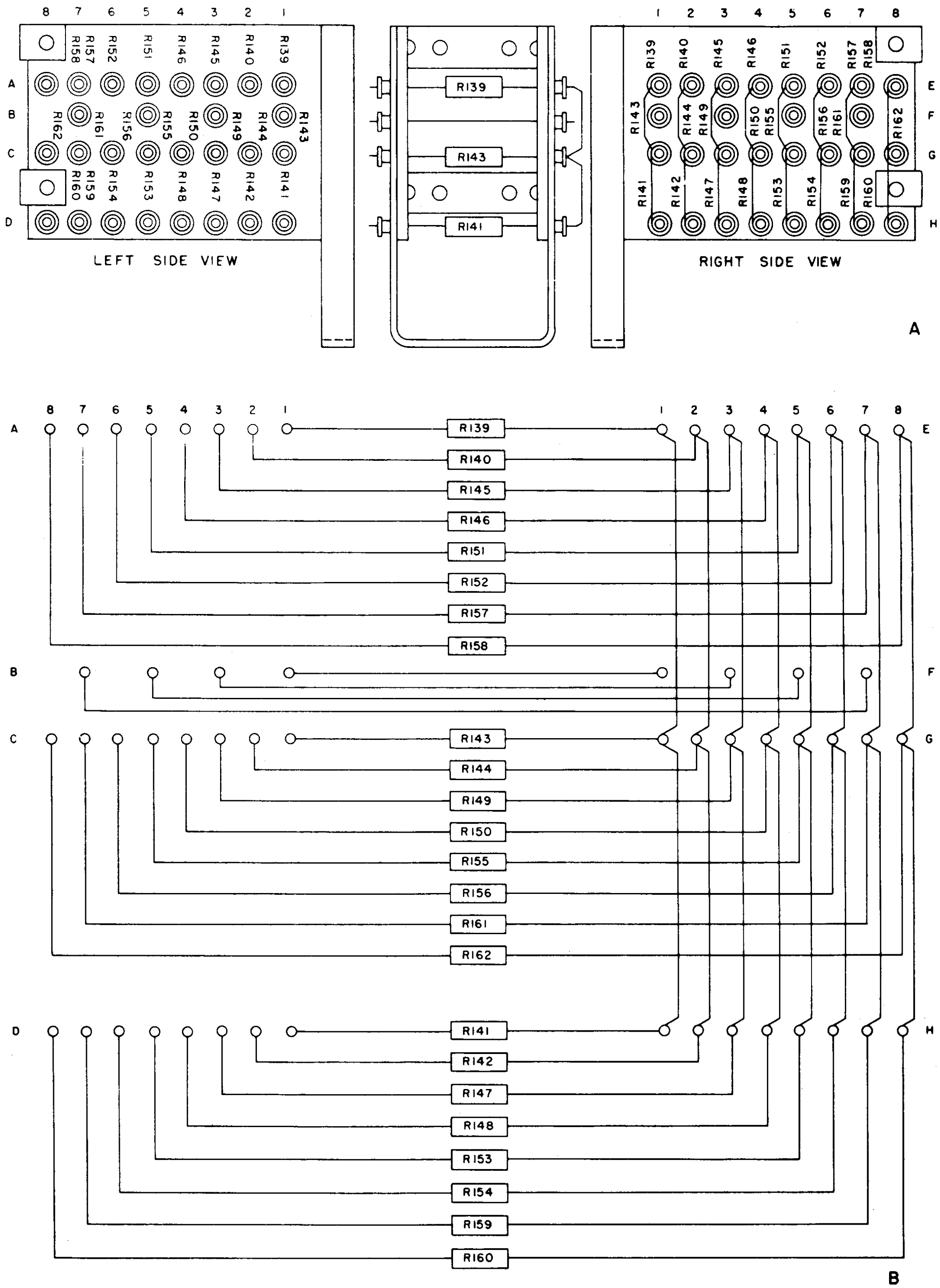
151. CARRIER SUPPLY PANEL Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in the CARRIER SUPPLY PANEL. This chart lists the symptoms that may be reported on the equipment repair tag or observed when performing maintenance at the organizational level (TM 11-2139-20). Once the trouble has been localized to the proper circuit, a tube check and a voltage and resistance measurement (TM 11-2139-20, fig. 11) should be sufficient to isolate the defective part.

Symptom	Probable trouble	Corrective measures
1. No carrier or pilot or test signal outputs (par. 150*b* through *e*).	*a.* Failure of +200-volt dc distribution circuits. *b.* Failure of 6.3-volt ac distribution circuits. *c.* Failure of 64-kc oscillator divider, or 4-kc amplifier circuits.	*a.* Check for presence of 200 volts dc. between standoff terminal E2 and ground. If not present, refer to figure 20. *b.* Check for presence of 6.3 volts ac across terminals 3 and 4 of V2 tube socket with terminal 3 ground. If voltage is not present, check the 6.3-volt ac distribution circuits and locate open or shorted circuits. *c.* Follow procedures in symptoms 2, 3, and 4.
2. Output at 64KC LOCAL jack, out of limits (par. 150*e*).	Failure of 64-kc oscillator or local amplifier circuits.	*a.* Check V1 and V2 tube socket voltages. *b.* Use signal substitution procedures (par. 152, tests No. 1, 2, and 3) to localize trouble.
3. Output at DIV 1 jack out of limits.	Failure of first divider circuits	*a.* Check output at 64KC LOCAL jack. *b.* Check V4 tube socket voltages. *c.* Use signal substitution procedures (par. 152, tests No. 4 through 9) to localize the trouble.
4. Output at DIV 2 jack out of limits.	Failure of second divider circuit	*a.* Check output at DIV 1 jack. *b.* Check V5 tube socket voltages. *c.* Use signal substitution procedures (par. 152, tests No. 10 through 14) to localize the trouble.
5. Output at 4 KC jack out of limits.	Failure of 4-kc amplifier circuit	*a.* Check output at DIV 2 jack. *b.* Check V6 tube socket voltages. *c.* Use signal substitution procedures (par. 152, tests No. 15 through 19) to localize the trouble.
6. Output at 8 KC, 12 KC, 16 KC, 20 KC, 56 KC, 72 KC, 88 KC, and 120 KC jacks out of limits.	Failure of odd harmonic generator circuit.	*a.* Check output at 4 KC jack. *b.* Use signal substitution procedures (par. 152, tests No. 20, 21, and 22) to localize the trouble.
7. Output at 8 KC, 16 KC, 56 KC, 72 KC, 88 KC, and 120 KC jacks out of limits.	Failure of even harmonic generator circuit.	*a.* Check output at jacks listed in symptom No. 6. *b.* Use signal substitution procedures (par. 162, test No. 23) to localize the trouble.
8. Output at 8 KC jack out of limits.	Failure of 8-kc filter and amplifier circuit.	*a.* Check output at 4 KC jack. *b.* Check V11 tube socket voltages. *c.* Use signal substitution procedures (par. 152, tests No. 24 through 28) to localize the trouble.
9. Output at 12 KC jack out of limits.	Failure of 12-kc filter and amplifier circuit.	*a.* Check output at 4 KC jack. *b.* Check V10 tube socket voltages. *c.* Use signal substitution procedures (par. 152, tests No. 29 through 34) to localize trouble.

Symptom	Probable trouble	Corrective measures
10. Output at 16 KC jack out of limits.	Failure of 16-kc filter and amplifier circuit.	*a.* Check V12 tube socket voltages. *b.* Use signal substitution procedures (par. 152, tests No. 35 through 41) to localize trouble.
11. Output at 20 KC jack out of limits.	Failure of 20-kc filter and amplifier circuit.	*a.* Check output at 4 KC jack. *b.* Check V9 tube socket voltages. *c.* Use signal substitution procedures (par. 152, tests No. 42 through 47) to localize trouble.
12. Output at 56 KC jack out of limits.	Failure of 56-kc filter and amplifier circuit.	*a.* Check output at 4 KC jack. *b.* Check V13 tube socket voltages. *c.* Use signal substitution procedures (par. 152, tests No. 48 through 53) to localize trouble.
13. Output at 72 KC jack out of limits.	Failure of 72-kc filter and amplifier circuit.	*a.* Check V14 tube socket voltages. *b.* Use signal substitution procedures (par. 152, tests No. 54 through 59) to localize trouble.
14. Output at 88 KC jack out of limits.	Failure of 88-kc filter and amplifier circuit.	*a.* Check output at 4 KC jack. *b.* Check V15 tube socket voltages. *c.* Use signal substitution procedures (par. 152, tests No. 59 through 65) to localize trouble.
15. Output at 120 KC jack out of limits.	Failure of 120-kc filter and amplifier circuit.	*a.* Check output at 4 KC jack. *b.* Check V16 tube socket voltages. *c.* Use signal substitution procedures (par. 152, tests No. 66 through 71) to localize trouble.
16. Output at terminals C and M of carrier supply test cable assembly out of limits.	Failure of output circuits of 8-kc carrier frequency.	*a.* Check output at 8 KC jack. *b.* Check circuits between T19 and P1, P2, and P3 for open or shorted circuits.
17. Output at terminals D and N of carrier supply test cable assembly out of limits.	Failure of output circuits of 12-kc carrier frequency.	*a.* Check output at 12 KC jack. *b.* Check circuits between T17 and P1, P2, and P3 for open or shorted circuits.
18. Output at terminals E and · of carrier supply test cable assembly out of limits.	Failure of output circuits of 16-kc carrier frequency.	*a.* Check output at 16 KC jack. *b.* Check circuits between T20 and P1, P2, and P3 for open or shorted circuit.
19. Output at terminals F and R of carrier supply test cable assembly out of limits.	Failure of output circuits of 20-kc carrier frequency.	*a.* Check output at 20 KC jack. *b.* Check circuits between T15 and P1, P2, and P3 for open or shorted circuits.
20. Output at terminals C and L of transmission test cable assembly.	Failure of output circuits of 56-kc carrier frequency.	*a.* Check output at 56 KC jack. *b.* Check circuits between T21 and J15 for open or shorted circuits.
21. Output at terminals A and J of transmission test cable assembly.	Failure of output circuits of 72-kc carrier frequency.	*a.* Check output at 72 KC jack. *b.* Check circuits between T22 and J15 for open or shorted circuits.
22. Output at terminals D and E of transmission test cable assembly.	Failure of output circuits of 88-kc carrier frequency.	*a.* Check output at 88 KC jack. *b.* Cheek circuits between T23 and J15 for open or shorted circuits.
23. Output at terminals H and R of transmission test cable assembly.	Failure of output circuits at 120-kc carrier frequency.	*a.* Check output at 120 KC jack. *b.* Check circuits between T24 and J15 for open or shorted circuits.
24. Pilot frequency output at terminals H and J of supply test cable assembly out of limits.	Failure of filter FL5 or 68-kc output circuits.	*a.* Check output at 4 KC jack. *b.* Use signal substitution procedures (par. 152, tests No. 75 and 76) to localize trouble.

Symptom	Probable trouble	Corrective measures
25. 12-kc test frequency output at terminals H and J of supply test cable assembly out of limits.	Failure of filter FL3 or 12-kc output circuits.	*a.* Check output at 4 KC jack. *b.* Use signal substitution procedures (par. 152, tests No. 74 and 75) to localize trouble.
26. 28-kc test frequency output at terminals H and J of supply test cable assembly out of limits.	Failure of filter FL4 or 28-kc output circuits.	*a.* Check output at 4 KC jack. *b.* Use signal substitution procedures (par. 152, tests No. 72 through 75) to localize trouble.
27. Synchronizing signal output at SYNC jack out of limits.	Failure of synchronizing signal input circuits.	Check circuits between J15 and J6 (SYNC) for open or shorted circuits
28. Synchronizing signal output at 64KC REM jack out of limits.	Failure of synchronizing signal modulator and 64-kc remote amplifier circuits.	*a.* Check output at SYNC jack. *b.* Check V7 tube socket voltages. *c.* Use signal substitution procedures (par. 152, tests No. 80 through 87) to localize trouble.
29. Output from synchronizing signal at DIV 1 jack out of limits.	Failure of connections between 64-kc remote amplifier and divider circuits.	*a.* Check output from local oscillator at DIV 1 jack. *b.* Check circuits between T13 and standoff terminals E10 and E11 for open or shorted circuits.
30. Output at 64KC LOCAL jack out of limits (par. 150g)) (CARR SYNC switch in REMOTE position).	Failure of blocking circuit for 64-kc local signal.	*a.* Check output at 64KC REM jack. *b.* Check V3 tube socket voltages. *c.* Check resistors R16 through R19 and capacitor C9. Replace defective parts. *d.* Cheek circuits associated with tube V3 for open or shorted circuits.
31. 68-kc visual or audible alarm indication. No 120-kc alarm indication.	Failure of 68-kc distribution circuit or alarm circuit associated with tube V8.	*a.* Check the 68-kc output at terminals H and J of J16. *b.* If normal indication is obtained in correction a, use signal substitution procedures (apr. 152, test No. 77). *c.* If normal indication is obtained in correction *b,* check V7 tube socket voltages and resistances. Check resistors and capacitors associated with the tube socket terminals. Replace defective parts. *d.* Check resistors R64 and R65. Replace if defective. *e.* Check capacitors C23 through C26. Replace if defective. *f.* Check varistors CR6 and CR7. *g.* Check relay K1.
32. 120-kc visual or audible alarm indication. No 68-kc alarm indication.	Failure of 120-kc distribution circuit associated with tube V8.	*a.* Check output at 120 KC jack. *b.* If normal indication is obtained in correction *a,* use signal substitution procedures (par. 152, tests No. 78 and 79) to localize trouble. *c.* If normal indication is obtained in correction *b,* check V7 tube socket voltages and resistances. Check resistors and capacitors associated with the tube socket terminals. Replace defective parts. *d.* Check relay K2. Replace if defective.
33. 68-kc and 120-kc visual or audible alarm indications.	Failure of the carrier and pilot producing circuits or alarm circuits associated with tube V8.	*a.* Check output of test jacks. *b.* If normal indications are obtained in correction *a,* follow procedures in symptoms 31 and 32 of this chart.



NOTES

1 SECTION A SHOWS PICTORIAL VIEWS OF THE RESISTOR BOARD ASSEMBLY; SECTION B SHOWS A PROJECTION OF THE RESISTOR BOARD ASSEMBLY.

2 SIMILAR ARBITRARY REFERENCES A THROUGH H, AND 1 THROUGH 8, HAVE BEEN ASSIGNED ON BOTH SECTIONS, FOR EXAMPLE, SECTION A IS IDENTICAL TO A1 ON SECTION B.

TM2139-35-149

Figure 104. CARRIER SUPPLY PANEL, resistor board wiring diagram.

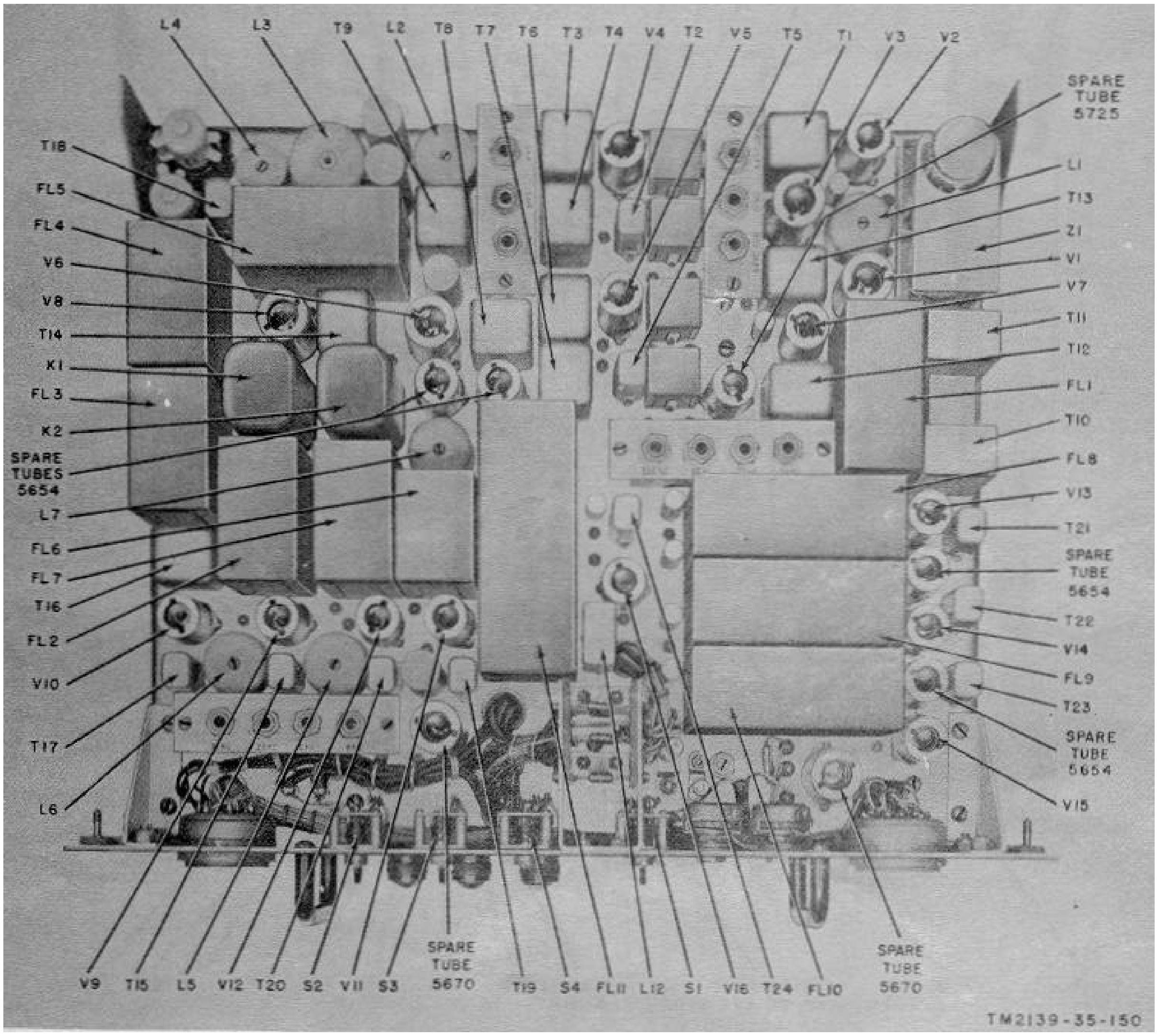


Figure 105. Telephone Carrier Frequency Supply TA-228/TCC-7, removed from transit case, top view, parts location.

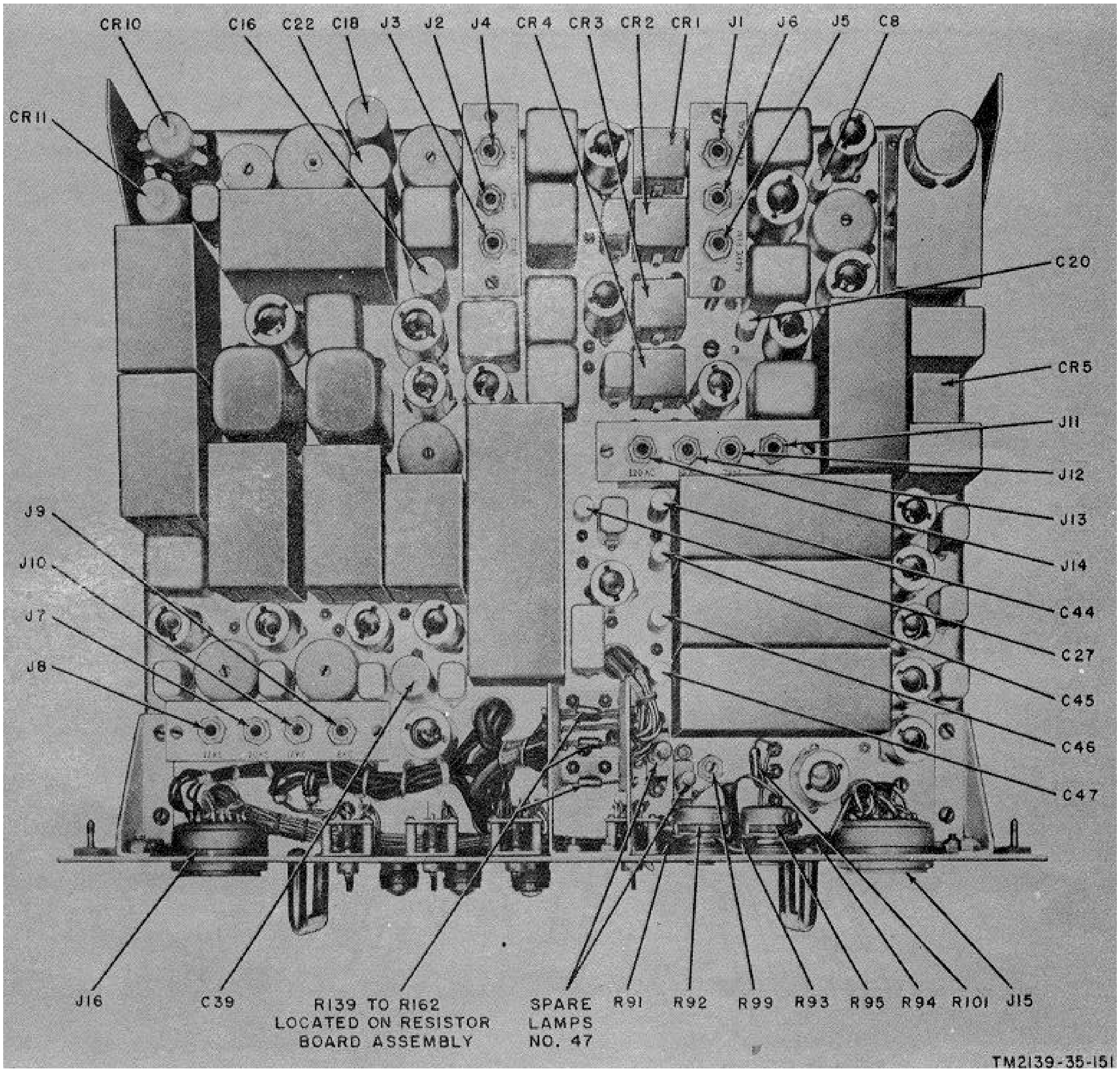


Figure 106. Telephone Carrier Frequency Supply TA-228/TCC-7, removed from transit case, top view, showing location of capacitors and test jacks.

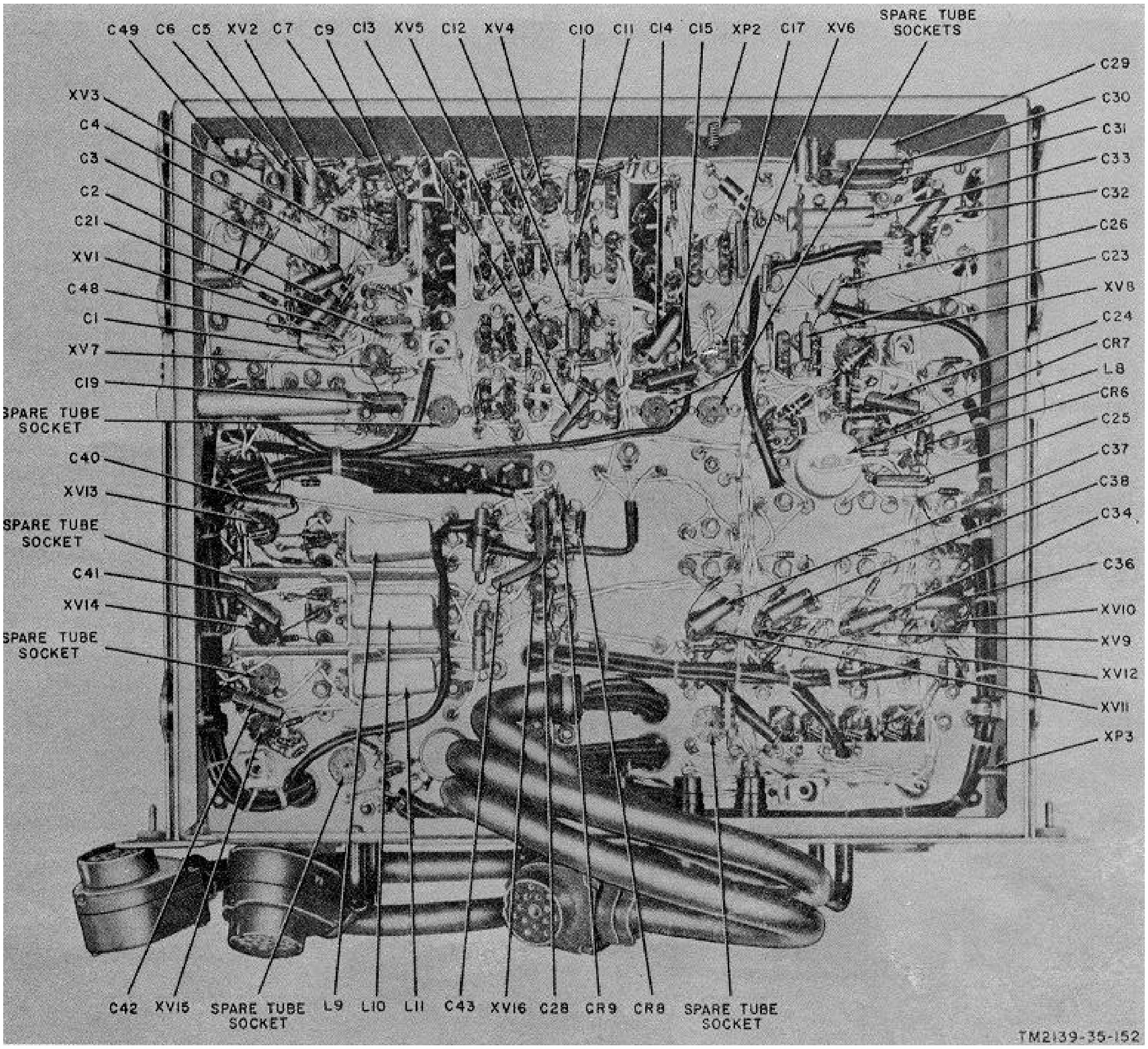


Figure 107. Telephone Carrier Frequency Supply TA-228/TCC-7, bottom view, showing location of coils, capacitors and tube sockets.

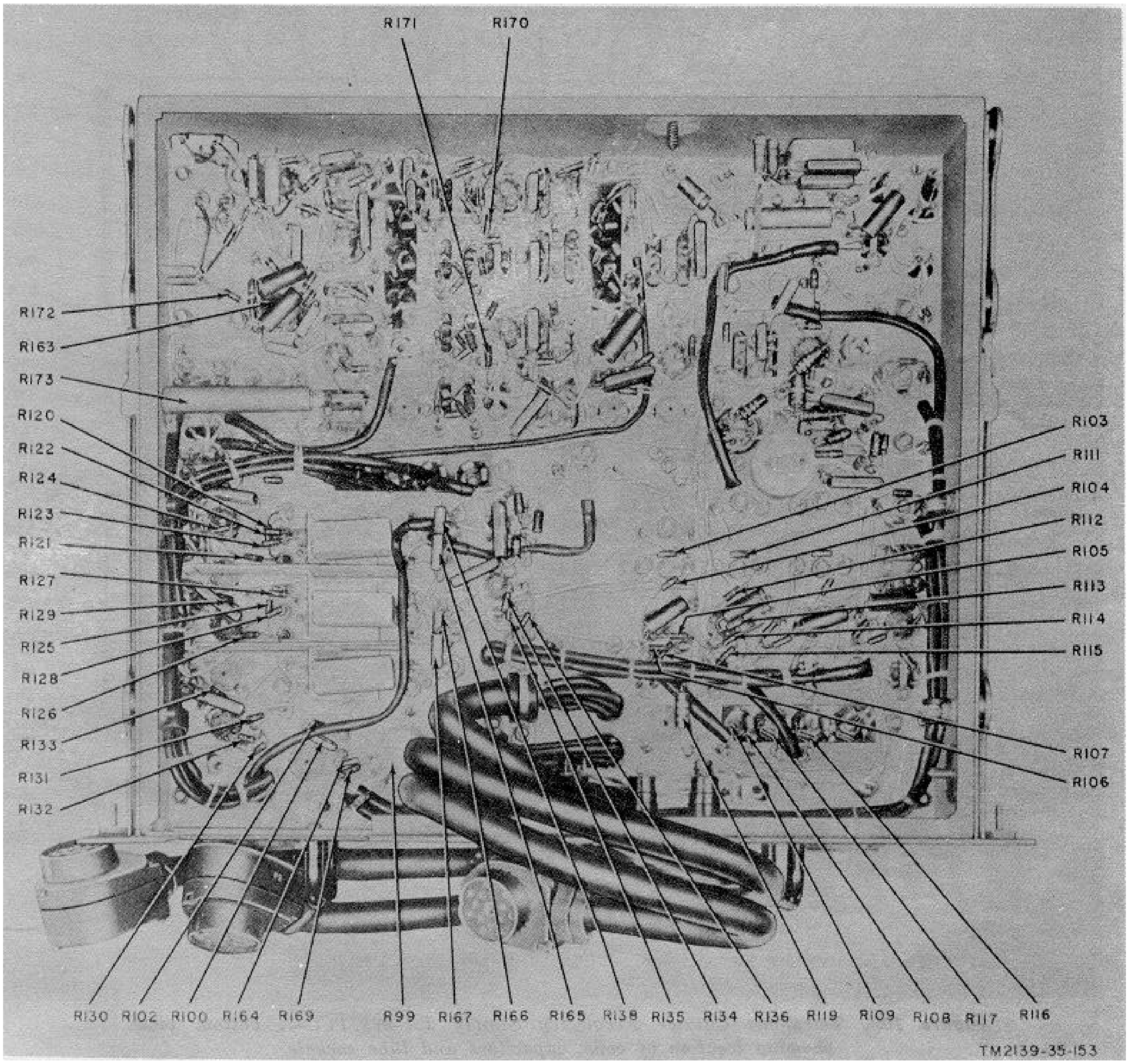


Figure 108. Telephone Carrier Frequency Supply TA-228/TCC-7, bottom view, showing location of resistors from R99 to R173.

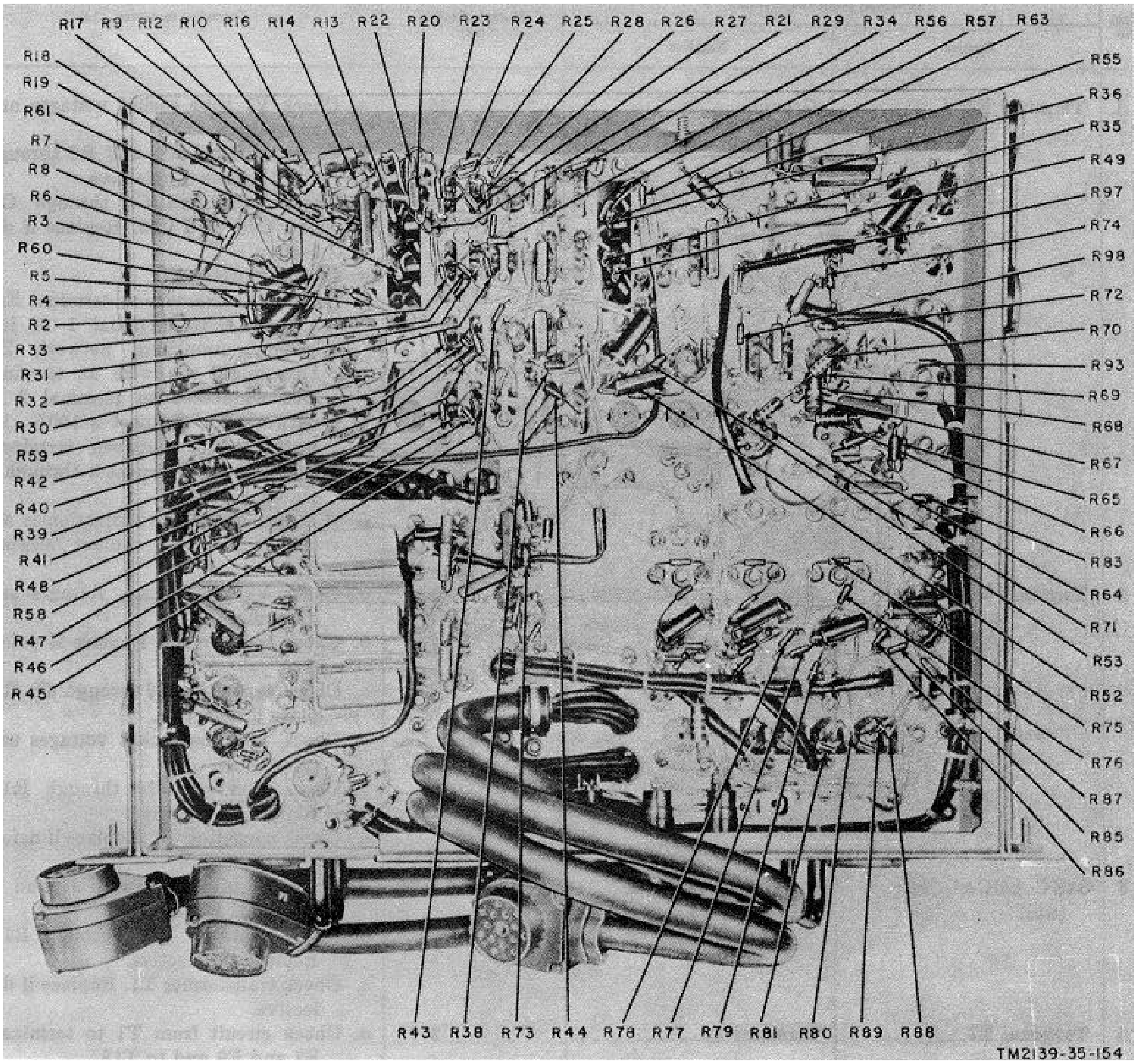


Figure 109. Telephone Carrier Frequency Supply TA-228/TCC-7, bottom view, showing location of resistors up to R98.

152. CARRIER SUPPLY PANEL Signal Substitution Chart

The signal substitution chart is used to supplement the troubleshooting procedures outlined in paragraph 151. The chart will aid in determining the defective stage or circuit. Voltage and resistance measurements are ordinarily sufficient to isolate the defective part in the defective stage or circuit. In each step of the signal substitution procedure, it is assumed that all previous steps have been satisfactorily completed. Use the pretest setup given in paragraph 150*a* except where indicated.

Test No	Voltmeter probe connections		Meter indication (ac)	Corrective measure
	Positive	Negative		
1	Terminal E4	Ground.........................	30	*a*. Check V1 tube socket voltages and resistances. *b*. Check resistors R2, and R5 through R8. Replace if defective. *c*. Check capacitors C1 through C5, and C48, and C49. Replace if defective. *d*. Check inductor L1. *e*. Disconnect the wire at terminal E61 connected to terminal 1 of frequency stabilizing network Z1. Disconnect the wire at terminal E62 connected to terminal 2 of network Z1. Connect a 100K, 1/2 watt resistor between terminals E61 and E62. Repeat *a* through *d* above. *f*. If a normal voltage indication is obtained in step *e*, replace network Z1.
2	Terminal 6 of T1	Ground.........................	80	*a*. Check V2 tube socket voltages and resistances. *b*. Check resistor R9. Replace if defective. *c*. Check capacitors C6 through C8. Replace if defective. *d*. Check V3 tube socket voltages and resistances. *e*. Check resistors R16 through R18. Replace if defective. *f*. Check capacitor C9. Replace if defective.
3	64KC LOCAL jack (tip).	64KC LOCAL jack (ring).	.75	*a*. Check circuit from T1 to J1 and to terminals E6 and E7. *b*. Check resistors R13 through R15. Replace if defective. *c*. Check transformer T1. Replace if defective.
4	Terminal E7	Terminal E9.................	2.7	*a*. Check circuit from T1 to terminals E7 and E9 and to T13. *b*. Check resistors R20 through R28. Replace if defective.
5	Terminal E10	Terminal E11...............	2.7	*a*. Check circuit from terminals E7 and E9 to terminals E10 and E11. *b*. Check resistors R24 through R27. *c*. Check varistor CRT. Replace if defective.
6	Terminal 1 of CR1..	Terminal 4 of CR1	.45	*a*. Check circuit from terminals E7 and E9 to terminals E13 and E14. *b*. Check V4 tube socket voltages and resistances. *c*. Check resistors R23 through R27 and R29 and R170. Replace if defective. *d*. Check capacitors C10 and C22. Replace if defective. *e*. Check transformers T2 and T3. Replace if defective. *f*. Check varistor CRT. Replace if defective.

Test No	Voltmeter probe connections		Meter indication (ac)	Corrective measure
	Positive	Negative		
7	Terminal E13	Terminal E14	3.8	*a*. Check circuit from T3 to terminals E13 and E14. *b*. Check resistors R30 through R33. Replace if defective. *c*. Check varistor CR2. Replace if defective.
8	Terminal 1 of CR2..	Terminal 4 of CR2	.5	*a*. Perform test No. 7. *b*. Check resistor R34. Replace if defective. *c*. Check capacitor C11. Replace if defective. *d*. Check transformer T4. Replace if defective.
9	DIV 1 jack (tip)	DIV 1 jack (ring)..........	.75	*a*. Check circuit from T4 to J2 and terminals E16 and E17. *b*. Check resistors R35 through R37. Replace if defective.
10	Terminal E16	Terminal E17	2.7	*a*. Check circuit from T4 to terminals E16 and E17. *b*. Check resistors R39 through R42. Replace if defective. *c*. Check varistor CR3. Replace if defective.
11	Terminal 1 of CR3..	Terminal 4 of CR3	.55	*a*. Check circuit from T4 to terminals E19 and E20. *b*. Check V5 tube socket voltages and resistances. *c*. Check resistors R39 through R42 and R171. Replace if defective. *d*. Check capacitor C12. Replace if defective. *e*. Check transformers T5 and T6. Replace if defective. *f*. Check varistor CR3. Replace if defective.
12	Terminal E19	Terminal E20	3	*a*. Check circuit from T6 to terminals E19 and E20. *b*. Check resistors R45 through R48. Replace if defective. *c*. Check varistor CR4. Replace if defective.
13	Terminal 1 of CR4..	Terminal 4 of CR4	.6	*a*. Perform test No. 12. *b*. Check resistor R44. Replace if defective. *c*. Check capacitor C13. Replace if defective. *d*. Check transformer T7. Replace if defective.
14	DIV 2 jack (tip)	DIV 2 jack (ring)..........	.75	*a*. Check circuit from T7 to J3 and T8. *b*. Check resistors R49 through R51. Replace if defective.
15	Terminal 4 of T8	Terminal 1 of T8	26.2	*a*. Check circuit from T7 to T8. *b*. Check capacitor C14. Replace if defective.
16	Terminal 3 or 7 of V6 tube socket.	Ground.........................	23	*a*. Check circuit from T8 to V6 tube socket. *b*. Check resistors R52 and R53. Replace if defective. *c*. Check capacitor C15. Replace if defective.

Test No	Voltmeter probe connections		Meter indication (ac)	Corrective measure
	Positive	Negative		
17	Terminal 7 of V6 tube socket.	Ground.........................	23	See corrective measures for test No. 16*a* through *c*.
18	Terminal 7 or terminal 5 of T9.	Ground.........................	82	*a.* Check V6 tube socket voltages and resistances. *b.* Check capacitors C16, C17, and C18. Replace if defective. *c.* Check inductor L2. Replace if defective.
19	Terminal 4 of T9	Ground.........................	9.2	*a.* Check circuit from T9 to J4, T10, and CR10. *b.* Check transformer T9. Replace if defective.
20	4 KC jack (tip)	4 KC jack (ring)...........	8.5	*a.* See corrective measures for test No. *19a* and *b*. *b.* Check resistors R55 and R56. Replace if defective.
21	Terminal 1 of L4.....	Ground.........................	8.5	*a.* See corrective measures for test No. 19*a* and b. *b.* Check circuit from L4 to FL2, FL3, FL4, FL5, and T18. *c.* Check resistor R74. Replace if defective. *d.* Check capacitors C29 through C33. Replace if defective. *e.* Check inductors L3 and L4. Replace if defective.
22	Terminal 1 of FL5 ..	Ground.........................	1.3	See corrective measures for test No. 21*a* through *e*.
23	Terminal 6 of T18...	Ground.........................	3.3	*a.* Follow test No. 21*a* through *e*. *b.* Check circuits from T18 to FL6, FL7, FL8, FL9, FL10, and FL11. *c.* Check transformer T18. Replace if defective.
24	Terminal 1 of V11 tube socket.	Ground.........................	15	*a.* Check circuit from FL6 to V11. *b.* Check resistors R103 and R104. Replace if defective. *c.* Check filter FL6.
25	Terminal 6 of T19...	Ground.........................	40	*a.* Check V11 tube socket voltages and resistances. *b.* Check resistors R106 and R107. Replace if defective. *c.* Check inductor L7. Replace if defective. *d.* Check capacitor C37. Replace if defective.
26	Terminal 3 of T19...	Terminal 1 of T19	1.4	*a.* Check circuit from T19 to J9, P1, P2, and P3. *b.* Check transformer T19. Replace if defective.
27	8 KC jack (tip)	8 KC jack (ring)...........	.75	*a.* Check circuit from T19 to J9. *b.* Check resistors R108 through R110. Replace if defective.
28	Terminal C of P1, P2, and P3.	Terminal M of P1, P2, and P3.	.82	*a.* Check circuit from T19 to P1, P2, and P3. *b.* Check resistors R151 through R156. Replace if defective.
29	Terminals 3 of FL3.	Ground.........................	.52	*a.* Check circuit from FL3 to T16 and S4.

Test No	Voltmeter probe connections		Meter indication (ac)	Corrective measure
	Positive	Negative		
				b. Check resistor R83. Replace if defective. *c*. Check filter FL3. Replace if defective.
30	Terminal 1 of V10 tube socket	Ground.........................	15	*a*. Check circuit from T16 to V10. *b*. Check resistor R84. Replace if defective. c. Check capacitor C35. Replace if defective. *d*. Check transformer T16. Replace if defective.
31	Terminal 6 of T17...	Ground.........................	40	*a*. Check V10 tube socket voltages and resistances. *b*. Check resistors R86 and R87. Replace if defective. c. Check capacitors C35 and C36. Replace if defective. *d*. Check inductor L6. Replace if defective.
32	Terminal 3 of T17...	Terminal 1 of T17	1.4	*a*. Check circuit from T17 to J8, P1, P2, and P3. *b*. Check transformer T17. Replace if defective.
33	12 KC jack (tip)......	12 KC jack (ring)	.75	*a*. Check circuit from T17 to J8. *b*. Check resistors R88 through R90. Replace if defective.
34	Terminal D of P1, P2, and P3.	Terminal N of P1, P2, and P3.	.82	*a*. Check circuit from T17 to P1, P2, and P3. *b*. Check resistors R145 through R150. Replace if defective.
35*	Terminal H of J16...	Terminal J of J16	.003	*a*. Check circuit from FL3 to terminals H and J of J16. *b*. Check resistors R91, R92, R96, R100, R101, and R102. Replace if defective. *c*. Check switch contacts of S4. Replace switch if defective.
36	Terminal 3 of FL7 ..	Ground.........................	14	*a*. Check circuit from FL7 to V12. *b*. Check resistors R111 and R112. Replace if defective. *c*. Check filter FL7. Replace if defective.
37	Terminal 1 of V12 ..	Ground.........................	14	See corrective measures for test No. 36*a* through *c*.
38	Terminal 6 of T20...	Ground.........................	40	*a*. Check V12 tube socket voltages and resistances. *b*. Check resistors R114 and R115. Replace if defective. *c*. Check capacitor C38. Replace if defective. *d*. Check inductor L8. Replace if defective.
39	Terminal 3 of T20...	Terminal 1 of T20	1.4	*a*. Check circuit from T20 to J10, P1, P2, and P3. *b*. Cheek transformer T20. Replace if defective.
40	16 KC jack (tip)......	16 KC jack (ring)	.75	*a*. Check circuit from T20 to J10. *b*. Check resistors R116, R117, and R118. Replace if defective.

