TECHNICAL MANUAL
No. 11-898

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RADIO RECEIVERS R-108/GRC, R-109/GRC, AND R-110/GRC

*This manual supersedes TM 11-898, 23 March 1951, including C 1, 3 March 1953.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This technical manual contains a description, detailed theory of operation, and instructions for field maintenance and repair of Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC (fig. 1). In addition, a chapter on repacking of the equipment for shipment or limited storage is included. Operation of the receivers is discussed in TM 11–284, TM 11–611, and TM 11–642.

b. Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC are similar in structure, function, and control arrangement. They differ from each other only in their operating frequency ranges, those components that determine the frequency range, and the bias source for the squelch oscillator. Therefore, unless otherwise specified, the discussions in this book apply to all three equipments and reference is made simply to the *re-*

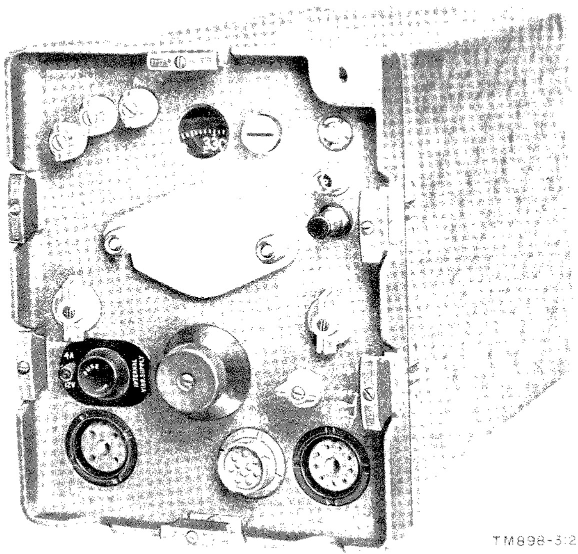


Figure 1. Radio Receiver R–109/GRC.

ceiver. Where specific differences exist between the units, these differences are described.

c. Equipments upon which modifications have been performed may differ in circuitry or parts from the equipment described in this manual. When differences do exist, refer to the following for detailed information:

(1) MWO SIG 11-898-1, 12 October 1953, Modification of Radio Receivers R-108/GRC, R-109/GRC, and R-110/GRC to Prevent Damage to Wiring.

(2) MWO SIG 11-898-2, 15 October 1953, Modification of Radio Receivers R-108/GRC, R-109/GRC, and R-110/GRC to Prevent I-F Instability at Low Temperatures.

(3) MWO SIG-11-898-3, 22 December 1953, Modification of Radio Receivers R-108/GRC, R-109/GRC, and R-110/GRC to Replace the Existing 4-Pin and 9-Pin Amphenol Connectors J6 and J8 with Improved Connectors.

d. Forward comments on this publication directly to: Commanding Officer, The Signal Corps Publications Agency, Fort Monmouth, New Jersey.

2. Forms and Records

a. Unsatisfactory Equipment Reports.

(1) DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in AR 700-38.

(2) DD Form 535, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in AR 700-38 and AF TO 00-35D-54.

b. Damaged or Improper Shipment Report. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745-45-5 (Army); Navy Shipping Guide, Article 1850-4 (Navy); and AFR 71-4 (Air Force).

c. Preventive Maintenance Form. DA Form 11-239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form (fig. 30).

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. The receivers (fig. 1) are small, lightweight, frequency-modulated (fm), superheterodyne types designed for use in vehicular or ground installations. The receivers provide for the reception of voice-modulated fm signals between 20 and 55 megacycles (mc). The receivers are similar except for the tuning range.

b. The frequency coverage of the receivers is indicated in the frequency spectrum chart (fig. 2). For comparison, the frequency coverage of other radio equipments with which the receivers may be associated in a working system is shown in the chart. For example, the chart shows that the frequency coverage of the receivers is identical with that of Receiver-Transmitters RT-66/GRC, RT-67/GRC, and RT-68/GRC.

4. System Application

a. General. As used in this discussion, the term *system* means a grouping of major and minor components arranged to form a complete working installation. The receivers are not a system in themselves, because they lack a power supply, an antenna, and a suitable receiving device, such as a headset or loudspeaker. To use the receiver in a working installation, these components must be provided.

(1) The audio receiving device may be a headset, the earpiece of a handset, a loudspeaker, or a combination of these.

(2) The operating power source may be either Power Supply PP-281/GRC, PP-282/GRC, or PP-448/GR, depending on whether a 12-, 24-, or 6-volt storage battery is involved. An external power source furnishing 6.3 and 130 volts direct current (dc) may be used in place of the power supplies.

b. Control Arrangement. The control arrangement used depends on the requirements of the system installation in which the receiver is used. Thus, some installations may require direct panel control. Others may require control from a local or a remote position. In systems such as Radio Set AN/GRC-3, the control arrangement may involve the selection of different operational functions, such as duplex channel operation, retransmission, or the selection of one or more communication paths, if several equipments are involved.