* See paragraph-150d(l) and (2), test setup.

Test No	Voltmeter probe connections		Meter indication (ac)	Corrective measure
	Positive	Negative		
41	Terminal E of P1, P2, and P3.	Terminal of P1, P2, and P3.	.82	*a*. Check circuit from T20 to P1, P2, and P3. *b*. Check resistors R157 through R162. Replace if defective.
42	Terminal 3 of FL2 ..	Ground.........................	9.2	*a*. Check circuit from FL2 to V9. *b*. Check resistors R75 and R76. Replace if defective. *c*. Check filter FL2. Replace if defective.
43	Terminal 1 of V9....	Ground.........................	9.2	See corrective measures for test No. 42a through c.
44	Terminal 6 of T15...	Ground.........................	41	*a*. Check V9 tube socket voltages and resistances. *b*. Check resistors R78 and R79. Replace if defective. *c*. Check capacitor C34. Replace if defective. *d*. Check inductor L5. Replace if defective.
45	Terminal 3 of T15...	Terminal 1 of T15........	1.4	*a*. Check circuits from T15 to J7, P1, P2, and P3. *b*. Check transformer T15. Replace if defective.
46	20 KG jack (tip)	20 KC jack (ring).........	.75	*a*. Check circuit from T15 to J7. *b*. Check resistors R80 through R82. Replace if defective.
47	Terminal F of P1, P2, and P3.	Terminal R of P1, P2, and P3.	.82	*a*. Check circuit from T15 to P1, P2, and P3. *b*. Check resistors R139 through R144. Replace if defective.
48	Terminal 3 of FL8 ..	Ground.........................	5	*a*. Check circuit from FL8 to V13. *b*. Check resistors R120 and R121. Replace if defective. *c*. Check filter FL8.
49	Terminal 1 of V13 ..	Ground.........................	5	See corrective measures for test No. 48*a* through *c*.
50	Terminal 6 of T21...	Ground.........................	38	*a*. Check V13 tube socket voltages and resistances. *b*. Check resistors R123, R124, and R165. Replace if defective. *c*. Check capacitors C40 and C45. Replace if defective. *d*. Check inductor L9. Replace if defective.
51	Terminal 3 of T21...	Terminal 1 of T21........	.75	*a*. Check circuit from T21 to J11 and J15. *b*. Check transformer T21. Replace if defective.
52	56 KC jack (tip)......	56 KC jack (ring).........	.75	See corrective measures for test No. 51*a* and *b*.
53	Terminal C of J15...	Terminal L of J15.........	.75	See corrective measures for test No. 51*a* and *b*
54	Terminal 3 of FL9 ..	Ground.........................	5	*a*. Check circuit from FL9 to V14. *b*. Check resistors R125 and R126. Replace if defective. *c*. Check filter FL9. Replace if defective.
55	Terminal 1 of V14 ..	Ground.........................	37	See corrective measures for test No. 54*a* through *c*.

Test No	Voltmeter probe connections		Meter indication (ac)	Corrective measure
	Positive	Negative		
56	Terminal 6 of T22...	Ground.........................	37	*a*. Check V14 tube socket voltages and resistances. *b*. Check resistors R128, R129, and R166. Replace if defective. *c*. Check capacitor C41 and C46. Replace if defective. *d*. Check inductor L10. Replace if defective.
57	Terminal 3 of T22...	Terminal 1 of T22	.75	*a*. Check circuit from T22 to J12 and J15. *b*. Check transformer T22. Replace if defective.
58	72 KC jack (tip)......	72 KC jack (ring)	.75	See corrective measures for test No. 57*a* and *b*.
59	Terminal A of J15...	Terminal J of J15	.75	See corrective measures for test No. 57*a* and *b*.
60	Terminal 3 of FL10.	Ground.........................	3.8	*a*. Check circuit from FL10 to V15. *b*. Check resistor R130. Replace if defective. *c*. Check filter FL10. Replace if defective.
61	Terminal 1 of V15 ..	Ground.........................	3.8	See corrective measures for test No. 60*a* through *c*.
62	Terminal 6 of T23...	Ground.........................	32	*a*. Check V15 tube socket voltages and resistances. *b*. Check resistors R132, R133, and R167. Replace if defective. *c*. Check capacitors C42 and C47. Replace if defective. *d*. Check inductor L11. Replace if defective.
63	Terminal 3 of T23...	Terminal 1 of T23	.75	*a*. Check circuit from T23 to J13 and J15. *b*. Check transformer T23. Replace if defective.
64	88 KC jack (tip)......	88 KC jack (ring)	.75	See corrective measures for test No. 63*a* and *b*.
65	Terminal D of J15...	Terminal E of J15.........	.75	See corrective measures for test No. 63*a* and *b*.
66	Terminal 3 of FL11.	Ground.........................	2.8	*a*. Check circuit from FL11 to V16. *b*. Check resistors R134 and R174. Replace if defective. *c*. Check filter FL11. Replace if defective.
67	Terminal 1 of V16 ..	Ground.........................	2.8	See corrective measures for test No. 66*a* through *c*.
68	Terminal 6 of T24...	Ground.........................	28	*a*. Check V16 tube socket voltages and resistances. *b*. Check resistors R136 through R138. Replace if defective. *c*. Check capacitors C43 and C44. Replace if defective. *d*. Check inductor L12. Replace if defective.
69	Terminal 3 of T24...	Terminal 1 of T24	.75	Check circuit from T24 to J14 and J15.
70	120 KC jack (tip)....	120 KC jack (ring)	.75	See corrective measures for 68*a* and *b*.
71	Terminal H of J15...	Terminal R of J15	.75	See corrective measures for 68*a* and *b*.
72	Terminal 3 of FL4 ..	Ground.........................	.46	*a*. Cheek circuit from FL4 to S4.

* See paragraph 150d(1) and (2), test setup.

Test No	Voltmeter probe connections		Meter indication (ac)	Corrective measure
	Positive	Negative		
				b. Check resistors R93 through R96. Replace if defective. *c*. Check filter FL4. Replace if defective.
73*	Terminal 1 of R95 ..	Ground.........................	.085	See corrective measure for test No. 72*a* through *c*.
74*	Terminal E33	Ground.........................	.003	*a*. Check circuit from FL4 to J16. *b*. Check resistors R100 through R102. Replace if defective. *c*. Check switch S4 contacts. Replace switch if defective.
75*	Terminal H of J16...	Terminal J of Jl6	.003	See corrective measures for test No. 74*a* through *c*.
76*	Terminal 3 of FL5 ..	Ground.........................	.42	*a*. Check circuit from FL5 to J16 and T14. *b*. Check resistors R97, R98, R99, R164, R169, R100, R101, and R102. Replace if defective. *c*. Check switch contacts of S4. Replace switch if defective.
77*	Terminal 6 of T14...	Terminal 5 of T14	1.2	*a*. Check circuit from FL5 to T14. *b*. Check capacitors C23 and C26. Replace if defective.
78	Terminal E31	Ground	22.5	*a*. Check circuit from T24 to V8. *b*. Check resistors R72 and R73. Replace if defective. *c*. Check capacitors C27 and C28. Replace if defective. *d*. Check varistors CR8 and CR9. Replace if defective.
79	Terminal 30............	Ground.........................	2.9	See corrective measures for test No. 78*a* through *d*.
80†	SYNC jack (tip)......	SYNC jack (ring)	.75	*a*. Check circuit from terminals F and of J15 to J6, T10, and T11. *b*. Cheek S1 switch contacts. Replace switch if defective.
81†	Terminal 5 and T10	Ground.........................	1.4	Check connections from T9 to T10.
82†	Terminal 2 of T11...	Ground.........................	.6	*a*. See corrective measures for test No. 74*a* through *c*. *b*. Check circuit from J6 to T10 and T11. *c*. Check circuit from T10 to T11. Replace if defective. *d*. Check transformers T10 and T11. Replace if defective. *e*. Check varistor CR5.
83†	Terminal 3 of FL1 ..	Ground.........................	.1	*a*. Check circuit from FL11 to T12. *b*. Check resistor R58. Replace if defective. *c*. Check filter FL1. Replace if defective.
84†	Terminal 6 of T12...	Ground.........................	.15	*a*. Check circuit from FL1 to V7. *b*. Check capacitor C19. Replace if defective. *c*. Check transformer T12.
85†	Terminal 6 of T13...	Ground.........................	95	*a*. Check V7 tube socket voltages and resistances. *b*. Check circuit from V7 to E5.

* See paragraph 150*d*(1) and (2), test setup

† See paragraph 150*g*(1) and (2), test setup.

Test No	Voltmeter probe connections		Meter indication (ac)	Corrective measure
	Positive	Negative		
				c. Check capacitors C19 through C21. Replace if defective.
86†	Terminal 4 of T13	Ground.........................	6.6	*a*. Check circuit from T13 to J5 and terminals E8 and E9. *b*. Check transformer T13. Replace if defective.
87†	64KC REM jack (tip)	64KC REM jack (ring)	.75	*a*. Check circuit from T13 to J5. *b*. Check resistors R60 through R62. Replace if defective.

†See paragraph 150g(1) and (2), test setup.

153. Dc Resistance of Transformers and Coils

Transformers and coils	Terminals	Resistance (ohms)
T1, T3, T12, T13, T14	1-2	1.5
	3-4	1.65
	5-6	160
T2, T5................................	1-3	32
	4-6	1,370
T4, T6, T16........................	1-2	3
	3-4	3.2
	5-6	150
T7, T8, T9	1-2	8.7
	3-4	8
	5-7	1,700
T10....................................	1-3	3.5
	4-5	9
T11....................................	1-2	1.16
	4-6	2.85
T15, T17, T19, T20............	1-3	1.7
		765
T18....................................	4-6	.7
		4
T21, T22, T23, T24............	1-3	.81
	4-6	876
L1......................................	....	3
L3......................................	....	8.4
L4......................................	....	2
L2, L5, L6, L7, L8.............	....	52
L9, L10, L11, L12.............	....	21

Section IX. POWER SUPPLY PP-827/U

154. Troubleshooting Data

Fig. No.	Par. No.	Description
33	....	Schematic diagram.
(TM 11-2139-20, fig. 20).	....	Tube socket voltage and resistance diagram.
110	....	Top view, location of parts.
111, 115.........	....	Right side view, location of parts.
112	....	Left side view, location of parts.
113	....	Wiring diagram.
158	 157	Dc resistance of transformers and coils.

155. 200-Volt Power Supply Test

(fig. 134)

a. Initial Procedures.

(1) Connect the carrier supply test cable assembly to connector P3 on the 200 VOLT POWER SUPPLY; connect a resistance of 445 ohms (four parallel 1800-ohm 38 w resistors) and a 160-ohm (2 w) resistor across terminals A and K and D and H respectively of the carrier supply test cable assembly.

(2) Connect P2 on the 200 VOLT POWER SUPPLY to an outlet that supplies either 115 or 230 volts at 60 cps.

(3) Operate the 115V-230V switch to the appropriate position.

b. Operational Test for 115- or 230-Volt Source.

(1) Operate the AC POWER switch to the ON position.

(2) Check the dc output indicated in the chart below with the multimeter and check the ac ripple voltage with the voltmeter.

Test conditions	Output taken at carrier supply test cable assembly terminals	Output voltage	Maximum ripple voltage (ac)
200V ADJ control fully counterclockwise	A and K	190 dc (max).	
200V ADJ control fully clockwise	A and K	210 dc (min).	
200V ADJ control adjusted for 200 volts	A and K	200 dc	.007
	D and H	9 ±1 dc	.002
No external filament load	B and L	7.2 ±5 ac.	
	E and J	7.2 ±5 ac.	
	F and P	7.2 ±5 ac.	
	M and N	7.2 ±5 ac.	

(3) Connect the multimeter, arranged to measure ac voltage, to the 115V CONVENIENCE OUTLET and then to the TO 600V POWER SUPPLY receptacle. The multimeter should indicate 115 volts for both tests when the input voltage is 115 volts; the multimeter should indicate 230 volts at the 600V POWER SUPPLY receptacle and 0 at the 115V CONVENIENCE OUTLET when the input voltage is 230 volts.

c. 230-Volt Test.

(1) Disconnect the power supply from the ac power source.

(2) Operate the AC POWER switch to the ON position and operate the 115V-230V switch to the 230V position.

(3) Connect the multimeter arranged as an ohmmeter, across terminals 2 and 3 of transformers T1, T2, and T3; the multimeter should indicate 0 ohm for each test.

(4) Connect the multimeter across the TO 600V POWER SUPPLY receptacles; the multimeter should indicate 3 ohms.

(5) Connect the multimeter across the 115V CONVENIENCE OUTLET; the multimeter should indicate infinite resistance.

d. Blower Motor Test.

(1) Replace the chassis in the transit case and apply power to the 200 VOLT POWER SUPPLY.

(2) Allow the power supply to remain in operation long enough to cause the blower motor to start. While the blower motor is operating, check to see that air is being moved out through the front grill.

e. High-Voltage Rectifier and Regulator Tests. Perform the tests indicated in the chart below to check the high-voltage rectifier circuit and the regulator circuit for troubles that were not located during the operational tests (a through *d* above). Prepare the 200 VOLT POWER SUPPLY for testing as explained in *a(2)* and (3) above. Operate the AC POWER switch to the ON position. Use the multimeter arranged as a voltmeter to make the following tests.

Test No.	Test conditions	Multimeter test jack connection		Meter indication (dc volts)
		Positive probe	Negative probe	
1	200V ADJ control adjusted for 00 volts.	J8	J6	200
		J9	J6	96
		J10	J6	95
		J11	J6	118
		J12	J6	180
		J13	J6	355
		J14	J8	1.75
		J15	J8	1.75
		J16	J8	1.75
		J17	J8	1.75
		J18	J8	1.75
		J19	J8	1.75
		J20	J8	1.75
		J21	J8	1.75
		J12	J8	-18
		J9	J8	110
		J10	J8	110
		J11	J8	88
		J22	J7	9
2	200V ADJ control fully counterclockwise	J12	J8	-26.5
3	200V ADJ control fully clockwise.	J12	J8	-4

156. 200-VOLT POWER SUPPLY Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in the 200 VOLT POWER SUPPLY. This chart lists the symptoms that may be reported on the equipment repair tag or observed when performing maintenance of the organizational level (TM 11-2139-20). Once the trouble has been localized to the proper circuit, a tube check and a voltage and resistance measurement (TM 11-2139-20, fig. 20) of the defective circuit should be sufficient to isolate the defective part. Arrange the 200 VOLT POWER SUPPLY for testing according to the operational test procedure (par. 155*a*).

Symptom	Probable trouble	Corrective measure
1. No dc output voltage (par. 155b (2)). Fuse F1 or F2 blows if 115-volt power source is used; fuse F4 blows if 230-volt power source is used.	*a.* Short circuit in the ac input circuit.	*a.* Check from J6 to J13 and from J6 to J8 for short circuits. Capacitor C1, C2, or C7 may be shorted (fig. 33). To locate short circuits in transformers, unsolder wires from taps 2 and 4 on transformer T2 Place switch S3 in the 115V position. Check for 2 ohms on windings 1-2 and 3-4 on transformer T1 or T3 Check windings 1-2 and 3-4 for 2 ohms on transformer T2. Place switch S3 in the 230V position and check between taps 1-4 for 8 ohms on transformer T1 or T3. Check for short circuits across input plug P2.
	b. Failure in high-voltage rectifier circuits V1, V2, and V3, or inductor L1.	*b.* Check for lighted filaments in tubes V1, V2, and V3 If not lighted, check tube wiring and transformer T1. If filaments do light, check from J6 to J13 for 495 +10 volts dc If voltage is not present, check for 35 +10 ohms (inductor L1) from J13 to pin 8 of tube V1 Check for continuity from J6 to tap 6 on transformer T2. Cheek tube socket voltages and resistances on V1, V2, or V3. On transformer T2, check for continuity of primary windings and from each blade of input plug P2 to taps 1-2 and 3-4. If J6 to J13 voltage is 495 +10 volts dc then check for 1,800 ohms from J13 to pin A of connector P3, and for continuity from J6 to pin K of connector P3.
2. Low dc output voltage and high output ripple voltage.	*a.* Failures in circuits associated with tubes V1 through V9.	*a.* Check tube socket voltage and resistances on tubes V1 through V9. Where trouble exists, check for tube failures and for opens in resistors R1, R2, R4, R21, R23, and R25 or capacitors C1, C2, and C4. Replace defective parts.

Symptom	Probable trouble	Corrective measure
	b. Failure in filament supply for tubes V4 through V8.	*b*. Check to see that AC POWER lamp lights. If lamp lights, check filaments of tubes V4 through V8 for 6.3 volts. Check for open or shorted circuits where no voltage is present. If lamp does not light, check lamp and wiring for open circuits. Unsolder wires from either tap 5 or tap 6 on transformer T1. Turn on ac power and check for 7.2 volts c .5 volts ac on winding 5-6 and 115V on winding 3-4 of T1. If no voltage is present, the winding is open or shorted. Check transformer T1. Replace if defective.
3. High dc. output voltage and high output ripple voltage.	Tubes V4 through V9 not functioning properly.	Check tube socket voltages and resistances for tubes V4 through V9. Where trouble exists, checks for opens in resistors R5 through R12, and R22, R24, R26, or R27. Replace if defective.
4. Erratic dc. output voltage and high output ripple voltage.	*a*. Flicker in tube V9 due to trouble in capacitor C6. *b*. Loose connections at one of the capacitors, at 200-volt adjustment control, or at tube sockets. Capacitor C3, C5, or C7 open.	*a*. Check for loose connections at capacitor C6. Check and replace C6 if necessary. *b*. Inspect for loose connections. Replace capacitor C3, C5, or C7 if trouble has not been located.
5. Output ripple too high with 95- volt line voltage. Normal dc output voltage, output ripple within limits with 115-volt line voltage.	Cathode circuits of tubes V4 through V7 open or contain aged resistors. Tubes V1 through V3 may be aged or inoperative.	Check dc. voltages across resistors R13 through R20, from J8 to each of the connectors J14 through J21 (fig. 33). Turn off power supply and check resistors R13 through R20. Replace open resistors. Resistors R13 through R20 should be replaced if they deviate c 15 percent from 27 ohms. Apply power and check tube socket voltages for tubes V1, V2, and V3. Where deviations exist, change tubes one at a time and recheck voltages. Reject aged tubes.
6. No. - 10-volt dc output voltage.	Failure in low-voltage rectifier CR1, inductor L2, or a shorted output	Operate AC POWER switch to OFF. Check from J7 to J22 for short circuits (fig. 33). If no short circuits are indicated, apply power to power supply. Check from J7 to J22 for -16 to -22 volts. If proper voltage is present, check continuity from J7 to pin D of connector P3, and from J22 to pin H of connector P3. If voltage is not present, operate the AC POWER switch to OFF. Check for 45 +10 ohms from J7 to terminal 1 of CRT; and check continuity from J22 to terminal 3 of CRT. Apply power to power supply. Check for 14 +3 volts ac across terminals 2 and 4 of CR1 and taps 7 and 8 on T1. If present, and no dc. voltage is present at terminals 1 and 3, CR1 is defective and must be replaced.

Symptom	Probable trouble	Corrective measure
7. Low dc output voltage at -10- volt supply, normal output, ripple voltage.	Aged varistor CR1	Carefully check J7 to J22 for 9 ±1.5 volts with 115-volt line and 160-ohm load. If dc voltage is below 7 volts, CR1 has aged and must be replaced.
8. Normal (- 10) dc. output voltage, high output ripple voltage.	Capacitor C9 open	Check for -10 volts dc on terminals of capacitors C9. If dc. voltage at C9 is not present, check for open circuits from J7 and J22 to capacitor terminals. If dc voltage is present at C9, replace capacitor C9.
9. No ac output at terminals B and L, J and E, F and P. or M and N.	Failure in transformer T3 windings or ac distributing and cable wiring.	Check for 7.2 ±.5 volts ac on corresponding windings with no voltage present at output terminals. Operate the AC POWER switch to OFF. On windings where voltage is present, check for opens in the distributing and cable wiring. On windings with no voltage, check for open windings or short circuits. To isolate trouble, unsolder one wire from either tap. Apply ac power and check windings for 7.2 ±.5 volt, with 115-volt input If voltage is present, check distributing wiring for short circuits. If 7.2 ±.5 volt is not present, the transformer should be replaced.
10. Power supply does not operate with the 230-volt input. Operation satisfactory for 115volt input.	Failure in input wiring, or transformer T1, T2, and T3 primary windings. Switch S3 may be defective.	Check for 115 volts on windings 1 to 2 and 3 to 4 of transformers T1, T2, and T3. Refer to symptom No. 1 for circuit trouble analysis. Symptoms Nos. 1 through 9 are applicable for 230volt ac input.
11. Blower inoperative (par. 155d)	*a*. Thermostat S2 inoperative *b*. Open circuit *c*. Blower B1 inoperative *d*. Capacitor C8	*a*. Short-circuit the terminals on thermostat S2 and check for blower operation. If blower operates, thermostat S2 is defective. Replace thermostat S2 and repeat test given in paragraph 155d. *b*. Short thermostat S2 and check for 115 volts across connector J1. If not present, inspect for open circuits. *c*. Replace blower B1. Short-circuit thermostat S2 terminals to check blower operation. *d*. Replace capacitor C8. Short thermostat S2 to check blower operation. If blower operates, capacitor C8 was defective and should be replaced.
12. No voltage at TO 600V POWER SUPPLY connectors (J2 and J3) and 115V CONVENIENCE OUTLETS (J4 and J5).	Failure in wiring to connectors J2 through J5.	Disconnect input plug P2 from input power source. Short-circuit the male contacts on plug P2. Connect the multimeter to the female contacts on connectors J2, J3, J4, and J5. The meter should indicate 0 ohm at each connector. Where no short is present, check for open circuits. Check fuse F3 and switch S3 if outlets J4 and J5 do not indicate a short.

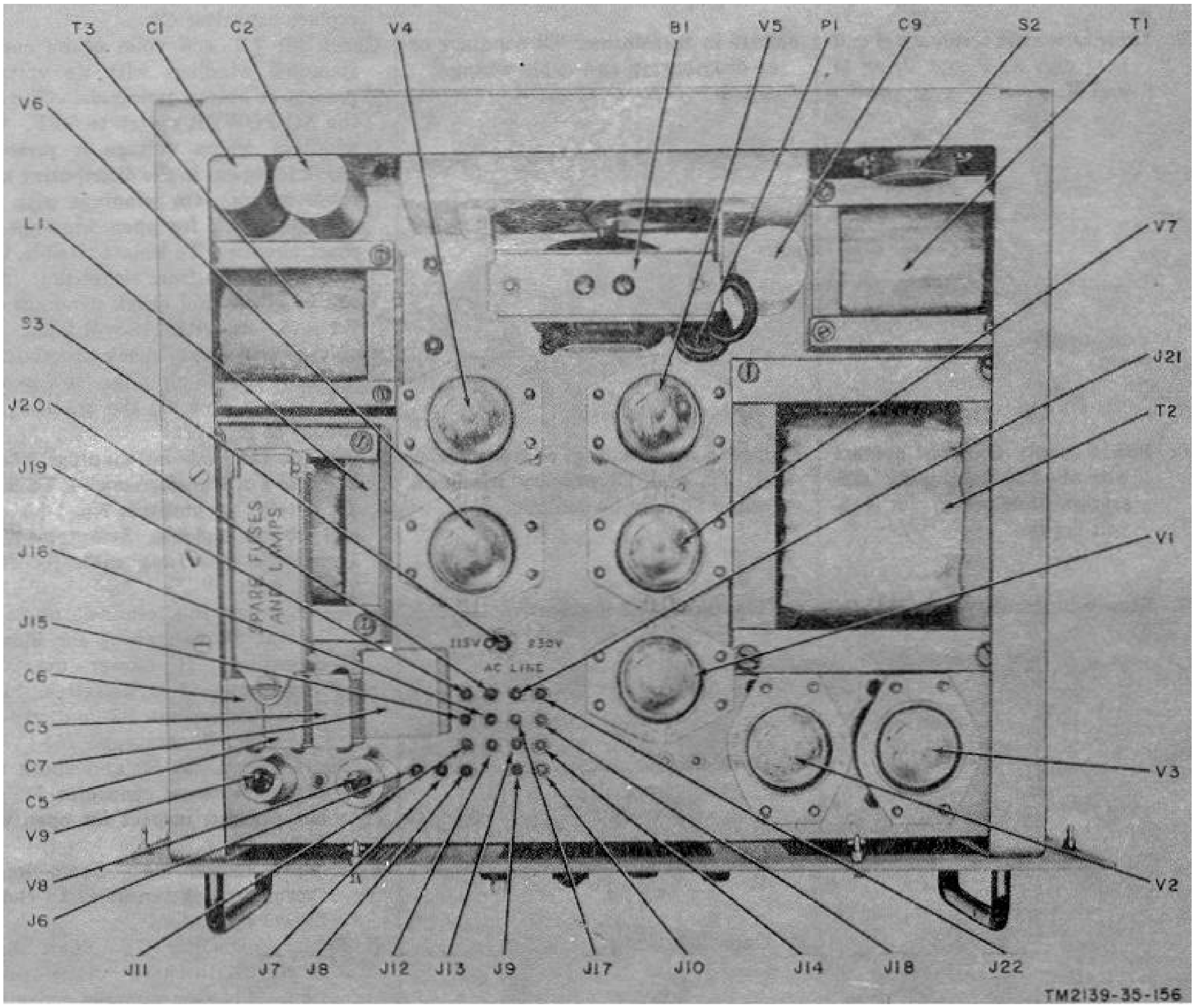


Figure 110. Power Supply PP-827/U, removed from transit case top view, parts location.

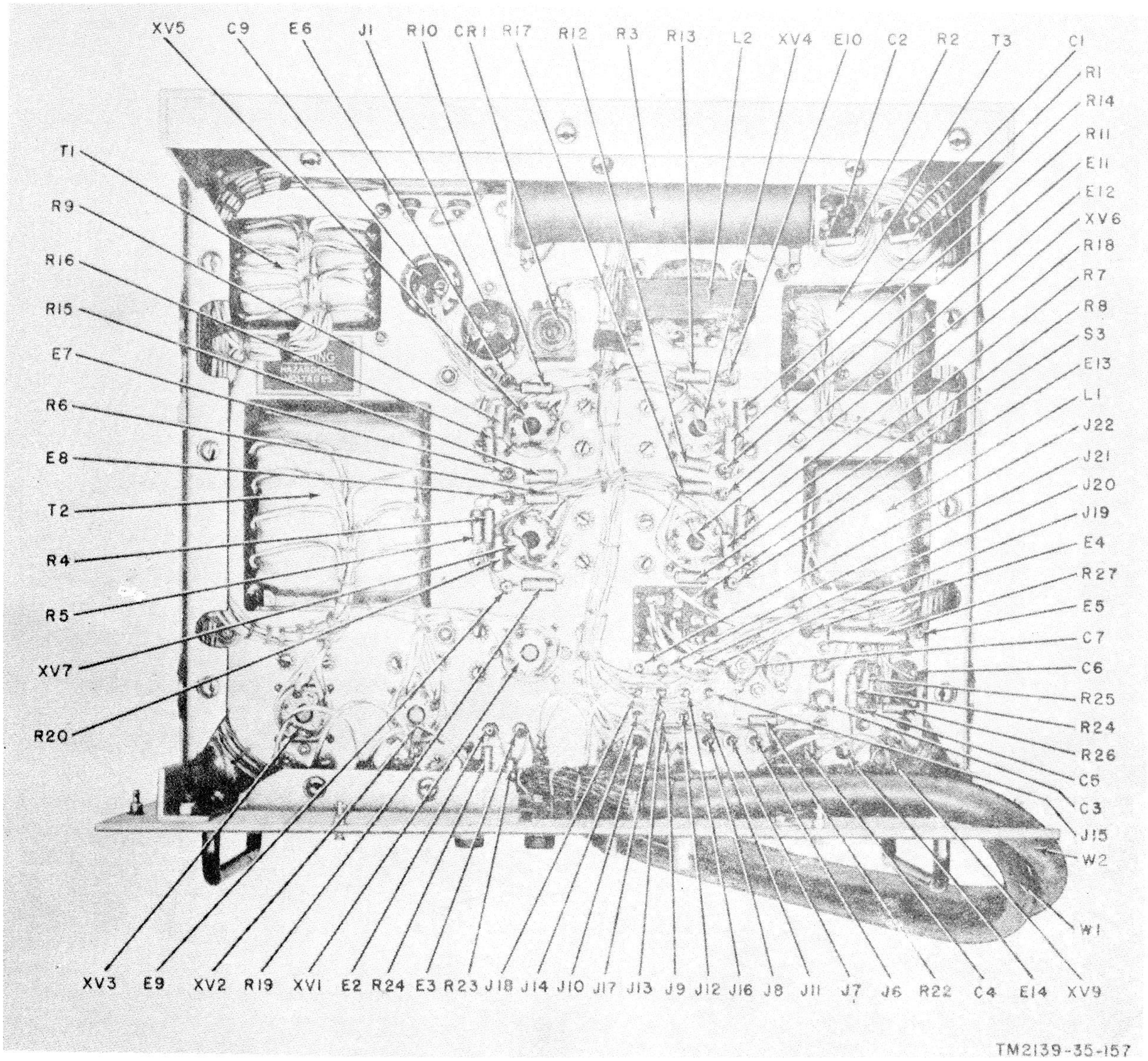


Figure 111. Power Supply PP--827/U, removed from transit case, bottom view, parts location.

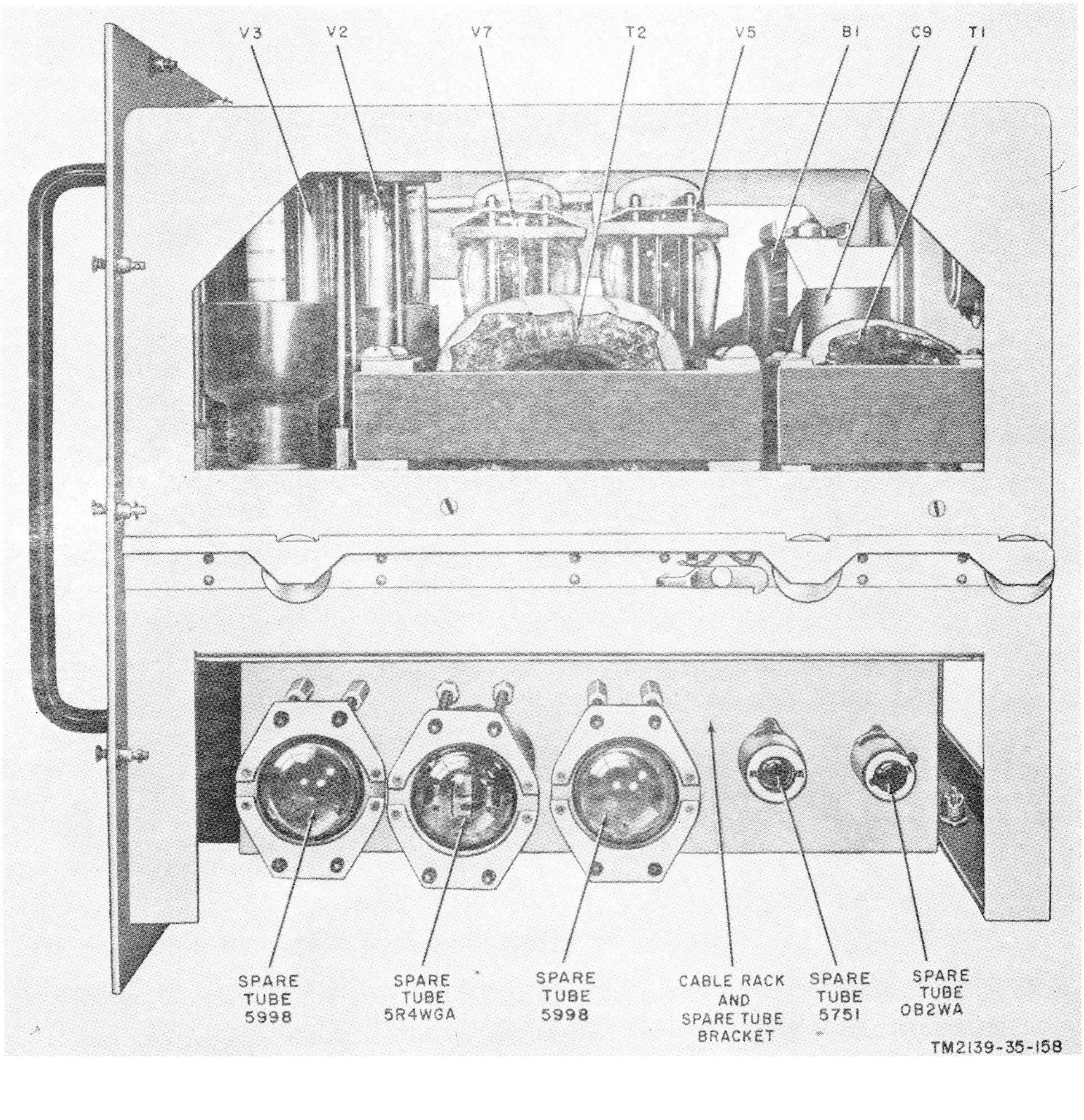


Figure 112. Power Supply PP--827/U, removed from transit case, right side view, parts location.

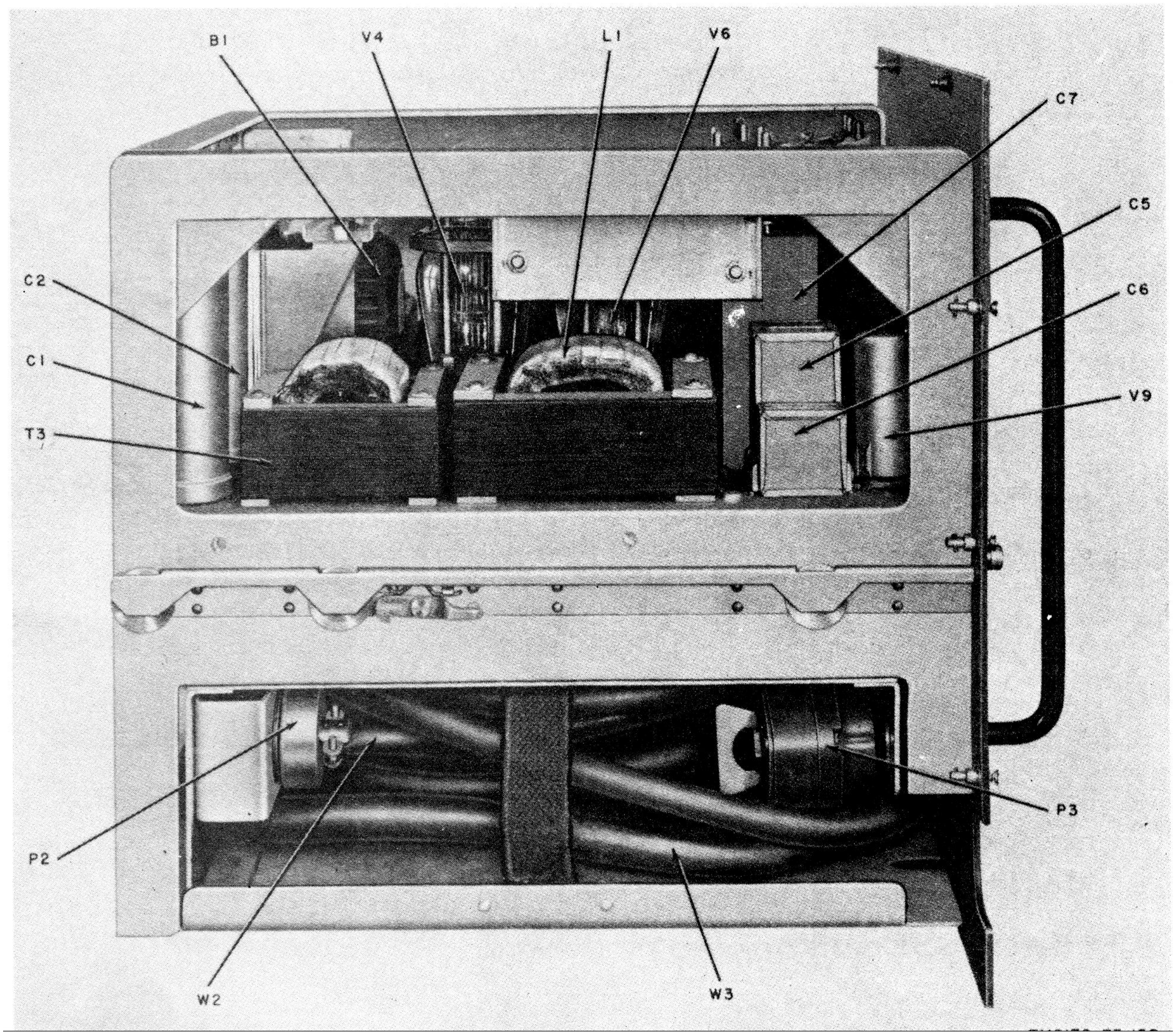


Figure 113. Power Supply PP--8 27/U, removed from transit case, left side view, parts location.

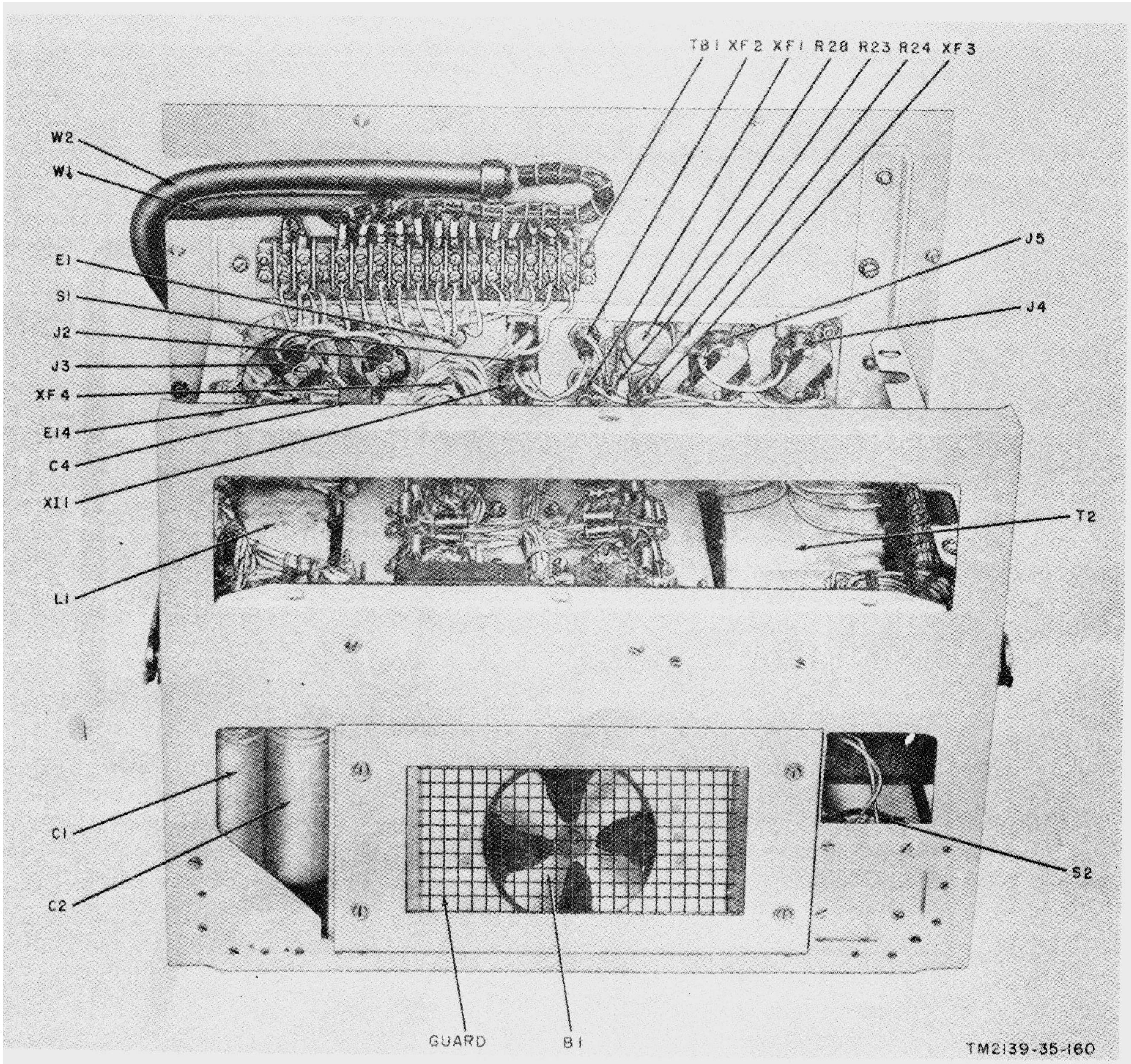


Figure 114. Power Supply PP-827/U, removed from transit case, rear view with cable rack and spare tube bracket removed, parts location.

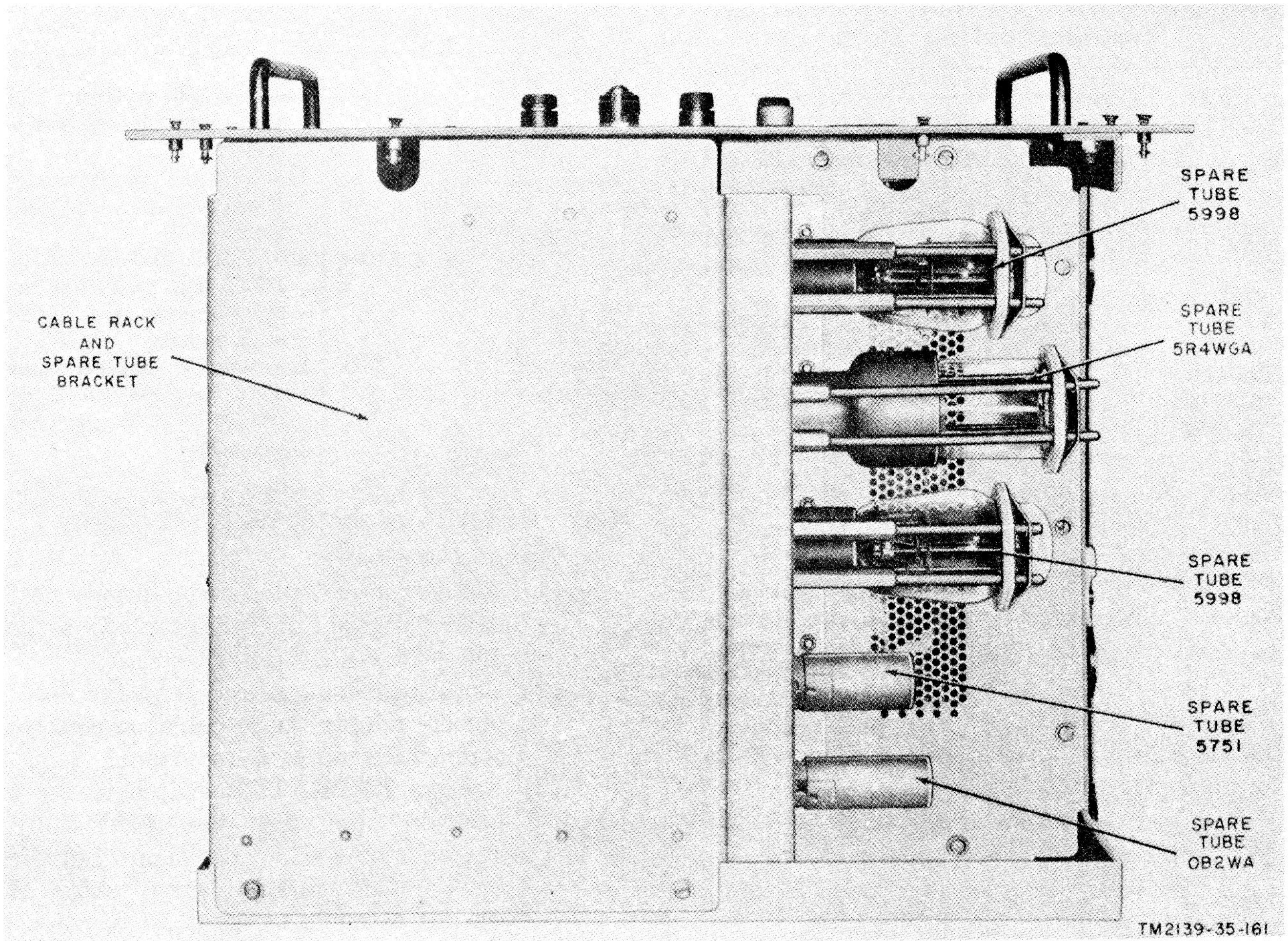


Figure 115. Power Supply PP--847/U, removed from transit case, bottom view with cable rack and spare tube bracket in place, parts location.

157. Dc Resistance of Transformers and Coils

Transformers	Terminals	Resistance (ohms)
T1...........................	1-2	7.4
	3-4	8.4
	5-6	.05
	7-8	13
	9-10	.07
T2...........................	1-2	1.7
	3-4	2
	5-6	29
	6-7	29
	5-7	58
T3................................	1-2	7.2
	3-4	7.9
	5-6	.074
	7-8	.154
	9-10	.131
	11-12	.069
	12-13	.069
	11-13	.138
L1..............................	....	37
L2..............................	....	33

Section X. POWER SUPPLIES PP-826/U AND PP-826A/U

158. 600-VOLT POWER SUPPLY Troubleshooting Data

Fig. No.	Par. No.	Descriptions
39		Power Supply PP-826/U (original units), schematic diagram.
40		Power Supply PP-826/U, (revised units), schematic diagram.
35		Power Supply PP-826A/U, schematic diagram.
(TM 11-2139-20, fig. 21).		Power Supply PP-826/U, tube socket voltage and resistance diagram.
116		Power Supply PP-826/U, (original units), bottom view, parts location.
117		Power Supply PP-826/U, (revised units), bottom view, parts location.
118		Power Supplies PP-826/U, (revised units serial No. 1170 through 2964 only) and PP-826A/U, bottom view, parts location.
119		Power Supplies PP-826/U, and PP-826A/U, removed from transit case, top view, parts location.
120		Low-voltage rectifier and alarm unit Z1, top view, parts location.
121		Low-voltage rectifier and alarm unit Z1, controls and parts location.
122		Low-voltage rectifier and alarm unit Z1, cover removed, bottom new, parts location.
123		Low-voltage rectifier and alarm unit Z2, top view, parts location.
124		Low-voltage rectifier and alarm unit Z2, side view, parts location.
125		Low-voltage rectifier and alarm unit Z2, bottom view, parts location.
159		Power Supply PP-826/U, (original units), wiring diagram.
161		Power Supply PP-826/U, (revised units), wiring diagram.
163		Power Supplies PP-826/U, (revised units serial No. 1170 through 2964 only) and PP-826A/U, wiring diagrams.
162		Low-voltage rectifier and alarm unit Z1, wiring diagram.
164		Low-voltage rectifier and alarm unit Z2, wiring diagram.
	162*a*	600 VOLT POWER SUPPLY, dc resistance of transformers and coils, main chassis.
	162*b*	Low-voltage rectifier and alarm units Z1 and Z2, dc resistance of transformers and coils.

159. Power Supply PP 826/U Tests

*a. Initial Procedures***.**

(1) Connect the 600V power supply test cable assembly to connector P3 on the 600 VOLT POWER SUPPLY.

(2) Strap terminals A and B on the 600V power supply test cable assembly; connect terminal C to ground.

(3) Set the REPEATER switch to the 0 position and set the 115V-230V switch to the 115V position. Set the 600V ADJ control to the center of the adjustment range.

(4) Loosen the locking nuts and set the LOAD CURRENT, LOW-VOLT ALARM, and HIGH-VOLT ALARM controls fully clockwise.

(5) Connect P1 to a 115-volt ac 60 cps power.

Warning: Be careful when making the tests described in *b* through *i* below. Dangerous voltages are present throughout the equipment.

b. Normal Output Voltage Output Test.

(1) Operate the ALARM CUTOFF switch to the horizontal position; operate the AC POWER switch to the ON position. The LOAD ALARM lamp should light and the buzzer should sound. Operate ALARM CUTOFF switch to the vertical position; the buzzer should be silenced.

(2) After 8 seconds, the CURRENT meter should indicate 80 ma ±10 ma

immediately. The LOAD ALARM lamp should go out 20 seconds later. Adjust the LOAD CURRENT control for an indication of 100 ma on the meter.

(3) Connect the multimeter, arranged for a 1,000-volt input, across test jacks J1 and J10; adjust the 600V ADJ control for a 600-volt indication on the multimeter.

(4) Connect the multimeter across terminals D and C of the power test cable assembly; the meter should indicate approximately 275 volts.

c. Output Ripple Test.

(1) Connect one side of a .5 µf capacitor to jack J1 on low-voltage rectifier and alarm unit Z1; connect a 1-megohm resistor across the binding posts on the voltmeter.

(2) Connect the voltmeter across the other side of the .5-µf capacitor and jack J10 on low-voltage rectifier and alarm unit Z1.

(3) The voltmeter should indicate a ripple voltage of less than 100 millivolts ripple.

d. Low Output Voltage Cutoff Test.

(1) Connect the multimeter across jacks J1 and J10 on low-voltage rectifier and alarm unit Z1. Adjust the LOAD Current control for an indication of 535 volts on the multimeter.

(2) Adjust the LOW-VOLT ALARM control until the power output is cut off; lock the control in this position. The LOAD ALARM and LOW VOLTAGE lamps should light and the buzzer should sound.

(3) Operat4e the RESTORE switch; the dc output should return to the level indicated in (1) above.

(4) Adjust the LOAD CURRENT control for an indication of 100 ma on the CURRENT meter.

e. High Output Voltage Cutoff Test.

(1) Connect the multimeter across jacks and alarm unit Z1. Adjust the LOAD CURRENT control for a reading of 670 volts on the multimeter.

(2) Adjust the HIGH-VOLT ALARM control until the power output is cut off; lock the control in this position. The LOAD ALARM and HIGH VOLTAGE lamps should light and the buzzer should sound. The multimeter should indicate 0 volt and the CURRENT meter should indicate 0 ma.

(3) Depress the RESTORE switch; the dc power should return to the level indicated in (1) above.

(4) Adjust the LOAD CURRENT control for and indication of 100 ma on the CURRENT meter.

f. Load Detection Test.

(1) Operate the AC Power switch to the OFF position; operate the REPEATER switch to position 1 and adjust the 600V ADJ control to extreme counterclockwise position.

(2) Connect the multimeter across jacks J1 and J10 on low-voltage rectifier and alarm unit Z1. Operate the AC POWER switch to the ON position. There should be no dc voltage output; the multimeter should indicate 0 volt and the CURRENT meter should indicate approximately 1- ma.

(3) Adjust the 600V ADJ contr ol until the dc voltage is restored. The indication on the CURRENT meter should drop to 0 and then rapidly build up to 100 ma. The multimeter should indicate 480 ± 10 volts dc. The voltage output should be cut off within 1 minute form the time that the power came on.

(4) Readjust the REPEATER switch to the 0 position, adjust the LOAD CURRENT control for an indication of 100 ma on the CURRENT meter, and adjust the 600V ADJ control for an indication of 600 volts on the multimeter.

g. 230-Volt Line Test.

(1) Operate the AC POWER switch to the OFF position.

(2) Operate the 115V-230V switch to the 230 volt position.

(3) Connect the multimeter, arranged as an ohmmeter, across terminals 2 and 3 of transformer T1 on the main chassis.

The multimeter should indicate 0 ohm.

(4) Connect the multimeter across terminals 2 and 3 of transformer T1 on low-voltage rectifier and alarm unit Z1. The multimeter should indicate 0 ohm.

h. Blower Motor Test.

(1) Install the 600 VOLT POWER SUPPPLY chassis in the carrying case and reconnect the power source to receptacle P1.

(2) Operate the AC POWER switch to the ON position.

(3) Allow the 600 VOLT POWER SUPPLY to remain in operation long enough to cause thermostat S3 to operate the blower motor. The blower motor should start about 20 minutes after the power has been turned on if the room temperature is approximately 60° F. Check to see that air is being moved out through the front grill.

160. Power Supply PP-826A/U, Tests

The operational tests for Power Supply PP-826A/U are the same as those for Power Supply PP-826/U (par. 159) except for the low output voltage cutoff test (*b* below) and the load detection test (*c* below).

a. Initial Procedure. Perform the initial procedures given in paragraph 159 *a*.

b. Low Output Voltage Cutoff Test.

(1) Operate the AC POWER switch to the ON position.

(2) Connect the multimeter arranged as a voltmeter across jacks J1 and J10 on low-voltage rectifier and alarm unit Z2. Adjust the LOAD CURRENT control for an indication of 535 volts on the multimeter.

(3) Adjust the LOW-VOLTAGE ALARM control so that the LOAD ALARM and LOW VOLTAGE lamps light and the buzzer sounds. Lock the control in this position.

(4) Operate and hold the RESTORE switch; the dc power should be interrupted. The CURRENT meter should indicate 15 ma.

(5) Release the RESTORE switch; the CURRENT meter should indicate 80 ma ± 10ma.

(6) Adjust the LOAD CURRENT control for an indication of 100 ma on the CURRENT meter.

c. Load Detection Test.

(1) Operate the AC POWER switch to the OFF position; operate the REPEATER switch to position 3 and adjust the 600V ADJ control to the extreme clockwise position.

(2) Connect the multimeter across jacks J1 and J10 on low-voltage rectifier and alarm unit Z2. Operate the AC POWER switch to the ON position. The multimeter should indicate 0 volt and the CURRENT meter should indicate more than 5 ma. The LOAD ALARM lamp should light and the buzzer should sound.

(3) Operate and hold the RESTORE switch until the LOAD ALARM lamp goes out and the buzzer stops sounding. The *minimum* indication on the CURRENT meter should be 15 ma.

(4) Release the RESTORE switch; the LOAD ALARM lamp will light but the dc power should not come on.

(5) Readjust the REPEATER switch to position 1 and hold the RESTORE switch in the operated position until the LOAD ALARM lamp is extinguished; release the RESTORE switch. The indication on the CURRENT meter should drop to 0 and then rapidly build up to 100 ma.

(6) The multimeter should indicate 480 volts ± 10 volts.

(7) Operate the AC POWER switch to the OFF position and readjust the REPEATER switch to the 0 position.

(8) Operate the AC POWER switch to the ON position and adjust the LOAD CURRENT control for an indication of 100 ma on the CURRENT meter. Adjust the 600V ADJ control for an indication of 600 volts on the multimeter.

161. Power Supplies PP-826/U and PP-826A/U Troubleshooting Chart

This chart is supplied as an aid in locating trouble in the 600 VOLT POWER SUPPLY. In the troubleshooting chart, all references to Power Supply PP-826/U, and low-voltage rectifier and alarm unit Z1 also apply to Power Supply PP-826A/U and low-voltage rectifier and alarm unit Z2 unless otherwise indicated. The chart lists the symptoms that may be reported on the equipment repair tag or observed when performing maintenance at the organizational level (TM 11-2139-20). After the trouble has been localized to the proper circuit, a tube check and a voltage and resistance measurement (TM 11-2139-20, fig. 21) of the stage or circuit should be sufficient to isolate the defective part.

Note. Relays K6 and K7 on some units (Order No. 14181-Phila-51, serial Nos. 1 through 799) may fail to operate properly due to contact wear and aging of the relay.

Caution: Do not strap contacts 2 and 3 or 4 and 5 of relay K1.

Symptom	Probable trouble	Corrective measures
1. Absence of normal dc output. CURRENT meter reads zero, LOAD ALARM lamp unlighted. LOW VOLTAGE lamp unlighted. HIGH VOLTAGE lamp unlighted. Buzzer silent. When AC POWER switch is operated to ON position, and with 115-volt input, fuses FI and F2 blow; or with 230-volt input, fuses F3 and F4 blow.	*a.* Defective transformers T1 and T2, or transformer T1 on low-voltage rectifier and alarm unit Z1, or associated circuits. Defective 115V-230V switch S2.	*a.* Operate AC POWER switch to OFF position and 115V-230V switch to 115V position. Check resistance between terminals 1 and 2, and 3 and 4 of transformer T1 on low voltage rectifier and alarm unit Z1. Resistance should be 30 ohms ±10 ohms. Operate 115V-230V switch to 230V position. Check resistance between terminals 1 and 4 of transformer T1. Resistance should be 125 ohms ±15 ohms Check resistance between terminals 1 and 4 on transformers T1 and T2. Resistance should be 8 ohms ±1 ohm. Operate 115V230V switch to 115V position . Check resistance between terminals 1 and 2, and 3 and 4 of transformers T1 and T2. Resistance should be 2 ohms ±.5 ohm. If readings are not normal, unsolder leads from terminals, one at a time, to isolate each transformer winding. Determine whether trouble is in transformer, or 115 to 230V switch by performing resistance checks (par. 162).
	b. Open connection between connectors J11 and P11.	*b.* Operate AC POWER switch to ON position. Check voltage between terminals 1 and 2, and between 3 and 4 of transformer T1 on low voltage rectifier and alarm unit Z1. It should be 115 volts ac If voltage is not present, check to see that connectors J11 and P11 are correctly seated. Check for opens in windings 1-2, 3-4, and 11-12. Check continuity from terminals 1, 2, 3, and 4 to input connector P1. If 115 volts ac is present, check voltage between terminals 11 and 12 for 7 volts act If 7 volts

Symptom	Probable trouble	Corrective measures
		ac is not present, replace transformer T1 (par. 166*f*). If 7 volts ac is present, unsolder a wire from either terminal 11 or 12 and check for opens in LOAD ALARM lamp circuit, LOW VOLTAGE lamp circuit, HIGH VOLTAGE lamp circuit, buzzer, relays K7 and K8 contacts 6 and 11, and ALARM CUTOFF switch S4. The connections to the alarm lamps and the buzzer from low-voltage rectifier and alarm unit Z2 are made through contacts 1-2-9 of relay K2, 1-2-9 of relay K5, 1-3 of relay K10, and 5-6-11 of relay K7. (1) On low-voltage rectifier and alarm unit Z1, check voltage between test jacks J9 and J10 for 155 volts. If voltage is present, operate AC POWER switch to OFF position, and check resistance between test jacks J1 and J9. Resistance should be 3,400 ohms ±100 ohms. If resistance is infinite, check for opens in resistor R18, relay K6 winding, relays K7 and K8 contacts 3 and 10, and relays K4 and K5 contacts 6 and 11. Check resistance between test jacks J1 and J10, with 600V ADJ control set to middle of adjustment range. Resistance should be 6,000 ohms ±100 ohms. If resistance is infinite, check for opens between terminal 29 on connectors P11 and J11, CURRENT meter, resistors R12 through R15, terminals A or B and C, and terminal 32 on connectors P11 and J11. (2) If previous troubles have been cleared and normal de power output does not come on, trouble can be isolated to either main chassis or to subchassis by substituting a good subchassis and repeating operational tests given in paragraph 159 to insure that main chassis is operating properly. If trouble still exists, inspect main chassis in accordance with applicable items of this chart. When all troubles are cleared from main chassis, reconnect original subchassis and repeat operational tests given

Symptom	Probable trouble	Corrective measures
		in paragraph 159*d* through *g* to isolate trouble in subchassis. Inspect subchassis for troubles in accordance with applicable items of this chart.
2. Absence of normal dc output. CURRENT meter reading between 5 and 20 ma. LOAD ALARM lamp lighted. LOW VOLTAGE lamp unlighted. HIGH VOLTAGE lamp unlighted. Buzzer sounds.	*a*. Relay K6 does not release. Defective REPEATER switch. Shorted capacitor C1, C2, or C3.	*a*. On low-voltage rectifier and alarm unit Z1, check resistance between test jacks J1 and J10, with 600V ADJ control fully counterclockwise. Resistance should be 6,700 ohms. Relay K6 will not release if load is less than 4,800 ohms. If reading is low, check operation of REPEATER switch by observing change in load resistance at each tap position. Check for shorts between test jacks J1 and J10 and between test jacks J1 on main chassis and J10. If shorts are present, unsolder one lead at a time from capacitor C1, C2, or C3 to isolate each capacitor. Then determine if capacitor is shorted. On low-voltage rectifier and alarm unit Z2, relay K6 will release if the resistance measured between test jacks J1 and J10 is greater than 3,000 ohms. If this resistance is lower, perform the same checks as specified for Z1 above.
	b. On low voltage rectifier and alarm unit Z1, either capacitor C4 or rectifier CR2 is defective.	*b*. On low-voltage rectifier and alarm unit Z1, check capacitor C4 for an open. Check rectifier CR2 for defects. Remove tube V1; adjust load (R12, R13, R14, and R15 in series) with 600V ADJ control to 6,000 ohms. Operate AC POWER switch to ON. Measure voltage between test jacks J9 and J10 for approximately +174 volts. If voltage is below +125 volts, capacitor C4 is open and must be replaced. Before replacing C4, check continuity of capacitor wiring. If voltage is below +157 volts with a good capacitor in the circuit, rectifier CR2 is defective and must be replaced. Replace tube V1 after checks are completed.
	c. Defective relay K7	*c*. On low-voltage rectifier and alarm unit Z1, check voltage between test jacks J7(-) and J8(+) for an indication of 40 volts ±4 volts. (Voltage is higher than 24 volts because of absence of load.) If voltage is not present, check for opens in winding of relay K7 and resistor R23. Then check to see that contacts 3 and 10 are not

Symptom	Probable trouble	Corrective measures
		sticking. Normal relay operation is as follows: When relay K7 operates, relay K6 releases and opens contacts 3 and 10 of relay K7. This places resistors R16 and R17 in series with winding of relay K6. Check adjustment of resistor R16. On low-voltage rectifier and alarm unit Z2, resistor R17 is not in series with variable resistor R16. Check the adjustment of variable resistors R16.
	d. On low-voltage rectifier and alarm unit Z1, capacitor C3 is open, or rectifier CR1 is defective.	*d*. On low-voltage rectifier and alarm unit Z1, if 40 volts is not present between test jacks J7(-) and J8 (+), check voltage between terminals 9 and 10 of transformer T1 for 33 volts ±3 volts act If voltage is not present, replace transformer T1 (par. 166*f*). If voltage is present, check for its presence between terminals 2 and 4 of rectifier CRT. If 33 volts ac is present, check for 40 volts dc between terminals 1 (-) and 3 (+) of rectifier CRT. If 40 volts is not present, replace rectifier CR1 (par. 166*f*). Check capacitor C3 for an open. Check rectifier CR1 for defects. If voltage between test jacks J7(-) and J8(+) is below 31 volts, capacitor C3 is open and must be replaced. Before replacing C3, check continuity of capacitor wiring. If voltage is below 36 volts with a good capacitor in the circuit, rectifier CR1 is defective and must be replaced.
3. Absence of normal dc output. CURRENT meter reads zero. LOAD ALARM lamp lighted. LOW VOLTAGE lamp unlighted. HIGH VOLTAGE lamp unlighted. Buzzer sounds.	*a*. Failure in load detecting circuit	*a*. On low-voltage rectifier and alarm unit Z1, check voltage between test jacks J9 and J10. Voltage indication should be 155 volts dc If voltage is present, operate AC POWER switch to OFF position. Check resistance between test jacks J1 and J9. Resistance should be 3,400 ohms ±100 ohms. If resistance is infinite, check for opens in resistor R18, relay K6 winding, relays K7 and K8 contacts 3 and 10, and relays K4 and K5 contacts 6 and 11. Set 600V ADJ control to middle of adjustment range and check resistance between test jacks J1 and J10. Resistance should be 6,000 ohms. If resistance is infinite, check for opens between terminal 29 on connectors P11 and J11, CURRENT meter M1, resistors R12

Symptom	Probable trouble	Corrective measures
		through R15, terminals A or B and C, and terminal 32 of connectors P11 and J11. If 155 volts is not present, check voltage across winding 5-6 of transformer T1. Voltage indication should be 140 volts ± 10 volts act If 140 volts ac is not present, replace transformer T1 (par. 166*f*). If voltage is present, check for its presence across yellow terminals of rectifier CR2. If voltage is not present, replace rectifier CR2. If voltage is present across yellow terminals, check for presence of dc voltage across red and black terminals of rectifier CR2. If no dc voltage is present, replace rectifier CR2. On low-voltage rectifier and alarm unit Z2, check for continuity from terminal 7 of relay K6 through contacts 3-10 of relay K7, and contacts 6-11 of relay K2 to test jack J1. Relays K4 and K8 are not used in low-voltage rectifier and alarm unit Z2.
	b. Failures in main rectifier circuits associated with tubes V1 and V2 and inductor L1.	*b*. If low-voltage rectifier and alarm unit Z1 is good, line voltage will be supplied to primaries of transformers T1 and T2. Check voltage across primary windings for presence of 115 volts act If 115 volts is present, check for lighted filaments in tubes V1 through V6 on main chassis. If tubes are not lighted, check tubes, socket wiring, and T2 windings 8 to 9 and 10 to 11 for open circuits. If 115 volts ac is not present on primary windings, check for opens between winding 7-8 of relay K1, between connectors P11 and J11, and in the 115V-230V switch. Since V1 and V2 operate at hazardous voltages, perform resistance continuity analysis in preference to other methods. If trouble is not located, check resistance between test jacks J1 and J3 for 7,100 ohms. If resistance is infinite, check resistor R7 and wiring for opens. Operate 600V ADJ control fully clockwise and check resistance between test jacks J1 and J4. Resistance should be 14,300 ohms. If resistance is infinite, check for opens across resistors R6, R12, R13, R14, and R15, CURRENT meter, and connecting wiring.

Symptom	Probable trouble	Corrective measures
		If trouble is not located, check resistance of L1 between test jack J1 and pin 4 of tube V1. Resistance should be 580 ohms. If resistance is infinite, check resistance across terminals 1 and 2 of inductor L1. Resistance should be 580 ohms. If resistance is infinite, replace choke L1. Check resistance between cap of tube V1 and terminal 6 of transformer T1, chassis ground, and test jack J10 on low-voltage rectifier and alarm unit Z1. Resistance should be 330 ohms +20 ohms. Repeat resistance check from cap of tube V2 to same points. Resistance should be 330 ohms +20 ohms. If resistance is infinite between terminal 5 or 7 and terminal 6, replace transformer T1 (par. 166*f*).
4. High output ripple voltage alarms normal.	--	Pin C of connector P3 not grounded. Strap between terminals B and C on terminal block TB1 is open. Capacitor C1, C2, or C3 may be open.
5. No low-voltage cutoff (PP-826/ U only). CURRENT meter indication 100 ma. LOAD ALARM lamp remains lighted. LOW VOLTAGE lamp unlighted. HIGH VOLTAGE lamp unlighted. Buzzer sounds.	Failures in circuits associated with tubes V5 and V6 and relays K2 and K3 located on low-voltage rectifier and alarm unit Z1.	On low-voltage rectifier and alarm unit Z1, use tube socket voltage and resistance diagrams (TM 11-2139-20), and check for opens in resistors R6, R8, R9, R10, R11, and R13. Check for open in capacitor C5. Check relay K2 winding and contacts 3 and 10 for sticking. Check to see that connectors P11 and J11 are properly seated. Refer to circuit description paragraphs.
6. Same as 5 except that LOAD ALARM lamp is unlighted.	*a*. Failures in relay K2, K4, K7, or K8 contacts and wiring associated with low-voltage cutoff operation.	*a*. Refer to circuit description paragraphs. Check for opens in the operate and lockup paths of relay K4.
	b. On low-voltage rectifier and alarm unit Z1, either capacitor C3 is open or rectifier CR1 is defective.	*b*. Same as 2*d* above.
7. Same as 5 except that LOAD ALARM lamp unlighted. LOW VOLTAGE lamp lighted.	*a*. Short between contacts 3 and 4 on relay K4.	Check for open between terminals 3 and 4 on relay K4. If a short exists, inspect relay base for solder shorts. If base is clear and trouble is still present check the relay.
8. No low-voltage cutoff (PP-826/U only CURRENT meter indicates between 80 and 85 ma. (Low voltage cutoff occurs with LOW VOLTAGE control adjusted in accordance with paragraph 159*d*.) LOAD ALARM lamp lighted. LOW VOLTAGE lamp lighted. HIGH VOLTAGE lamp unlighted.	Failure in circuits associated with tubes V2, V3, and V4 located on low-voltage rectifier and alarm unit Z1.	On low-voltage rectifier and alarm unit Z1, check voltage between test jacks J3 and J4. Voltage should be 470 volts +20 volts. If voltage is not present, check for open in choke L1 and in associated wiring. Check to see that connectors P11 and J11 are correctly seated. If voltage is present, check for opens in resistors R1, R2, R3, R5, and R14. On main chassis, check for opens in resistors R1, R2, R5, and R9.

Symptom	Probable trouble	Corrective measures
Buzzer sounds. Symptoms repeat when RESTORE switch is operated.		
9. No high-voltage cutoff *Note*. Relay K8 is not used in the low-voltage rectifier and alarm unit Z2 of the PP_826A/U power supply. However, except for this difference, the symptoms, probable troubles, and corrections of this item apply to both power supplies. CURRENT meter reads 100 ma. LOAD ALARM lamp unlighted. LOW VOLTAGE lamp unlighted HIGH VOLTAGE lamp unlighted. Buzzer sounds.	Troubles in symptom 5 have been repaired. Failures in relays K2, K3, K5, K6, K7, and K8 contacts or associated wiring.	Refer to the circuit description paragraph. Check for opens in the operate and lockup paths of relay K5.
10. Same as 9 except that HIGH VOLTAGE lamp is lighted.	Short between contacts 3 and 4 on relay K5.	Same as 6c above.
11. No high-voltage cutoff (See note 9 above.) CURRENT meter indicates between 115 and 120 ma. (High voltage cutoff occurs with HIGH VOLTAGE control adjusted in accordance with paragraph 195*e*). LOAD ALARM lamp lighted. LOW VOLTAGE lamp unlighted HIGH VOLTAGE lamp unlighted. Buzzer sounds. Symptoms repeat when RESTORE switch is pressed.	Failures in circuits associated with tubes V3, V4, and V5 on main chassis; tube V2 and relay K3 on low voltage rectifier and alarm unit Z1.	Check for opens in resistors R3 and R4 on main chassis and in resistors R4 and R14 on low-voltage rectifier and alarm unit Z1.
12. Load detection test requirements not met (Ran 159*f* or 160*c*). Dc output current comes on. Improper reading across test jacks J1 and J10 on low-voltage rectifier and alarm unit Z1 (Power Supply PP-826/U, only).	a. Variable resistor R16 out of adjustment or open. b. Relay K9 terminals 1 and 2 or 5 and b. 6 are shorted.	a. Readjust R16 in accordance with final testing. If adjustment is not possible, check for opens in resistors R16 and R17. Check for opens across terminals 1 and 2, and 5 and 6. If either pair is shorted, inspect relay base for solder shorts. If base is clear and trouble is still present, check relay K9.
13. Load detection test requirements not met (par. 159*f*). Power did not cut off (Power Supply PP-826/U, only).	Resistor R22 in low voltage rectifier and alarm unit Z1 open.	Check for open in resistor R22 for continuity of connecting wiring.
14. Power supply fails to start (Power Supply PP-826A/U, only),	Resistor R16 in low voltage rec ifier and alarm unit Z2 out of adjustment or defective.	Adjust or replace resistor R16.
15. Low line power cutoff test requirements not met. Power supply did not cut off when line voltage was reduced (Power Supply PP-826A/U, only).	Variable resistor R20 out of adjustment or shorted. Relay K2 contacts 6 and 11 sticking.	Refer to the circuit description. Readjust R20 as instructed in paragraph 194*j*. If adjustment is not possible, check for opens in resistor R20. Check to see that relay K2 contacts are not sticking.

Symptom	Probable trouble	Corrective measures
16. Load detection test requirements not met (par. 160*c*). LOW VOLTAGE AND LOAD ALARM lamps do not light, buzzer does not sound, and the dc output is not interrupted (Power Supply PP-826A/U only).	Relay K2 has not released. Defective connections to relays K2, K5, and K7.	Check for 7 volts ac between terminal 11 of transformer T1 of the low-voltage rectifier and alarm unit Z2, and terminal 1 of relay K2. If voltage is zero, measure the voltage between terminal 11 of transformer T1 and terminal 2 of relay K2. If voltage is 7 volts, relay K2 has not released; check the adjustment of the LOW-VOLT ALARM control (par. 160b).
17. Power supply cycles on and off. LOAD ALARM lamp flashes on and off. Ac input 97 volts or higher.	Variable resistor R20 out of adjustment or open.	Check for open in resistor R20, wiring to relay K2 contacts 6 and 11.
18. 230-volt line test requirements not met (par. 159*h*). Operational tests (par. 159*b* through *g*) were satisfactory.	Failure in input wiring, in primary windings of transformers T1 and T2 on main chassis, or in primary windings of transformer T1 on low-voltage rectifier and alarm unit Z1. Defective 115 V-230V switch S2.	Check voltage across primary windings of transformers T1 and T2 on main chassis and T1 on low-voltage rectifier and alarm unit Z1. If 115 volts ac is not present, check fuses F3 and F4 and associated wiring. Check for opens in input wiring through switch S2. See symptoms Nos. 1 through 17.
19. Blower unoperative ------------------	*a*. Defective thermostat S3 -----------------	*a*. Short terminals on thermostat and check for blower operation. If blower operates, replace thermostat S3 and repeat blower test (par. 159*c*).
	b. Open circuit	*b*. Short thermostat and check voltage. The voltage across connector J2 should be 115 volts. If voltage is not present, inspect for open circuits. Check to see that connectors J2 and P2 are properly seated.
	c. Defective blower B1	*c*. Substitute good blower. Short thermostat to check blower operation.
	d. Defective capacitor C6	*d*. Replace capacitor C6 and perform blower operational test (par. 159 *c*).
20. Equipment meets all requirements, but tube V1, V2, V3, or V4 appears to be inoperative.	*a*. Defective rectifier tube V1 or V2	*a*. Operate AC POWER switch to the OFF position and remove the plate cap from an apparently operative tube. Operate AC POWER switch to ON and check for normal operation. (Equipment is capable of normal operation for a short period of time with only one tube operating.) **Caution: Hazardous voltages are present when power is on. Check voltages and resistances at tube sockets. Replace tube if necessary.**
	b. Defective series-regulator tube V3 or V4.	*b*. Repeat procedures given in a above for tubes V3 and V4.
	c. Defective voltage regulator tube V4 on low-voltage rectifier and alarm unit Z1.	*c*. On low-voltage rectifier and alarm unit Z1, check voltage across test jacks J4 and J5. It should be 40 volts +15 volts. If voltage is 90 volts, replace tube V4. If 90 volts is still present, check for opens in associated wiring.

Symptom	Probable trouble	Corrective measures
	d. Failure in time-delay circuit (capacitors C4 and C5 and resistor R9 and main chassis).	*d.* Check voltage across terminals of capacitors C4 and C5 for an exponentially increasing voltage. This voltage should rise to 125 volts ±5 volts in 15 seconds. If voltage does not have this exponential characteristic, replace capacitors C4 and C5. If voltage is not present, check for open circuits in associated wiring. Check resistance between test jacks J1 and J3. Resistance should be 7,100 ohms. If resistance is infinite, check resistance across terminals of resistor R7. Resistance should be 7,100 ohms. Replace resistor R7 if defective.
	e. Defective capacitor C1 or C2 on main chassis.	*e.* On low-voltage rectifier and alarm unit Z1, check high-voltage filter output ripple across test-jacks J1 and J10. It should be 8 volts ac (par. 159*c*). **Caution: Use dc blocking network to protect the voltmeter from 1,000 volts.** If 14 volts ac is present, replace capacitor C2. If 21 volts ac is present, replace capacitor C1.
21. After AC POWER switch is operated to ON, LOAD ALARM lamp does not light, and buzzer does not sound. CURRENT meter reads 100 (Power Supply PP-826/U, only).	Failure in transformer T1, contacts 6 and 11 of relays K7 and K8, or associated wiring, on low-voltage rectifier and alarm unit Z1.	On low-voltage rectifier and alarm unit Z1, check voltage across terminals 11 and 12 of transformer T1. Voltage should be 7 volts act If voltage is absent, replace transformer T1 (par. 166*f*). If voltage is present, check for opens in LOAD ALARM lamp, buzzer, relays K7 and K8 contacts 6 and 11, ALARM CUTOFF switch, and connectors P11 and J11 pins 31 and 35.
22. After AC POWER switch is operated to ON, the LOAD ALARM and LOW VOLTAGE lamps light and the buzzer does not sound (Power Supply PP-826A/U, only).	Failure in transformer T1. Contacts 19 of relay K2 are open, contacts 5-11 of relay K7 are open, or contacts 1-9 of relay K5 are open.	On low-voltage rectifier and alarm unit unit Z2, check the voltage across terminals 11-12 of transformer T1. If voltage is present, check for opens in relays K2, K7, and K5.
23. When low-voltage cutoff occurs, LOW VOLTAGE alarm lamp does not light. LOAD ALARM lamp lights. Buzzer sounds.	Failure in LOW VOLTAGE alarm lamp circuit.	On low-voltage rectifier and alarm unit Z1, check resistance across terminals 2 and 9 of relay K4. Resistance should be 10 to 15 ohms. If resistance is infinite, check for opens in LOW VOLTAGE alarm lamp, connectors P11 and J11 pins 35 and 2, and associated wiring. Check to see that relay K4 winding and contacts 2 and 9 are not sticking.

Symptom	Probable trouble	Corrective measures
24. When the output voltage decreases below approximately 530 volts, the LOAD ALARM and LOW VOLTAGE lamps do not light and the buzzer does not sound (Power Supply PP--826A/U, only).	Failure in transformer T1, contacts of relay K2, or associated wiring on low-voltage rectifier and alarm unit Z2.	On low-voltage rectifier and alarm unit Z2, check winding of transformer T1, contacts on relays K2, K5, and K7. Readjust variable resistor R16 (par. 194*a*).
25. When high-voltage cutoff occurs, HIGH VOLTAGE alarm lamp does not light. LOAD ALARM lamp lights. Buzzer sounds.	Failure in HIGH VOLTAGE alarm lamp circuit.	On low-voltage rectifier and alarm unit Z1, check resistance across terminals 2 and 9 of relay K5. Resistance should be 10 to 15 ohms. If resistance is infinite, check for opens in HIGH. VOLTAGE alarm lamp, connectors J11 and P11 pins 35 and 30, and associated wiring. Check relay K6 l winding. See that contacts 2 and 9 are not sticking.

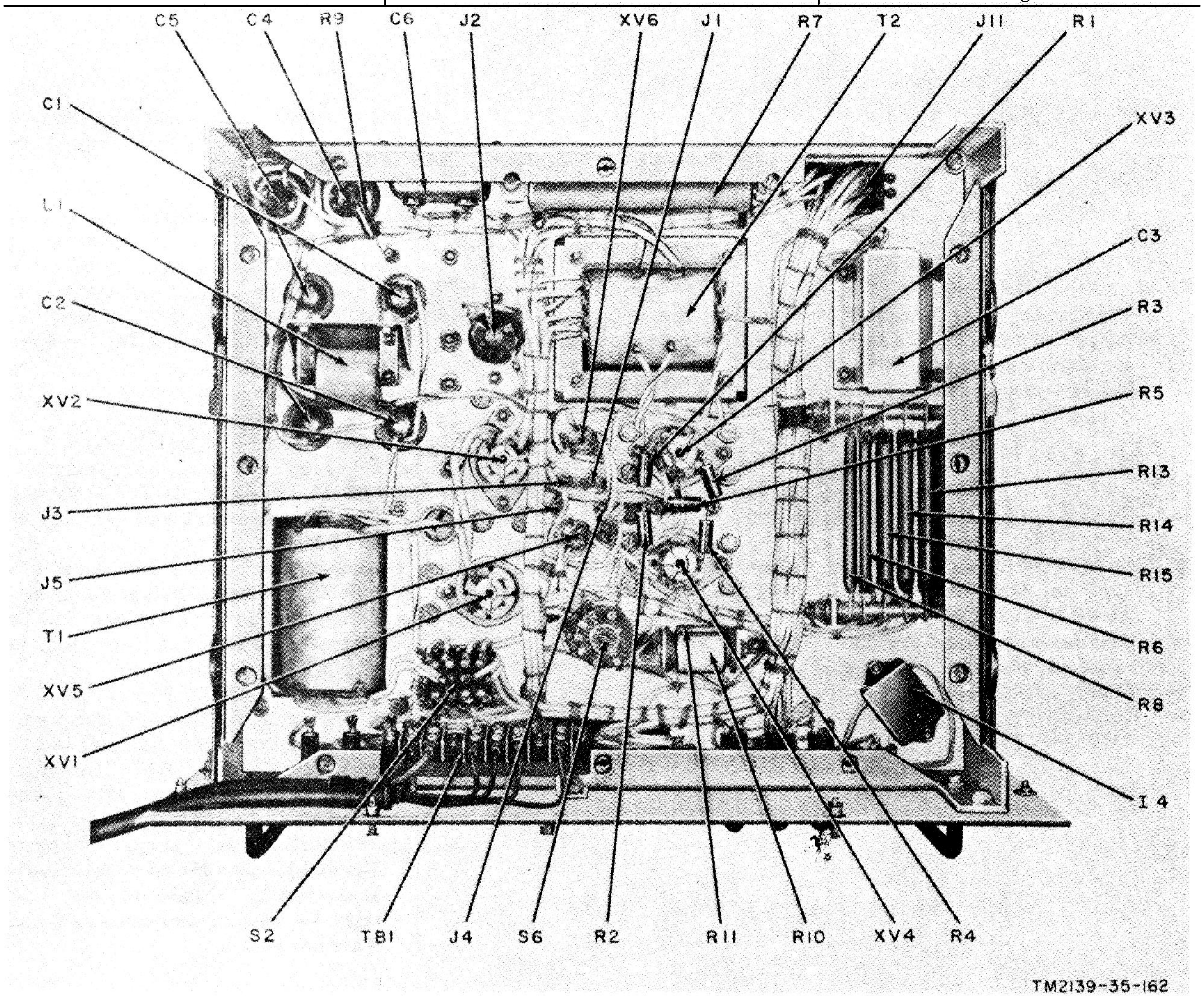


Figure 116. Power Supply PP--826/U, (original units), removed from transit case, bottom view, parts location.

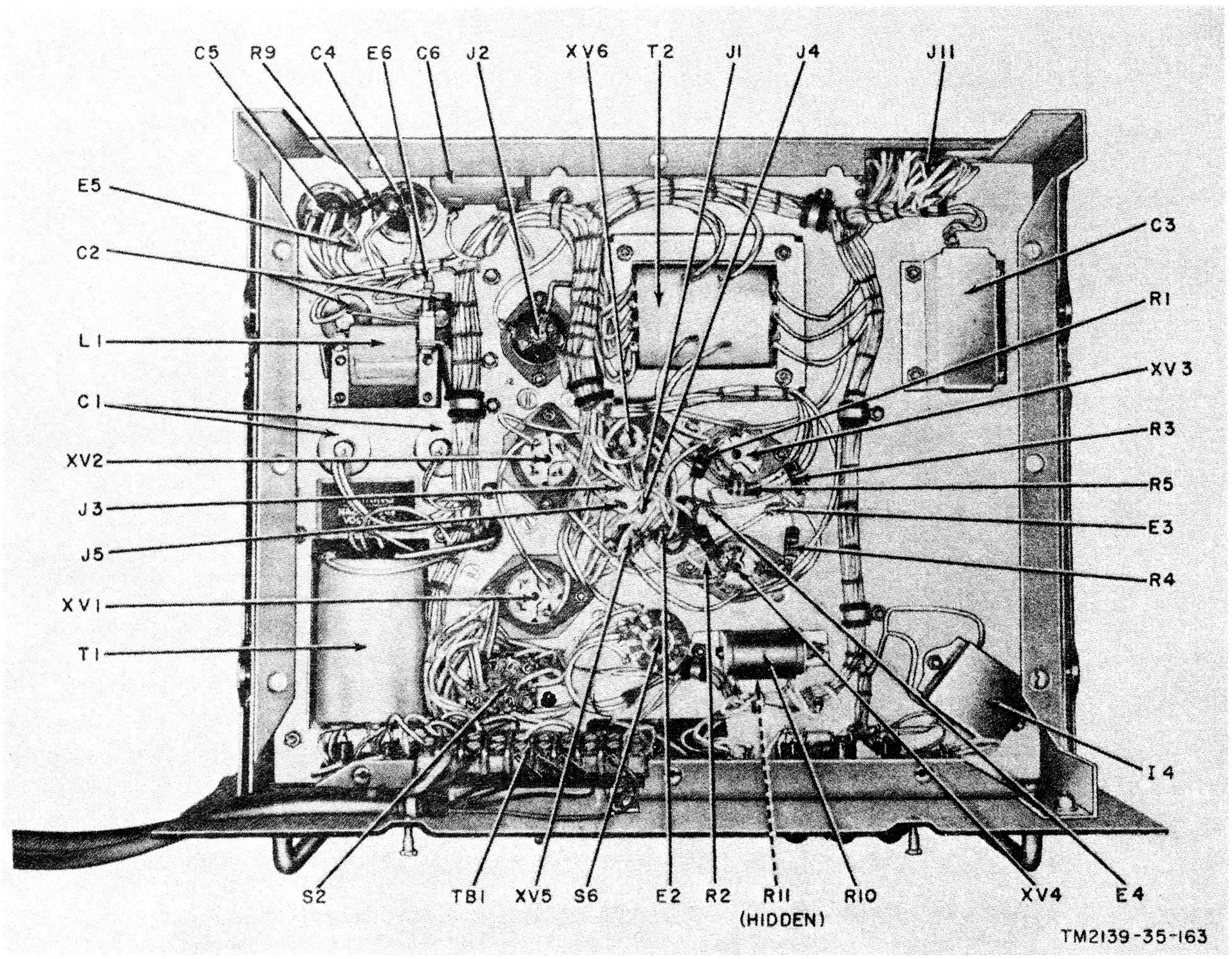


Figure 117. Power Supply PP--826/U, (revised unite), removed from transit case, parse location.