c. Radio Sets AN/GRC–3, AN/GRC–5, and AN/GRC–7. A typical system using Radio Receiver R–108/GRC as an auxiliary channel (or monitoring receiver) is known as Radio Set AN/GRC–3. Similar systems using Radio Receivers R–109/GRC and R–110/GRC are known as Radio Sets AN/GRC–5 and AN/GRC–7, respectively, and are covered in TM 11–284. Radio Sets AN/GRC–3, –4, –5, –6, –7, and –8. The three systems are identical except for frequency range; therefore, Radio Set AN/GRC–3 will be taken as an example in the following discussion. The set uses Receiver-Transmitter RT–66/GRC as a receiver-transmitter, Radio Receiver R–108/GRC as an auxiliary receiver, Receiver-Transmitter RT–70/GRC as an auxiliary receiver-transmitter, AF Amplifier AM–65/GRC as an interphone amplifier, and power supplies and other minor components necessary to complete the installation. Wiring in Mounting MT–297/GR interconnects the power, audio, and control circuits of the several components and the local or remote control units where, by means of switches, these circuits may be associated with each other in any one of several possible combinations to produce one of the following methods of operation.

(1) Push-to-talk operation over either of the two receiver-transmitters with the auxiliary receiver acting as a monitoring unit.

(2) Rebroadcast or relay station operation involving the retransmission of a message received by Radio Receiver R–108/GRC over the transmitter portion of Receiver-Transmitter RT–70/GRC, or the retransmission of the output of the receiver portion of one of the receiver-transmitters over the transmitter portion of the other receiver-transmitter.

(3) Duplex operation, involving transmission and reception at the same time. In this case, Radio Receiver R–108/GRC may be used for reception and the transmitter portion of one of the receiver-transmitters may be used simultaneously for transmission. The transmit and receive frequencies must be different and must be chosen carefully to prevent interaction between the receiver and transmitter.

(4) Interphone communication within a vehicle through AF Amplifier AM–65/GRC. In this arrangement, the signals from Radio Receiver R–108/GRC and from the receiver portions of the two receiver-transmitters may be routed to any one or more of several monitoring positions within the vehicle or other installation.

(5) The major components of Radio Sets AN/GRC–3, AN/GRC–5, and AN/GRC–7 are described in separate technical manuals. The use of Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC as parts of these sets is described in TM 11–284.

d. Other Systems. Other systems using the receivers are as follows:

(1) Radio Sets AN/VRC–16, AN/VRC–17, and AN/VRC–18, covered in TM 11–611.

(2) Radio Sets AN/VRC–20, AN/VRC–21, and AN/VRC–22, covered in TM 11–642.

5. Technical Characteristics

Frequency range:	
R–108/GRC	20 to 28 mc.
R–109/GRC	27 to 39 mc.
R–110/GRC	38 to 55 mc.
Type of tuning	Continuously variable, and detent selection of three preset frequencies.
Channel spacing	100 kc.
Number of channels:	
R–108/GRC	80.
R–109/GRC	120.
R–110/GRC	170.
Receiver type	Fm, single-conversion, superheterodyne.
Types of signals received	Voice-modulated or tone.
Number of tubes	15.
Intermediate frequency	4.3 mc.
Method of calibration of tuning dial	Built-in, 4.3-mc, crystal-controlled oscillator.
Calibration frequencies	Multiples of 4.3 mc.
Accuracy of calibration	Approximately ±.01 per cent.
Current drain:	
6-volt vehicular battery	3.5 amperes.
12-volt vehicular battery	2 amperes.
24-volt vehicular battery	1.5 amperes.