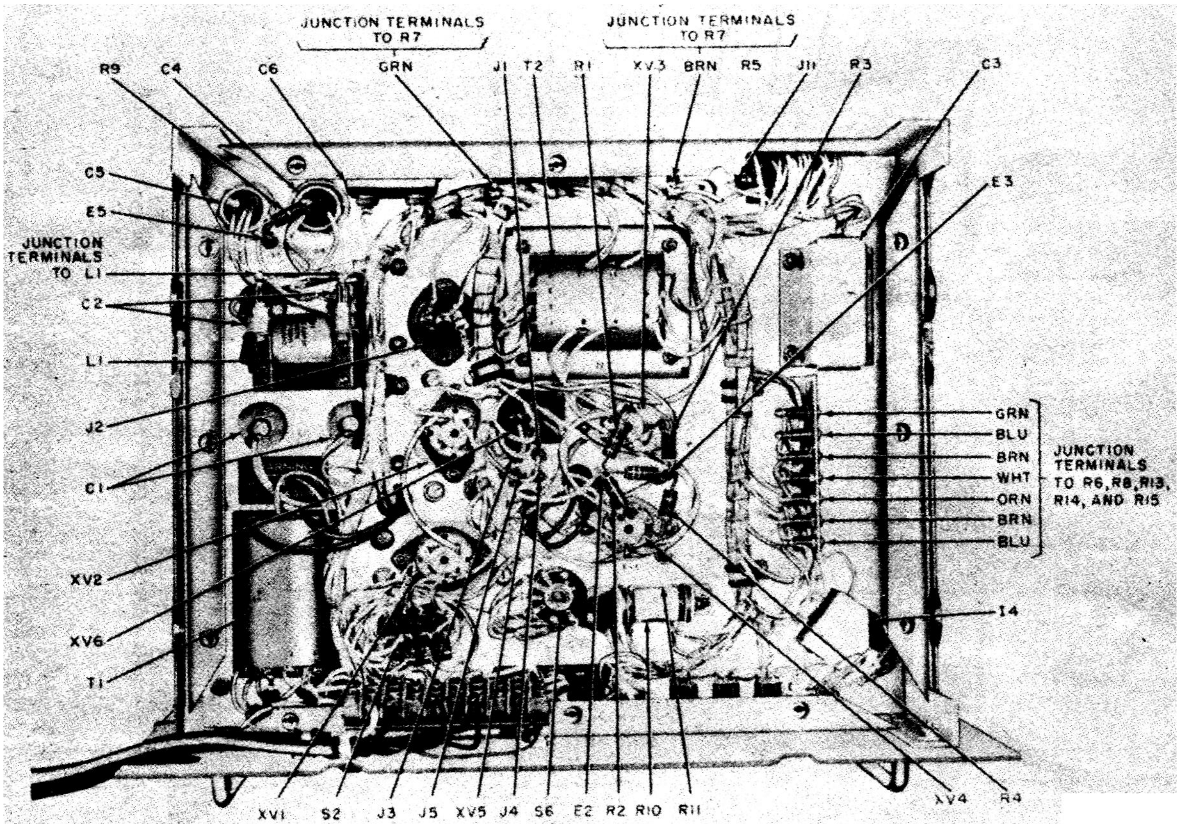


Figure 118. Power Supplies PP-826/U, (serial Nos. 1170 through 2964) and PP-826A/U, removed from transit case, bottom view, parts location.

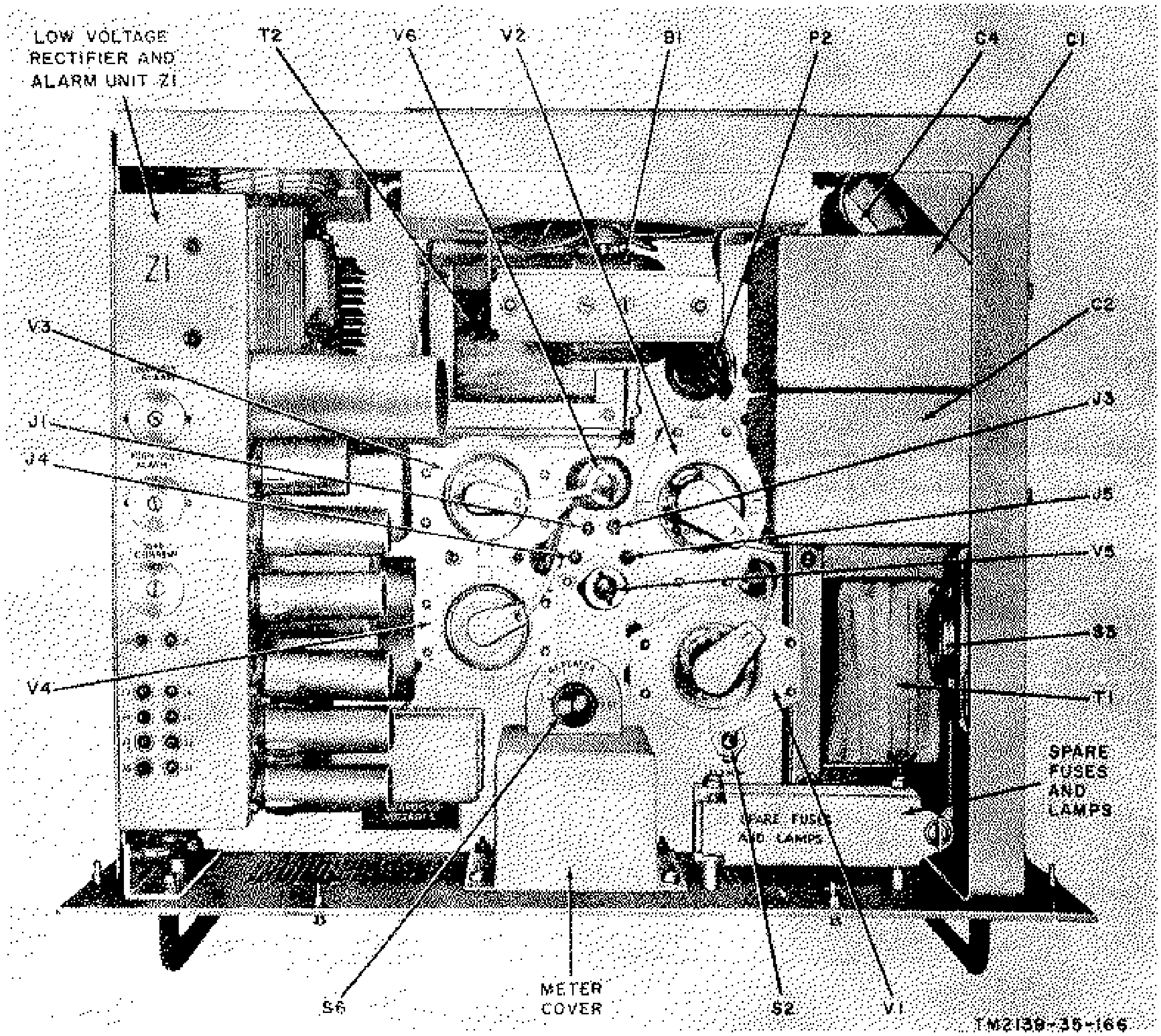


Figure 119. Power Supplies PP-826/U, and PP-826A/U, removed from transit case, top view, parts location.

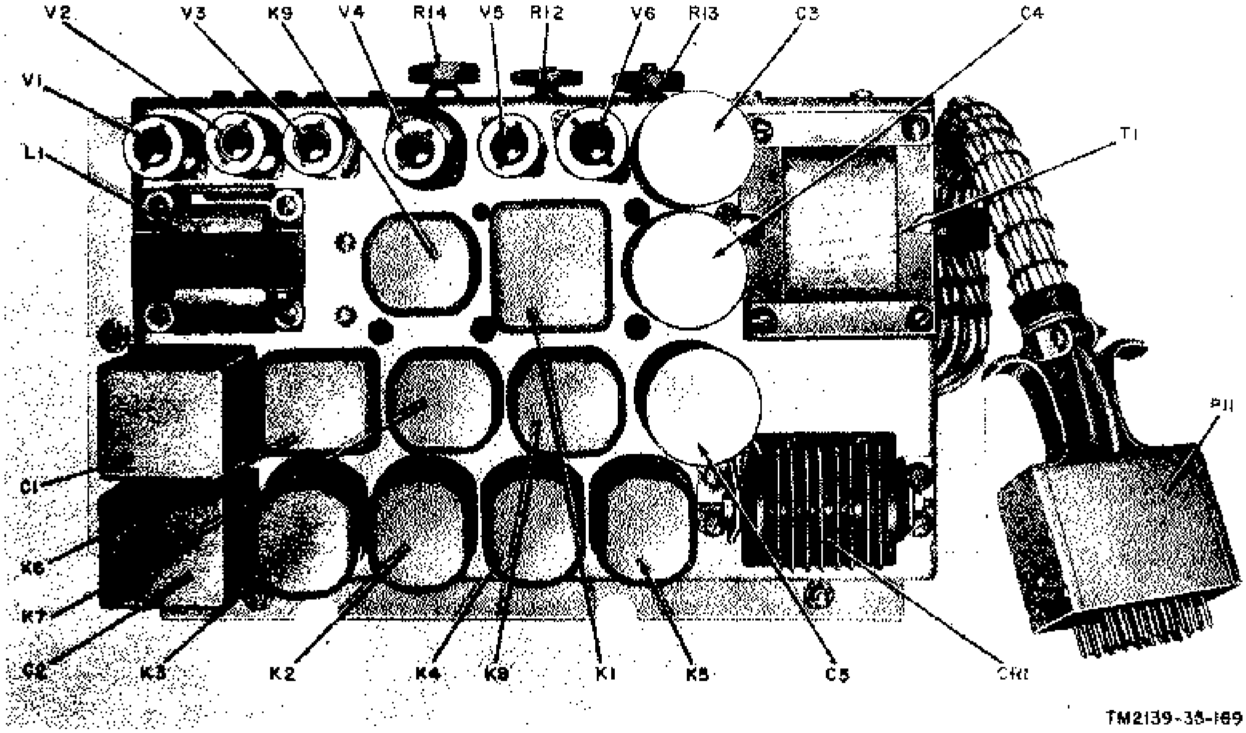


Figure 120 Low-voltage rectifier and alarm unit Z1 (part of Power Supply PP--826/U, top view, parts location.

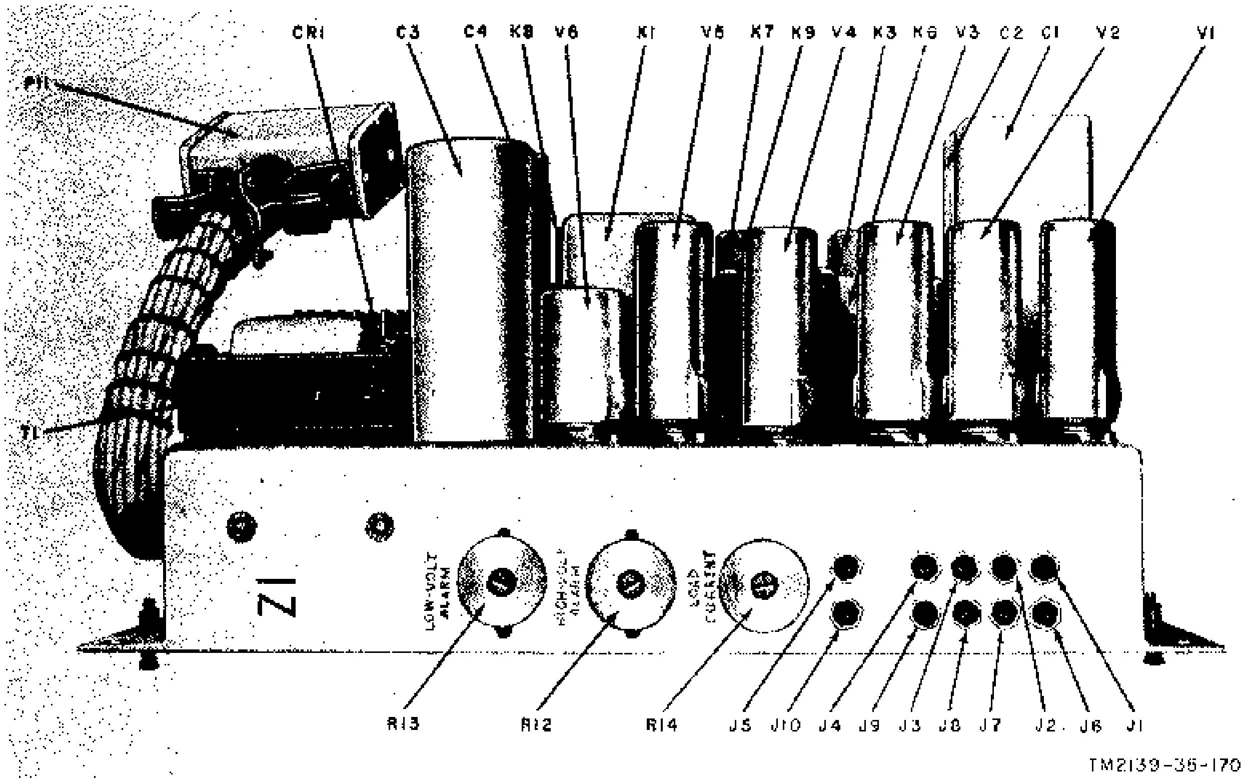


Figure 121. Low-voltage rectifier and alarm Z1 (part of Power Supply PP--826/U, side view, control and parts location.

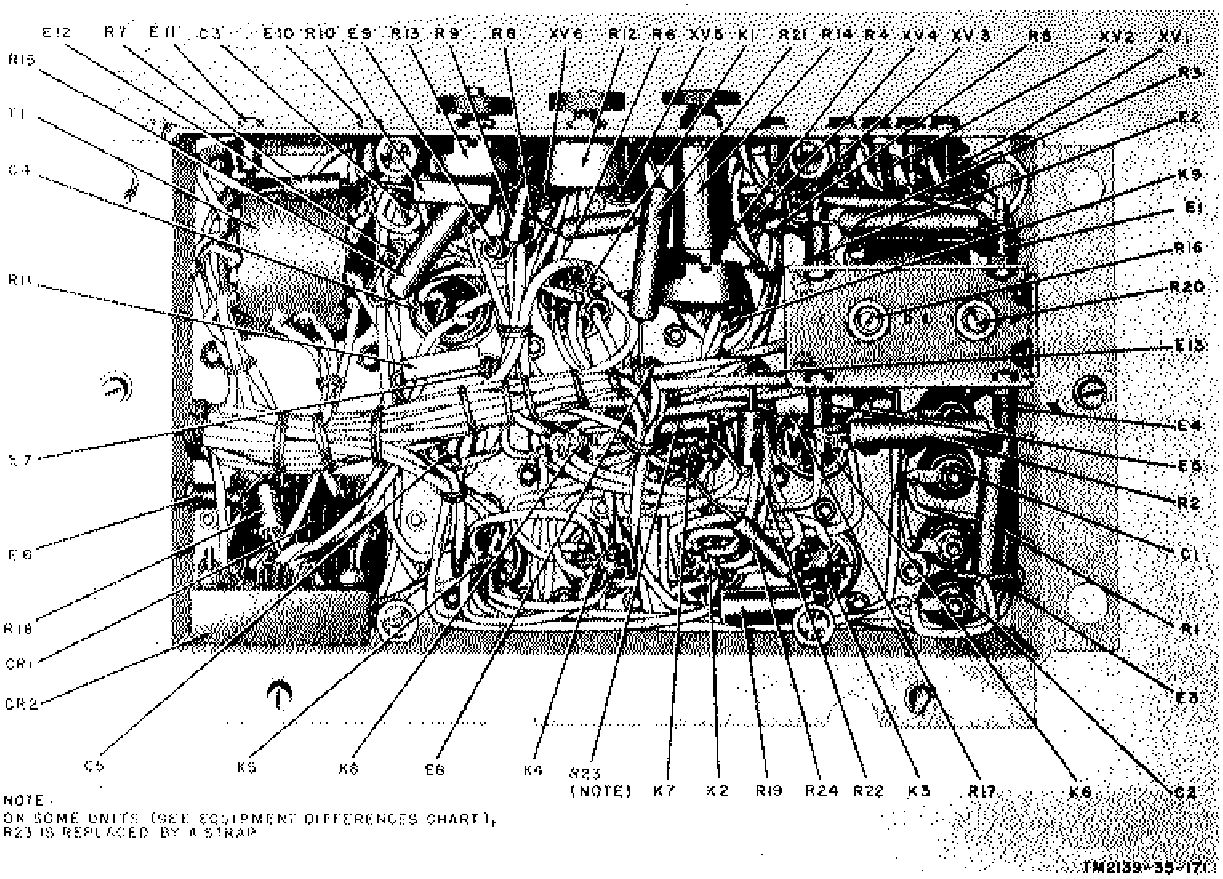


Figure 122. Low-voltage rectifier and alarm unit Z1 (part of Power Supply PP--826/U, bottom view, parts location.

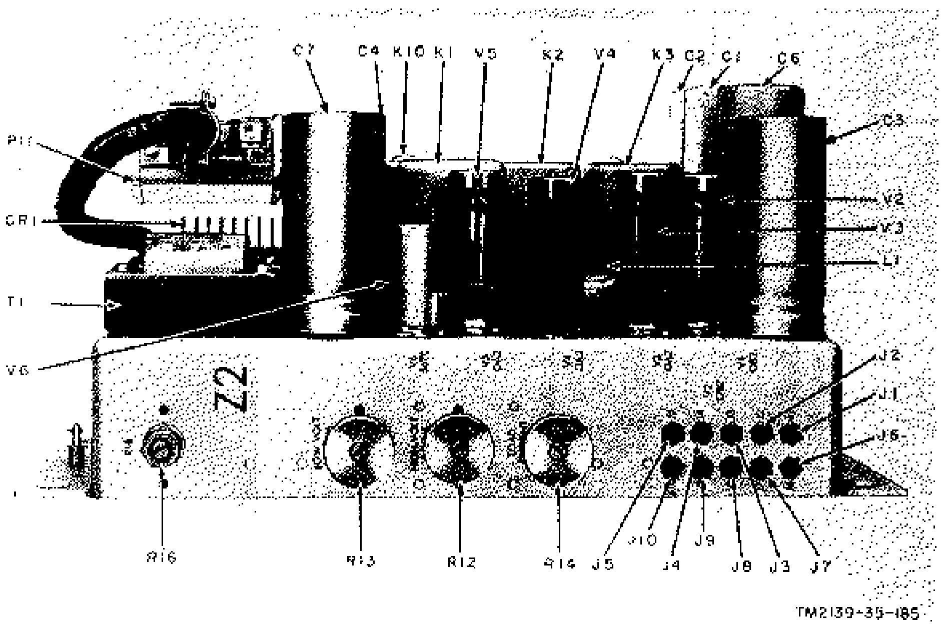


Figure 123. low-voltage rectifier and alarm unit Z2 (pant of Power Supply PP--826A/U, top view, parts location,.

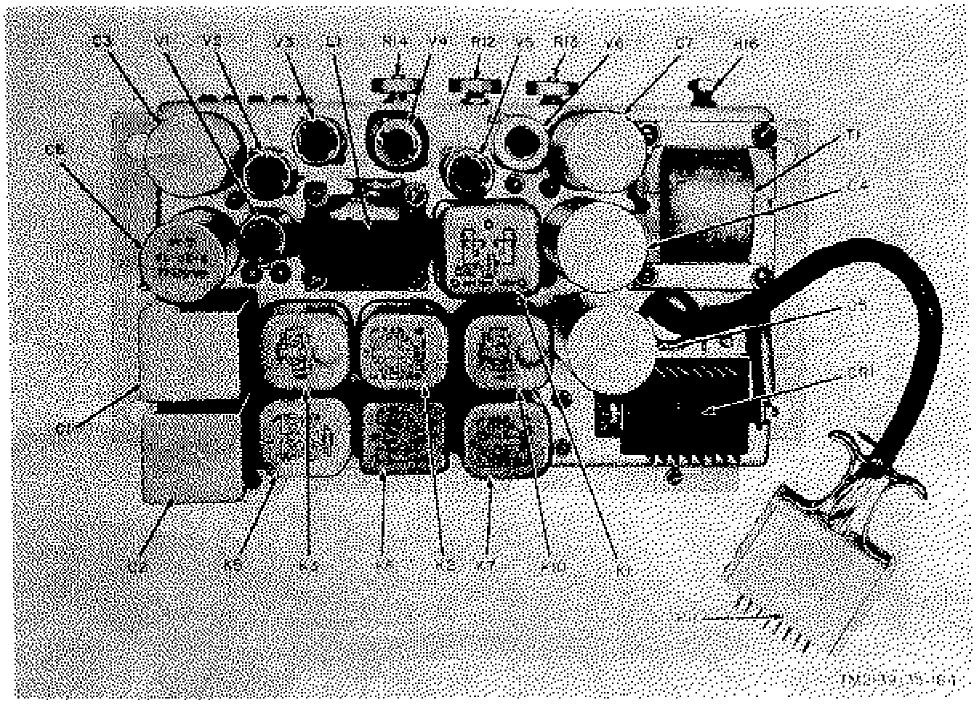


Figure 124. Low-voltage rectifier and alarm unit Z2 (part of Power Supply PP--826A/U, side view, control and parts location.

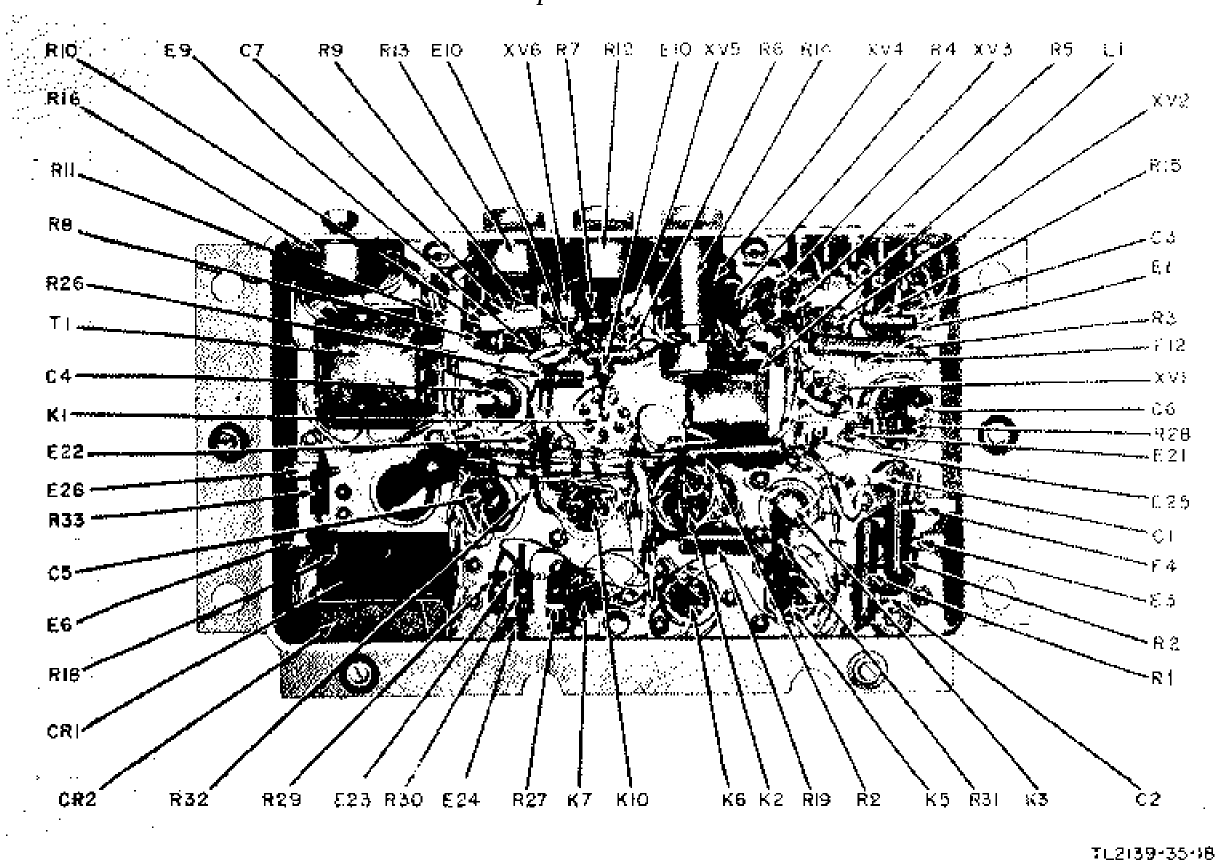


Figure 125. Low-voltage and rectifier and alarm. unit Z2 (part of Power Supply PP--826A/U, bottom view, parts location.

162. Power Supplies PP-826/U, and PP-826A/U, Dc Resistance of Transformers and Coils

a. Main Chassis.

Transformers and Coil	Terminals	Resistance (ohms)
T1..........................	1-2	3.6
	3-4	3.9
	5-6	327.5
	6-7	327.5
	5-7	655
T2..........................	1-2	6.6
	3-4	7.6
	5-6	513
	6-7	513
	5-7	1,026
		.33
		.036
L1		650

b. Low-Voltage Rectifier and Alarm Units Z1 and Z2.

Transformers and Coil	Terminals	Resistance (ohms)
T1..........................	1-2	59
	3-4	66
	5-6	325
	7-8	2.6
	9-10	13.8
	11-12	.96
L1		650

Section XI. FILTER, NETWORK, EQUALIZER, AND RELAY TEST PROCEDURES

163. Filter, Network, and Equalizer Tests

a. General. A filter, network, or equalizer is tested by re-moving it from its respective panel and measuring its loss at specified frequencies. These components are complete assemblies and must be replaced as such if found to be defective; they cannot be repaired.

b. Initial Procedure.

(1) Locate the designation of the component to be tested in the *filter, equalizer, or network* column of the test procedures chart (*e* below).

(2) Connect the resistors, signal generator, and output meter specified in the *add. connect. info.* column as shown in A, figure 126. Values for resistors A through G are given in the filter, equalizer, and network pretest setup chart (*c* below).

(3) Adjust the signal generator for the output frequency and the output level given in the *signal generator test frequency* and the *pretest output* columns respectively (*e* below).

(4) Connect the component to be tested in the appropriate test setup as referenced in the *test figures* column. Refer to the additional connection information (*d* below) specified in the *add. connect. info.* column (*e* below).

(5) The *test output* column lists the output meter indication across resistor F for the components being tested.

c. Filter, Equalizer, and Network Pretest Setup Chart. Use the following chart to select the proper resistance values for the filter, equalizer, or network under test. The required resistor arrangement is referenced in the *resistor arrangement* column (*e* below).

Note. Many of the resistors required are not provided in the test facilities kit. If resistors of the proper value cannot be obtained locally, use combinations of the resistors provided with the test facilities kit to provide the required resistance values.

Arrangement	Impedance (ohms)	Resistor values (ohms)						
	Input-output	A	B	C	D	E	F	G
1--------------	15-15 ---------------	0	191	261	15.4	0	15.4	0
2--------------	75-75 ---------------	0	191	261	75	0	75	0
3--------------	75-27K -------------	0	191	261	75	0	Not used	17K
4--------------	135-135 ------------	0	191	261	261	0	135	0
5--------------	135-40K -----------	0	191	261	261	0	Not used	30K
6--------------	135-40K -----------	0	191	261	261	0	40K	0
7--------------	200-27K -----------	0	191	261	261	64.9	Not used	17K
8--------------	240-240 ------------	0	191	261	261	105	240	0
9--------------	600-600 ------------	470	365	470	2,200	0	600	0
10 ------------	1,500-1,500 -------	470	365	470	2,200	910	1000	0
11 ------------	13K-13K-----------	0	0	Not used	Not used	13K	Not used	300
12 ------------	13K-20K-----------	0	0	Not used	Not used	13K	Not used	10K
13 ------------	27K-27K-----------	0	0	Not used	Not used	27K	Not used	17K
14 ------------	60K-10K-----------	0	0	Not used	Not used	60K	Not used	0
15 ------------	100K-100K--------	0	0	Not used	Not used	100K	Not used	100K

* A strap is used for resistors A, B. E, and G when 0 ohm is specified.

d. Additional Connection Information for Filter, Equalizer, and Network Tests. The following connection information is used when referenced in the add. connect. Info. column of the test procedures chart (e below). Instructions for the use of the procedures in (1) through (9) below are given in *b*(4) above.

(1) Use the audio level meter for the pretest setup and the test measurements.

(2) Use the voltmeter for the pretest setup and the test measurements.

(3) Connect a 15-uuf capacitor across terminals 3 and 4 of the filter to be tested.

(4) Strap terminals 1 and 5 together on the equalizer to be tested.

(5) Connect 600 ohms across terminals 2 and 3.

(6) Connect terminal 4 to the case. Do not connect it to ground.

(7) Strap terminal 4 to 5; no connection between terminals 6 and 7.

(8) Strap terminal 6 to 7; no connection between terminals 4 and 5.

(9) Strap terminal I to 3. e. Test Procedures Chart.

e. Test Procedures Chart.

Note. Do not adjust the signal generator after it has been set up for a test unless a new pretest setup is required.

Panel or assembly	Filter, equalizer, or network	Pretest setup: Resistor arrangement (sub par. *c*)	Pretest setup: Signal generator test frequency (kc)	Pretest setup: Pretest output (db)	Pretest setup: Test setup figures 126	Pretest setup: Test setup figures 127	Add. connect. info. (sub par. *d*)	Test output (db)
CHAN 1	FL104	9	7	10	B	----------	(2)	-27.8 max.
	FL102, FL103	9	5	10	B	----------	(2)	-16.8 ±1.5.
			7	10	-----------	----------	-----------	-16.8 ±1.5.
			7.5	10	-----------	----------	-----------	-16.8 ±1.5.
	FL101	9	1	10	B	----------	(2)	-6.8 min.
CHAN 2	FL204	9	7	10	B	----------	(2)	-27.8 max.
	FL202, FL03	9	9	10	B	----------	(2)	-16.8 ±1.5.
			11	10	-----------	----------	-----------	-16.8 ±1.5.
			11.5	10	-----------	----------	-----------	-16.8 ±1.5.
	FL201	9	1	10	B	----------	(2)	-6.8 min.
CHAN 3	FL304	9	7	10	B	----------	(2)	-27.8 max.
	FL302, FL303	9	13	10	B	----------	(2)	-16.8 ±1.5.
			15	10	-----------	----------	-----------	-16.8 ±1.5.
			15.5	10	B	----------	-----------	-16.8 ±1.5.
	FL301	9	1	10	B	----------	(2)	-6.8 min.

Panel or assembly	Filter, equalizer, or network	Pretest setup					Add. connect. info. (sub par. *d*)	Test output (db)
		Resistor arrangement (sub par. *c*)	Signal generator test frequency (kc)	Pretest output (db)	Test setup figures			
					126	127		
							(2)	-27.8 max.
CHAN 4	FL404----------	9	7	10	B	----------	(2)	-17.8 ±1.5.
	FL402, FL403	9	17	10	B	----------	----------	-17.8 ±1.5.
			19	10	----------	----------	----------	-17.8 ±1.5.
			19.5	10	----------	----------	(2)	-6.8 min.
	FL401----------	9	1	10	B	----------	(1)	-12 min.
SUBGROUP PANEL	FL1, FL2, FL3	11	20	-10	B	----------	----------	-50 max.
			56	0	----------	----------	----------	-50 max.
			72	0	----------	----------	(1)	-60 max.
	FL4, FL5 ------	4	70	0	B	----------	----------	-65 min.
			88	0	----------	----------	----------	-21 min.
			92.5	-10	----------	----------	----------	-19 min.
			99	-10	----------	----------	----------	-21 min.
			107	-10	----------	----------	----------	-15 max.
			120	0	----------	----------	(1)	-65 min.
	FL6, FL7 ------	4	64	0	B	----------	----------	-65 max.
			72	0	----------	----------	----------	-20 min.
			76.5	-10	----------	----------	----------	-18 min.
			83	-10	----------	----------	----------	-20 min.
			91	-10	----------	----------	----------	-35 max.
			120	0	----------	----------	(1)	-70 max.
	FL8, FL9 ------	4	52	0	B	----------	----------	-55 max.
			56	0	----------	----------	----------	-18 min.
			60.5	-10	----------	----------	----------	-16 min.
			67	-10	----------	----------	----------	-18 min.
			75	-10	----------	----------	----------	-65 max.
			95	0	----------	----------	(1)	-8 ±3.
GROUP PANEL	EQ2-------------	9	40	0	B	----------	----------	-4 ±3.
			68		----------	E	(1) (9)	-35 max.
	EQ3-------------	9	55	0	----------	----------	(1) (9)	-35 max.
			55	0	B	----------	(1)	-15 min.
	FL1 -------------	9	60	-10	B	----------	----------	-55 max.
			68	-10	----------	----------	----------	-35 max.
			85	-10	----------	----------	(1)	-45 max.
	FL2 -------------	15	67	0	B	----------	----------	-14 min.
			68	-10	----------	----------		-35 max.
			69	0	----------	----------	(1), (9)	-5.5 min.
	FL3 -------------	9	60	-10	B	----------	----------	-30 max.
			64	-10	----------	----------	----------	-50 max.
			85	-10	----------	----------	----------	-9 ±3.
	Z1 ---------------	9	25	0	F	----------	----------	-12 ±3.
			68	0	F	----------	----------	-4 ±3.
			25	0	----------	A	----------	-6 ±3.
			68	0	----------	A	----------	-2 ±3.
			25	0	----------	B	----------	-3 ±3.
			68	0	----------	B	(5)	-30 to -40.
	Z2 ---------------	1	30	0	C	----------	----------	-30 to -40.
			65	0	----------	----------	(7)	-7 ±3.
	Z3 ---------------	9	28	0	E	----------	(7)	-4 ±3.
			68	0	----------	----------	(8)	-0 ±3.
			28	0	----------	----------	(8)	-4 ±3.
			68	0	----------	----------	(7)	-2 ±3.
	Z4 ---------------	9	28	0	E	----------	----------	-7 ±3.
			68	0	----------	----------	----------	-9 ±3.
	Z5 ---------------	9	25	0	F	----------	----------	-12 ±3.
			68	0	F	----------		-4 ±3.
			25	0		A		

Panel or assembly	Filter, equalizer, or network	Pretest setup			Test setup figures		Add. connect. info. (sub par. *d*)	Test output (db)
		Resistor arrangement (sub par. *c*)	Signal generator test frequency (kc)	Pretest output (db)	126	127		
			68	0	-----------	A	-----------	-6 ±3.
			25	0	-----------	B	-----------	-2 ±3.
			68	0	-----------	B	-----------	-3 ±3.
12-68 kc amplifier	Z1 ---------------	2	62	0	D	-----------	(6)	-50 to -60
Regulator and	FL1--------------	14	62	0	B	-----------	(1)	-45 max.
alarm Z6.			65	0	-----------	-----------	-----------	-40 max.
			68	-10	-----------	-----------	-----------	-15 minimum.
Modem and am-	FL1--------------	8	108	-10	B	-----------	(1)	-12.9
plifier AR4.			120	0	-----------	-----------	-----------	-55 max.
			200	-10	-----------	-----------	-----------	-55 max.
	Z1 ---------------	2	110	0	D	-----------	(6)	-45 to -60
JUNCTION	FL101, FL102	10	4	10	-----------	C	-----------	-11.8 min.
PANEL.			12	10	-----------	-----------	-----------	-57.8 max.
		9	6	10	-----------	D	-----------	-21.8 max.
			12	10	-----------	-----------	-----------	-9.8 min.
TEST PANEL	FL1--------------	12	58	0	B	-----------	(1)	-45 max.
			62	-10	-----------	-----------	-----------	-19.5 min.
			65	0	-----------	-----------	-----------	-45 max.
	FL3--------------	3	193	0	B	-----------	(1), (3)	-20 max.
			194	-10	-----------	-----------	-----------	+4 min.
			195	0	-----------	-----------	-----------	-20 max.
	FL3--------------	13	180	0	B	-----------	(1)	-20 max.
			194	-10	-----------	-----------	-----------	-16 min.
			206	0	-----------	-----------	-----------	-45 max.
			250	0	-----------	-----------	-----------	-50 max.
	FL4--------------	11	20	-10	B	-----------	(1)	-12 min.
			56	0	-----------	-----------	-----------	-50 max.
			72	0	-----------	-----------	-----------	-50 max.
	FL5--------------	7	68	-10	B	-----------	(1), (3)	-30 max.
			83	-10	-----------	-----------	-----------	-17.5 min.
			91	-10	-----------	-----------	-----------	-17.5 min.
			99	-10	-----------	-----------	-----------	-17.5 min.
			120	-10	-----------	-----------	-----------	-25 max.
ORDER WIRE	FL101 ----------	10	6	10	B	-----------	(2)	-11.8 min.
PANEL.			9	10	-----------	-----------	-----------	-37.8 max.
			20	10	-----------	-----------	-----------	-37.8 max.
	EQ101 ----------	9	.2	10	-----------	F	-----------	-45.8
			1	10	-----------	-----------	-----------	-13.8
			1.4	10	-----------	-----------	-----------	-15.3
			1	10	-----------	-----------	-----------	-13.8
CARRIER SUP-	FL1--------------	4	60	-10	B	-----------	-----------	-45 max.
PLY PANEL.			64	-10	-----------	-----------	-----------	-21 min.
			68	-10	-----------	-----------	(4)	-55 max.
	FL2--------------	5	16	10	B	-----------	(1)	-42.8 max.
			20	10	-----------	-----------	-----------	2 min.
			24	10	-----------	-----------	-----------	-42.8 max.
	FL3--------------	4	12	10	B	-----------	(2)	-14.8 min.
			15	10	-----------	-----------	-----------	-47.8 max.
	FL4--------------	4	24	0	B	-----------	(1)	-45 max.
			28	-10	-----------	-----------	-----------	-19.5 min.
			32	0	-----------	-----------	-----------	-40 max.
	FL5--------------	4	60	-10	B	-----------	(1)	-60 max.
			68	-10	-----------	-----------	-----------	-18 min.
			76	-10	-----------	-----------	-----------	-55 max.
	FL6--------------	5	4	10	B	-----------	(2)	-17.8 max.
			8	10	-----------	-----------	-----------	3 min.
			12	10	-----------	-----------	-----------	-17.8 max.

Panel or assembly	Filter, equalizer, or network	Pretest setup					Add. connect. info. (sub par. *d*)	Test output (db)
		Resistor arrangement (sub par. *c*)	Signal generator test frequency (kc)	Pretest output (db)	Test setup figures			
					126	127		
	FL7 ----------	5	12	10	B	-----------	(2)	-42.8 max.
			16	10	----------	-----------		2 min.
			20	10	----------	-----------		-42.8 max.
	FL8 ----------	5	52	0	B	-----------	(1)	-35 max.
			56	-10	----------	-----------		-3 min.
			60	0	----------	-----------		-35 max.
	FL9 ----------	5	68	0	B	-----------	(1)	-35 max.
			72	-10	----------	-----------		-5 min.
			76	0	----------	-----------		-35 max.
	FL10---------	5	84	0	B	-----------	(1)	-40 max.
			88	-10	----------	-----------		-7 min.
			92	0	----------	-----------		-40 max.
	FL11---------	5	116	0	B	-----------	(1)	-30 max.
			120	-10	----------	-----------		-8 min.
			124	0	----------	-----------		-30 max.

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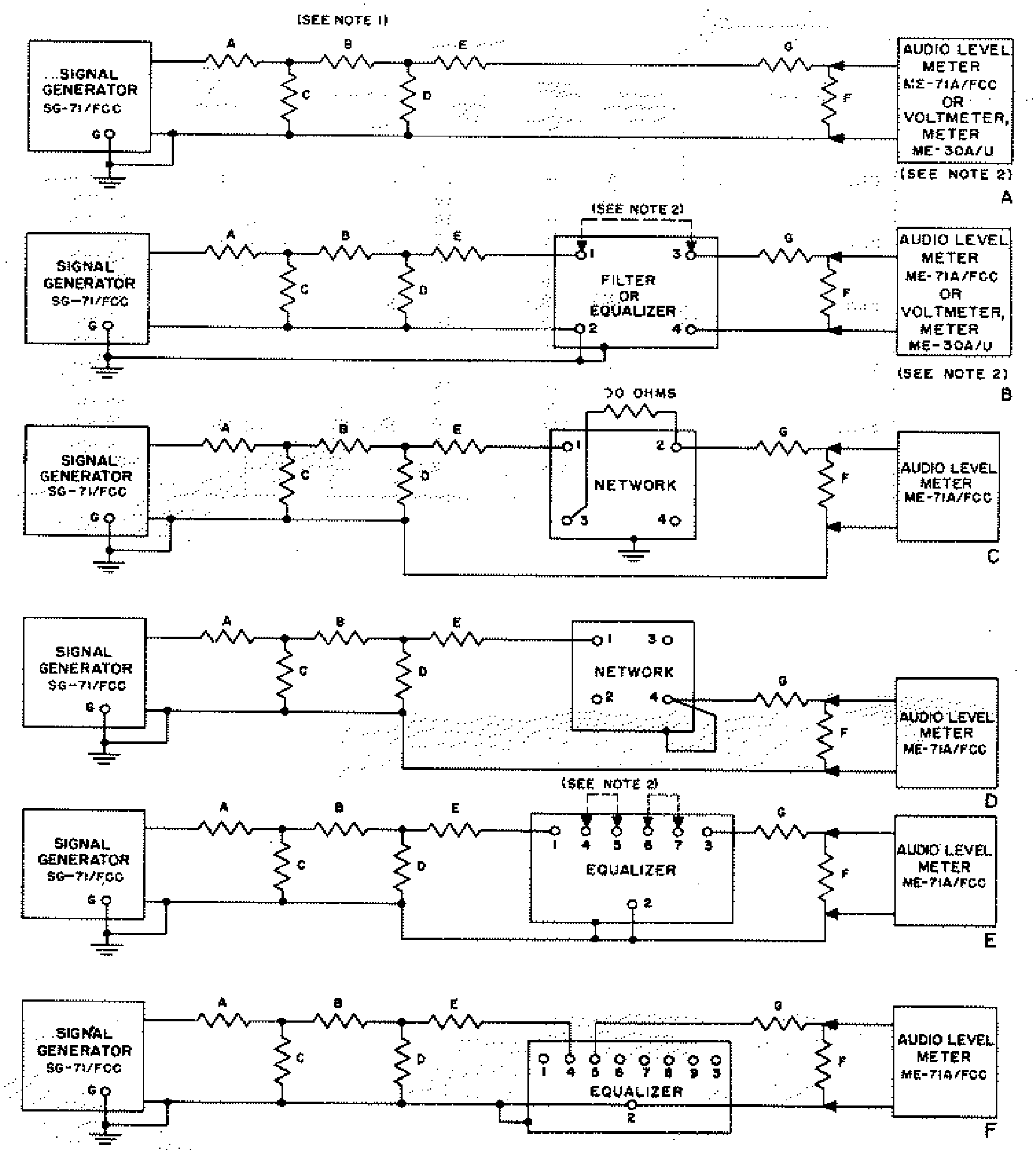
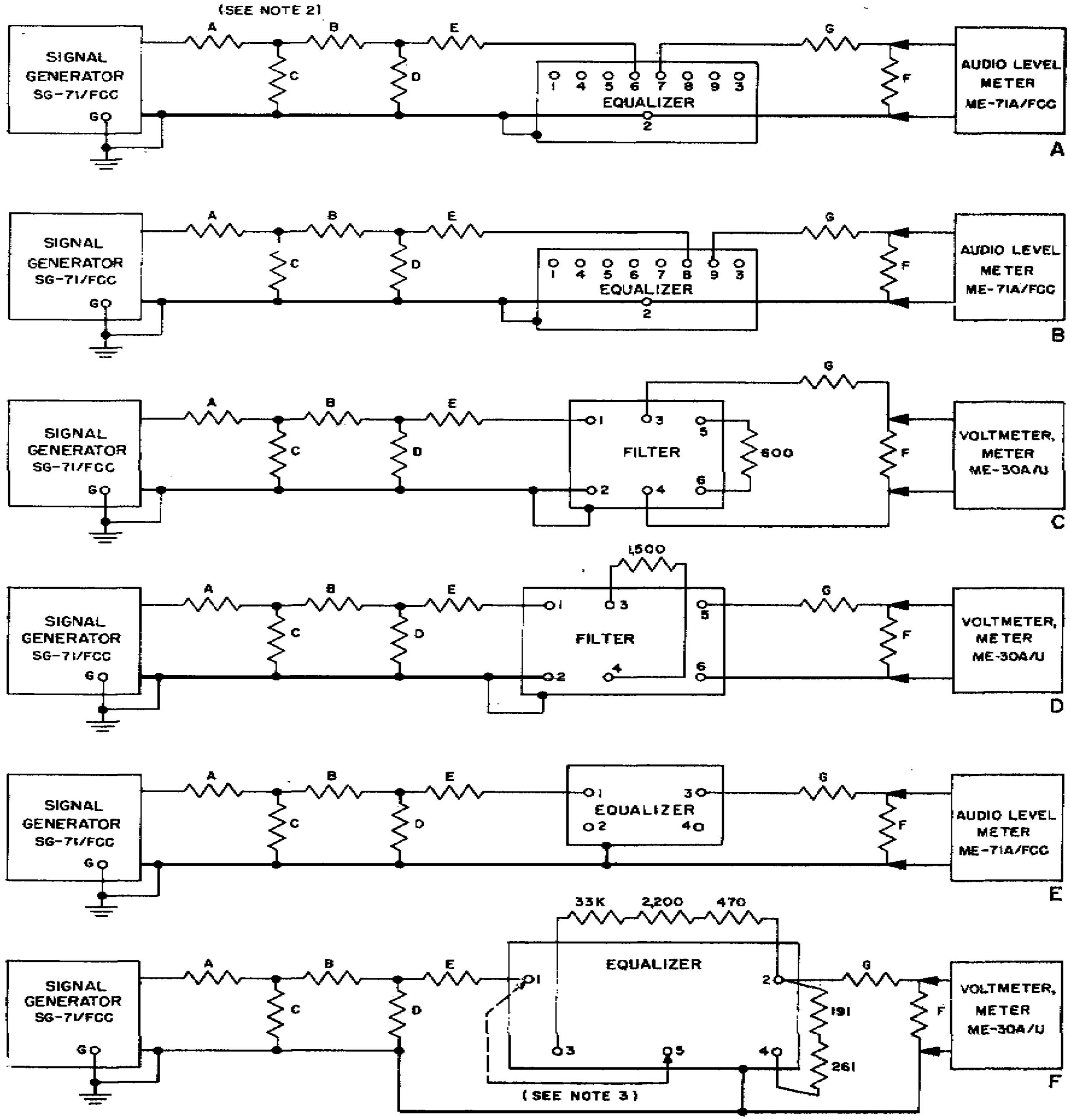


NOTES:

1. VALUES FOR RESISTORS USED IN TEST SETUPS ARE GIVEN IN THE FILTER, EQUALIZER, AND NETWORK PRETEST SETUP CHART
2. CONNECTED AS INDICATED IN TEST PROCEDURES.

TM2139-35-172

Figure 126. Filter, network, and equalizer test setups.



NOTES

1. UNLESS OTHERWISE SHOWN, RESISTANCES ARE IN OHMS.
2. VALUES FOR RESISTORS USED IN TEST SETUPS ARE GIVEN IN THE FILTER, EQUALIZER, AND NETWORK PRETEST SETUP CHART.
3. CONNECT AS INDICATED IN TEST PROCEDURES.

TM2139-35-173

Figure 127. Filter and equalizer test setups.

164. Relay Tests

(fig. 128)

To test a relay, check the resistance of the relay winding, and the continuity of the relay contacts when the relay is in both the operated and the nonoperated condition. The following checks, however, do not assure that the relay is operating on the proper value of current. If the relay adjustment is suspected, replace the relay.

a. Winding Resistance Check. The resistances of the relay windings are given in the chart in c below. These readings are taken with the multimeter.

b. Contact Continuity. When the relay under test is in the nonoperated condition, check contacts for continuity. Use the appropriate schematic diagram to determine where continuity should exist. To check for continuity when the relay is in the operated condition, use the following procedures. The POWER switch on the AN/TCC-7 must be in the OFF position.

(1) A 25K, 2.25- watt variable resistor and a 200-volt power source are required for these tests. Connect terminals 1 and 3 of the 25K variable resistor across the voltage source as shown in figure 128.

(2) Before each relay test, connect the multimeter to ground and terminal 2 of the 25K variable resistor. Adjust the resistor to obtain 0 volt. Ground terminal Y of the relay and connect terminal X of the relay, as given in the chart (c below), to terminal 2 of the resistor. Connect the multimeter between terminal 2 and ground and adjust the resistor for the voltage as specified in the chart. The relay should operate at this voltage. Make a continuity check of the contacts in the closed position when the relay is operated.

c. Relay Chart.

Panel or unit	Relay designation	Winding Terminals X	Winding Terminals Y	Winding resistance (ohms)	Operating voltage (dc)
Regulator and alarm unit Z6 -	K1 -----------------------	8	7	8K	80
	K2 -----------------------	8	7	8K	80
Ringer-oscillator Y101 --------	K1 -----------------------	8	7	8K	80
CARRIER SUPPLY PANEL-	K1 -----------------------	8	7	8K	80
	K2 -----------------------	8	7	8K	80
Low voltage rectifier and alarm Z1 (part of 600-VOLT POWER SUPPLY).	K1 -----------------------	8	7	230	18
	K2 -----------------------	22	21	2,550	28
	K3, K10[b] ---------------	8	7	2,550	18
	K4[c]-----------------------	22	21	425	27
	K5 -----------------------	22	21	425	27
	K6 -----------------------	8	7	980	15
	K7[a]-----------------------	22	21	425	27
	K8[c]-----------------------	22	21	415	18
	K9[c]-----------------------	8	7	425	27

[a]In Power Supplies PP-826/U, serial numbers 800 through 2964 and in Power Supplies PP-826A/U, serial numbers 2940 through 2964, relay K7 has
a winding resistance of 415 ohms and an operating voltage of 18 volts.

[B] Used on Power Supply PP-826A/U only.

[C] Used on Power Supply PP-826/U- only

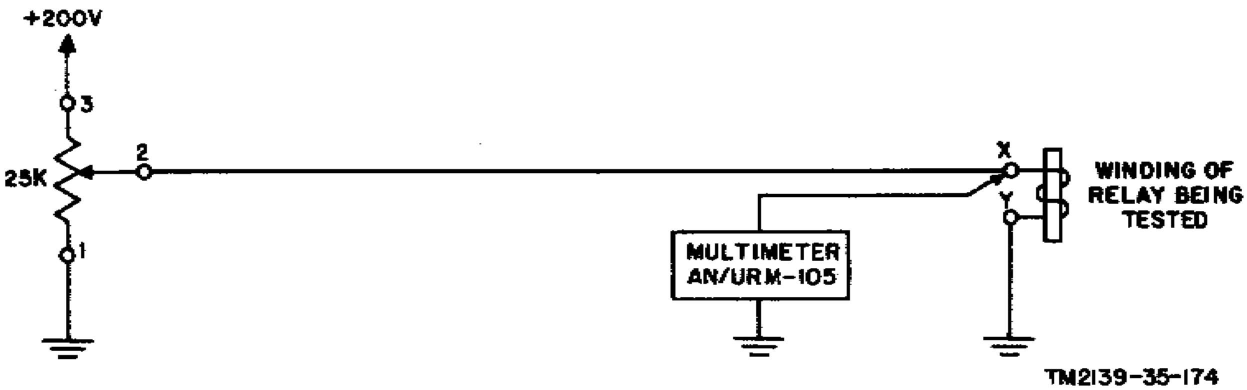


Figure 128. Relay test setup.

Section XII. REPAIRS ANDALINEMENT

165. Replacement or Removal of Assemblies and parts

Most of the parts of Telephone Terminal AN/TCC-7 are readily accessible and are replaced easily if found to be faulty. Refer to the applicable parts location diagrams when parts require replacement.

a. Replacement of Switch Assemblies. Switch assemblies are switches with circuit elements, such as resistors or capacitors, mounted on the switch terminals. To replace a switch assembly, first tag the wire connected to the switch and then remove the switch assembly from its mounting. Examine the switch assembly to note the physical placement of the circuit elements mounted on the switch. Remove the circuit elements which are mounted on the switch and connect those in good condition to the replacement switch; be careful to place them as nearly as possible in the same physical positions which they occupied on the original switch. References to wiring and circuit element placement diagrams for switch assemblies in the TEST PANEL appear in the chart below. See figure 155 for the external wiring to the switches. Figure 92 shows the placement and wiring of circuit elements mounted on CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch S103 in the ORDER WIRE PANEL.

Switch	Fig. No.
ATTENUATOR switch S2-----	79
MEASURE SELECTIVE switch S3.	80
MEASURE NON-SELECTIVE switch S4.	81
SEND switch S5 ----------------	82
FAULT TEST switch S6 -------	83

b. Removal of Channel Assembly Parts. To remove a lever switch or a variable resistor of a channel assembly, first remove the channel plug-in assembly from the combining frame of the CHAN MODEM (TM 11-2139-20, par. 14). Unscrew the three screws which hold the front plate of the channel assembly in place, and then remove the part in question.

c. Removal of 21-Pin Connectors. To gain access to the underside of a 21-pin connector on the CHAN MODEM combining frame, remove all four channel assemblies. Two screws hold each of the four 21-pin connectors in place in the frame (fig. 52). Remove the screws from all the connectors in order to lessen the strain on the wiring harness and withdraw the connectors from the frame as far as the attached cables will permit.

d. Removal of SUBGROUP PANEL Parts. To remove a faulty part on the shelf panel (fig. 60), turn the SUBGROUP PANEL upside down and remove the bottom cover plate. Unscrew the four screws that hold the cable clamp bracket in place (fig. 59). Move the cable clamp bracket to one side to reach the parts.

e, Removal of GROUP PANEL Parts.

(1) To remove a faulty part on the shelf panel, first remove the shelf mounting screws circled by a black ring. Then (facing the front panel) lift the panel up and to the right to expose the bottom of the shelf panel and provide access to the parts (fig. 62).

(2) To remove a faulty filter or equalizer network, it may be necessary to remove one or more of the supporting brackets to reach to the part in question.

f. Removal of TEST PANEL Parts. To remove a faulty part in the TEST PANEL, it is necessary, in cases, to remove one or more of the shields that cover the switches and capacitors on the TEST PANEL (fig. 3, TM 11-2139-20).

g. Replacement of CARRIER SUPPLY PANEL Resistor Board Assembly. Resistors R139 through R162 in the CARRIER SUPPLY PANEL (figs. 104 and 106) are mounted between two vertical boards. The resistors and the boards comprise a resistor board assembly. If necessary to replace the assembly, refer to figure 104 for the wiring and placement of the resistors between the mounting boards. Figure 160 shows the wiring external to the assembly.

166. Miscellaneous Alinement and Adjustment Procedure

a. General. Instructions for the alinement and adjustment of the components and assemblies of Telephone Terminal AN/TCC-7 appear in *b* through *f* below. Initial adjustment and tests of Telephone Terminal AN/TCC-7 appear in TM 11-2189-10. Refer to the appropriate troubleshooting chart if any trouble is encountered during alinement and adjustment.

b. CHAN MODEM. No alinement is necessary unless transformers, filters, or varistors are replaced. If these parts are replaced in any channel assembly, test the repaired component in accordance with the instructions given in the final tests. (par. 170 or 171).

c. SUBGROUP PANEL. No alinement is necessary unless transformers, filters, or varistors are replaced. If these parts are replaced, test the subgroup (1, 2, or 8) being alined in accordance with the instructions given in the final tests (par. 172 or 173).

d. Ringer-Oscillator Yl01, ORDER WIRE PANEL. No alinement is required unless transformer T1, T2, or T3 and capacitors and resistors associated with the oscillator circuit are replaced. If these parts are replaced, aline the ringer-oscillator in accordance with the instructions given in the final tests (par. 188).

e. CARRIER SUPPLY PANEL. No alinement is necessary unless the parts described in (1) through (3) below are replaced.

(1) *Oscillator frequency adjustments*. If network Z1 or the capacitors, resistors, or inductors associated with the 64-kc local oscillator stage are replaced, adjust capacitor C49 in accordance with the instructions given in the final tests (par. 189*a* and *b*).

(2) *4-kc output adjustment*. If transformer T8 or T9, inductor L3 or L4, or capacitors or resistors associated with the 4-kc amplifier stage are replaced, strap capacitors C30 and C31 in accordance with the instructions given in the final tests (par. 189*a* and *b* (4)).

(3) *Channel carrier output adjustments*. If the transformers, inductors, capacitors, or resistors associated with any carrier amplifier stage are replaced, install a resistor in parallel with the inductor associated with the carrier amplifier that was repaired in accordance with the instructions given in the final tests (par. 189*a* and *c*).

f. 600 VOLT POWER SUPPLY. No alinement is necessary unless the parts described in (1) and (2) below are replaced.

(1) If relay K9, transformer T1, varistor CR1, or resistor R15 is replaced, adjust resistor R20 in accordance with the instructions given in the final tests (PP-826/U, par. 194*a* and *j*).

(2) If relay K6, varistor CR2, transformer T1, capacitor C4, or resistor R16, R17, or R18 is replaced, adjust resistor R16 in accordance with instruction given in the final tests (PP-826/U, par. 194*a* and *i*) or (PP-826A/U, par. 195*a*).

167. TEST PANEL, Alinement Procedures

(fig. 78)

Before performing the alinement procedures on the TEST PANEL, perform the final test procedures on the flat amplifier AR2 and the IF amplifier AR1 (par. 188).

a. Initial Procedures.

(1) Connect the power, carrier supply, and transmission test cable assemblies as shown in figure 78.

(2) Turn the power on and allow the TEST PANEL to warm up for at least 1 hour before performing the alinement procedures.

(3) Connect a 135-ohm resistor across the tip and sleeve of the jack assembly

(4) Connect the signal generator, resistors R6 through R8, attenuator and transformer T107 as shown in figure 78.

(5) Set the attenuator for 0 db loss ant adjust the signal generator to the output frequency and the output level indicated in the test procedures (*b* through *e* below). Check the output level across the 135-ohm resistor with the voltmeter.

(6) Connect the test jack assembly to the TEST PANEL after the test circuit has been connected and the signal generator has been set to the proper frequency and output level.

b. Circuit for Nonselective Measurements, TEST PANEL. To adjust the nonselective measurement circuits, use the initial procedures (*a* above) and the procedures below.

(1) Set the switches listed below to the positions indicated.

Switch	Position
MEASURE---------------------	TRANSMISSION.
MEASURE SELECTIVE----	OFF.
MEASURE NON SELECTIVE.	CHECK 1 KC CHECK HF.

(2) Adjust the signal generator to deliver 68 kc ± 100 cps.

(3) Set the attenuator for 0-db loss.

(4) Adjust the signal generator output level to obtain a reading of .775 volt across the 135-ohm resistor.

(5) Set the attenuator for 42-db loss.

(6) Insert the TEST PANEL measure plug into the test Jack assembly.

(7) Remove the cap nut from the R17 control on flat amplifier AR2, and ad. just R17 for a 0-db meter reading on TEST PANEL meter M1. Replace the cap nut on R17, and remove the measure plug from the test Jack assembly

c. Circuit for Selective Measurements, TEST PANEL. Before adjusting the selective measurement carrier oscillator circuit, perform the initial procedures (*a* above) and aline the circuit for nonselective measurements (*b* above). Use the procedures listed below to aline the selective measurement carrier oscillator circuit.

(1) Set the switches and controls listed below to the positions indicated.

Control	Position
MEASURE.-----------------------------	TRANSMISSION.
MEASURE SELECTIVE-------------	OFF.
MEASURE NON SELECTIVE.-----	OFF.
COARSE TUNE -----------------------	Midposition
FINE TUNE ---------------------------	Midposition
GAIN -----------------------------------	Midposition
AMP GAIN (IF AMP)----------------	Midposition
Resistor R44 ---------------------------	Midposition.

(2) Connect a lead between terminal E25 and terminal 1 of section 3 of MEASURE SELECTIVE switch S3 or between equivalent points. Set the attenuator for 0 db loss. Adjust the signal generator to 110 kc ±3 cycles at .775 volt. Set the attenuator for a 42-db loss. Insert the TEST PANEL measure plug into the test Jack assembly.

(3) Adjust capacitor C12 for a maximum Indication on TEST PANEL meter M1; change the attenuator setting as necessary to keep the reading on scale. Remove the lead ((2) above) and the measure plug from the test Jack assembly.

(4) For each position of the MEASURE SELECTIVE switch in the chart in (5) below use the following procedure:

(*a*) Set the attenuator for a 0 db loss.

(*b*) Adjust the signal generator to the frequency shown in the table for that switch position.

(*c*) Adjust the signal generator output level to the voltage shown in the table.

(*d*) Adjust the attenuator to the loss indicated in the table.

(*e*) Insert the TEST PANEL measure plug into the test jack assembly.

(*f*) Adjust the capacitor indicated in

the table for the switch position used to obtain a maximum reading on TEST PANEL meter M1. It may be necessary to readjust the attenuator to keep the TEST PANEL meter reading on scale.

(5) Remove the measure plug from the test jack assembly.

MEASURE SELECTIVE switch position	Test signal frequency (cycles)	Signal generator output (volt)	Attenuator setting (db)	Adjust capacitor
CHECK GAIN..............	68 kc ±3	.775	40	C37
12KC	12 kc ±3	.775	42	C30,C31*
28KC	28 kc ±3	.775	42	C34
65KC	65 kc ±3	.775	32	C27
37KC	37 kc ±3	.775	32	C40
67KC	67 kc ±3	.775	42	C43
83KC	83 kc ±3	.775	42	C45
99KC	99 kc ±3	.775	42	C46
GRP PANEL 62KC........	62 kc ±3		30	C47

*Start with C30 and C31 in minimum capacity positions.

d. Selective Measurement IF Circuit, TESTPANEL. To adjust the selective measurement IF circuit, follow the procedures in a through c above, and then the procedures in (1) through(3) below.

(1) Set the MEASURE SELECTIVE switch to the CHECK GAIN position. Set the signal generator to 68 kc ±100 cycles at .775 volt; set the attenuator for a 40-db loss. Insert the measure plug into the test jack assembly and adjust the FINE TUNE control for a maximum reading on the TEST PANEL meter; change the attenuator setting as required to keep the meter reading as close to 0 db as possible. Operate the GAIN control to both its extreme clockwise and counterclockwise positions; note the meter readings. Then adjust the GAIN control for a meter reading midway between the readings noted. Remove the measure plug from the test jack assembly.

(2) Operate the MEASURE SELECTIVE and MEASURE NON-SELECTIVE switches to the GRP PANEL 62KC positions. Adjust the signal generator to 62 kc± 100 cycles at .775 volt. Set the attenuator for a 70-db loss. Insert the measure plug in the test jack assembly. Adjust the FINE TUNE control for a maximum meter reading. Adjust the AMP GAIN control of IF amplifier AR1 for a 0-db meter reading. Remove the measure plug from the test jack assembly.

(3) Set the MEASURE NON-SELECTIVE switch to the OFF position and the MEASURE SELECTIVE switch to the CHECK GAIN position. Adjust the signal generator to 68 kc ± 100 cycles at .775 volt. Set the attenuator for a 46-db loss. Insert the measure plug into the test jack assembly. Adjust the FINE TUNE control for a maximum indication on the TEST PANEL meter. Remove the locking nut from the R44 control, and adjust R44 for a 0-db meter reading. Replace the locking nut on R44 and remove the measure plug from the test jack assembly.

e. Hf Oscillator, TEST PANEL. To adjust the hf oscillator, follow the procedures in *a* through *d* above, and then the procedures in (1) through (6) below.

(1) Set the switches or controls listed below to the positions indicated. Adjust capacitor C50 for a frequency of 68 kc ± 10 cycles as measured with the frequency meter connected between terminal 6 of section 1 of the SEND switch and chassis ground.

Control	Position
HF-------------------------------	Midposition.
65 KC TR OR FAULT TEST	Midposition.
65 KC REC-------------------	Midposition.
R38-----------------------------	Midposition.
SEND--------------------------	CHECK GAIN CHECK HF.
HF FREQ ---------------------	Midcapacity.

(2) Set the SEND switch to the 65 KC REC position. Adjust capacitor C59 for a frequency of 65 kc ±10 cycles as measured with the frequency meter.

(3) Operate the REP 3 pushbutton of the FAULT TEST switch, and adjust capacitor C57 for a frequency of 83kc ±10 cycles as measured with the frequency meter. Release the push button.

(4) Operate the REP 2 pushbutton of the FAULT TEST switch, and adjust capacitor C55 for a frequency of 91 kc ±10 cycles as measured with the frequency meter. Release the pushbutton.

(5) Operate the REP 1 pushbutton of the FAULT TEST switch, and adjust capacitor C53 for a frequency of 99 kc ±10 cycles as measured with the frequency meter. Release the pushbutton.

(6) Operate the MEASURE SELECTIVE switch to the OFF position, the MEASURE NON-SELECTIVE switch to the CHECK 1 KC CHECK HF position, and the SEND switch to the 65 KC TR OR FAULT TEST position.

(7) Connect terminals T and S of the test jack assembly to terminals K and W of the power test cable assembly (fig. 78).

(8) Insert the measure plug into the test jack assembly. Operate the 5 db pushbutton of the ATTENUATOR switch; and adjust the 65 KC TR OR FAULT TEST control for a 0-db meter reading. Release the pushbutton.

(9) Remove the locking nut from the R38 control. Operate the MEASURE NON-SELECTIVE switch to the FAULT TEST position, and, with the REP 2 pushbutton of the FAULT TEST switch operated, adjust the R38 control for a meter reading of -2.5 db. Replace the locking nut on R38.

CHAPTER 4
FINAL TESTING

Section I. GENERAL

168. Purpose of Final Testing

The tests outlined in this chapter are designed to measure the performance capability of a repaired equipment. Equipment that meets the standards stated in the tests will furnish satisfactory operation, equivalent to that of new equipment.

169. Test Equipment Required for Final Testing

In addition to the tools and test equipment listed in paragraph 77, the following items are required for final testing:

Item	Technical manual	Common name
Electron Tube Test Set TV-2/U ----------------	TM 11-2661-------------------	Tube test set
Electronic Multimeter TS-505/U or equal----	TM 11-5511-------------------	Electronic multimeter
Oscilloscope OS-8A/U --------------------------	TM 11-1214-------------------	Oscilloscope
Transmission Measuring Set TS-559/FT -----	TM 11-2094-------------------	Transmission measuring set
Variable Transformer TF-171/USM ----------		Variable transformer

Section II. TELEPHONE MODEM TA-219/U

170. CHAN MODEM Transmitting Tests

(fig. 129)

Follow the procedure given in *a* through *c* below to test each channel in the CHAN MODEM. Channel assemblies must be installed in the CHAN MODEM for testing.

a. Initial Procedure

(1) Operate all switches on the CHAN MODEM to their normal positions.

(2) Interconnect the supply, transmission, and carrier supply test cable assemblies, 200 VOLT POWER SUPPLY, and CHAN MODEM.

(3) Interconnect a 600-ohm resistor across terminals A and K of the transmission test cable assembly.

(4) Connect signal generator No. 2B, resistors R1 through R3, the attenuator, and transformer T109.

(5) Connect signal generator No. 1 across the terminals of the supply test cable assembly as indicated in the chart below. Adjust the signal generator to the output frequency indicated for the channel under test at an output level of .82 volt as measured with the voltmeter.

Channel assy under test	Signal generator No. 1 output freq (kc)	Terminals of supply test cable assembly
CHAN 1------	8	C and M
CHAN 2------	12	D and N
CHAN 3------	16	E and P
CHAN 4------	20	F end R

b. CHAN MODEM, Transmitting Direction.

(1) Interconnect signal generator No. 2B and associated components (*a*(3) above). Connect a 600-ohm resistor across terminals 3 and 6 of transformer T109 and set the attenuator for a 0-db loss. Adjust the signal generator for an output frequency of

1 kc at an output level of -13.8 db measured across the 600-ohm resistor.

(2) Disconnect the 600-ohm resistor and connect terminals 3 and 6 of the transformer to the 2W 4WT binding posts on the channel under test.

(3) Operate the 4W-2W switch to the 2W position.

(4) Connect the voltmeter across terminals A and K of the transmission test cable assembly.

Note. The following procedure involves a circuit arrangement in which jumpering shorting of the resistors of the channel modulator output pad results in a decrease in the output voltage of that circuit. The procedure for adjusting the output of CHAN 1 of the CHAN MODEM is described in (5) below. The procedure used for adjusting the other three channel assemblies is the same.

(5) Jumper resistors R116 and R143 (fig. 2) in the order given in (*a*) through (*d*) below; note the output obtained for each condition. Select the arrangement that will produce an output power closest to an indication of -28.8 ±1 db on the voltmeter. After determining the correct strapping, remove the straps and replace with permanent straps.

(*a*) Neither R116 nor R143 is strapped.

(*b*) Only R116 is strapped.

(*c*) Only R143 is strapped.

(*d*) Both R116 and R143 are strapped.

c. Transmitting Direction Overload Loss Test.

(1) Connect signal generator No. 2A and associated components (*a*(3) above). Connect a 600-ohm resistor across terminals 3 and 6 of transformer T109.

(2) Adjust the signal generator for an output frequency of 1 kc at an output level of 14.7 db as measured across terminals 3 and 6 of transformer T109 with the voltmeter.

(3) Disconnect the 600-ohm resistor from the transformer and reconnect terminals 3 and 6 of the transformer to the 2W 4WT binding posts on the channel under test.

(4) Connect the voltmeter across terminals A and K of the transmission test cable assembly. The voltmeter indication should not be more than 2 db higher than the indication received in *b*(5) above.

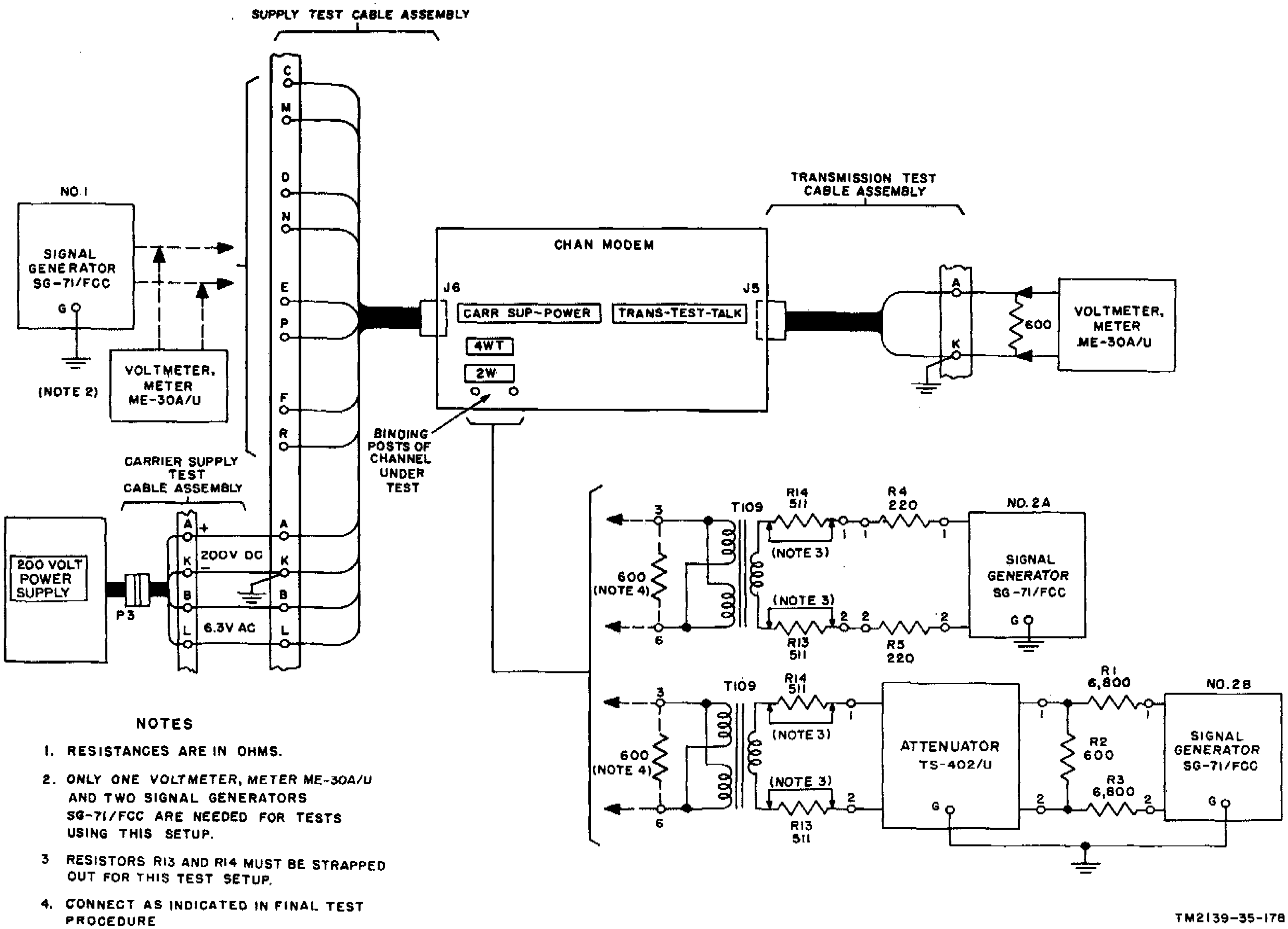


Figure 129. CHAN MODEM, final test setup, transmitting direction.

171. CHAN MODEM Receiving Tests

(fig. 130)

Follow the procedure given in *a* through *c*. below to perform the receiving test on each of the channel assemblies in the CHAN MODEM. The channel assemblies must be installed in the CHAN MODEM to be tested.

a. Initial Procedure.

(1) Operate all switches on the CHAN MODEM to their normal positions.

(2) Interconnect the supply, transmission, carrier supply test cable assemblies, 200 VOLT POWER SUPPLY, and CHAN MODEM.

(3) Interconnect signal generator No. 2, resistors R1 through R3, the attenuator, and transformer T109.

(4) Connect signal generator No. 1 to terminals of the supply test cable assembly as indicated in the chart below for the channel assembly being tested. Adjust the signal generator for the output frequency indicated for the channel under test. Using the voltmeter, adjust the signal generator for the output frequency indicated for the channel under test. Using the voltmeter, adjust the signal generator for an output level of .82 volt as measured across the terminals of the supply test cable assembly.

Channel assembly under test	Signal generator No. 1 output frequency (kc)	Supply test cable assembly terminal
1---------------	8	C and M.
2---------------	12	D and N.
3---------------	16	E and P.
4---------------	20	F and R.

b. Receiving Circuit Test.

(1) Connect a 600-ohm resistor across terminals 3 and 6 of transformer T109. Adjust the attenuator for a 0-db loss; adjust the signal generator for an output frequency as indicated for the channel under test (chart below) at an output level of-3.8 db as measured across the 600-ohm resistor.

Channel assembly under test	Signal generator No. 2 output frequency (kc)	Outer level (db)
CHAN 1 ----------	7	2
CHAN 2 ----------	11	2
CHAN 3 ----------	15	2
CHAN 4 ----------	19	1

(2) Connect terminals 3 and 6 of transformer T109 to terminals E and P of the transmission test cable assembly.

(3) Connect the voltmeter. and a 600-ohm resistor across the 4WR binding posts on the channel assembly under test.

(4) Operate the 4W-2W switch to the 4W position on the channel assembly under test. Operate the GAIN control on the channel assembly to the extreme clockwise position.

(5) The voltmeter should indicate the output of the channel assembly under test as indicated in the output level column of the chart given in (1) above.

(6) Repeat the procedure given in (1) through (5) above using the frequencies listed in the chart below for each channel assembly. The voltmeter should indicate 1.4± 2.4 db *less* than the output obtained in (5) above.

Channel assembly under test	Input frequency (cps)
1 --------------------------------	7,675
1 --------------------------------	4,550
2 --------------------------------	11,675
2 --------------------------------	8,550
3 --------------------------------	15,675
3 --------------------------------	12,550
4 --------------------------------	19,675
4 --------------------------------	16,550

(7) Using the test frequencies indicated in (1) above, adjust the channel GAIN control from the extreme counterclockwise position to the extreme clockwise position. The voltmeter indication should vary at least 20 db between these two positions on the GAIN control.

c. Hybrid Balance, Test

(1) Connect a 600-ohm resistor across terminals3 and 6 of transformer T109.

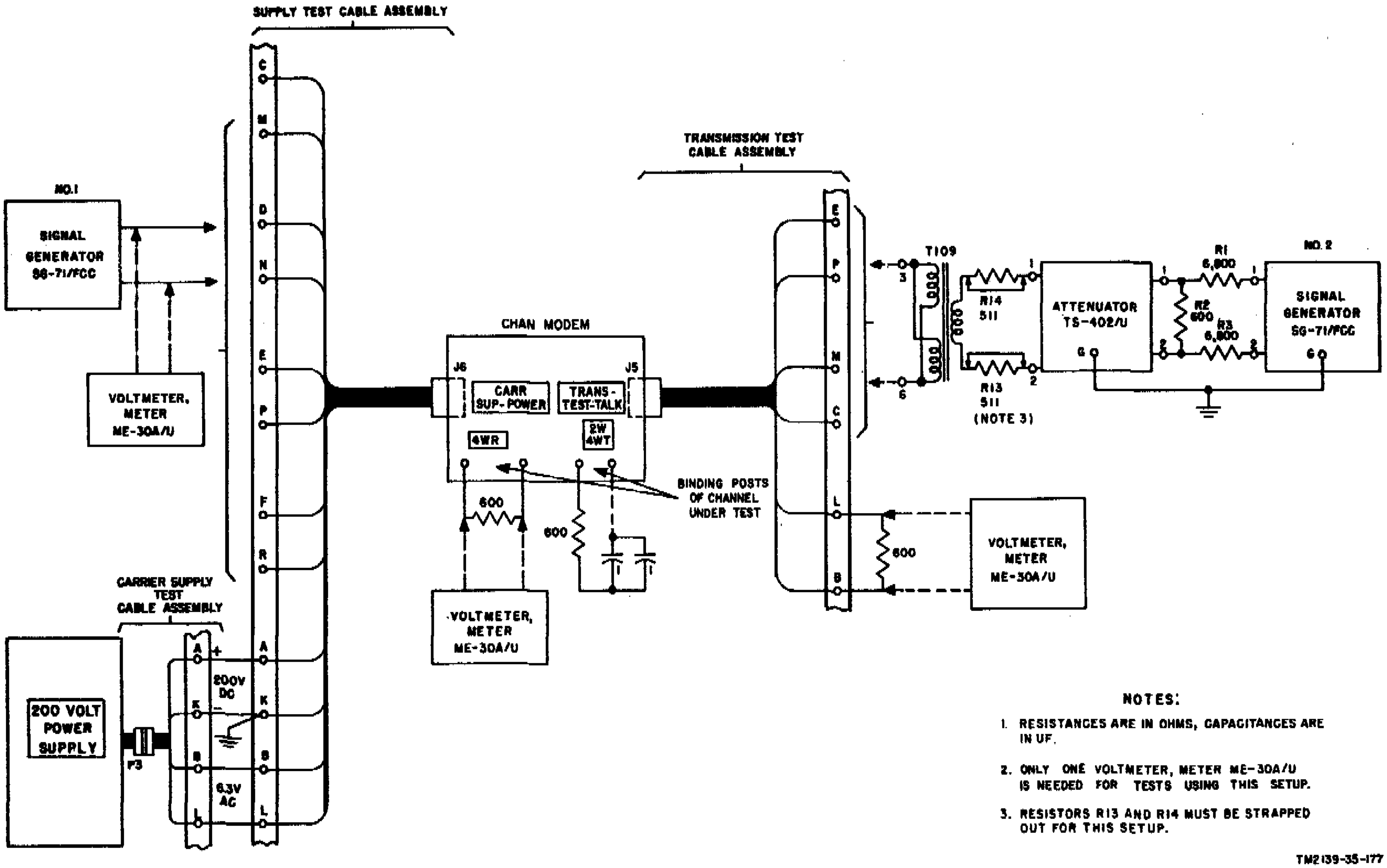


Figure 150. CHAN MODEM, final test setup, receiving direction.

(2) Arrange the attenuator for a 0-db loss; adjust signal generator No. 2 for an output frequency of 1 kc at an output level of -3.8 db measured across the 600-ohm resistor.

(3) Remove the 600-ohm resistor ((1)above) and connect terminals 3 and 6 of transformer T109 to terminals M and C of the transmission test cable assembly.

(4) Operate the 4W-2W switch to 2W;operate the TALK-MON switch to TALK; and operate the SEND-MEAS switch to SEND.

(5) Interconnect a 600-ohm resistor in series with two parallel 1-uf capacitors across the 2W 4WT binding posts.

(6) Connect the voltmeter and a 600-ohm resistor across terminals B and L of the transmission test cable assembly terminal board. The voltmeter should indicate a power level of -41 db or less.

Section III. TELEPHONE MODEM TA--227/U

172. SUBGROUP PANEL, Transmitting TEST

(fig. 56)

a. Initial Procedures.

(1) Interconnect the transmission, power, and carrier supply test cable assemblies, 135-ohm resistors, 200 VOLT POWER SUPPLY and the SUBGROUP PANEL.

(2) Connect signal generator No. 2, resistors R1 through R3, the attenuator, and transformer T108. Connect a 600-ohm resistor across terminals 1 and 3 of the transformer.

b. Transmitting Circuit Output Test.

(1) Connect signal generator No. 1 to terminals A and J of the transmission test cable assembly. Adjust the signal generator for an output frequency of 72 kc at an output level of .75 volt as measured with the voltmeter.

(2) Set the attenuator for a 0 db loss; adjust signal generator No. 2 for an output frequency of 11 kc at an output level of -3.8 db measured across terminals 1 and 3 of transformer T108 with the audio level meter.

(3) Connect a subgroup test cable assembly to CHAN MODEM 2 connector P2.

(4) Disconnect the 600-ohm resistor from transformer T108 and connect terminals 1 and 3 of the transformer to terminals A and K of the subgroup test cable assembly.

(5) Set the attenuator for a 35-db loss. Adjust the TR AMP GAIN control to the extreme clockwise position.

(6) Connect the voltmeter to terminals A and L of the power test cable assembly

(7) Strap the output pads associated with subgroup channel 2 until the voltmeter indicates -48.8 $\pm$.6 db.

Note. Two pads are provided-one for a 2-db loss, and the other adjustable by taps in approximately 1-db steps. The 2-db pad will usually be connected into the circuit of subgroup channel 1. The loss of the adjustable pad is increased by changing the taps in the direction from R47 to R43.

(8) Check the output at the following additional test points with the voltmeter; the output should be $\pm$1 db of the reading obtained in (7) above.

(*a*) Terminals K and W of the power test cable assembly.

(*b*) 60-108 KC OUT binding posts.

(*c*) 60-108 KC OUT ALT binding posts

(*d*) 60-108 KC OUT jack.

Note. Use the test plug assembly (terminals T1 and R) to connect the voltmeter to the 60-108 KC OUT jack.

(9) Repeat the tests given in (1) through (7) above with signal generator No. 2 readjusted to provide an output frequency of 4.5 kc. The output signal should be within +1.8 and -2 db of the signal measured in (8) above.

(10) Perform the test given in (1) through (9) above, using the connection points, frequencies, and output levels indicated for signal generators No. 1 and 2 in the chart below. The output level should be the same as indicated in (7), (8), and (9) above.

	Signal generator No. 1			Signal generator No. 2		
Subgroup channel under test	Transmission test cable assembly connection	Frequency (kc)	Output level(kc)	Subgroup test cable assembly connection	Frequency (kc)	Output level (db)
1	C and L -------------	56	.75	A and K (PL) ------	11	-3.8
3	D and E-------------	88	.75	A and K (P3)-------	11	-3.8

c. Special Service Transmission Test.

(1) Connect signal generator No. 2 and associated components as described in a (2) above. Adjust signal generator No. 2 as described in b (2) above. Remove the 600-ohm resistor from terminals 1 and 3 of transformer T108. Connect terminals 1 and 3 to the SPECIAL SERVICE IN 2 binding posts.

(2) Connect signal generator No. 1 across terminals A and J of the transmission test cable assembly. Adjust the signal generator for an output frequency of 72 kc at an output level of .75 volt.

(3) Operate the TR AMP GAIN control to the extreme clockwise position and operate the SPECIAL SERVICE 2 switch to SPL SERV.

(4) Connect the voltmeter across terminals A and L of the power test cable assembly. The voltmeter should indicate -48.8 db ±.6 db.

(5) Perform the test given in (1) through (4) above for subgroup channels 1 and 3. Use the output frequencies, output levels and connection points for signal generators No. 1 and 2 as indicated in the chart below.

	Signal generator No. 1			Signal generator No. 2		
Subgroup channel under test	Transmission test cable assembly connection	Frequency (kc)	Output level(kc)	Subgroup test cable assembly connection	Frequency (kc)	Output level (db)
1	C and L ---------------	56	.75	1---------------------	11	-3.8
3	D and E---------------	88	.75	3---------------------	11	-3.8

d. Transmitting Carrier Leak Test.

(1) Connect signal generator No. 1 terminals C and L of the transmission test cable assembly. Adjust the signal generator for an output frequency of 56 kc at an output of .75 volt.

(2) Connect the audio level meter across terminals A and L of the power test cable assembly.

(3) The audio level meter should indicate a maximum carrier leak of -80 db.

(4) Connect signal generator No. 1 to terminals A and J of the transmission test cable assembly; adjust the signal generator for an output frequency of 72 kc at an output of .75 volt. The audio level meter should indicate a maximum of -90 db.