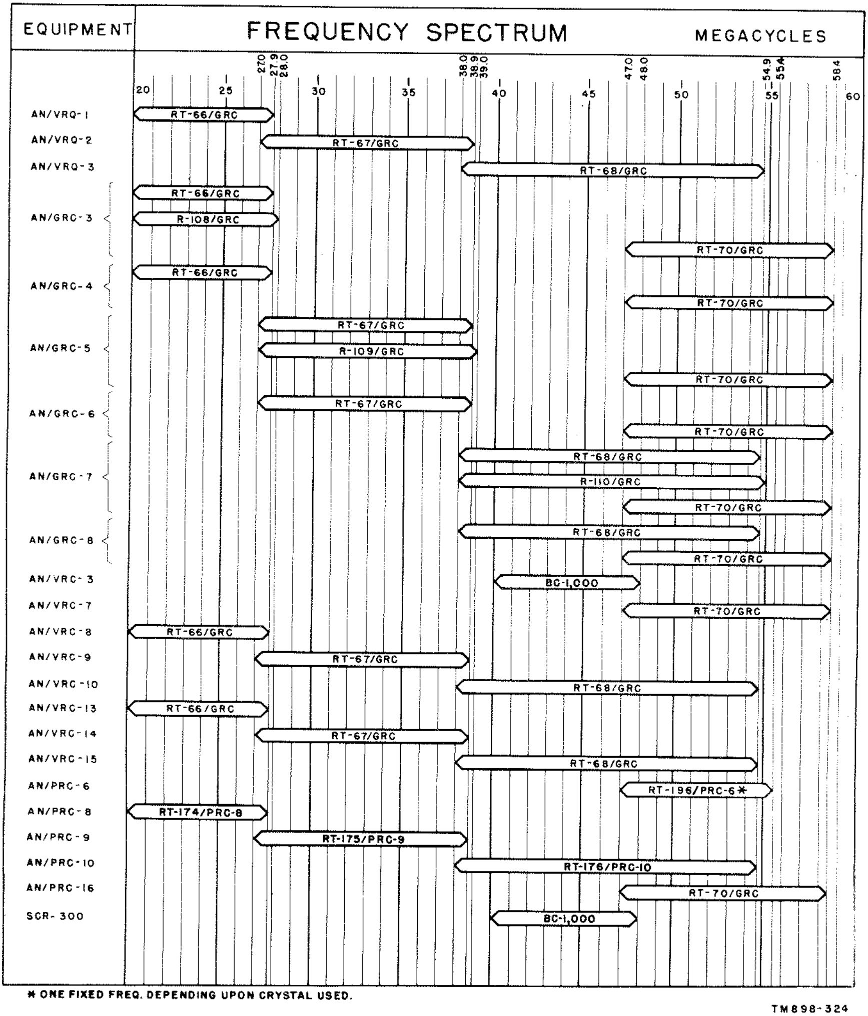


Figure 2. Frequency spectrum chart.

Power supply:	
6-volt vehicular battery	Power Supply PP–448/GR.
12-volt vehicular battery	Power Supply PP–281/GRC.
24-volt vehicular battery	Power Supply PP–282/GRC.
External (emergency supply)	6.3-volt and 130-volt external dc supply.
Antenna	Portable whip antenna. Coaxial connector and binding post on front panel.
Sensitivity	Over 25 db signal plus noise-to-noise ratio at ½ microvolt (all ranges), deviation ±15 kc, 1,000 cps.
Hf oscillator range:	
R–108/GRC	24.3 to 32.3 mc.
R–109/GRC	31.3 to 43.3 mc.
R–110/GRC	42.3 to 59.3 mc.
Bandwidth:	
(6 db down)	85 kc ±15 kc.
(40 db down)	Less than 195 kc.
Audio output:	
Loudspeaker	500 milliwatts.
Earphones	40 mw.
Fixed level	20 mw ±3 mw.
Audio output impedances (each)	600-ohm unbalanced.
Squelch circuit	Continuously variable panel-mounted SQUELCH control adjusts squelch sensitivity to open on signals from approximately .3 μv to 75μv. OFF position of control disables squelch circuit.
External relay connection	Receiver provides 5 milliamperes of current for operation of an external control relay. Current is controlled by squelch circuit.

6. Description of Receivers

a. Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC are small, compact, single-conversion, superheterodyne type (less power supply) designed for the reception of fm voice signals within the combined tuning range of 20 to 55 mc. This range is divided among the three sets as shown in paragraph 5. Continuously variable tuning is provided. Provision also is included for detent selection of three preset frequencies.

b. A front view of a receiver is shown in figure 1. The unit is a panel-and-chassis assembly with an outer case. All operating controls and cable connectors are mounted on the front panel and are accessible to the operator. The flange around the four edges of the panel protects the controls from damage caused by impact. The flange is provided with cutouts to accommodate the cables that attach to the receptacles at the front of the panel. Immersionproof seals and caps insure a watertight assembly. The outer case is attached to the front panel by means of wing-type Dzus fasteners. A gasket around the edges of the cover completes the watertight assembly. Channel rails attached to the bottom of the outer case make it possible to install the unit on a suitable mounting when used in a vehicular installation. The case is corrugated for greater strength and for protection from warping or damage caused by vibration and shock.

c. The receiver may be operated from a 6-, 12-, or 24-volt storage battery, in conjunction with a plug-in, vibrator-type voltage supply (Power Supply PP–448/GR, PP–281/GRC, or PP–282/GRC, covered in TM 11–5036), or from an external power source which will provide 6.3 volts and 130 volts direct current for the filament and plate circuits, respectively. Normally, the receivers are furnished without the vibrator voltage supply unit.

d. The physical dimensions are—

Height	9 inches.
Width	7¼ inches.
Depth	12$^{13}/_{16}$ inches.
Weight (less vibrator power supply).	20¼ pounds (approx.)
Weight (including vibrator power supply).	25 pounds (approx.).

7. Differences in Models

Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC differ from each other in the following respects:

a. Frequency range:

R–108/GRC	20 to 28 mc.
R–109/GRC	27 to 39 mc.
R–110/GRC	38 to 55 mc.

b. Some component values differ (figs. 48, 49, and 50).

c. The radio-frequency (rf) stage of Radio Receiver R–108/GRC only receives bias from the grid circuits of the limiter and fourth intermediate-frequency (if.) stages.

d. In Radio Receivers R–108/GRC and R–109/GRC, the squelch oscillator receives its bias from the grid circuits of the limiter and the fourth if. stages.

e. In Radio Receiver R–110/GRC, the squelch oscillator receives its bias from the limiter stage only.

8. Controls and Connectors
(figs. 4 and 5)

a. External Controls and Connectors.