(5) Connect signal generator No. 1 to terminals D and E of the transmission test cable assembly; adjust the signal generator for an output frequency of 88 kc at an output of .75 volt. The audio level meter should indicate a maximum of -89 db.

173. SUBGROUP PANEL, Final Test, Receiving Tests

(fig. 57)

a. Initial Procedures.

(1) Interconnect the transmission, power, and carrier supply test cable assemblies, 600-ohm resistors, SUBGROUP PANEL and 200 VOLT POWER SUPPLY.

(2) Connect signal generator No. 2, resistor R1 through R3, attenuator, and transformer T107.

b. Receiving Circuit Test.

(1) Connect the output of signal generator No. 1 across terminals A and J of the transmission test cable assembly;

adjust the signal generator for an output frequency of 72 kc at an output level of .75 volt.

(2) Connect the voltmeter and a 135-ohm resistor across terminals 1 and 2 of transformer T107. Set the attenuator for a 0-db loss; adjust signal generator No. 2 for an output frequency of 83 kc at an output level of -7.8 db as measured with the voltmeter. Disconnect the voltmeter and the 135-ohm resistor.

(3) Connect terminals 1 and 2 of transformer T107 to terminals H and R of the transmission test cable assembly.

(4) Adjust the DEM 2 GAIN control to the extreme clockwise position, and set the attenuator for a 5-db loss.

(5) Connect a subgroup test cable assembly to CHAN MODEM 2 connector P2.

(6) Connect the voltmeter and a 600-ohm resistor to terminals E and P of the subgroup test cable assembly with terminal P as ground. The voltmeter should indicate 5.2 db ± 3 db.

(7) Readjust the DEM 2 GAIN control to the extreme counterclockwise position.

(8) The voltmeter indication should be not less than -4.8 db.

(9) Readjust the DEM 2 GAIN control to the extreme clockwise position.

(10) Readjust signal generator No. 2 (*b*(2) above) for an output frequency of 76.5 kc at an output level of -7.8 db.

(11) The voltmeter should indicate 5.2 db ± 1.8 db.

(12) Connect the voltmeter and a 600-ohm resistor across the SPECIAL SERVICE OUT 2 binding posts. Operate the SPECIAL SERVICE 2 switch to SPL SERV. The voltmeter should indicate 5.2 db ± 3 db.

(13) Connect the voltmeter to terminals T1 and R of the test plug assembly; insert the plug of the test plug assembly into the DEM OUT 2 jack. The voltmeter should indicate 5.2 db ± 3 db.

(14) Disconnect signal generator No. 2. The voltmeter should indicate a maximum of -32.8 db.

(15) Perform the test given in (1) through (11) above using the connections, control settings, frequencies and output levels given in the chart below for channel 1 of the SUBGROUP PANEL.

Test	Signal generator No. 1			Signal generator No. 2			Voltmeter		
	Transmission test cable assembly connection	Frequency (kc)	Output level (db)	Transmission test cable assembly connection	Frequency (kc)	Output level (db)	DEM 1 GAIN control	Subgroup test cable assembly connection	Indication (db)
1 --	C and L ------	56	.75	H and R-----	67	-7.8	Clockwise	E and P (P3)	6.7±3
2 --	C and L ------	56	.75	H and R-----	67	-7.8	Counter-clockwise	E and P (P3)	-3.3
3 --	C and L ------	56	.75	H and R-----	67	-7.8	Clockwise	E and P (P3)	6.7 ± 1.8

(16) Perform the test given in (12) and (13) above. Connect the voltmeter and resistor across the SPECIAL SERVICE OUT 1 binding posts. Operate the SPECIAL SERVICE 1 switch to SPL SERV, and insert the test plug assembly into the DEM OUT 1 jack. The voltmeter should indicate 6.7 ± 3 db.

(17) Disconnect signal generator No. 2 from terminals H and R of the transmission test cable assembly. The voltmeter should indicate a maximum of -31.3 db.

(18) Perform the tests given in (1) through (11) above using the connections, control settings, frequencies, and output levels given in the chart below for channel 3 of the SUBGROUP PANEL.

Test	Signal generator No. 1			Signal generator No. 2			DEM 1 GAIN control	Voltmeter	
	Transmission test cable assembly connection	Frequency (kc)	Output level (db)	Transmission test cable assembly connection	Frequency (kc)	Output level (db)		Subgroup test cable assembly connection	Indication (db)
1 --	D and L------	88	.75	H and R------	99	-7.8	Clockwise	E and P (P1)	4.2±3
2 --	D and L------	88	.75	H and R------	99	-7.8	Counter-clockwise.	E and P (P1)	5.8 min.
3 --	D and L------	88	.75	H and R------	92.5	-7.8	Clockwise	E and P (P1)	4.2±1.8

(19) Perform the test given in (12) and (13) above. Connect the voltmeter and resistor across the SPECIAL SERVICE OUT 3 binding posts. Operate the SPECIAL SERVICE 3 switch to SPL SERV, and insert the test plug assembly in the DEM OUT 3 jack. The voltmeter should indicate 4.2 ± 3 db.

(20) Disconnect signal generator No. 2 from terminals H and R of the transmission test cable assembly; the voltmeter should indicate a maximum of -32.8 db.

c. 60-108KC IN Test.

(1) Perform the procedures in *b*(1) and (2) above.

(2) Connect signal generator No. 2 and associated components to the 60-108KC IN binding posts. Set the attenuator for a 5-db loss.

(3) Adjust the DEM GAIN 2 control to the extreme clockwise position.

(4) Connect the subgroup test cable assembly to connector P2. Connect the voltmeter to terminals E and P. The voltmeter indication should be 5.2 ± .5 db.

(5) Connect the signal generator to terminals T_1 and R of the test plug assembly. Insert the test plug assembly into the 60-108 KC IN jack. The voltmeter should indicate 5.2 ±.5 db.

Section IV. AMPLIFIER-PILOT REGULATOR AM--707/TCC-7

174. Transmission Circuit Tests

(fig. 131)

a. Initial Procedures.

(1) Interconnect the JUNCTION PANEL, GROUP PANEL, 200 VOLT POWER SUPPLY, resistors, and test cable assemblies.

(2) Interconnect signal generator No. 2, the resistors, attenuator, and transformer T107.

(3) Connect signal generator No. 1 across terminals H and R of the subgroup test cable assembly connected to connector P2 on the GROUP PANEL. Adjust the signal generator for an output frequency of 120 kc at an output level of .75 volt.

b. Carrier *Transmission Circuit Transmitting Direction.*

(1) Connect a 135-ohm resistor across terminals 1 and 2 of transformer T107. Set the attenuator for a 0-db loss. Adjust signal generator No. 2 for an outputfor an output frequency of 60 kc at an output level of -7.8 db measured across the 135-ohm resistor. Remove the 135-ohm resistor from transformer T107.

(2) Connect terminals 1 and 2 of transformer T107 to terminals A and L of the carrier test cable assembly. Set the attenuator for a 42-db loss.

(3) Operate the CABLE REELS TO FIRST AN/TCC-11 TR switch to the 23 position.

(4) Connect the voltmeter and a 135-ohm resistor across terminals 1 and 2 of the junction panel test cable assembly; the voltmeter should indicate -7.8 ± 2 db.

(5) Disconnect signal generator No. 2 and associated components and readjust the signal generator for an output frequency of 83 kc as explained

in (1) above. Repeat the test procedures given in (2) through (4) above. The voltmeter indication should be -7.8 ±2 db.

(6) Repeat the procedure given in (5) above, using an output frequency of 108 kc.

(7) Disconnect signal generator No. 2 and associated components and readjust for an output frequency of 83 kc at an output level of -7.8 db ((1) above). Connect the signal generator and associated components across terminals A and L of the carrier test cable assembly.

(8) Connect the voltmeter to terminals T_1 and R of the test plug assembly; insert the plug of the test plug assembly into the TR AMP OUT jack. The voltmeter should indicate -39.8 ± 2 db.

(9) Connect signal generator No. 2 and associated components to the SPECIAL SERVICE 60-108KC IN binding posts. Set the attenuator for a 0-db loss; readjust the output of the signal generator for an output frequency of 83 kc at an output level of -7.8 db.

(10) Connect the voltmeter across the 135-ohm resistor connected across terminals 1 and 2 of the junction panel test cable assembly. The voltmeter should indicate -7.8 ± 2 db.

(11) Connect signal generator No. 2 and associated components to the SPECIAL SERVICE 12-60 KC IN binding posts. Adjust the signal generator No. 2 for an output frequency of 28 kc at an output level of -7.8 db.

(12) Operate the SPECIAL SERVICE 12-60 KC switch to SPL SERV.

(13) Connect the voltmeter across the 135-ohm resistor connected to terminals 1 and 2 of the junction panel test cable assembly. The voltmeter should indicate -7.8 ± 2 db.

(14) Connect signal generator No. 2 and associated components to terminals H and J of the carrier supply test cable assembly. Set the attenuator for a 35-db loss and adjust the signal generator for an output frequency of 68 kc at an output level of -7.8 db.

(15) Connect the voltmeter across the 135-ohm resistor connected across terminals 1 and 2 of the junction panel test cable assembly. The voltmeter should indicate -8.3 ±1.5 db.

c. Order Wire Transmission Circuit.

(1) Connect a 135-ohm resistor across terminals 1 and 2 of transformer T107; adjust the attenuator for 0-db loss and adjust signal generator No. 2 for an output frequency of 1 kc at an output level of -11.8 db as measured across the 135-ohm resistor.

(2) Remove the 135-ohm resistor and connect signal generator No. 2 to terminals 1 and 2 of the junction panel test cable assembly.

(3) Connect the voltmeter across the 600-ohm resistor connected across terminals L and M, with terminal M as ground, of the carrier test cable assembly terminal board (connected to plug P101). The voltmeter should indicate -6.7 ±1.5 db.

(4) Connect signal generator No. 2 and associated components across terminals 3 and 4 of the junction panel test cable assembly.

(5) Connect the voltmeter across the 600-ohm resistor that is connected to terminals F and S (with terminal S as ground) of the carrier test cable assembly. The voltmeter should indicate -10.1 db ±1.5 db.

d. Carrier Transmission Circuit, Receiving Direction.

(1) Connect a 135-ohm resistor across terminals 1 and 2 of transformer T107. Set the attenuator for a 0-db loss; adjust signal generator No. 2 for an output frequency of 68 kc at an output level of -7.8 db as measured across the 135-ohm resistor.

(2) Remove the 135-ohm resistor and connect the output of signal generator No. 2 and associated components to terminals 3 and 4 of the junction panel test cable assembly.

(3) Adjust the CABLE REELS TO FIRST AN/TCC-11 REC switch to

position 23; operate the BULGE ADJ 28 KC and SLOPE ADJ 12 KC controls to position 0; operate the REGULATOR switch to MAN.

(4) Connect a 10K resistor and 135-ohm resistor across terminals T_1 and R of the test plug assembly as shown in figure 131. Connect the voltmeter across the 135-ohm resistor and insert the plug of the test plug assembly into the REC IN jack; the voltmeter should indicate -46.8 ±2 db.

(5) Disconnect the 10K and 135-ohm resistors and connect the voltmeter across terminals Tl and R of the test plug assembly.

(6) Adjust the FLAT ADJ 68 KC control to the extreme clockwise position and insert the plug of the test plug assembly into the REC AMP 1 OUT jack position. Readjust the attenuator for an indication of -37.8 db on the voltmeter. The attenuator should be set for a loss of 31 ±3 db.

(7) Adj ust the FLAT ADJ 68 KC control to the extreme counterclockwise position. The voltmeter should indicate -57.8 db.

(8) Adjust the FLAT ADJ 68 KC control for an indication of -39.8 db on the voltmeter.

(9) Insert the plug of the test plug assembly into the REC AMP 2 OUT jack. Adjust the MAN REG OUTPUT control for an indication of -39.8 db on the voltmeter.

(10) Disconnect signal generator No. 2 and associated components from terminals 3 and 4 of the junction panel test cable assembly. Connect a 135ohm resistor across terminals 1 and 2 of transformer T107. Set the attenuator for a 0-db loss and adjust the signal generator for an output frequency of 12 kc at an output level of -7.8 db as measured across the 135-ohm resistor. Remove the 135ohm resistor.

(11) Connect signal generator No. 2 and associated components to terminals 3 and 4 of the junction panel test cable assembly.

(12) Insert the plug of the test plug assembly into the REC AMP 2 OUT jack. The voltmeter should indicate -46.5 ± 3 db.

(13) Adjust signal generator No. 2 ((10) and (11) above) for an output frequency of 28 kc. The voltmeter should indicate -44.8 db with the plug of the test cable assembly inserted in the REC AMP 2 OUT jack.

(14) Adjust signal generator No. 2 ((10) and (11) above) for an output frequency of 60 kc. The voltmeter should indicate -40.8 ±2 db with the plug of the test plug assembly inserted in the REC AMP 2 OUT jack.

(15) Connect a 135-ohm resistor across terminals H and R of subgroup test cable assembly connected to plug P1. Adjust the DEM GAIN control to the extreme clockwise position. Adjust signal generator No. 2 for an output frequency of 12 kc ((10) above).

(16) Connect the voltmeter across the 135-ohm resistor ((15) above). The voltmeter should indicate -11.3 ±2.5 db.

(17) Readjust the signal generator for an output frequency of 28 kc ((10) above). The voltmeter indication should be 1.9 ± 1.5 db greater than that in (16) above.

(18) Insert the plug of the test plug assembly (with the voltmeter across terminals Tl and R) into the DEM OUT jack and then reconnect the voltmeter across the DEM OUT binding posts. The voltmeter indication should be the same as that given in (17) above.

(19) Repeat the tests given in (15) and (15) above with signal generator No. 2 readjusted for an output frequency of 60 kc. The voltmeter indication should be within 5.1 db of the indication in (15) above.

(20) Connect the 135-ohm resistor across terminals D and R of the carrier supply test cable assembly. Readjust signal generator No. 2 for an output frequency of 65 kc ((10) above) and connect the signal generator and associated components

to terminals D and R of the carrier supply test cable assembly.

(21) Set the attenuator for a 4-db loss; connect the voltmeter across terminals T1 and R of the test plug assembly terminal board. Insert the plug of the test plug assembly into the REC AMP 1 OUT jack. The voltmeter should indicate -40.1 ± 2 db.

e. Carrier Transmission, Looped Circuit.

(1) Connect a 135-ohm resistor across terminals 1 and 2 of transformer T and adjust signal generator No. 2 for an output frequency of 68 kc at an output level of -7.8 db. Remove the 135-ohm resistor.

(2) Connect signal generator No. 2 and associated components across terminals H and J of the carrier supply test cable assembly. Strap terminals 1 and 3, and 2 and 4 of the junction panel test cable assembly.

(3) Operate the CABLE REELS TO FIRST AN/TCC-11 TR and the CABLE REELS TO FIRST AN/ TCC-11 REC switches to position 11.

(4) Adjust the attenuator for a 35-db loss. Connect the voltmeter across terminals Tl and R of the test plug assembly. Insert the plug of the test plug assembly into the TR AMP OUT jack; the voltmeter should indicate -39.8 ± 2 db. If necessary, adjust the signal generator output control until a reading of -39.8 ± 2 db is obtained.

(5) Reinsert the plug of the test plug assembly into the REC AMP 1 OUT jack. Adjust the FLAT ADJ 68 KC control for an indication of -39.8 +2 db on the voltmeter.

(6) Insert the plug of the test plug assembly into the REC AMP 2 OUT jack. Operate the REGULATOR switch to AUTO and adjust the AUTO REG OUTPUT control to the extreme counterclockwise position. The voltmeter should indicate -48.3 ± 2.5 db after the regulator circuit is stabilized.

(7) Adjust the AUTO REG OUTPUT control for an indication of -39.8 ±2 db on the voltmeter. Connect a multimeter, arranged to measure dc voltage, the REG VOLTS jacks on regulator and alarm unit Z6; the multimeter should indicate 3.5 +.5 volts dc

(8) Operate the ALARM TEST switch on regulator and alarm unit Z6 to the 2 LOW position. Operate the ALARM CUT OFF switch to NORMAL. Set the ADJ LOW control to the extreme counterclockwise position; then turn the control slowly clockwise until the LOW ALARM lamp lights and the audible alarm sounds. Release the ALARM TEST switch.

(9) Operate the ALARM CUT OFF switch to LOW. The audible alarm should be silenced. Operate the ALARM CUT OFF switch to NORMAL; the LOW ALARM lamp should go out and the audible alarm should sound. Reoperate the ALARM CUT OFF switch to LOW, the audible alarm should be silenced.

(10) Operate the ALARM TEST switch to the 1 HIGH position. Operate the ALARM CUT OFF switch to NORMAL. Set the ADJ HIGH control to the extreme counterclockwise position; then turn the control slowly until the HIGH ALARM lamp lights and the audible alarm sounds. Release the ALARM TEST switch.

(11) Operate the ALARM TEST switch to the 1 HIGH position; the audible alarm should be silenced. Operate the ALARM CUT OFF switch to NORMAL. The HIGH ALARM lamp should go out and the audible alarm should sound. Reoperate the ALARM CUT OFF switch to the NORMAL position. The audible alarm should be silenced.

(12) Connect a 10-ohm resistor across terminals F and P of the subgroup test cable assembly. Connect the voltmeter across the 10-ohm resistor.

The voltmeter should indicate -.3 ±3 db.

(13) Set the attenuator for a 30-db loss. Connect the voltmeter to terminals T_1 and R of the test plug assembly. Insert the plug of the test plug assembly into the REC AMP 2 OUT jack. The voltmeter should indicate -39.8 ± 1.4 db. Set the attenuator for a 42-db loss; the voltmeter indication should increase 1.1 db.

(14) Set the attenuator for a 36-db loss. Operate the REGULATOR switch to MAN and adjust the MAN REG OUTPUT control for an indication of -39.8 ±2 db on the voltmeter.

(15) Connect a 135-ohm resistor and the voltmeter across terminals T and R of the test plug assembly. Insert the plug of the test plug assembly into the TR 62 KC jack; the voltmeter should indicate -29.4 ± 2 db. Insert the plug of the test plug assembly into the REC 62 KC jack, the voltmeter should indicate -25.6 +2 db.

(16) Adjust signal generator No. 2 for an output frequency of 12 kc ((1) above). Connect the signal generator and associated components to the SPECIAL SERVICE 12-60 KC IN binding posts.

(17) Connect the voltmeter and a 135ohm resistor across the SPECIAL SERVICE 12-60 KC OUT binding posts. Set the attenuator for a 0-db loss. Operate the 12-60 KC SPECIAL SERVICE switch to SPL SERV. The voltmeter should indicate -10 ± 2 db.

(18) Remove the 135-ohm resistor from terminal T_1 and R of the test plug assembly and connect the voltmeter across the terminals. Insert the plug of the test plug assembly into the SPL SERV 12-60 KC IN jack; the voltmeter should indicate -1.8 ±1 db.

(19) Repeat the test procedure in (16) and (17) above using frequencies of 28 and 60 kc. The voltmeter should indicate 9.6 +2.5 db and 10.1 ±3 db respectively.

(20) Adjust signal generator No. 2 for an output frequency of 83 kc at an output level of 10 db as measured across a 135-ohm resistor connected across terminals 1 and 2 of transformer T107. Remove the 135-ohm resistor from terminals 1 and 2 of the transformer and connect the signal generator and associated components to the SPECIAL SERVICE 60-108 KC IN binding posts.

(21) Operate the 60-108 KC switch to SPL SERV. Set the attenuator for a 0-db loss. Insert the plug of the test plug assembly into the SPL SERV 60-108 KC IN jack; the voltmeter should indicate -12.8 db.

(22) Connect the voltmeter and a 135-ohm resistor across terminals T_1 and R of the test plug assembly. Adjust the DEM GAIN control to the extreme clockwise position. . Insert the plug of the test plug assembly into the DEM OUT jack; the voltmeter should indicate -3.5 ± 3 db.

(23) Connect the voltmeter and the 135-ohm resistor across the SPECIAL SERVICE 60-108 KC OUT binding posts. The voltmeter should indicate within ± .3 db of the reading obtained in (22) above. Adjust the DEM GAIN control to the extreme counterclockwise position; the voltmeter indication should be reduced by at least 10 db.

(24) Adjust signal generator No. 2 for an output frequency of 68 kc. Set the attenuator for a 35-db loss. Connect the voltmeter across terminals T_1 and R of the test plug assembly. Insert the plug of the test plug assembly into the REC IN jack.

(25) Set the CABLE REELS TO FIRST AN/TCC-11 TR switch to position 23 and set the CABLE REELS TO FIRST AN/TCC-11 REC switch to position 2. Operate the switches, one step at a time, until the CABLE REELS TO FIRST AN/TCC-11 TR switch is at position 2 and the CABLE REELS TO FIRST AN/ TCC-11 REC switch is at position 23.

Check the voltmeter at each position of the switches. The voltmeter indications should not vary more than ± .5 db of each other at the switch position.

(26) Readjust signal generator No. 2 for an output frequency of 12 kc. Set the CABLE REELS TO FIRST AN/ TCC-11 TR and the CABLE REELS TO FIRST AN/TCC-11 REC switches to positions 11. Set the SLOPE ADJ 12 KC control and the BULGE ADJ 28 KC control to the -5 position. Adjust the attenuator to obtain an indication of -51.8 ± .5 db on the voltmeter. Reset the SLOPE ADJ 12 KC control to the +5 position. The voltmeter indication should increase at least 12 db.

(27) Readjust signal generator No. 2 for an output frequency of 28 kc. Reset the SLOPE ADJ 12KC control to the -5 position. The voltmeter should indicate -51.8 ± .5 db. Reset the BULGE ADJ 28 KC control to the +5 position. The output signal strength should increase at least 6 db.

175. 12-68 Kc Amplifier Tests

(fig. 132)

a. Initial Procedure.

(1) Interconnect the modem and amplifier and carrier supply test cable assemblies, 200 VOLT POWER SUPPLY, carrier supply test cable assembly, and the 12-68 kc amplifier.

(2) Interconnect the signal generator, resistors, attenuator, and transformer T108.

(3) Connect the resistors and capacitors to the modem and amplifier test cable assembly.

b. Power Distribution Test. Connect the multimeter across terminal 12 (ground) and the terminal indicated in the chart below on the modem and amplifier test cable assembly. The multimeter should indicate the voltages listed in the chart for each test.

Terminal	Dc voltages		
	Avg	Min	Max
20 -------------------	16.2	14.7	17.7
8 --------------------	18.5	17.0	20.0
13 -------------------	18.8	17.6	20.1

Note. The measurements in the above table are made with no teat signal input..

c. Gain Test Without Feedback Through 600ohm Leg of Input Hybrid.

(1) Connect a 600-ohm resistor across terminals 1 and 3 of transformer T108. Set the attenuator for a 0-db loss and adjust the signal generator for an output frequency of 28 kc at an output level of -23.8 db as measured across the 600-ohm resistor. Remove the 600-ohm resistor.

(2) Connect the output of the signal generator and associated components to terminal 0 of the modem and amplifier test cable assembly and ground.

(3) Set the attenuator for a 63-db loss.

(4) Connect a ground to terminal E5 of the 12-68 kc amplifier.

(5) Connect the voltmeter between terminal 14 of the modem and amplifier test cable assembly and ground. The voltmeter should indicate -3.8 ± 5 db.

(6) Adjust the signal generator for an output frequency of 12 kc as described in (1) above.

(7) The voltmeter should indicate a minimum of -11.8 db.

(8) Adjust the signal generator for an output frequency of 68 kc as described in (1) above.

(9) The voltmeter should indicate a minimum of -11.8 db.

d. Gain Test With Feedback Through 600ohm Leg of Input Hybrid.

(1) Disconnect the ground from terminal E5 of the amplifier and readjust the attenuator for a 32-db loss.

(2) Repeat the test procedures given in *e*

Figure 131 GROUP PANEL and JUNCTION PANEL, final test setup.
(Contained in separate envelope)

above. The voltmeter should indicate the values shown in the chart below.

Signal generator frequency (kc)	Output signal level (db)
12	-3.3 ±2 db.
28	±1 db of the indication received for 12 kc
68	+.3±1 db of the indication received 12 kc. Record this indication

(3) Set the attenuator for a 12-db loss; repeat the 68 kc test. The voltmeter indication should not vary more than ± 1 db from the 68 kc indication recorded in (2) above.

(4) Connect the voltmeter to terminals 15 and 18 of the modem and amplifier test cable assembly with terminal 18 as ground. The voltmeter should indicate between 3.4 and 4.4 db.

(5) Remove the resistor-capacitor network connected between terminals 6 and 7 of the modem and amplifier test cable assembly.

(6) Set the attenuator for a 22-db loss. The voltmeter should indicate -3.3 ± 1 db.

e. Gain Test With Feedback Through 120ohm (Pilot) Leg of Input Hybrid.

(1) Connect a 135-ohm resistor across terminals 1 and 3 of transformer T108. Set the attenuator for a 0-db loss and adjust the signal generator for an output frequency of 68 kc at an output level of -7.8 db as measured across the 135-ohm resistor.

(2) Connect a 600-ohm resistor between terminal 0 of the modem and amplifier test cable assembly and ground. Connect the resistor-capacitor network between terminals 6 and 7 of the modem and amplifier test cable assembly as shown in figure 132.

(3) Disconnect the 135-ohm resistor between terminals 2 and 6 of the modem and amplifier test cable assembly and ground.

(4) Disconnect the 135-ohm resistor from terminals 1 and 3 of transformer T108 and connect the transformer to terminals 2 and 6 of the modem and amplifier test cable assembly. Set the attenuator for a 45-db loss.

(5) Connect the voltmeter to terminals 14 and 16 of the modem and amplifier test cable assembly. The voltmeter should indicate -.7 ± 1.2 db.

f. Phase Margin Test.

(1) Operate the 200 VOLT POWER SUPPLY switch to the OFF position.

(2) Disconnect the signal generator and associated components from terminals 2 and 6 of the modem and amplifier test cable assembly. Disconnect the 600-ohm resistor from terminal 0 and ground of the modem and amplifier test cable assembly terminal board.

(3) Connect the voltmeter between the plate pin of tube V2 and ground.

(4) Operate the 200 VOLT POWER SUPPLY switch to the ON position. When a steady reading is obtained the voltmeter should indicate .1 volt or less.

176. Regulator and Alarm Unit Z6, Final Tests

(fig. 67)

a. Initial Procedure.

(1) Interconnect the modem and amplifier and carrier supply test cable assemblies, 200 VOLT POWER SUPPLY, resistors, and regulator and alarm unit Z6.

(2) Connect the signal generator, resistors R1 through R3, attenuator, and transformer T108 together. (Do not connect the transformer to terminals 0 and 3 of the test cable assembly.)

(3) Operate all switches to their normal positions.

(4) Set the attenuator for a 0-db loss. Connect a 600-ohm resistor across terminals 1 and 3 of transformer T108. Adjust the signal generator for an output frequency of 68 kc at an output level of -7.8 db as measured across the 600-ohm resistor. Disconnect the 600-ohm resistor.

b. Regulating Function Test.

(1) Connect transformer T108 to terminals 0 and 3 of the modem and amplifier test cable assembly.

(2) Set the attenuator for a 2-db loss.

(3) Connect the multimeter to REG

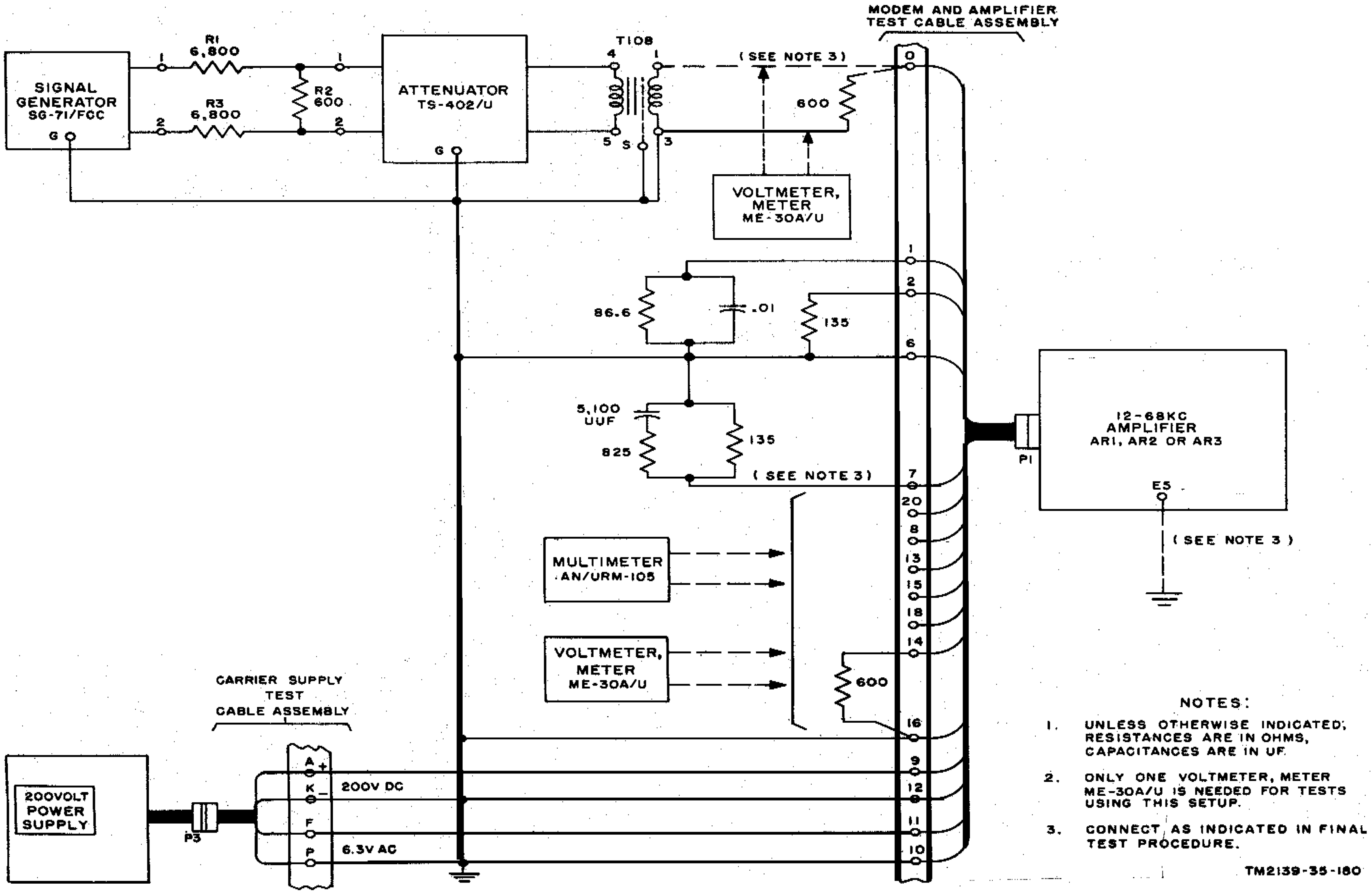


Figure 132. 12-68 kc amplifier (part of GROUP PANEL) final setup

VOLTS jacks J1 and J2 and adjust the 20k variable resistor until the multimeter indicates 3.5 ±.5 volts dc.

(4) Connect the multimeter to terminals 14 and 12 of the modem and amplifier test cable assembly. The multimeter should indicate 65 ±20 volts dc.

(5) Connect the multimeter (arranged to measure current) in series with the 200-volt supply lead connected to terminal A of the carrier supply test cable assembly. The multimeter should indicate 61 ±10 ma.

(6) Set the attenuator for a 3-db loss. Connect the multimeter (arranged to measure voltage) to REG VOLTS jacks J1 and J2. The multimeter should indicate 6 volts minimum.

(7) Set the attenuator for a 1-db loss. The multimeter should indicate 2 volts maximum.

c. Alarm Function Test.

Note. Perform the adjustments described in (1) and below with care. The adjustments are critical.

(1) Operate the ALARM TEST switch to the 1 HIGH position. Vary the ADJ HIGH control until high alarm relay K1 just releases. Measure the resistance across terminals 1 and 16, and 1 and 5 of the modem and amplifier test cable assembly with the multimeter. The multimeter should indicate 0-ohm for each measurement.

(2) Operate the ALARM TEST switch to the 2 LOW position. Vary the ADJ LOW control until low alarm relay K2 just releases. Measures the resistance across terminals 1 and 13, and 1 and 2 of the modem and amplifier test cable assembly. The multimeter should indicate 0-ohm for each measurement.

(3) Set the attenuator for a 4-db loss. Low alarm relay K2 should release and high alarm relay K1 should remain operated. Measure the resistance across terminals 1 and 2, 1 and 11, and 1 and 13 of the modem and amplifier test cable assembly. The multimeter should indicate 0-ohm for each measurement.

(4) Set the attenuator for a 3-db loss. Low alarm relay K2 should operate.Measure the resistance across terminals 1 and 13, and 1 and 2 of the modem and amplifier test cable assembly. The multimeter should indicate an infinite resistance for each measurement.

(5) Set the attenuator for 0-db loss. High alarm relay K1 should release, and low alarm relay K2 should remain operated. Measure the resistance across terminals 1 and 16, 1 and 5, and 1 and 8 of the modem and amplifier test cable assembly. The multimeter should indicate 0-ohm for each measurement.

(6) Set the attenuator for 3-db loss. High alarm relay K1 should operate. Measure the resistance across terminals 1 and 16 of the modem and amplifier test cable assembly. The multimeter should indicate an infinite resistance.

177. Modem and Amplifier AR4, Final Tests

(fig. 71)

a. Initial Procedures.

(1) Interconnect the modem and amplifier and carrier supply test cable assemblies, 200 VOLT POWER SUPPLY, and modem and amplifier AR4.

(2) Connect terminals 6 and 9 of the modem and amplifier test cable assembly together.

(3) Connect a 200-ohm variable resistor across terminals 9 and 12 of the modem and amplifier test cable assembly and connect a 135-ohm resistor across terminals 15 and 18, and 14 and 17.

(4) Connect signal generator No. 1 to terminals 10 and 11 of the modem and amplifier test cable assembly. Adjust the signal generator for an output frequency of 120 kc at an output level of -2.5 db.

b. Transmitting Circuit Test.

(1) Connect signal generator No. 2A, resistors R1 through R3, attenuator and transformer T107 together. Connect a 135-ohm resistor across terminals 1 and 2 of transformer T107. Set the attenuator for a 0-db loss and adjust the signal generator for an output

frequency of 60 kc at an output level of -6.5 db measured across the 135-ohm resistor with the audio level meter. Disconnect the 135-ohm resistor.

(2) Connect terminals 1 and 2 of transformer T107 to terminals 4 and 5 of the modem and amplifier test cable assembly.

(3) Connect a 600-ohm resistor across terminals 1 and 2 of the modem and amplifier test cable assembly.

(4) Set the attenuator for a 42-db loss. Connect the audio level meter across the 600-ohm resistor connected to terminals 1 and 2. Tune the audio level meter for 60 kc; it should indicate -47 $\pm$1.5 db.

(5) Readjust signal generator No. 2A for an output frequency of 83 kc ((1) and (2) above) . Readjust the audio level meter for 37 kc; it should indicate -47 $\pm$1.5 db.

(6) Readjust signal generator No. 2A for an output frequency of 100 kc ((1) and (2) above). Tune the audio level meter for 20 kc; it should indicate -47 $\pm$1.5 db.

c. Receiving Circuit Test.

(1) Connect a 600-ohm resistor acrossterminals 1 and 3 of transformer T108. Set the attenuator for a 0-db loss and adjust signal generator No. 2 for an output frequency of 37 kc at an output level of 3.8 db as measured across the 600-ohm resistor. Disconnect the 600-ohm resistor.

(2) Connect terminals 1 and 3 of transformer T108 across terminals 16 and 19 of the modem and amplifier test cable assembly terminal board.

(3) Adjust the 200-ohm variable resistor across terminals 9 and 12 for minimum resistance.

(4) Connect the voltmeter to terminals 14 and 17 of the modem and amplifier test cable assembly terminal board. The voltmeter should indicate -5.3 $\pm$2 db. Record this value.

(5) Adjust the signal generator No. 2B for an output frequency of 60 kc ((1) and (2) above). The voltmeter indication should be within 1 db of the indication in (4) above.

(6) Adjust signal generator No. 2B for an output frequency of 12 kc ((1) and (2) above). The voltmeter indication should be within 1 db of the indication in (4) above.

Section V. TELEPHONE TEST SET TS -760/TCC-7 (PART OF RECEIVER-TRANSMITTER TEST SET GROUP OA 443/TCC-7)

178. High-Frequency Oscillator Circuit Tests

(fig. 78)

a. Initial Procedure.

(1) Interconnect the power, transmission,and carrier supply test cable assemblies, terminating resistors, 200VOLT POWER SUPPLY, and TESTPANEL.

(2) Interconnect the signal generator, resistors R6 through R8, attenuator, transformer T107, 135-ohm resistorand test jack assembly.

b. SEND Lamp Test.

(1) The SEND lamp should light whenthe SEND switch is operated to 65 KC REC, and 65 KC TR OR FAULT

(2) The SEND lamp should go off when the SEND switch is operated to CHECK GAIN CHECK HF.

c. ATTENUATOR Switch Operation Test.

(1) Operate the MEASURE NONSELECTIVE. switch to CHECK 1 KC CHECK HF. Insert the measure cord plug into the test jack assembly connected to the signal source.

(2) Set the attenuator for a 46 db loss; adjust the signal generator for an output frequency of 68 kc at an output level of 0 db as indicated on the test panel meter.

(3) Operate and hold the 5 db push button of the ATTENUATOR switch and set the attenuator for a 41-db loss. The test panel meter should indicate 0 ±.7 db. Reset the attenuator for a loss of 46-db and release the 5 db push button.

(4) Operate and hold the 10 db push button of the ATTENUATOR switch and set the attenuator for a 36-db loss. The test panel meter should indicate 0 ±.7 db. Reset the attenuator for a 46-db loss and release the 10 db push button.

(5) Operate and hold the 20 db push button of the ATTENUATOR switch and set the attenuator for a 26-db loss. The test panel meter should indicate 0 db ±.7 db. Reset the attenuator for a 46-db loss and release the 20 db push button.

d. Hf Oscillator Frequencies, Test.

(1) Set the HF, 65 KC TR OR FAULT TEST, and 65 KC REC controls at approximately midpositions. Connect the frequency meter between terminal 6 of section 1 of the SEND switch and chassis ground.

(2) For each position of the SEND and FAULT TEST switches listed below, the frequency meter should indicate within the limits given in the f requency column.

SEND switch position	Push button of FAULT TEST switch operated	Frequency
CHECK GAIN	None---------	68kc ± 100 cps
CHECK HF.	None---------	65 kc ±150 cps
65 KC REC	REP 3 -------	83 kc ±300 cps.
65 KC REC	REP 2 -------	91 kc ±300 cps.
65 KC REC	REP 1 -------	99 kc ±300 cps.
65 KC REC		

e. Hf Control Range Test.

(1) Operate the switches listed below to the indicated positions.

Switch	Position
MEASURE SELECTIVE ------	OFF.
MEASURE NONSELECTIVE	CHECK 1 KC CHECK HF.
SEND -------------------------------	CHECK GAIN CHECK HF.

(2) Insert the TEST PANEL measureplug into the CHECK HF jack. Operate the HF control to its extremeclockwise p o sition. The TESTPANEL meter reading should be ±2.5db or more. Operate the HF controlto its extreme counterclockwise position. The meter reading should be ±2.5 db or less.

(3) Readjust the HF control for a 0-db reading on the meter.

f. Check of TO TS-712/TCC-11 Connector J5

(1) Connect the test jack assembly toterminals D and R of the transmissiontest cable assembly.

(2) Operate and hold the 20 db push button of the ATTENUATOR switch.Insert the TEST PANEL measure plug into the test jack Assembly. TheTEST PANEL meter should indicate±3 ±.8 db. Remove the measureplug from the test jack assembly and release the push button.

(3) Measure the resistance between terminals D and L and between D and A of the transmission test cable assembly with the Multimeter. The resistance should be 680 ± 68 ohms.

g.. 65 KC TR OR FAULT TEST .Range Test.

(1) Connect the test jack assembly across terminals K and W of the power test cable assembly. Operate the SEND switch to the 65 KC TR OR FAULT TEST position. Set the 65 KC TR OR FAULT TEST control to its extreme clockwise position. Operate and hold the 5db push button of the ATTENUATOR switch. Insert the measure

plug into the test jack assembly. The TEST PANEL meter reading should be +3 db or more.

(2) While holding the 5db push button operated, set the 65 KC TR OR FAULT TEST control to its extreme counterclockwise position. The TEST PANEL meter reading should be -3 db or less.

(3) While holding the 5db push button operated, adjust the 65 KC TR OR FAULT TEST control for a 0-db reading on the TEST PANEL meter. Release the 5db push button .

h. Fault Test Output Test.

(1) Operate the MEASURE NONSELECTIVE switch to the FAULT TEST position. Operate and hold the REP 2 push button. The TEST PANEL meter reading should be -2.5 +.3 db. Release the push button.

(2) Operate and hold the REP 3 push button. The meter reading should be -2.5 +1 db. Release the push button.

(3) Operate and hold the REP 1 push button. The meter reading should be -2.5 +1 db. Release the push button.

i. 65 KC REC Control Range Test.

(1) Connect the test jack test cable assembly across terminals D and R of the power test cable assembly. Operate the MEASURE NONSELECTIVE switch to GRP DEM OUT. Operate the SEND switch to 65 KC REC. Set the 65 KC REC control to its maximum clockwise position. Insert the TEST PANEL measure plug into the test jack assembly. The TEST PANEL meter should read between +4.5 and +6.5 db.

(2) Check to see that the 65 KC REC control is capable of being adjusted for a reading of -5 db on the TEST PANEL meter. Remove the measure plug from the test jack assembly.

179. Test Oscillator, 1 Kc, Tests

(fig. 78)

a. Initial Procedure. Prepare the TESTPANEL for testing as explained in paragraph 178a.

b. 1-Kc Oscillator Output Test.

(1) Operate the MEASURE NONSELECTIVE switch to the CHECK 1 KC CHECK HF position. Insert the TEST PANEL measure plug into the CHECK 1 KC jack. Set the 1 KC control to its maximum clockwise position. The TEST PANEL meter reading should be +2.5 db or more.

(2) Set the 1 KC control to its maximum counterclockwise position. The meter reading should be -3 db or less.

(3) Adjust the 1 KC control for a 0-db meter reading.

(4) Insert the measure plug in the CHANNEL OUT jack. The meter reading should be 0 db +.5 db.

(5) Check for continuity between terminals P and F and between C and S of the power test cable assembly with the multimeter.

c. Oscillator Frequency Test.

(1) Connect the frequency meter across terminals P and C of the power test cable assembly.

(2) The frequency meter should indicate 1 kc +20 cps.

180. Selector Measuring Circuit Tests

(fig. 78)

a. Initial Procedure. Prepare the TEST PANEL for testing as explained in paragraph 178a.

b. Carrier Oscillator Output Test.

(1) Remove the bottom shield from the TEST PANEL chassis. Set the MEASURE SELECTIVE switch to OFF. Set the COARSE and FINE TUNE controls to their midpositions. Make no connection to the TEST PANEL measure cord.

(2) Calibrate the audio level meter (par. 79). Set its switches as shown in the chart below. Connect the audio level meter G binding post to chassis ground on the TEST PANEL and the unmarked binding post to terminal 2 of transformer T3. Tune the audio level -meter for a maximum meter reading in the vicinity of 304 kc. The reading on the audio level meter should be between 0 +4 db.

Audio level meter switch	Position
INJECTOR --------------	REC
METER ------------------	REC. O.
ATTENUATOR --------	VM-UNBAL 600 Ω
SELECTOR -------------	BRG.

(3) Repeat the measurement in (2) above for each of the other positions of the MEASURE SELECTIVE switch. As an aid in tuning the audio level meter, the frequencies of the TEST PANEL carrier oscillator for the various MEASURE SELECTIVE switch positions are given in the chart below. The readings on the audio level meter, should be 0 ±4 db for all switch positions, and the difference between maximum and minimum readings, excluding the measurement in the off position should be less than .5 db.

MEASURE SELECTIVE switch position	Frequency (kc)
CHECK GAIN	262
12KC ---------------------------------	206
28KC ---------------------------------	222
68KC ---------------------------------	262
65KC	259
37KC ---------------------------------	231
67KC ---------------------------------	261
83KC ---------------------------------	277
99KC ---------------------------------	293
GRP PANEL 62KC-----------------	256

(4) Remove the audio level meter connections and replace the bottom shield plate on the TEST PANEL chassis.(7

c. FINE TUNE Control Range Test.

(1) Operate the MEASURE NONSELECTIVE switch to OFF; the MEASURE SELECTIVE switch to CHECK GAIN, and set the FINE TUNE control to the extreme clockwise position.

(2) Set the attenuator for a 46-db loss; adj ust the signal generator for an output frequency of 68 kc at an output level of .775 volt as measured across terminals T and S of the test jack assembly.

(3) Insert the TEST PANEL measure plug into the test jack assembly connected to the test signal source.

(4) Adjust the COARSE TUNE control for a maximum meter indication.

(5) Set the FINE TUNE control to the extreme counterclockwise position.

(6) Adjust the signal generator for a maximum meter indication. Check the frequency of the signal generator with the frequency meter. The frequency should be between 70 and 71 kc.

(7) Readjust the signal generator for an output frequency of 68 kc.

(8) Adjust the FINE TUNE control to its midposition. Adjust the COARSE TUNE control for a maximum meter indication.

d. GAIN Control Range Test.

(1) Set the attenuator for a 47-db loss.

(2) Adjust the signal generator for an output frequency of 68 kc at an output level of .775 volt as measured across the test jack assembly.

(3) Insert the measure cord plug into the test jack assembly.

(4) Adjust the FINE TUNE control for a maximum meter indication.

(5) Adjust the GAIN control for a 0-db indication on the meter.

(6) Set the attenuator for a 45-db loss. Adjust the GAIN control for a 0-db indication on the meter.

Note. If a 0-db indication cannot be obtained on the meter, readjust AMP GAIN control R17 on the IF amplifier.

(7) Set the attenuator for a 46-db loss. Check to be sure that the FINE TUNE control is adjusted for maximum indication on the meter. Readjust the GAIN control for a 0-db indication on the meter.

e. Selective Circuit Sensitivity Test.

(1) Set the attenuator for a 0-db loss and adj ust the signal generator as indicated in the signal generator frequency and voltmeter reading columns of the chart in (3) below.

(2) Insert the plug of the measure cord into the test jack assembly connected

to the signal source. Set the attenuator for the loss indicated in the attenuator setting column.

(3) Adjust the FINE TUNE control to obtain a maximum reading on theTEST PANEL meter for each position of the MEASURE SELECTIVE switch. The meter should be within the limits given in the TEST PANEL meter reading column.

MEASURE SELECTIVE switch position	Signal Generator frequency (kc±100cps)	Voltmeter reading (ac volt)	Attenuator setting (db)	TEST PANEL meter reading (db)
CHECK GAIN --------	68	0.775	46	0
68KC--------------------	12	.731	48	0± .5
12KC--------------------	28	.731	48	0± .5
28KC--------------------	68	.731	38	0± .5
68KC--------------------	65	.731	38	0± .5
65KC--------------------	37	.731	38	0± .5
37KC--------------------	67	.731	48	0± .7
67KC--------------------	83	.731	48	0± .7
83KC--------------------	99	.731	48	0± .7
99KC--------------------	62	.775	70	0± .9
GRP PANEL 62KC* -				

* In this test, operate the MEASURE NONSELECTIVE switch to the GRP PANEL 62KC position.

181. Nonselective Measuring Circuit Test

(fig. 78)

a. Initial Procedure. Arrange the TEST PANEL for the following test as explained in paragraph 178a.

b. Test Procedures.

(1) Set the attenuator for a 0-db loss and adjust the signal generator as indicated in the signal generator frequency and voltmeter reading columns of the chart in (3) below.

(2) Insert the measure cord plug into the test jack assembly connected to the test signal source. Set the attenuator for the loss indicated in the attenuator setting column.

(8) The TEST PANEL meter indication should be within the limits given in the TEST PANEL meter reading column for each position of the M E A S U R E NON-SELECTIVE switch.

MEASURE NON-SELECTIVE switch positon	Signal Generator frequency (kc±100cps)	Voltmeter reading (ac volts)	Attenuator setting (db)	TEST PANEL meter reading (db)
CHECK 1 KC CHECK HF.	68	0.775	46	0 ± .1
CHANNEL OUT-------------	1	.870	0	0 ± .5
SUB GRP MOD IN----------	7	.775	39	0 ± .5
SUB GRP MOD IN----------	19	.775	39	0 ± .5
GRP DEM OUT--------------	68	.781	11	0 ± .5
SUB GRP DEM OUT -------	68	.775	0	0 ± .5
OW TR AMP OUT ----------	1	.699	13	0 ± .5
OW REC AMP ---------------	1	.757	46	0 ± .5
CARR SUPPLY --------------	1	.731	0	0 ± .5
CARR SUPPLY --------------	68	.749	0	0 ± .5
CARR SUPPLY --------------	120	.740	0	0 ± .5
FAULT TEST ----------------	83	.707	41	0 ± .1.5
FAULT TEST ----------------	91	.707	41	0 ± .1.5
FAULT TEST ----------------	99	.707	41	0 ± .1.5

182. MEASURE Switch Operation and Meter Scale Accuracy Tests

(fig. 78)

a. Initial Procedure. Prepare the TEST PANEL for the following tests as explained in paragraph 178a.

b. MEASURE Switch Test.

(1) Operate the MEASURE switch to 200 VOLTS. Adjust the 200 VOLT POWER SUPPLY for a 0-db meter reading on the TEST PANEL meter. Measure the voltage between terminals V and J of the power test cable assembly with the multimeter. The reading should be 200 ± 7 volts.

(2) Operate and leave the MEASURE switch in the 600 VOLTS position. No reading should be obtained on TEST PANEL meter.

(3) Operate the AC POWER switch to the OFF position. Connect terminal A to terminal V on the power test cable assembly. Operate the AC POWER switch to the ON position. The TEST PANEL meter reading should be 0 db. Remove the strap between terminals A and V.

c. Meter Scale Accuracy Test.

(1) Set the attenuator for a 46-db loss. Adjust the signal generator for an output frequency of 68 kc at an output level of .775 volt as measured across the test jack assembly.

(2) Set the attenuator to each of the values indicated in the Attenuator loss column of the chart below. Insert the measure cord plug into the test jack assembly. Check the TEST PANEL meter indication at each of the attenuator settings; the meter indication for each attenuator setting should be within the limits given in the TEST PANEL meter reading column of the chart below.

Attenuation loss (db)	TEST PANEL meter reading (db)
39	+7± .3
40	+6± .3
41	+5± .3
42	+4± .3
43	+3± .3
44	+2± .3
45	+1± .3
46	0
47	-1± .3
48	-2± .3
49	-3± .4
50	-4± .5
51	-5± .6
52	-6± .7
53	-7± .8

183. Flat ond IF Amplifier Test

(fig. 86)

Note. The final test procedures for the two amplifier units are identical. Where test results or unit designations are different, parentheses are used in text to indicate IF amplifier ART.

a. Initial Procedures (for Complete Test). If the amplifier is part of a complete TEST PANEL, use the procedure outlined in (1) through (4) below. If the amplifier is to be tested as a separate unit, use the procedure outlined in b below.

(1) Disconnect connector P2 from connector J1 of the amplifier and insert test plug connector P675 into connector J1.

(2) Connect the test cable assemblies, 200 VOLT POWER SUPPLY, TEST PANEL, and amplifier as shown in C, figure 86.

(3) Apply power to the TEST PANEL and operate the MEASURE switch to the TRANSMISSION position.

(4) Connect test signal source as shown in A, figure 86.

b. Initial Procedures (for Separate Test). If the amplifier to be tested is not part of a complete TEST PANEL and must be tested separately, use the following procedure to prepare the amplifier for testing.

(1) Insert test plug connector P675 into connector J1 of the amplifier.

(2) Connect the amplifier, 200 VOLT POWER SUPPLY, measuring set, and test cable assembly as shown in B. figure 86.

(3) Apply power to the amplifier.

(4) Connect test signal source as shown in A, figure 86.

c. Range of GAIN Control R17 Test. Perform the appropriate initial procedure (a or b above) before proceeding to steps (1) through (9) below.

(1) Adjust the signal generator output frequency to 68 kc ±100 cps as read on the frequency meter.

(2) Set the attenuator for a 0-db loss.

(3) Adjust the signal generator output control for a reading of .775 volt on the voltmeter.

(4) Set the attenuator for a 49- (51-) db loss

(5) Connect test lead B of the test plug assembly to terminal D of the plug connector P675. Connect the GND lead to chassis ground.

(6) Insert the test plug assembly into the test jack assembly.

(7) Remove the cap nut from GAIN (AMP GAIN) control R17 on the amplifier, and set R17 to its maximum clockwise position. The TEST PANEL meter (a above) or the measuring set meter (b above) should read ±2.5 ±1.5 db (±3.5 ±1.5 db).

(8) Adjust GAIN (AMP GAIN) control R17 to its maximum counterclockwise position. The meter should read--3.5 ±1.5 db (-5.0 ±1.5 db).

(9) After making the tests above, adjust GAIN (AMP GAIN) control R17 for a 0-db reading on the meter. Replace the cap nut on GAIN control R17. Remove the test plug assembly from the test jack assembly.

d. Frequency Characteristic Test. Perform the appropriate initial procedure (a or b and c above) before proceeding with steps (1) and (2) below.

(1) Use the following procedure for tests at frequencies of 1, 12, and 68 kc. Connect the frequency meter across resistor R7 to check the frequency of the signal generator.

(a) Set the attenuator for a 0-db loss. Adjust the signal generator output control for a reading of .776 volt as indicated on the voltmeter.

(b) Set the attenuator for a 49- (61-) db loss.

(c) Insert the test plug assembly into the test jack assembly. Adjust the frequency of the signal generator f or each test frequency within the limits given in the following chart.

Signal generator frequency	TEST PANEL or measuring set meter reading
68 kc ±100 cps ------------	-0
1 kc ±20 cps ---------------	-±.3±1
12 kc ±100 cps ------------	-0±1

(2) Use the following procedure for the test at 194 kc generator within the limits given in the chart in (5) below.

(a) Connect the audio level meter, along with the voltmeter, across the 135ohm resistor.

(b) Arrange the switches of the audio level meter as follows:

Audio level meter switch	Position
INJECTOR ----------------	-REC
METER---------------------	-REC.
ATTENUATOR ----------	-0 DB
SELECTOR ---------------	-VM-UNBAL 600 Q BRG

(c) Set the frequency of the signal generator to approximately 68 kc. Set the attenuator for 0-db loss. Adjust the signal generator output for a reading of .775 volt on the voltmeter.

(d) Adjust the frequency dial of the audio level meter for a maximum meter reading.

(e) Adjust the IF GAIN control of the audio lever meter for a meter read -

ing of 0-db. Do not disturb this setting for the remainder of the test.

(f) Change the frequency of the signal generator to 194 kc ± 100 cps as measured with the frequency meter.

(g) Adjust the frequency dial of the audio level meter for a maximum meter reading. Adjust the signal generator output control for a 0-db reading on the audio level meter.

(h) Set the attenuator for a 49- (51-) db loss.

(i) Insert the test plug assembly into the test jack assembly; the TEST PANEL or the measuring set meter should indicate 0 ±1 db.

Section VI. ORDER WIRE RECEIVER-TRANSMITTER RT-280/TCC-7 (PART OF RECEIVER- TRANSMITTER TEST SET GROUP 0A-443/TCC-7)

184. Continuity Test of Switch S103

Perform the following test before proceeding with other final tests of the **ORDER WIRE PANEL**.

a. Remove the switch from its mounting in the panel. Be careful not to remove any of the leads or touch any part of the switch against the panel while making these tests.

b. Operate the switch to the position indicated in the *Switch S103 setting column in the chart below*. Connect the multimeter across the test points indicated at the top of each of the other six columns. The multimeter should indicate the resistance value indicated for each switch setting

Switch S103 setting	Resistance measurements (ohms)					
	Term. 11, sect 3b to term.12,sect 4	Term 10, sect 4 to term. 12, sect 4	Term.12, sect 2 to term. 11, sect 3	Term.12, sect 1 to term. 11, sect. 3	Term.11,sect 4 to term.10, sect.4	Term.1,sect 1 to term.2, sect 3
RADIO --------	1,100-1,300	[a]Open	Open	Open	Open	70-80
0-11 ------------	1,100-1,300	Open	Open	Open	Open	Open
12-34-----------	2,100-2,400	0-0.2	4,700-5,500	500-650	Open	Open
35-57-----------	3,700-4,300	0-0.2	4,700-5,500	800-950	Open	Open
58-80-----------	5,800-6,600	0-0.2	9,400-10,600	410-550	Open	Open
81-103---------	8,500-9,600	0-0.2	15,000-18,000	240-300	Open	Open
104-126 -------	12,000-14,200	0-0.2	15,000-18,000	500-650	Open	Open
127-149 -------	Open	0-0.2	21,000-27,000	500-650	Open	Open
150-160 -------	Open	0-0.2	30,000-40,000	390-500	Open	Open
150-160 ------- (HOT)	Open	0-0.2	30,000-40,000	61-69	0-0.2	Open

[a] *Open* should correspond to a resistance reading greater than 5 megohms.

[b] Section 1 is the section nearest the knob end.

185. ORDER WIRE PANEL, Transmission Circuit Final Tests

The following procedures are used for testing all components of the **ORDER WIRE PANEL** transmission circuit except receiving and transmitting amplifiers AR101 and AR102

a. Initial Procedures (fig. 133).

(1) Interconnect the power, and carrier supply test cable assemblies, resistors, 200 VOLT POWER SUPPLY, and ORDER WIRE PANEL.

(2) Interconnect signal generator B, resistors R1 through R3, attenuator, and. transformer T109

b. Lamp and Buzzer Test.

(1) Apply power to the ORDER WIRE PANEL. The CALL lamp should light and the buzzer in ringer-oscillator Y101 should sound as soon as the power is applied.

(2) The CALL lamp should go out and the buzzer should be silenced about 30 seconds after the power has been applied.

c. Load Test (fig. 133).

(1) Connect the handset to TB 101 on the ORDER WIRE PANEL. Measure the current delivered by the 200 and 10 volt sources of the 200 VOLT POWER SUPPLY with the conditions listed in the chart in (3) below.

(2) Connect the multimeter (arranged to measure current) in series with the lead connected to terminal T and then with the lead connected to terminal V of the power test cable assembly to measure the 10 volt and 200 volt sources respectively.

(3) Use either test 3 or 4 depending on the type handset being used. Clamp the handset in its storage position for test 3 or 4

Test	Talk lever switch on telephone handset HS101	Dc supply (volts)	Current (ma)
1 ------	Any position ---------------------	200	37±5
2 ------	Nonoperated ---------------------	10	12.5±1
3 ------	Operated (type TS-9F) --------	10	68±35
4 ------	Operated (type H-60) ----------	10	50±20

(4) Disconnect the telephone handset from TB101. Be sure to tag each lead.

d. Transmitting Circuit Output Test From 2W EXT Binding Posts (fig. 133).

(1) Connect a 600-ohm resistor across terminals 3 and 6 of transformer T109. Adjust the attenuator for a 0-db loss; adjust signal generator B for an output frequency of 1 kc at an output level of 13.8 db as measured across the 600-ohm resistor.

(2) Disconnect the 600-ohm resistor from the transformer and connect the transformer to the 2W EXT binding posts.

(3) Operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to RADIO.

(4) Connect the voltmeter across terminals L and M of the power test cable assembly. The voltmeter should indicate 12.5 ±2 db.

(5) Connect the voltmeter across terminals T. and R on the test plug assembly and insert the test plug assembly into the TR AMP OUT jack. The voltmeter should not be more than .4 ±5 db of the indication received in (4) above.

(6) Adjust the TR GAIN control to the extreme counterclockwise position. Connect the voltmeter across terminals L and M of the power test cable assembly. The voltmeter indication should be--26.8 ±5 db.

(7) Adjust the TR GAIN control to the extreme clockwise position. Operate the SEND OW switch to ON. The voltmeter indication should be a maximum of--34.8 db.

(8) Disconnect transformer T109 from the 2W EXT binding posts. Adjust signal generator B for an output frequency of 300 cps at an output level of -13.8 db as measured across a 600-ohm resistor connected across terminals 3 and 6 of the transformer. Remove the 600-ohm resistor.

(9) Reconnect the transformer across the 2W EXT binding posts. The voltmeter should indicate not less than .7 ±2 db below the indication received in (4) above. Note the reading obtained.

(10) Readjust the signal generator for an output frequency of 1,700 cps as described in (8) above. Reconnect the transformer to the 2W EXT binding posts. The voltmeter indication should be within 1.5 db of the indication obtained in (4) above. Note the reading obtained.

(11) Readjust the signal generator for an output frequency of 1 kc as described in (8) above. Reconnect the transformer across the 2W EXT binding posts.

(12) Operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch from position 0-11 through position 150-160, one position at a time. At each switch position, the voltmeter should indicate within ±2 db of the indication obtained in (4) above.

(13) Operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to 150-160 (HOT). The voltmeter should indicate not more than

1 ±2 db higher than the indication obtained in (4) above.

(14) Readjust the signal generator for an output frequency of 300 cps. Reconnect the transformer to the 2W EXT binding posts. Operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to 104-126. The voltmeter should not indicate more than 8.5 ± db more than the indication obtained in (4) above.

(15) Readjust the signal generator for an output frequency of 1,700 Cps. Reconnect the transformer to the 2W EXT binding posts. The voltmeter indication should not indicate more than 1.2 ±2 db of the indication obtained in (4) above.

e. Transmitting Circuit Output Test Using Input From Telephone Handset (fig.. 188).

(1) Interconnect signal generator C, resistors R1 through R3, the attenuator, transformer T101, and the 301-ohm resistor.

(2) Connect a 50-ohm resistor across terminals 1 and 4 of transformer T101. Set the attenuator for a 0-db loss; adjust signal generator C for an output frequency of 1 kc at an output level of--17.8 db as measured across terminals 1 and 4 of the transformer. Remove the 50-ohm resistor.

(3) Disconnect the 10-volt dc supply from terminals A and T of the power test cable assembly. Strap terminals A and T together.

(4) Connect terminals 1 and 4 of transformer T101 to terminals 2 and 3 of TR101 on the ORDER WIRE PANEL.

(5) Operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 to 0-11.

(6) Connect the voltmeter across terminals L and M of the power test cable assembly. The voltmeter should indicate a maximum of--17.8 db.

(7) Operate the ORDER WIRE switch to TALK. The voltmeter indication should be 4 ±2 db less than the indication obtained in d (4) above.

(8) Connect terminals 1 and 4 of transformer T101 to terminals 1 and 3 of TB101. The voltmeter indication should be 1.5 ±2 db less than the indication obtained in d (4) above.

(9) Operate the CHANNEL T A L K switch to LINE and the ORDER WIRE switch to TALK. Connect the voltmeter across terminals C and P of the power test cable assembly; The voltmeter should indicate -22.3 ±1.6 db.

(10) Operate the CHANNEL TALK switch to TEST BD. Connect the voltmeter to terminals D and R of the power test cable assembly. The voltmeter indication should be--22.3 db ±1.6 db.

f. Transmitting Direction From Test Signal Connection (fig. 133).

(1) nterconnect signal generator, resistors R4 and R5, attenuator, and transformer T109.

(2) Connect a 10-ohm resistor across terminals 3 and 6 of T109. Adjust the attenuator for a 0-db loss; adjust the signal generator for an output frequency of 1 kc at an output level of -7.8 db as measured across the 10ohm resistor.

(3) Connect terminals 3 and 6 of transformer T109 to terminals K and W of the power test cable assembly.

(4) Operate the CHANNEL TALK switch to TEST BD; ORDER WIRE switch to TALK; and the CABLE REELS TO NEXT AN/TCC-7 or AN/TCC-8 switch to RADIO.

(5) Connect the voltmeter to terminals L and M of the power test cable assembly. The voltmeter indication should be a maximum of -23.8 db.

(6) Operate the SEND OW switch to ON. The voltmeter should indicate 4 ±1.5 db higher than the indication obtained in d(4) above.

Figure 133. ORDER WIRE PANEL, final test setup, transmitting direction..
(Contained in separate envelope)

(7) Operate the ORDER WIRE switch to RING. The voltmeter should indicate 8.5 ±2 db less than the indication obtained in d(4) above.

g. Order Wire Channel, Receiving Direction Test (fig. 91).

(1) Interconnect the power, and carrier supply test cable assemblies, 301- and 600-ohm resistors, ORDER WIRE PANEL and 200 VOLT POWER SUPPLY.

(2) Interconnect signal generator A, resistors R1 through R3, the attenuator, and transformer T109.

(3) Connect the 1,300- and 301-ohm resistors in series across terminals 3 and 6 of transformer T109. Set the attenuator for a 0-db loss;. adjust the signal generator for an output frequency of 1 kc at an output level of -25.8 db as measured across terminals 3 and 6 of transformer T109. Remove the 1,300- and 301-ohm resistors and connect terminals 3 and 6 of transformer T109 to terminals F and S of the power test cable assembly.

(4) Set the attenuator for a 15-db loss. Connect a 600-ohm resistor and the voltmeter across the 2W EXT binding posts. The voltmeter should indicate -7.8 with a tolerance of ±2, or--3.5 db. Record the reading.

(5) Repeat the procedure in (3) above, except adjust the signal generator for 300 cps The voltmeter should indicate within .5 ±1 db of the indication obtained in (4) above.

(6) Repeat the procedure in (3) above, except adjust the signal generator for 1,700 cps. The voltmeter should indicate within ±1 db of the indication obtained in (4) above.

(7) Readjust the signal generator to 1 kc (3) above. Connect the voltmeter across terminals T1 and R of the test plug assembly. Insert the test plug into the REC AMP in jack. The voltmeter should indicate -21.3 ±1 db. Record this indication.

(8) Insert the test plug assembly into the REC AMP OUT jack.. The voltmeter should indicate within ±1.5 to -2.7db of the indication obtained in (7) above.

(9) Set the attenuator for a 5-db loss. Operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to RADIO. Insert the test plug assembly into the REC AMP IN jack. The voltmeter should indicate within 10.5 ±2 db of the indication obtained in (7) above.

(10) Repeat the procedure in (3) above, except adjust the signal generator to 1,700 cps. Operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to 0-11 and adjust the REC GAIN control to the extreme counterclockwise position. The voltmeter should indicate not less than 2 ±5 db of the indication obtained in (7) above.

(11) Repeat the procedure in (3) above, except adjust the signal generator for 1,600 cps. Use the frequency meter to check the output frequency. Set the attenuator for a 15-db loss and then a 37-db loss. The CALL lamp should light and the buzzer should sound for each attenuator setting.

(12) Repeat the procedure in (3) above, except adjust the signal generator for 1 kc. Set the attenuator for a 15-db loss. Connect two series 121-ohm resistors across terminals 3 and 5 of TB101. Connect the voltmeter to terminals 3 and 6 of TB101, with terminal 3 ground. The voltmeter should indicate a maximum of--49.8 db.

(13) Set the attenuator for a 10-db loss. Operate the ORDER WIRE switch to TALK. The voltmeter should indicate--5.3 with a tolerance of ±2, or -3.5 db. Record this reading. Disconnect the 121-ohm resistors from terminals 3 and 5 of TB101.

(14) Connect two 75-ohm resistors across terminals 3 and 4 of TB101. Connect the voltmeter to terminals 3 and 4 of TB101. The voltmeter should indicate not less than 7 ±2 db below the indication obtained in (13) above.

h. Receiving Direction from Message Channels Test (fig. 91).

(1) Interconnect the signal generator B. resistors R1 through R3, attenuator, and transformer T109.

(2) Connect a 600-ohm resistor and a 301ohm resistor in parallel across terminals 3 and 6 of transformer T109. Set the attenuator for a 0-db loss; adjust the signal generator for an output frequency of 1 kc at an output level of--9.8 db as measured across terminals 3 and 6 of T109 with the voltmeter.

(3) Disconnect the 301-ohm resistor and connect terminals 3 and 6 of transformer T109 to terminals D and R of the power test cable assembly. Operate thr CHANNEL TALK switch to LINE, and the ORDER WIRE switch to TALK.-

(4) Connect two series-connected 121-ohm resistors across terminals 3 and 5 of TB101.. Connect the voltmeter to terminals 3 and 5 of TB101 with terminal 3 as ground. The voltmeter should indicate--23.8 ±2 db.

(5) Connect signal generator B across terminals C and P of the power test cable assembly. Operate the CHANNEL TALK switch to TEST BD, and the ORDER WIRE switch to TALK. The voltmeter should indicate within ±.5 db of the indication obtained in (4) above.

(6) Disconnect the voltmeter and connect the telephone handset to TB101. A 1-kc tone should be heard in the handset.

186. Transmitting Amplifier AR101 Tests (fig. 94).

a. Initial Procedure.

(1) Interconnect the carrier supply, and modem and amplifier test cable assemblies, 200 VOLT POWER SUPPLY, 1,300 and 301-ohm resistors, transmitting amplifier AR101, and 200 VOLT POWER SUPPLY.

(2) Interconnect the signal generator, resistors R1 through R3, attenuator, and transformer T109.

(3) Connect a 600-ohm resistor across terminals 3 and 6 of transformer T109. Set the attenuator for 0-db loss and adjust the signal generator for an output frequency of 1 kc at an output level of -13.8 db as measured across the 600-ohm resistor. Disconnect the 600-ohm resistor.

b. Load Test. Connect the multimeter (arranged to measure current) in series with the lead connected to terminal 13 of the modem and amplifier test cable assembly to determine the total current being drawn by transmitting amplifier AR101. The multimeter should indicate 13.5±2 ma.

Gain Test.

(1) Connect terminals 3 and 6 of transformer T109 to terminals 2 and 0 of the modem and amplifier test cable assembly (terminal 0 is ground)

(2) Set the attenuator for a 39-db loss. Connect the voltmeter to terminals 17 and 19 of the modem and amplifier test cable assembly. The voltmeter should indicate--10.1 ±1.5 db.

(3) Repeat the procedure in a(3) and (1) and (2) above except adjust the signal generator for 300 cps. The voltmeter' should indicate .4 db ±1 less than the indication obtained in (2) above.

(4) Repeat the procedure in a(3) and (1) and (2) above except adjust the signal generator for 2 kc. The voltmeter should indicate .3 ±1 db less than the indication obtained in (2) above.

187. Receiving Amplifier AR102 Tests (fig. 97)

a. Initial Procedures.

(1) Interconnect the carrier supply, and modem and amplifier test cable assemblies, 200 VOLT POWER SUPPLY, 825-ohm resistor, and receiving amplifier AR102.

(2) Interconnect the signal generator, resistors R1 through R3, attenuator, and transformer T109.

(3) Connect a 301-ohm resistor and a 1,300-ohm resistor across terminals 3 and 6 of transformer T109. Set the attenuator for a 0-db loss. Adjust the signal generator for an out-

put frequency of 1 kc at an output level of--37.8 db as measured across terminals 3 and 6 of transformer T109. Disconnect the resistors from across terminals 3 and 6 of transformer T109.

b. Load Test. Connect the multimeter (arranged to measure current) in series with the lead connected to terminal 13 of the modem and amplifier test cable assembly to determine the total current being drawn by receiving amplifier AR102. The multimeter should indicate.6 ±1.5 ma.

c. Gain Test.

(1) Connect terminals 3 and 6 of transformer T109 across terminals 2 and 0 of the modem and amplifier test cable assembly with terminal 0 as ground.

(2) Set the attenuator for a 32-db loss. Connect the voltmeter across the 825ohm resistor. The voltmeter should indicate -10.5 ±1 db. Note this reading.

(3) Readjust the signal generator (a(3) above) for an output frequency of 300 cps. Repeat the test given in (1) and (2) above. The voltmeter should indicate .1 ±1 db higher than the indication obtained in (2) above.

(4) Readjust the signal generator (a(3) above) for an output frequency of 2 kc. Repeat the test given in (1) and (2) above. The voltmeter should indicate .1 db ± db less than the indication obtained in (2.) above.

188. Ringer Oscillator Y101 Tests (fig. 100)

a. Initial Procedure.

(1) Interconnect the carrier supply and modem and amplifier test cable assemblies, 200 VOLT POWER SUPPLY, and ringer oscillator Y101.

(2) Interconnect the signal generator, resistors R1 through R3, attenuator, and transformer T109.

(3) Connect a 600-ohm resistor across terminals 3 and 6 of transformer T109. Adjust the attenuator for a 0-db loss; adjust the signal generator for an output frequency of 1,600 cps at an output level of .31 volt as measured across the 600-ohm resistor. Remove the 600-ohm resistor.

b. Oscillator Frequency and Output Level Test.

Note. Allow the ringer oscillator to warm up at least 30 minutes before performing this test.

(1) Strap terminals 2 to 6 and 5 to 8 of the modem and amplifier test cable assembly terminal board. Connect a 600-ohm resistor across terminals 0 and 1 of the modem and amplifier test cable assembly.

(2) Connect the frequency meter across the 600-ohm resistor. The output frequency from the ringer-oscillator should be 1,600 ±4 cps. Strap capacitors C7, C8, and C9, and adjust capacitor C5 until the proper frequency is obtained.

(3) Connect the voltmeter across the 600ohm resistor. The voltmeter should indicate .275 ±.03 volt.

(4) Disconnect the straps between terminals 2 and 6 and 5 and 8 of the modem and amplifier test cable assembly. Disconnect the 600-ohm resistor from terminals 0 and 1 of the test cable assembly.

c. Ringer Oscillator Y101 Sensitivity Test.

(1) Connect terminals 3 and 6 of transformer T109 to terminals 0 and 1 of the modem and amplifier test cable assembly.

(2) Set the attenuator for a 30-db loss. The buzzer should sound. Disconnect terminals 3 and 6 of transformer T109 from terminals 0 and 1 of the test cable assembly. The buzzer should be silenced.

(3) Set the attenuator for a 3-db loss and reconnect the transformer to terminals 0 and 1. The buzzer should sound. Disconnect the transformer from terminals 0 and 1; the buzzer should be silenced.

Note. The total current drawn by the ringer oscillator should be 18 ±4 ma.

d. Ringer Response Test.

(1) Set the: attenuator for a 7-db loss. Connect terminals 3 and 6 of trans-

former T109 to terminals 0 and 1 of the modem and amplifier test cable assembly. After a short time the buzzer should sound.

(2) Disconnect the transformer from terminals 0 and 1; the buzzer should be silenced.

e. Guard Circuit Test.

(1) Connect a 600-ohm resistor across terminals 3 and 6 of transformer T109. Set the attenuator for a 0-db loss; adjust the signal generator for an output frequency of 300 cps at an output level of .14 volt as measured across the 600-ohm resistor.

(2) Disconnect the resistor and connect terminals 3 and 6 of transformer T109 to terminals 0 and 1 of the modem and amplifier test cable assembly. Connect the electronic multimeter between standoff E2 and chassis ground. The multimeter should indicate 9.5 ±4 volts dc.

(3) Repeat the procedure in (1) above, except adjust the signal generator for 1 kc. The electronic multimeter should indicate 7.5 ±1.5 volts dc.

(4) Repeat the procedure in (1) above, except adjust the signal generator for 3 kc. The electronic multimeter should indicate 10.5 ±2 volts dc.

Section VII. TELEPHONE CARRIER FREQUENCY SUPPLY TA-228/TCC-7

189. CARRIER SUPPLY PANEL Output Tests (fig. 103)

a. Initial Procedures.

(1) Interconnect the supply, transmission, and carrier supply test cable assemblies 200 VOLT POWER SUPPLY, and CARRIER SUPPLY PANEL.

(2) Strap terminals P. C, M, and E of the supply test cable assembly together. Connect ground to terminal N and then strap terminals D, R. F, and K to terminal N of the supply test cable assembly. Connect the terminating resistors to the test cable assemblies.

b. Tuning Adjustments of 64-kc Oscillator and 64- to 4-kc Frequency Divider Circuits.

(1) Disconnect frequency stabilizer network Z1 from standoff terminals E61 and E62 (fig. 20) and replace it with a 100,000-ohm resistor.

(2) Connect the frequency meter across terminals T1 and R of the test plug assembly (fig. 103) and insert the plug of the test plug assembly into the 64KC LOCAL jack.

(3) Adjust capacitors C49A and C49B to obtain a 64-kc ± 100-cps indication on the frequency meter.

(4) Disconnect the 100,000-ohm resistor and reconnect frequency stabilizer network Z1. Disconnect capacitors C30 and C31 from standoff terminals E51 and E52 respectively. Connect the oscilloscope between terminal 1of inductor L3 and ground; the wave shape on the oscilloscope should be a stable sine wave. Reconnect either capacitor C30 or C31, or both, for a maximum deflection on the oscilloscope.

Note. Maximum deflection may be obtained with neither capacitor C30 nor C31 reconnected.

(5) Allow a 20-minute warmup time for the frequency stabilizer network; remeasure the frequency at the 64KC LOCAL jack ((2) above). The output frequency should be 64 kc ±2 cps.

(6) Connect the oscilloscope across terminals 1 and 2 of transformer T3. Capacitor C10 may have either of two values: 300 uuf or 380 uuf. Select the value for C10 that results in the larger output of 32 kc.

(7) Connect the oscilloscope across terminals 1 and 2 of transformer T4. Capacitor C11 may have either of two values: 300 uuf or 390 uuf Select the value for C11 that results in the larger output of 16 kc.

(8) Connect the oscilloscope across terminals 1 and 2 of transformer T6. Ca

pacitor C13 may be used alone or in parallel with capacitor C50. Select the arrangement that results in the larger output of 8 kc. Disconnect the oscilloscope.

c. Channel Assemblies Carrier Output Adjustment Test. Connect the voltmeter across the terminals of one of the carrier supply test cable assemblies as indicated in the voltmeter connection column of the following chart

Voltmeter connection	Resistor Designation	Resistor Value		
F and R	R78	3,000	3,900	4,700
E and P	R86	7,500	9,100	11 K
D and N	R106	6,800	8,200	10 K
C and M	R114	5,100	6,200	7,500

Select the value of the resistor indicated in the resistor value column which provides an output of .5 ±1.5 db as indicated on the voltmeter.

d. Subgroup and Group Panel Carrier Output Adjustment Test.

(1) Connect the voltmeter across terminals T1 and R of the test plug assembly.

(2) Insert the plug of the test plug assembly into the jack listed in the voltmeter connection column of the following chart. Select a value for the resistor (fig. 20) listed in the resistor value column which provides an output of -.3 ±.5 db indicated on the voltmeter.

Voltmeter connection (jack)	Resistor designation	Resistor Value				
56 KC........................	R123	2, 400	3, 000	3, 900		
72 KC........................	R128	2, 200	2, 700	1,600*		
88 KC........................	R132	2, 700	3, 300	4, 300	2K	
120 KC......................	R136	1, 200	1, 600	2K	680*	910*

* In panels bearing Order No. 14181-P-51 serial numbers I through 15, the 1,600-ohm value for R128 is 3,300 ohms; the 680- and 910-ohm values given for R136 should not be used.

(3) Connect the multimeter to terminals A and K of each of the carrier Supply test cable assemblies. The multimeter should indicate 200 volts dc at each test cable assembly.

(4) Connect the multimeter across terminals B and L of each of the carrier supply test cable assemblies. The multimeter should indicate 6.3 volts ac at each test cable assembly.

e. Pilot and Test Frequencies Output Test.

(1) Connect the voltmeter across terminal E37 and ground.

(2) Operate the 12 & 28 KC switch to the ON position. The 12 & 28 KC lamp should light.

(3) Ground terminal 3 of filters FL4 and FL5. Adjust the 12 KC variable resistor to the extreme counterclockwise position. The voltmeter should indicate a maximum of-29 db.

(4) Readjust the 12 KC variable resistor to the extreme clockwise position. The voltmeter should indicate a minimum of -25 db.

(5) Disconnect the ground from terminal 3 of filters FL4 and FL5 and disconnect the voltmeter.

(6) Connect the audio level meter to terminal H and J of the Supply teat cable assembly. Adjust the audio level meter to measure a frequency of 28 kc. Adjust the 28 KC variable resistor to the extreme counterclockwise position. The audio level meter should indicate--54 db or less.

(7) Readjust the 28 KC variable resistor to the extreme clockwise position. The audio level meter should indicate at least--50 db.

(8) Operate the 12 & 28 KC switch to OFF. The 12 & 28 KC lamp should go out. Readjust the audio level meter to measure 68 kc. Adjust the 68-kc variable resistor to the extreme counterclockwise position. The audio level meter should indicate -44 db or less. Readjust the 68-kc variable resistor to the extreme clockwise position

The audio level meter should indicate at least 40 db.

190. CARRIER SUPPLY PANEL, Miscellaneous Tests

(fig. 103)

a. Initial Procedure. Prepare the CARRIER SUPPLY PANEL for testing as explained in paragraph 189a.

b. 68-kc and 120-kc Alarm Test.

(1) Connect terminal 1 of the frequency stabilizer network to ground. The 68 KC and 120 KC ALARM lamps should light. Connect the multimeter to terminals B and E of the supply test cable assembly. The multimeter should indicate 6.3 volts act

(2) Operate the 68 KC ALARM CUTOFF and the 120 KC ALARM CUTOFF switches. The multimeter should indicate zero voltage and the alarm lamps should remain lighted.

c. Test for Spurious Operation of Frequency Dividers.

(1) With terminal 1 of the frequency stabilizer still grounded, connect the voltmeter to terminals T1 and R of the test plug assembly. Insert the plug of the test plug assembly into the DIV 2 jack.

(2) The voltmeter should indicate a maximum of .1 volt. Remove the plug from the jack and disconnect the ground from terminal 1 of the frequency stabilizer network.

d. Test Jacks Test. Insert the plug of the test plug assembly into the 4KC, 8KG, 12KC, 16KC, 20KC, S4KC LOCAL, DIV 1, and DIV 2 jacks. The voltmeter should indicate--.3 ±3 db at each jack.

e. Remote Operation Test.

(1) Connect the signal generator to terminals F and P of the transmission test cable assembly. Adjust the signal generator for an output frequency of 68 kc ±100 cps as measured with the frequency meter at an output level of--.3 db as measured with the voltmeter.

(2) Connect the voltmeter to terminals T. and R of the teat plug assembly. Operate the CARR SYNC switch to REMOTE.

(3) Insert the plug of the test plug assembly into the SYNC jack and then the 64KC REM jack. The voltmeter should indicate -.3 ±3 db at each jack.

(4) Insert the plug of the test plug assembly into the 64KC LOCAL test jack. The voltmeter should indicate less than .2 volt. The 68 KC and 120 KC ALARM lamps should not be lighted.

Section VIII. POWER SUPPLY PP 827/U

191. Initial Procedures

(fig. 134)

The purpose of this pretest setup is to prepare the equipment for final test.

a. Interconnect the 200 VOLT POWER SUPPLY and the carrier supply test cable assembly.

b. Place the AC POWER switch to the ON position.

***Caution*: Disconnect ac power from the power supply.**

c.Measure the resistance between the carrier supply test cable assembly terminals listed in the chart below and ground or between other points as indicated with the multimeter.

Test terminal	To	Resistance	Position of 115V -230V switch
B	R	Infinite.	
J	R	Infinite.	
F	R	Infinite.	
M	R	Infinite.	
A	R	Infinite.	
D	R	Infinite.	
R	R	Infinite.	
P2*	R	Infinite.	115V.
P2*	R	Infinite.	230V.
A	K	36K-44K.	

* Test from both terminals of input plug P2.

192. Voltage Requirements Test (fig. 134)

a. Connect the power supply as shown. Operate the 115V-230V switch to the 115V position. Connect plug P2 to the 115-volt variable power source. Use variable transformer TF-171/USM. Connect the multimeter across the variable power source and adjust the transformer as indicated in the chart in g below. Operate the AC POWER switch to ON. The AC POWER lamp should light.

b. Refer to the appropriate notes in g below before performing each test.

c. Perform tests 1 through 5 (g below), using the multimeter bridged across terminals A and K of the carrier supply test cable assembly. Measure the output voltages as indicated in the chart.

d. Make tests 6 through 8, using the multimeter bridged across terminals D and H of the carrier supply test cable assembly. Measure the output voltages.

e. Repeat tests 1 through 4, using the voltmeter bridged across terminals A and K of the carrier supply test cable assembly. Measure the maximum ripple voltage.