Control or connector	Function
VOLUME control (R62)	Adjusts the receiver audio output level.
Power OFF switch (S2)	Applies or removes the prime source of power from the receiver power supply when the vibrator power supply unit is used. This switch is not in the circuit when external batteries are used. Voltage selector switch S1 must be used (*b* below).
SQUELCH sensitivity (R65 and S4)	Adjusts the degree of the receiver squelch. In the OFF position (maximum counterclockwise), the squelch (or receiver noise quieting circuit) is disabled, providing no quieting action.
ANT TUNE (C4)	Tunes the input circuit of the radio-frequency stage.
DIAL LIGHT switch (S3)	Controls output connection of tuning oscillator V10 and the operation of dial lamp E14 as follows: In the TUNE position, the output of the tuning oscillator is connected to the input of the rf amplifier. The dial lamp is lighted. *Note.* The knob must be held manually in the TUNE position. In the OFF position, the output of the tuning oscillator is grounded and the dial lamp is turned off. In the ON position, the tuning oscillator output remains grounded, but the dial lamp is turned on.
TUNING knob	Selects the receiver operating channel. Continuously variable tuning over the entire range of the receiver is provided. Rotation of the knob rotates the CHANNEL dial and (with detent set) actuates the detent flags.
CHANNEL dial and window	The dial, controlled by the TUNING knob, is calibrated in 10-channel (1-mc) steps and in minor subdivisions representing 1-channel (100-kilocycle) intervals. The dial numbers are channel numbers. When divided by 10 the channel numbers give the operating frequency in mc.
DETENT VERNIERS A, B, C	Provide a fine adjustment of each of the three detent frequency settings.
Diamond-shaped cover plate	Loosening both screws permits turning the plate away to expose the DIAL and detent locking screws. A table is provided on the cover plate to permit entering the channel number and the corresponding organization for which the detents have been set.
Detent adjustment screws DET A, DET B, and DET C (under diamond-shaped cover plate).	Lock the detent mechanism for three frequencies within the tuning range of the receiver.
DIAL adjustment screw (under diamond-shaped cover plate).	Permits adjustment of the dial calibration by shifting the dial plate with respect to the tuning capacitor.
FUSE holder and extractor	Holds 4-ampere fuse used for protection of equipment.
Battery voltage indicator plate	Indicates the voltage of the external supply required to operate the receiver, depending on the setting of 6 12 & 24 VOLTS-OFF-EXTERNAL SUPPLY S1 (voltage selector switch) and the rating of the vibrator power supply unit that is plugged into the power-supply compartment.
Dial LAMP	Illuminates the dial during receiver tuning or dial calibration.
ANT connector (J3) (upper connector)	Connector for a coaxial lead from the antenna to the antenna circuit within the receiver.
ANT binding post (E6) (lower connector)	Connector for a single-wire antenna lead.
POWER IN connector (J6)	Connector for the vehicular battery or the external power supply to the receiver power supply circuits.
AUDIO connector (J7)	Connector for the receiver audio output to audio device used.
REC CONTROL connector (J8)	Connector for the fixed-level audio output of the receiver and to an external control relay or other control circuit, as required by a particular installation.

b. Internal Controls.

Control	Function
Fixed-level output gain control (R42)	Adjusts the audio output level from the fixed-level audio amplifier (V12).
Voltage selector switch (S1)	Connects the receiver filament and plate voltage circuits to permit operation from any one of the following types of power sources: In the 6, 12, & 24 VOLTS position, connects the power supply circuits in the receiver for operation with vibrator-type Power Supply PP–448/GR and a 6-volt storage battery, or Power Supply PP–281/GRC and a 12-volt storage battery, or Power Supply PP–282/GRC and a 24-volt storage battery. Strap connections provided in the vibrator power supply unit arrange the filament circuits of the receiver to provide the required 6.3 volts to the receiver filaments. In the OFF position, acts as on-off switch when external power supply is used. In the EXTERNAL SUPPLY position, connects the plate and filament supply circuits to external 6-volt and 130-volt power sources.

9. Additional Equipment Required

The following materials and components are not supplied as part of Radio Receiver R–108/GRC, R–109/GRC, or R–110/GRC, but are required for their installation and operation.

a. In a vehicular installation, Power Supply PP–281/GRC, PP–282/GRC, or PP–448/GR, depending on whether the vehicular storage battery is a 12-, 24-, or a 6-volt battery, must be plugged into the compartment of the receiver. In other installations, an external source of 6.3 and 130 volts dc may be used.

b. A typical antenna test setup (TM 11–284) would include the following antenna components assembled to form a vehicular antenna suitable for use with the receiver:

(1) Mast Section MS–116–A.
(2) Mast Section MS–117–A.
(3) Mast Section MS–118–A.
(4) Mast Section AB–24/GR.
(5) Mast Base AB–15/GR.

Note. For other possible antenna test combinations, see TM 11–611 and TM 11–642.

c. Headset HS–33 or Chest Set Group AN/GSA–6.

d. Suitable power and rf cables and connectors.

10. Tools and Materials Supplied

The following are supplied with each receiver:

- 3 Allen wrenches, Nos. 8, 6, and 4
- 1 tube puller, Kellem type 11–16
- 1 circuit label, folded in a compartment on the chassis
- 2 instruction manuals
- 1 fuse, Buss AGU–4, 4 amperes

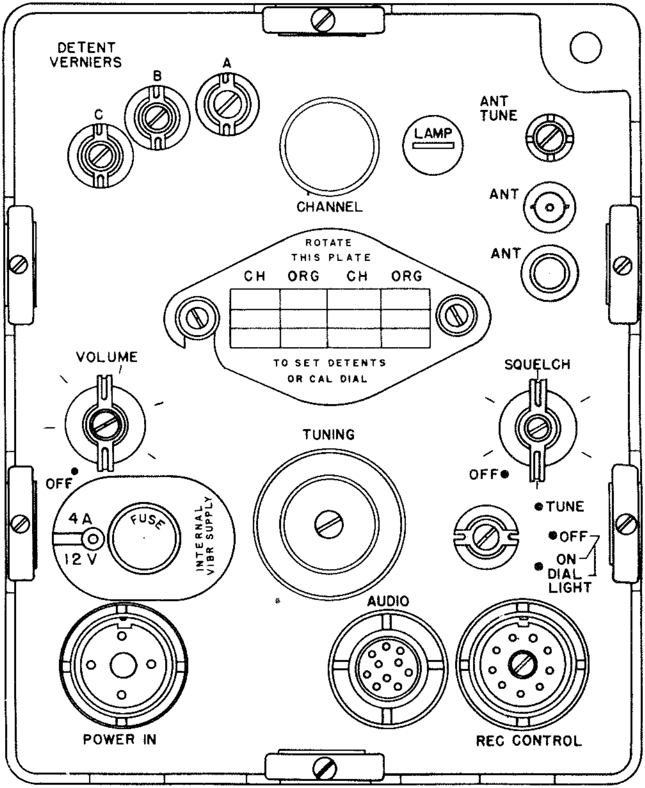


Figure 4. Panel controls and connectors.

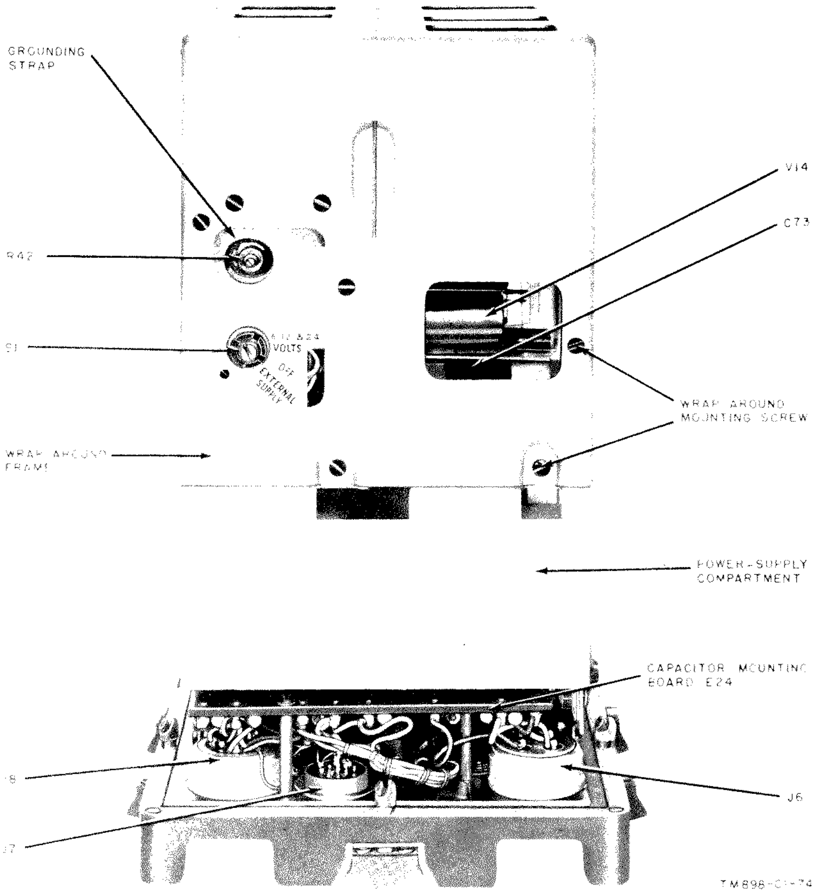


Figure 5. Receiver chassis, bottom view showing internal controls.

CHAPTER 2

THEORY OF RADIO RECEIVERS R–108/GRC, R–109/GRC, AND R–110/GRC

Note. Detailed descriptions of the circuits of Radio Receiver R–108/GRC are given in this chapter. These descriptions apply also to Radio Receivers R–109/GRC and R–110/GRC, except where noted.