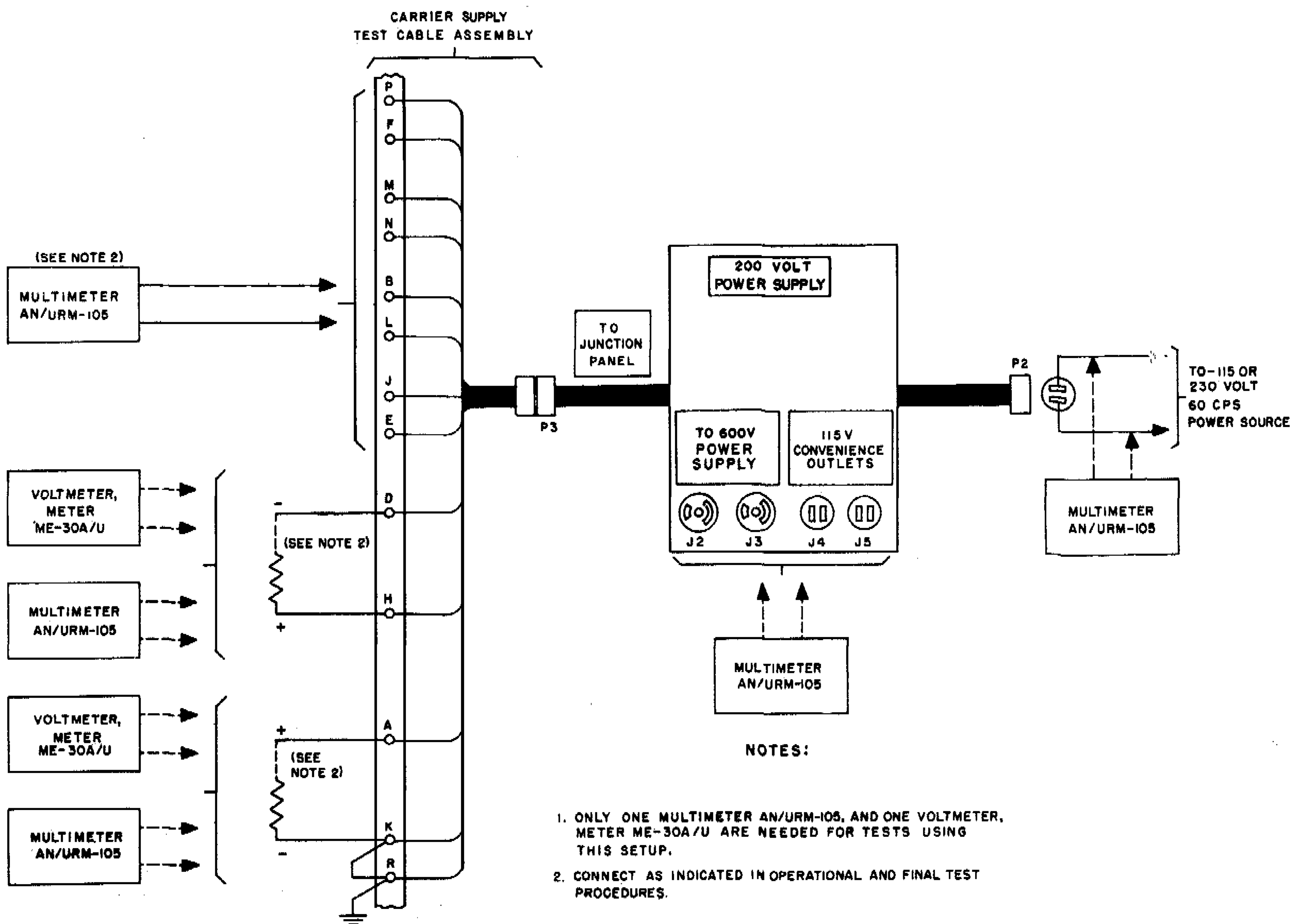
f. Repeat tests 6 and 7, using the voltmeter bridged across terminals D and H of the carrier supply test cable assembly. Measure the maximum ripple voltage.

g. The tests for the 200 VOLT POWER SUPPLY are listed in the chart below.

Test	Resistance termination across terminals of carrier supply test cable assembly		See	Ac input	Voltage across terminals of carrier supply test cable assembly		Maximum ripple voltage across terminals of carrier supply test cable assembly	
No.	Terminals a and K (ohms)	Terminals a and K (ohms)	Notes	(volts)	Terminals a and K (ohms)	Terminals a and K (ohms)	Terminals a and K (ohms)	Terminals a and K (ohms)
1	740	1,000, 2w	1 2 8 10	115	200	----------------	.01	
2	740	1,000, 2w	3 8 10	97.5	197-200	----------------	.01	
3	800	1,000, 2w	3 9 10	115	200-202	----------------	.01	
4	800	1,000, 2w	1 2 9 10	115	200	----------------	.01	
5	800	1,000, 2w	3 9 10	130	200-203	----------------	.02	
6	387	1,000, 2w	4 11	115	190-210			
7	387	1,000, 2w	5 10 11	115	200	12 1	------------	.03
8	387	1,000, 2w	5 10 11	115	200	9 1	------------	.03
9	387	1,000, 2w	6 11	115	200	9 1		
10	800	1,000, 2w	7 9	115				
11	800	1,000, 2w	9 12	230	--------------	12 1		

Notes.

1. Adjust the 200V ADJ control to obtain this voltage; the voltage increases when the control is turned clockwise.
2. The panel under test should be permitted to operate at least 5 minutes under the conditions of test No. 1 before proceeding with the subsequent tests. Do not interrupt the ac power during tests No. 1 through 4.
3. Do not readjust the 200V. ADJ control when proceeding from test No. 1 through test No. 4.
4. Adjust the 200V ADJ control from maximum counterclockwise to maximum clockwise position. The readings obtained should be equal to, or greater than, the dc range indicated in the chart. After completing test No. 5, adjust the 200V ADJ control to an output of 200 volts dc across terminals A and X, as read on the multimeter. Tighten the locknut.
5. Measure the ripple voltage, with the voltmeter connected to terminals D and H of the carrier supply test cable assembly.
6. Measure the dc voltage across terminals M and N. P and F, B and L, and E and J of the carrier supply test cable assembly with the multimeter. The multimeter should read 7.2 ±1 volt.
7. Measure the ac voltage across outlets TO 600V POWER SUPPLY J2 and J3, and across 115 V CONVENIENCE OUTLETS J4 and J5. The multimeter should read 115 ±1 volt.
8. The 740 ohm resistance is formed by connecting two 1,500-ohm 25-watt variable resistors in parallel and adjusting them to obtain a resistance of 740 ohms
9. The 800-ohm resistance is formed by connecting two 1,600-ohm 37-watt resistors in parallel.
10. Note the *average* value of ripple voltage. Ignore momentary peaks.
11. The 387-ohm resistance is formed by connecting a 1,000-ohm 55-watt resistor and a 630-ohm 87-watt resistor in parallel.
12. Before performing this test, set the AC POWER switch to OFF. Set the 115V-230V switch to 230V and adjust the ac input voltage to 230 volts. Set the AC POWER switch to ON and perform test No. 11. Measure the dc voltage across terminals M and N of the carrier supply test cable assembly with the multimeter. The multimeter should indicate 7.2 ±1 volt.



TM2139-35-182

Figure 134. Power Supply PP -8 27/U, operational and final test setup.

193. Blower Operation Test
(fig. 134)

Note. Perform the following test with the power supply installed in its transit case.

a. Turn the power on and operate the power supply until the temperature within the panel is sufficient to cause thermostat S2 to close and cause the blower to operate. This usually takes about 20 minutes if the room temperature is about 60° F.

b. See that air is being forced *out* of the front panel grill.

Section IX. POWER SUPPLIES PP 826/U AND PP 826A/U

194. Power Supply PP 826/U Tests
(figs. 39 or 40 and 135)

a. Initial Procedure.

(1) Measure the resistances at the test points indicated in the chart below. Operate the AC POWER switch to ON and operate the 115V-230V switch to 115V.

Caution: **Be sure the ac power has been disconnected from the power supply.**

Test Points	Resistance (ohms)
Term. E on term. board 1 to grd Term.	Infinite
F on term. board 1 to grd	Infinite
Term. 1 on transformer T1 (main chassis) to grd.	Infinite
Term. 11 on transformer T1 (low voltage rectifier and alarm unit Z1) to grd.	Infinite
Term. 9 on transformer T1 (low voltage rectifier and alarm unit Z1) to grd.	Infinite
Term. E on term. board 1 to term. 9 on transformer T1 (low voltage rectifier and alarm unit Z1)	Infinite
Term. E on term. board 1 to term. 11 on transformer T1 (low voltage rectifier and alarm unit Z1).	Infinite

Test Points	Resistance (ohms)
Term. E on term. board 1 to term. 1 on Transformer T1 (main chassis)	Infinite.
Term B on term. Board 1 to grd	2
Term C on term. Board 1 to grd	.2.
Term D on term. Board 1 to grd	450K (+90K, –270K).
Term A on term. Board 1 to grd*	450K (+90K, –270K).

* Operate the REPEATER switch to position 3.

(2) Measure the resistances between the test points on the REPEATER switch indicated in the chart below. Operate the REPEATER switch to the position indicated in the REPEATER switch position column. Connect the multimeter to the jacks indicated in the test jacks column. Operate the 600V ADJ control to the position indicated in the 600V ADJ position column. The resistors checked in each test are listed in the resistors measured column and the normal indication are listed in the resistance . column.

REPEATER switch position	Test jacks	600C ADJ	Resistors measured	Resistance (ohms) ±20 percent
3 ----------------------------	J1 to J3----------	Fully clockwise-------------------	R7---------------------	7,100
3 ----------------------------	J3 to J4----------	Fully clockwise-------------------	R12 --------------------	2,000
3 ----------------------------	J3 to J4----------	Fully counterclockwise----------	R6---------------------	500
2 ----------------------------	J3 to J4----------	Fully counterclockwise----------	R6, R13 --------------	2,300
1 ----------------------------	J3 to J4----------	Fully counterclockwise----------	R6, R13, R14 -------	4,100
0 ----------------------------	J3 to J4----------	Fully counterclockwise----------	R6, R13, R14, R15	5,700
TEST ----------------------	J4 to ground----	Fully counterclockwise----------	None ------------------	0

(3) Interconnect the 600 V power-supply teat cable assembly, RC network, and 600 VOLT POWER SUPPLY.

(4) Operate the AC POWER switch to OFF; operate the REPEATER switch to 3; and adjust the LOW VOLT ALARM and LOAD RENT controls to the extreme counterclockwise position.

(5) Adjust the LOW-VOLT ALARM and

HIGH-VOLT ALARM controls to the extreme clockwise position. Adjust variable resistors R16 and R20 (low voltage rectifier and alarm unit Z1) to the extreme clockwise position.

(6) Connect power input plug PI to the variable power source (use variable transformer TF-171/USM). Adjust the input to 115 volts.

(7) Connect the multimeter across terminals A and B of the 600 V power supply test cable assembly.

(8) Short one of the 1,800-ohm resistors. Adjust the variable resistor for a resistance reading of 4,000 ohms on the multimeter.

(9) Operate the AC POWER switch to ON. The CURRENT meter should indicate between 10 and 17 ma.

(10) Adjust variable resistor R16 slowly counterclockwise until relay K6 releases, causing relays K8, K9, and K1 to operate. The indication on the CURRENT meter should drop to zero and then rapidly build up to between 60 and 100 ma. Operate the AC POWER switch to OFF.

(11) Remove the short across the 1,800 ohm resistor.

b. Normal Output Voltage Test.

(1) Connect the multimeter across terminals A and B of the 600-volt power supply test cable assembly. Adjust the variable resistor for a resistance of 6,000 ohms on the multimeter. Disconnect the multimeter.

(2) Operate the AC POWER switch to the ON position. Adjust the variable transformer for an input of 115 volts.

(3) The LOAD ALARM lamp should light; operate the ALARM CUTOFF switch to the horizontal position. The alarm buzzer should sound. Operate the ALARM CUTOFF switch to the vertical position; the buzzer should be silenced. The CURRENT meter should indicate 80 ±15 ma within 8 seconds of the time the AC POWER switch is turned on. Recheck the line voltage ((2) above).

(4) Approximately 30 seconds after power is applied, adjust the LOAD CURRENT control for an indication of 100 ma on the CURRENT meter.

(5) Connect the multimeter across terminals A and B of the 600-volt power supply test cable assembly. Adjust the variable resistor for a meter indication of 600 volts. The LOAD ALARM lamp should go out.

(6) Connect the multimeter across terminals B and D of the 600V power sup- ply test cable assembly. The multimeter should indicate 275 ±10 volts.

c. Output Ripple Voltage Test.

(1) Connect a 1-megohm resistor between the GND and unmarked terminals on the voltmeter. Connect a .5-uf capacitor between the unmarked terminal on the voltmeter and terminal A on the 600 V power supply test cable assembly. Connect the GND terminal of the voltmeter to terminal B of the 600 V power supply test cable assembly.

(2) The voltmeter should indicate a maximum ripple voltage of .2 volt.

d. Line Voltage Regulation Test.

(1) Adjust the input voltage to 115 volts. Note the indication on the CURRENT meter. Adjust the variable transformer to 132.5 volts. The indication on the CURRENT meter should not increase more than 1 ma. Check the ripple voltage (c above). The ripple voltage should be less than .2 volt.

(2) Adjust the variable transformer to 97.5 volts. The indication on the CURRENT meter should decrease not more than 1 ma. Check the ripple voltage (c above). The ripple voltage should be less than .2 volt.

(3) Readjust the variable transformer to 115 volts. Disconnect the voltmeter.

e. Low-Voltage Cutoff Range and Requirements Test.

(1) Connect the multimeter to terminals A and B of the 600 V power supply test cable assembly. Adjust the variable resistor until the output voltage cuts off. The multimeter should indicate between 450 and 510 volts at the time cutoff occurs. The LOAD

ALARM and LOW VOLTAGE lamps should light and the buzzer should sound.

Note If cutoff cannot be reached with the variable resistor adjusted to provide approximately 450 volts indication on the multimeter, adjust the LOW-VOLT ALARM control until cutoff occurs between 450 and 510 volts.

(2) Operate the AC POWER switch to OFF. Adjust the variable resistor R677 to provide an indication of 6,000 ohms on the multimeter. Arrange the multimeter to measure dc volts. Operate the AC POWER switch to ON. Press the RESTORE switch momentarily; dc power should be restored. The LOAD ALARM and LOW VOLTAGE lamps should go out and the buzzer should be silenced.

(3) Adjust the variable resistor to provide an indication of approximately 680 volts. Adjust the LOW-VOLT ALARM to the extreme clockwise position. Adjust the variable resistor until cutoff occurs. The multimeter indication should be a minimum of 570 volts.

(4) Adjust the LOW-VOLT ALARM control to the extreme counterclockwise position. Repeat the procedure in (2) above.

(5) Adjust the variable resistor for an indication of 532 volts on the multimeter. Adjust the LOW-VOLT ALARM control until cutoff occurs. This is the normal position for the LOW-VOLT ALARM control and the control should remain at this setting. More than one trial may be required to obtain the proper setting.

(6) Adjust the variable resistor until cutoff occurs. Cutoff should occur between 530 and 535 volts. The LOAD ALARM and LOW VOLTAGE lamps should light and the buzzer should sound. Readjust the power supply for normal operation ((2) above).

f *High-Voltage Cutoff Range and Requirements Test.*

(1) Connect the multimeter to terminals A and B of the 600 V power supply test cable assembly. Increase the output voltage by adjusting the variable resistor until the cutoff occurs. The LOAD ALARM and HIGH VOLTAGE lamps should light. Cutoff should occur at 750 volts or above.

Note. If cutoff does not occur at 750 volts, adjust the 600V ADJ control until cutoff occurs.

(2) Operate the AC POWER switch to OFF. Adj ust the variable resistor for an indication of 6,000 ohms on the multimeter. Adjust the 600V ADJ control to the extreme counterclockwise position. Arrange the multimeter to measure dc volts. Operate the AC POWER switch to ON, and operate the RESTORE switch momentarily. Dc power should be restored immediately and the LOAD ALARM and HIGH VOLTAGE lamps should go out; the buzzer should be silenced

(3) Adjust the variable resistor for an output voltage of approximately 570 volts. Adjust the HIGH-VOLTAGE ALARM control to the extreme clockwise position. Slowly increase the output voltage by adjusting the variable resistor. Cutoff should occur at 660 volts or less.

(4) Adjust the HIGH VOLTAGE ALARM control fully counterclockwise. Repeat the procedure in (2) above.

(5) Adjust the variable resistor for an indication of 672 volts on the multimeter. Adjust the HIGH VOLTAGE ALARM control until cutoff occurs. More than one trial may be required to obtain the proper setting. Tighten the locknut on the control.

(6) Increase the output voltage by adjusting the variable resistor until cutoff occurs (between 670 and 675 volts). The HIGH VOLTAGE and LOAD ALARM lamps should light and the buzzer should sound. Readjust the HIGH VOLTAGE ALARM control, if necessary ((5) above).

(7) Restore normal operation ((2) above) .

g. Low-Voltage Alarm Operation Below 530 Volts.

(1) Connect the multimeter across terminals A and B of the 600 V power supply test cable assembly. Adj ust the 600V ADJ control for an indication of 600 volts dc on the multimeter.

(2) Adjust the LOAD CURRENT control for an indication of 100 ma on the CURRENT meter.

(3) Adjust the variable resistor for an output voltage of 510 volts as indicated on the multimeter. While reducing the voltage to 510 volts, a low voltage cutoff will occur. The LOW VOLTAGE and LOAD ALARM lamps should light and the buzzer should sound.

(4) Operate the RESTORE switch; the dc output voltage will be restored. Continue the adjustment of the variable resistor ((3) above) . The starting time delay will provide time to complete this adjustment.

(5) The LOAD ALARM lamp should go out and dc should be restored to the line after the 20-second time delay; low-voltage cutoff should occur.

(6) Operate the RESTORE switch; the dc output voltage will be restored. Adjust the variable resistor for an output voltage of 600 volts as indicated on the multimeter.

h. Load Current Range Test.

(1) Connect the multimeter across terminals A and B of the 600 V power supply test cable assembly.

(2) Adjust the LOAD CURRENT control from the extreme clockwise position to the extreme counterclockwise position. Adjust the. variable resistor for a voltage indication of between 535 and 670 volts while the LOAD CURRENT control is being adjusted to prevent cutoff from occurring.

(3) The LOAD CURRENT control range should be 90 to 115 ma. Adjust the LOAD CURRENT control for a CURRENT meter indication of 100 ma; adjust the variable resistor for an output voltage of 600 volts.

(4) Hand-tighten the locknut on the LOAD CURRENT control.

i. Load Detection Circuits and Requirements Test.

(1) Connect the multimeter across terminals A and B of the 600V power supply test cable assembly. Adjust the variable resistor for an output voltage of 480 volts

Notes.

1. Below 530 volts, a low-voltage cutoff should occur. Operate the RESTORE switch and continue to adjust for 480 volts.
2. After the 20-second starting time delay, another low-voltage cutoff should occur.

(2) Operate the AC POWER switch to OFF. Adjust variable. resistor R16 (inside low voltage rectifier and alarm unit Z1) to the extreme clockwise position.

(3) Operate the AC POWER switch to ON. Dc power should not come on and the CURRENT meter should indicate between 8 and 15 ma.

(4) Adjust variable resistor R16 counterclockwise until relay K6 releases. The CURRENT meter indication should drop to zero and then increase to 100 ma. Quickly adjust the variable resistors for an output voltage of 400 volts as indicated on the multimeter. Low-voltage cutoff should not occur if the adjustment is completed within 20 seconds.

(5) Operate the AC POWER switch to OFF and then to ON. The dc output should not come on and the LOAD ALARM lamp should remain lighted.

(6) Hand-tighten the locknut on resistor R16. Recheck the position of R16 by slowly adjusting the variable resistor until normal dc output is restored. When the CURRENT meter indicates 100 ma, the multimeter should indicate 480 +10 volts. If necessary, readjust resistor R16 to obtain these values.

(7) Operate the AC POWER switch to OFF and adjust the 600 V ADJ control to the extreme counterclockwise position. Adjust the variable resistor for a resistance of 4,000 ohms. Ar-

range the multimeter to measure dc voltage. Operate the AC POWER switch to ON; dc power should not come on but the CURRENT meter should indicate about 10 ma. Adjust the variable resistor until dc power just comes on. The CURRENT meter indication should drop to 0 ma and rapidly rise to 100 ma. The output voltage as read on the multimeter should be 480 ±10 volts. Repeat the procedures in (1) through (6) above if the requirements are not met.

j. LOW Line Voltage Cutoff Protection Adjustments and Requirements Test.

(1) Adj ust the input voltage of the ac source to 115 volts. Connect the multimeter-to terminals A and B of the 600 V power supply test cable assembly. Adj ust the 600-V ADJ control for an indication of 600 volts on the multimeter. Adjust the LOAD CURRENT control for an indication of 100 ma on the CURRENT meter.

(2) Adjust the input voltage of the ac source to 93 volts with the variable transformer. Adj ust resistor R20 (inside low voltage rectifier and alarm unit Z1) slowly counterclockwise until relay K9 releases. The buzzer should sound and the LOAD ALARM lamp . should light. The dc output should decrease and the power supply should cycle on and off but should not cut off. Hand tighten the locknut on resistor R20.

(3) Increase the input voltage of the ac source to 97 volts. The power supply should stop cycling and the CURRENT meter should indicate 100 ma. Readj ust resistor R20 if the power supply continues to recycle.

(4) Adjust the input voltage to between 60 and 70 volts; cutoff should occur. Readjust the input voltage to 115 volts; dc output should be restored automatically. Interrupt the input voltage for 2 seconds; normal operation should restore automatically. If the requirements are not met, repeat the procedures in (1) through (3) above,

k. Blower Operational Test.

(1) After all previous final tests have been completed on the power supply, install the power supply in its carrying case.

(2) Operate the AC POWER switch to ON and operate the power supply until the temperature within the panel is sufficient to close thermostat S2, and operate the blower. This usually takes about 20 minutes if the room temperature is about 60° F.

(3) See that the blower forces air out of the front panel grill.

195. Power Supply PP 826A/U Tests
(figs. 35 and 135)

a Initial Procedures.

(1) Measure the resistance at the test points indicated in paragraph 194a (1).

(2) Check the resistance between the contacts of the REPEATER switch as indicated in paragraph 194a(2).

(3) Interconnect the 600 V power supply test cable assembly, the RC network, and the 600 VOLT POWER SUPPLY.

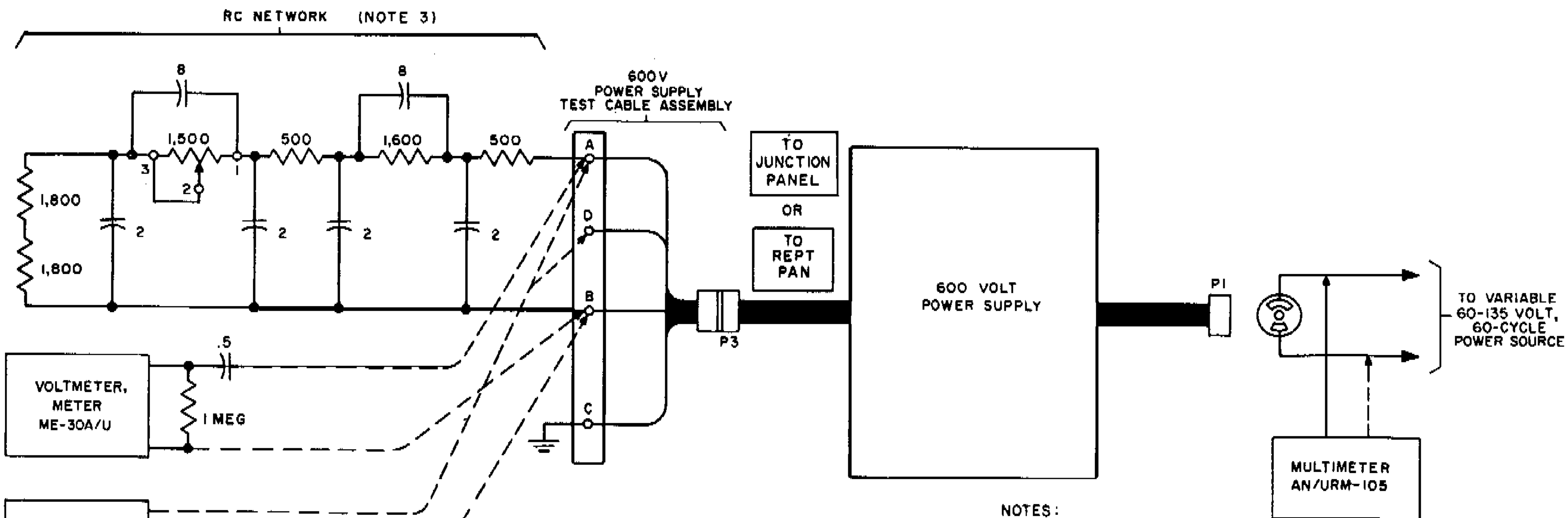
(4) Operate the AC POWER switch to OFF; operate the 115V-230V switch to 115V; and operate the REPEATER switch to position 3.

(5) Adjust the 600-V ADJ and the LOAD CURRENT controls to the extreme counterclockwise positions.

(6) Disconnect resistor R32 (on low voltage rectifier and alarm unit Z2) from standoff terminal E22.

(7) Adjust the LOW-VOLT ALARM and HIGH-VOLT ALARM controls to their extreme counterclockwise positions; adjust variable resistor R16 (on low voltage rectifier and alarm unit Z2) to the extreme clockwise position.

(8) Connect the multimeter across terminals A and B of the 600 V power supply test cable assembly. Short both 1,800-ohm resistors of the RC network (fig. 135) and adjust variable resistor for an indication of 3,000 ohms on the multimeter.



NOTES:

1. UNLESS OTHERWISE INDICATED; RESISTORS ARE IN OHMS, CAPACITORS ARE IN UF.
2. ONLY ONE MULTIMETER AN/URM-105 IS NEEDED FOR TESTS USING THIS SETUP
3. THE 2 UF AND 8 UF CAPACITORS AND ONE RESISTOR (500 OHM) ARE NOT PART OF THE TEST FACILITIES KIT. THE REQUIREMENTS FOR THESE ITEMS ARE LISTED IN THE FOLLOWING CHART:

ITEM	TOL %	RATING
500Ω RESISTOR	±5%	10W
2UF CAPACITOR	±20%	400V DC
8UF CAPACITOR	±20%	400V DC

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Figure 135 Power Supply PP-826(*)/U, final test setup.

(9) Connect the power supply to the variable power source (use variable transformer TF-171/USM). Adjust the transformer for 115 volts.

(10) Disconnect the multimeter from terminals A and B and operate the AC POWER switch to ON. The CURRENT meter should indicate between 16 and 23 ma. Adjust resistor R16 slowly counterclockwise until relay K6 releases and relay K1 operates. The CURRENT meter indication should drop to zero and then rapidly increase to approximately 90 ma. Tighten the locknut on resistor R16.

(11) Operate the AC POWER switch to OFF and reconnect resistor R32 to standoff E22. Remove the short across the 1,800-ohm resistor.

b. Safeguard Against Starting into Open Line Test.

(1) Disconnect the 1,800-ohm resistors from the RC network.

(2) Adjust the input voltage for 132.5 volts. Operate the AC POWER switch to ON. The LOAD ALARM lamp should light and the buzzer should sound after about 1 second. Operate the ALARM CUTOFF switch to silence the buzzer.

(3) Operate and hold the RESTORE switch until the LOAD ALARM lamp is extinguished and the buzzer sounds. Release the switch and operate the ALARM CUTOFF switch to silence the buzzer. After about 1 second the LOAD ALARM lamp should light and the buzzer should sound.

(4) Operate the AC POWER switch to OFF. Adjust the input voltage to 115 volts; discharge all capacitors in the RC network and reconnect the 1,800-ohm resistors.

c. Safeguard Against Starting into Low Resistance Test.

(1) Short the 2 μf capacitor at the junction of the 1,500-ohm variable resistor and the 500-ohm resistor of the RC network. Operate the AC POWER switch to ON.

(2) The LOAD ALARM and LOW VOLTAGE lamps should light and the buzzer should sound. After about 1 second, the LOW VOLTAGE lamp should go out and the LOAD ALARM lamp should remain lighted and the buzzer should continue to sound. Silence the buzzer by operating the ALARM CUTOFF switch.

(3) Repeat the procedures given in b(3) above to see that the correct indications are obtained. Disconnect the short from the 2 μf capacitor (1) above).

d. Normal Operating Condition Test.

(1) Connect the multimeter across terminals A and B of the 600 V test cable assembly. Adjust the variable resistor of the RC network for a reading of 6,000 ohms on the multimeter. Disconnect the multimeter.

(2) Short the 2 μf capacitor at the junction of the 1,500-ohm variable resistor and the 500-ohm resistor.

(3) Operate the AC POWER switch to ON. The LOAD ALARM lamp should light and the buzzer should sound. Operate the ALARM CUTOFF switch to silence the buzzer.The CURRENT meter indication should increase to 80 ±15 ma within 8 seconds. If necessary, adjust the line voltage to 115 volts.

(4) Approximately 30 seconds after the AC POWER switch is set to the ON position, adjust the LOAD CURRENT control clockwise until the CURRENT meter indicates exactly 100 ma. Arrange the multimeter to measure dc voltage. Connect the multimeter to terminals A and B on the 600 V power supply test cable assembly. Adjust the variable resistor to obtain a reading of 600 volts dc on the multimeter. The LOAD ALARM lamp should extinguish.

(5) Connect the multimeter across terminals D and B of the 600 V power supply test cable assembly. The multimeter should indicate 275± 10 volts dc.

(6) Operate the AC POWER switch to OFF and disconnect the short from

the terminals of the 2 μf capacitor ((2) above).

e. Starting into Low Resistance with High Ac input.

(1) Connect a short across the 2 μf capacitor at the junction of the 1,500ohm variable resistor and the 1,800ohm resistor. Connect the multimeter across terminals A and B of the 600 V test cable assembly.

(2) Adjust the variable resistor of the RC network for a reading of 3,000 ohms on the multimeter. Disconnect the multimeter.

(3) Adjust the ac input voltage to 132.5 volts with the variable transformer and set the AC POWER switch to ON. The LOAD ALARM and the LOW VOLTAGE lamps should light and the buzzer should sound. The indication on the CURRENT meter should rise to approximately 100 ma after about 10 seconds but the lamps should remain lighted and the buzzer should continue to sound.

(4) After approximately 30 seconds, operate and hold the RESTORE switch. The indication on the CURRENT meter should decrease to approximately 15 ma. The LOAD ALARM and LOW VOLTAGE lamps should extinguish, and the buzzer should be silenced.

(5) Release the RESTORE switch. The CURRENT meter indication should drop to zero and immediately start increasing toward 100 ma, the LOAD ALARM and LOW VOLTAGE lamps should light, and the buzzer should sound.

(6) Operate the AC POWER switch to OFF. Disconnect the short from the terminals of the 2 μf capacitor ((1) above).

(7) Connect the multimeter, arranged as an ohmmeter, to terminals A and B of the 600 V test cable assembly. Adjust the variable resistor for a reading of 6,000 ohms.

f. Low-Voltage Alarm Range and Requirements Test.

(1) Arrange the multimeter to measure dc voltage. Connect the multimeter to terminals A and B of the 600 V test cable assembly.

(2) Adjust the variable resistor to decrease the voltage to 530 volt dc.

(3) Slowly rotate the LOW-VOLT ALARM control clockwise until the LOW VOLTAGE and LOAD ALARM lamps light and the buzzer sounds. Hand-tighten the locknut on the control.

(4) Adjust the variable resistor to increase the voltage to 600 volts dc. After approximately 30 seconds, the lamps should be extinguished and the buzzer should stop sounding.

g. High-Voltage Cutoff Range and Requirements Test.

(1) Connect the multimeter to terminals A and B of the 600 V test cable assembly. Increase the output voltage with the variable resistor of the RC network to 672 volts dc.

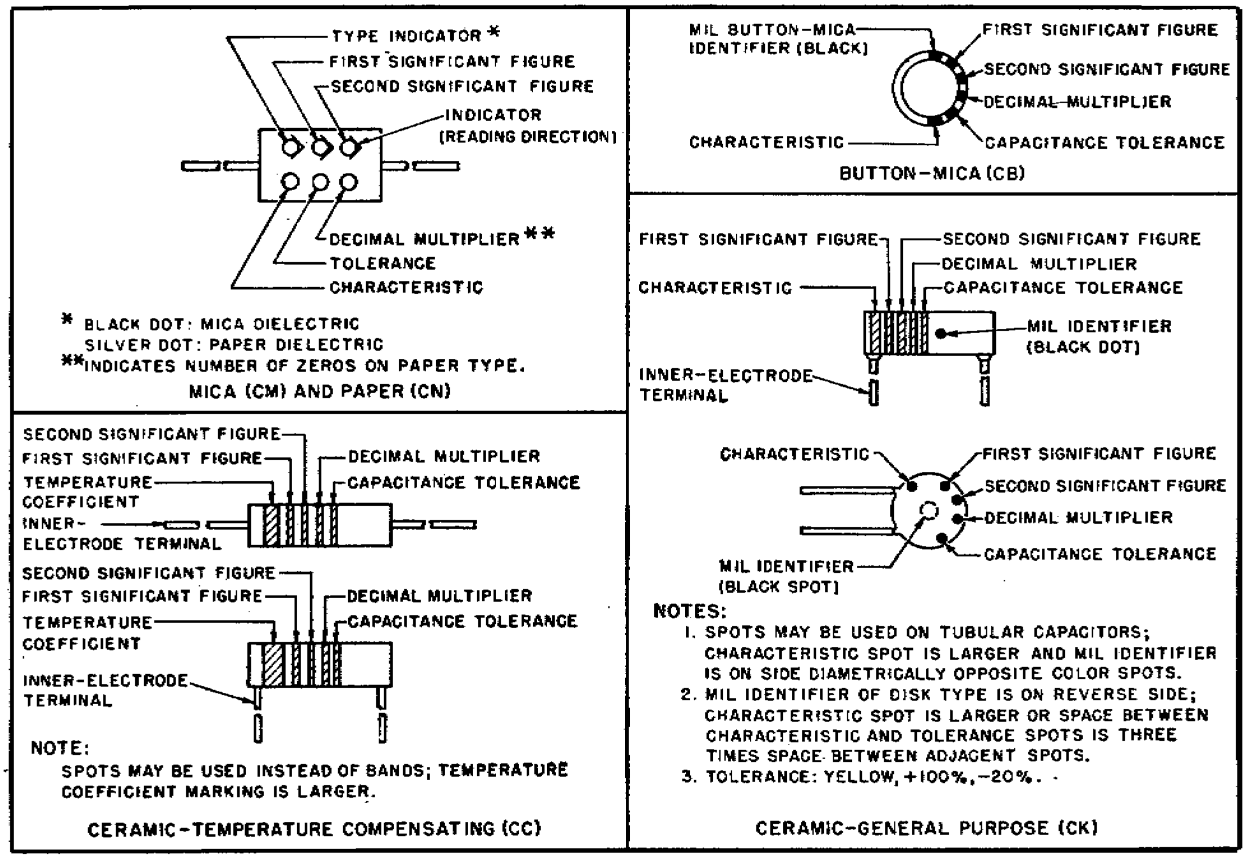
(2) Adjust the HIGH-VOLT ALARM control for cutoff. This adjustment may drift slightly, depending on the warmup time allowed for tube V6 and associated relay K3 circuits; therefore, more than one trial may be required to obtain the required setting. When the setting becomes stable, hand-tighten the locknut on the HIGH-VOLT ALARM Control.

(3) Check the high-voltage cutoff requirements by adjusting the variable resistor to increase the output voltage. Cutoff should occur between 670 and 675 volts. The HIGH VOLTAGE and LOAD ALARM lamps should light, and the buzzer should sound.

(4) Operate and release the RESTORE switch. The power supply should start (CURRENT meter indication increases toward 100 ma and the LOAD ALARM and LOW VOLTAGE lamps light). Quickly adjust the variable resistor to decrease the voltage indicated on the multimeter to 600 volts. After approximately 30 seconds, the lamps should be extinguished and the buzzer should stop sounding.

Note. If cutoff occurs before the voltage is reduced to 600 volts, repeat the procedure in(4) above.

CAPACITOR COLOR CODE MARKING (MIL-STD CAPACITORS)



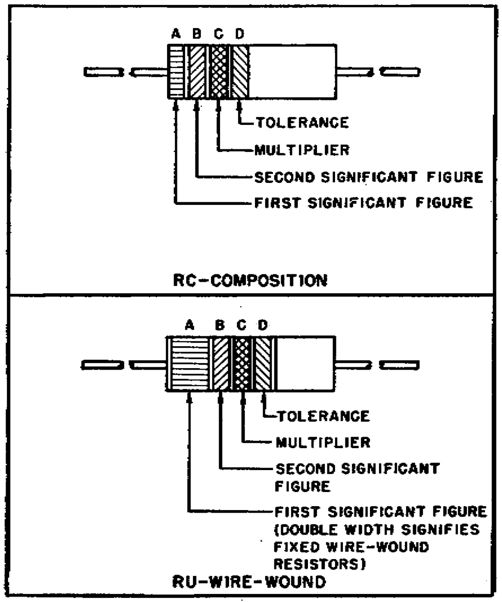
CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE[2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC OVER 10UUF	CC 10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		−30
RED	2	100	2	C	H		X	2		2	2		−80
ORANGE	3	1,000	3	D	J	D			30				−150
YELLOW	4	10,000	4	E	P								−220
GREEN	5		5	F	R						5	0.5	−330
BLUE	6		6		S								−470
PURPLE (VIOLET)	7		7		T	W							−750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	−330(±500)[3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

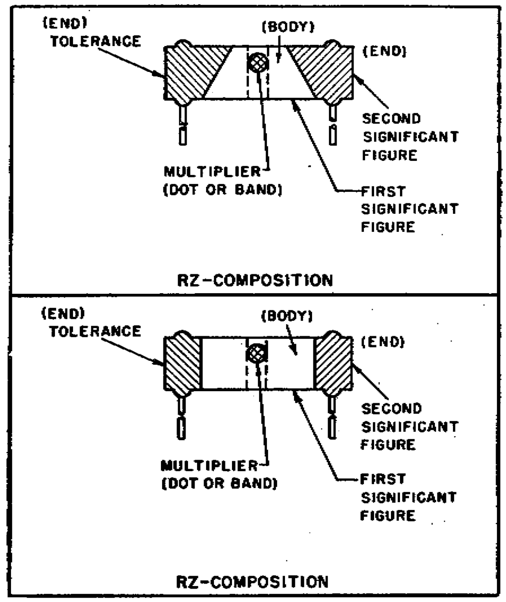
1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS. STD-CI
2. IN PERCENT, EXCEPT IN UUF FOR CC. TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

Figure 136 MIL STD capacitor color code marking.

AXIAL-LEAD RESISTORS
(INSULATED)



RADIAL-LEAD RESISTORS
(UNINSULATED)



RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH.
WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND0 OR END COLOR THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

EXAMPLES (BAND MARKING):

10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C. NO BAND D.

4.7 OHMS ±5 PERCENT: YELLOW BAND A. PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):

10 OHMS ±20 PERCENT: BROWN BODY. BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.

3,000 OHMS ±10 PERCENT: ORANGE BODY BLACK END; RED DOT OR BAND; SILVER END.

STD-RI

Figure 137. MIL-STD resistor color code marking.

Figure 158. Telephone Modem TA-219/U, wiring diagram.

Figure 139. CHAN I (part of Telephone Modem TA-219/U), wiring diagram.

Figure 140. CHAN 2 (part of Telephone Modem TA-219/U), wiring diagram.

Figure 141. CHAN 3 (part of Telephone Modem TA-219/U), wiring diagram.

Figure 142. CHAN 4 (part of Telephone Modem TA-219/U), wiring diagram.

Figure 143. Telephone Modem TA-227/U, wiring diagram. Figure 143--Continued.

Figure 144. GROUP PANEL (part of Amplifier-Pilot Regulator AM-707/TCC-7), wiring diagram.

Figure 144 - Continued.

Figure 145. 12-68 kc amplifier (AR1, AR2, or AR3) (part of GROUP PANEL), wiring diagram.

Figure 146. Regulator and alarm unit Z6 (part of GROUP PANEL), wiring diagram.

Figure 147. Modem and amplifier AR4 (part of GROUP PANEL) wiring diagram.

Figure 148. JUNCTION PANEL (part of Amplifier-Pilot Regulator AM-707/TCC-7), wiring diagram.

Figure 149. JUNCTION PANEL (part of Amplifier-Pilot Regulator AM-707/TCC-7) with modified ground bus, wiring diagram.

Figure 150. Telephone Carrier Frequency Supply TA-228/TCC-7, wiring diagram.

Figure 150--Continued.

Figure 151. Receiver-Transmitter Order Wire RT-280/TCC-7, (part of Receiver Transmitter Test Set Group OA-448/TCC-7), wiring diagram.

Figure 151--Continued.

(Contained in separate envelope)

Figure 152. Transmitting Amplifier AR101 (part of ORDER WIRE PANEL), wiring diagram.

Figure 155. Receiving amplifier AR102 (part of ORDER WIRE PANEL), wiring diagram.

Figure 154. Ringer-oscillator Y101 (part of ORDER WIRE PANEL), wiring diagram.

Figure 155. Telephone Test Set TA-760/TCC-7 (part of Receiver-Transmitter Test Set Group OA-443/TCC-7), wiring diagram.

Figure 155--Continued.

Figure 156. IF amplifier AR1 (part of TEST PANEL), wiring diagram.

Figure 157. Flat amplifier AR2 (part of TEST PANEL), wiring diagram.

Figure 158. Power Supply PP-827/U (200 VOLT POWER SUPPLY), wiring diagram.

Figure 159. Power Supply PP-826/U (600 VOLT POWER SUPPLY), wiring diagram (original units).

Figure 160. Low-Voltage rectifier and alarm unit Z1 (part of Power Supply PP-826/U), wiring diagram (original units).

Figure 161. Power Supply PP-826/U (600 VOLT POWER SUPPLY), wiring diagram (revised units);

Figure 162. Low-Voltage rectifier and alarm unit Z1 (part of Power Supply PP-826/U), wiring diagram (revised units).

Figure 165. Power Supply PP-826/U bearing Order No. 14181-Phila-51, serial numbers 1,170 through 2,964, and Power Supply PP-826A/U, wiring diagram.

Figure 164. Low-Voltage rectifier and alarm unit Z2 (part of Power Supply PP-826A/U), wiring diagram. (Contained in separate envelope)

APPENDIX
REFERENCES

Following is a list of references applicable and available to the field and depot repairman of Telephone Terminal AN/TCC-7.

TB SIG 328	Telephone Carrier System Test Facilities Kit MK - 155/TCC.
TM 11-381	Cable Assembly CX-1065/G, Telephone Cable Assemblies CX-1606/G and CX-1512/U and Telephone Loading Coil Assembly CV-260/G.
TM 11-687	Radio Set AN/TRC-24, Radio Terminal Set AN/TRC-35, and Radio Relay Set AN/TRC-36.
TM 11-900	Power Units PE-75-C, -D, -J. -K, -P. -S. -T. -U.-W. -AA, -AB,-AC, and -AE.
TM 11-900A	Power Unit PE-75-AF.
TM 11-1214	Instruction Book for Oscilloscope OS-8A/U.
TM 11-2044	Attenuator TS-402/U and TS-402A/U.
TM 11-2094	Transmission Measuring Set TS-559/FT.
TM 11-2139-10	Telephone Terminal AN/TCC-7, Operators manual.
TM 11-2139-20	Telephone TerminalAN/TCC-7, Organizational Maintenance.
TM 11-2140-10	Telephone Repeater AN/TCC-8 and Telephone Repeater AN/TCC-21, Operator's Manual.
TM 11-2140-20	Telephone Repeater AN/ TCC-8 and Telephone Repeater AN/TCC-21, Organizational Maintenance.
TM 11-2140 35	Telephone Repeater AN/ TCC-8 and Telephone Repeater AN/TCC-21, Field and Depot Maintenance.
TM 11-2143	Telephone Test Set TS-712/ TCC-11
TM 11-2148	Telephone Repeater AN/ TCC-11.
TM 11-2150	Telephone Carrier Systems Using Telephone Terminal AN/TCC-7, Telephone Repeater AN/TCC-8 (AN/ TCC-21), Telephone Repeater AN/TCC-11, and Telephone Test Set TS--712/TCC-11.
TM 11-2151	Audio Level Meter ME-71A/ FCC and ME-71B/FCC.
TM 11-5061	Electron Tube Test Set TV-2/U.
TM 11-5057	Frequency Meter AN/ USM-26.
TM 11-5083	Electron Tube Test Set TV-7/U, TV-7A/U, and TV-7B/U.
TM 11-5088	Signal Generators SG-71/FCC and SO-71A/FCC.
TM 11-5132	Electric Voltmeter ME308/U and Voltmeter. Meter ME-30A/U.
TM 11-5511	Electronic Multimeter TS505/U.

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