Section I. ELECTRICAL THEORY

11. Block Diagram

(figs. 6 and 7)

a. The received fm signal is applied to rf amplifier V1. In Radio Receiver R–108/GRC only, an automatic gain control (agc) voltage from V7 and V8 is also applied to V1. In V1, the signal is amplified and then coupled to the mixer stage together with a signal from oscillator stage V3. Sum and difference frequencies are produced in the mixer stage, but only the difference frequency of 4.3 mc is passed to the if. amplifier stages.

b. The 4.3-mc if. signal is amplified by conventional if. amplifier stages V4, V5, V6, and V7. The signal is then applied to limiter stage V8, which eliminates any amplitude variations in the if. signal applied to the discriminator even though the input signal may vary. In Radio Receivers R–108/GRC and R–109/GRC, a portion of the grid voltages developed in V7 and V8 is coupled to squelch oscillator V11 to remove squelch action when a signal is received. In Radio Receiver R–110/GRC, the squelch voltage for V11 is received only from the grid circuit of V8.

c. The discriminator stage, V9 and one-half of V10, converts the 4.3-mc if. signal into an audio-frequency (af) signal, which is applied to two separate audio amplifier circuits.

(1) One circuit is a two-stage audio amplifier consisting of V13 and V14. The gain is adjustable by the VOLUME control on the front panel. The output is taken from V13 and V14. The output from V13 is sufficient for earphones. The output from V14, which is greater, can be used for a speaker.

(2) The other amplifier circuit consists of one stage, V12. This output is not adjustable from the front panel. However, an internal adjustment is provided. The audio output from this stage is used in system applications.

d. The squelch oscillator disables the audio amplifier stages during no-signal periods. When no signal is being received, the output from the oscillator is sufficient to cut off the audio amplifier stages. When a signal is received, the squelch oscillator is disabled thereby permitting the audio amplifiers to operate.

e. The tuning oscillator provides a 4.3-mc signal for testing purposes. When the DIAL LIGHT switch is in the TUNE position, the test signal is applied to the antenna circuit. The signal is then passed through to the discriminator where the desired audio tone is produced for use in calibrating the receiver.

12. Antenna Circuit

(figs. 8 and 9)

a. The antenna lead is plugged into coaxial ANT connector J3 or connected to ANT binding post E6. A coaxial cable connects the antenna input terminals through P1 and J1 to the untuned primary of T1.

b. The signal is inductively coupled to the secondary of T1. The secondary of T1 is tuned to the desired frequency by section A of TUNING capacitor C3, ANT TUNE capacitor C4, and capacitor C1. The signal selected by this resonant circuit is then applied to the grid of rf amplifier V1.

13. Rf Amplifier Stage V1

(figs. 8 and 9)

a. The receiver rf stage V1 uses a type 6AK5 pentode tube. The grid circuit is tuned to resonance at the dial frequency by the tuned secondary circuit of T1 (par. 12), which is returned to

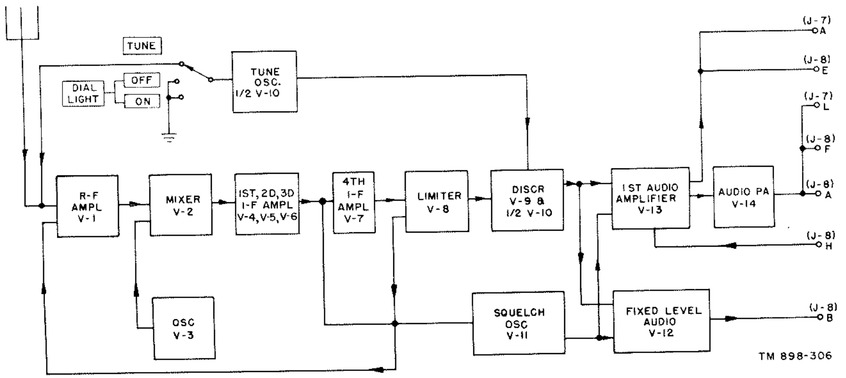


Figure 6. Radio Receiver R–108/GRC, block diagram.

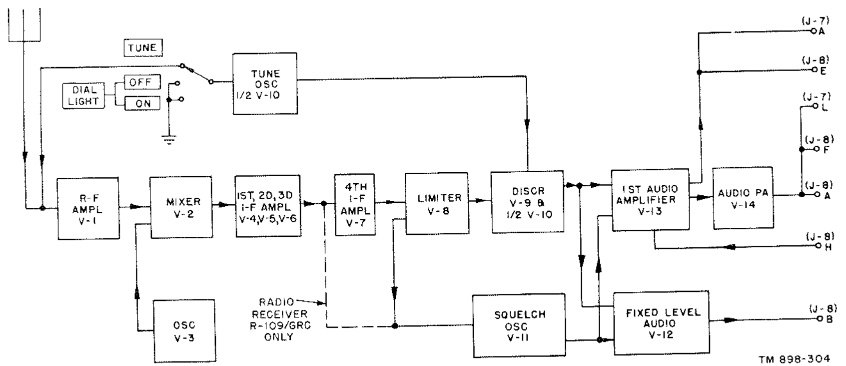


Figure 7. Radio Receivers R–109/GRC and R–110/GRC, block diagram.

ground for rf through capacitor C2. The tube is self-biased because of the plate current flow through cathode resistor R2, which is bypassed for rf by capacitor C5. Resistor R1 limits grid current flow during reception of strong signals. Bypass capacitor C6, connected to the other terminal of the cathode, balances out wiring inductance in the cathode lead. C7 is connected in either of two positions. When C7 is connected between pin 4 of V1 and ground, it balances out the inductance of the filament wiring of V1. When C7 is in the plate circuit of V1, it functions with C9 as an rf bypass for the plate and screen voltages.

b. In Radio Receiver R–108/GRC, the combination of bias voltages developed in the grid circuits of V7 and V8, because of grid current flow in these tubes, is fed back as a negative voltage to the grid of V1. In this connection, R1, R76, and R70, in the feed-back path, act as a voltage divider. The voltage thus developed across R1, in combination with the voltage across R2, modifies the gain of V1 and therefore the overall gain of the receiver. In

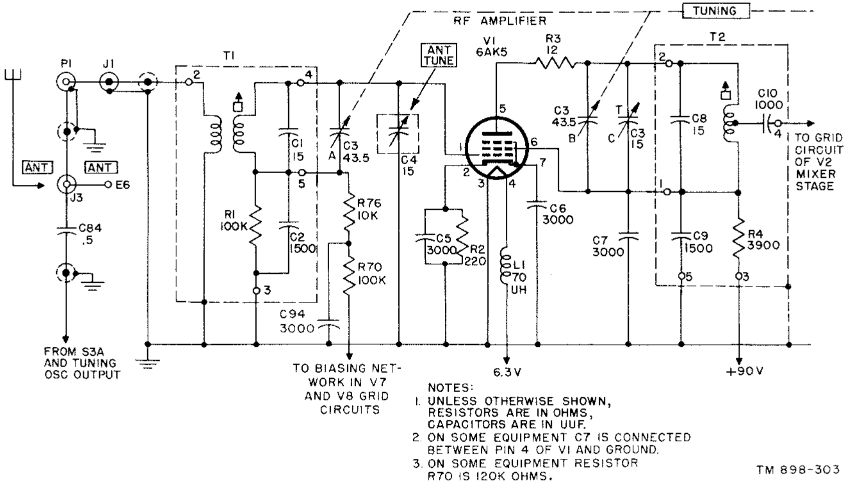


Figure 8. Radio Receiver R–108/GRC, antenna and rf amplifier circuits.

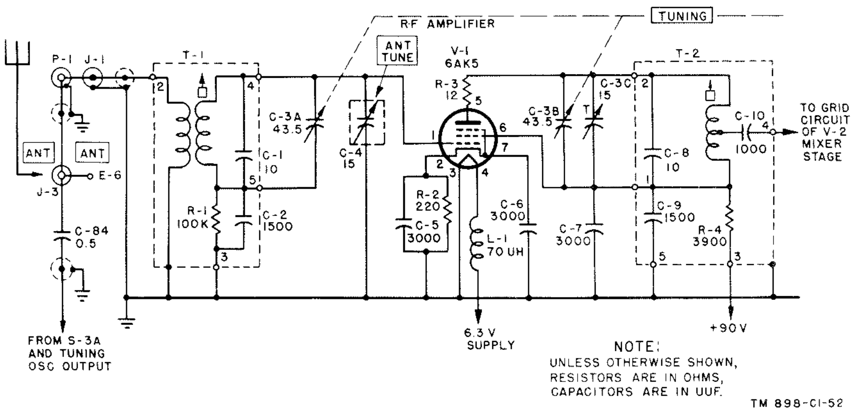


Figure 9. Radio Receivers R–109/GRC and R–110/GRC, antenna and rf amplifier circuits.

Radio Receivers R–109/GRC and R–110/GRC, the grid of the rf amplifier is returned to ground with no agc bias voltage applied from V7 and V8. Therefore, the gain of this stage does not vary with the bias developed in the grid circuits of V7 and V8.

c. The plate circuit of V1 includes the parallel-resonant circuit composed of the primary of T2, sections B and C of tuning capacitor C3, and capacitor C8. Trimmer capacitor C3C is used for the alinement of the stage at the high-frequency (hf) end of the tuning range. The powdered-iron core of the inductance in T3 is used for alinement at the low-frequency (lf) end.

d. Voltage for the plate and the screen is fed from the regulated plate supply circuit to terminal 3 of T2, where it is applied through voltage-dropping resistor R4 to the screen grid and through T2 and parasitic suppressor resistor R3, to the plate. Capacitors C9 and C7 are rf bypasses for the plate and screen supply voltages, respectively. Filament voltage is obtained from the filament supply circuit, through isolating choke coil L1.

e. The output of V1 is taken from a tap on T2 and is coupled through capacitor C10 to a similar tap on the V2 grid circuit tuning inductance in T3. The selection of the tap is made in manufacture to insure proper match between the plate circuit impedance of V1 and the grid circuit impedance of V2. Capacitor C10 also blocks dc from the grid circuit of V2. This method of coupling is used to insure the less-than-critical coupling required for this stage.

14. Receiver Variable Oscillator V3

(fig. 10)

The self-excited variable receiver oscillator uses a type 3A5 twin triode tube V3 in a modified Colpitts circuit. To obtain maximum transconductance, the two triode sections of the tube are connected in parallel.

a. Tuned Circuit. The oscillator is tuned to resonance by the parallel-resonant circuit composed of the coil inductance in T4, sections F and G of variable gang capacitor C3 in series with capacitor C21 and capacitors C18 and C19. Capacitor C21 also provides temperature compensation at the lf end of the oscillator tuning range, thus stabilizing its operation. Temperature compensation at the high end of the frequency range is controlled by shunt padding capacitors C18 and C19. Alinement of the oscillator at the low end of its frequency range is accomplished by varying the inductance of the tuning coil by means of the powdered-iron dust core. The hf end of the oscillator frequency range is alined by means of trimmer capacitor C3G. For a particular setting of the tuning capacitor, the frequency generated by the oscillator is determined by the inductance of the coil and the total capacity in the circuit, and is always equal to the dial frequency plus 4.3 mc. Exact calibration of the oscillator with the dial is accomplished by means of a DIAL screw under the diamond-shaped cover just above the TUNING control and by bending the dial cam plate to the required shape by means of the 13 cam-adjusting screws (figs. 26–29).

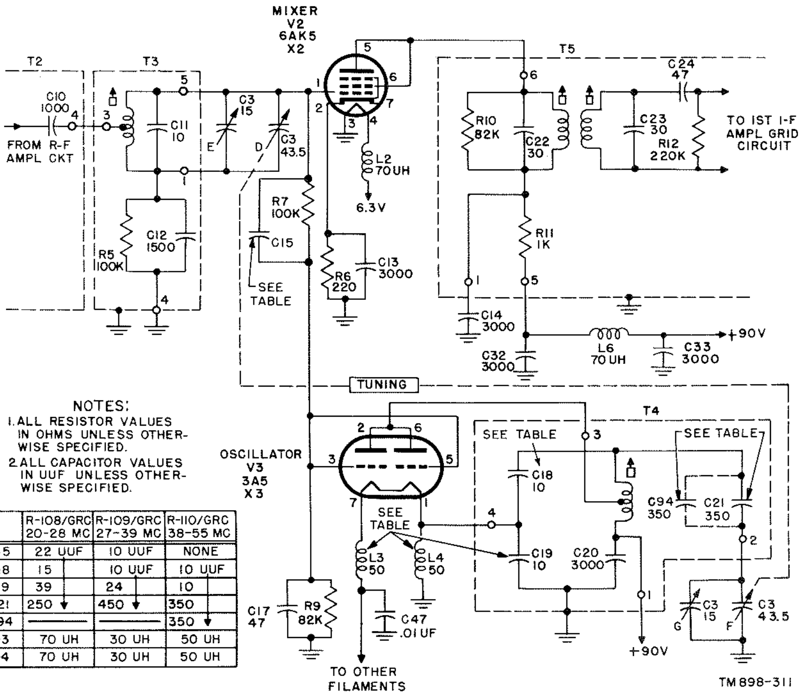
b. Colpitts Arrangement. The arrangement of the oscillator into a modified Colpitts circuit is shown in figure 10. Capacitors C18 and C19 constitute the conventional Colpitts voltage-dividing circuit. The plate of the tube is tied to a tap on the inductance, while the grid is effectively connected through capacitor C17 to ground, and thus to the other end of the tank circuit. Thus, the plate and grid are connected effectively across the oscillator tank circuit. The amount of oscillator feedback is determined by the ratio of the values of capacitors C18 and C19. Oscillator feedback from the plate to the grid circuit is accomplished through capacitor C17. The oscillator output is taken from the grid of V3 through coupling resistor R7 to the control grid of mixer tube V2. In Radio Receivers R–108/GRC and R–109/GRC, resistor R7 is shunted by capacitor C15, which provides additional coupling.

c. Plate and Filament Supply. Plate voltage for V3 is taken from the 90-volt supply circuit and applied through the inductance in T4 to the plates (pins 2 and 6). Capacitor C20 is a plate supply bypass. Filament current is supplied through isolating choke L3, which is bypassed by C47. The other side of the filament is returned to ground through isolating choke L4. Resistor R9 and capacitor C17 form a grid leak biasing network.

15. Receiver Mixer V2

(fig. 10)

a. The mixer stage uses a type 6AK5 pentode tube V2. The tube is connected as a triode. Injection of signal voltage from the rf amplifier V1 and from the receiver oscillator V3 takes place at the control grid of V2. The signal voltage from the plate circuit of V1 is coupled through C10 to T3. The coil of T3 provides the inductive element of the parallel-resonant circuit, which tunes the grid of V2 to resonance at the desired frequency. The capacitive element of this tuned circuit includes capacitors 3D, 3E, and C11. For alinement at the lf end of the tuning range, the inductance of the coil in T3 is adjustable by means of a powdered-iron core. For alinement at the



	R-108/GRC 20-28 MC	R-109/GRC 27-39 MC	R-110/GRC 38-55 MC
C-15	22 UUF	10 UUF	NONE
C-18	15	10 UUF	10 UUF
C-19	39	24	10
C-21	250	450	350
C-94	—	—	350
L-3	70 UH	30 UH	50 UH
L-4	70 UH	30 UH	50 UH

Figure 10. Receiver variable oscillator and mixer circuits.

hf end of the tuning range, adjustment is made by means of trimmer capacitor C3E.

b. The grid circuit is returned to ground for dc through grid leak resistor R5 and for rf through bypass capacitor C12. Resistor R5 also limits grid current flow for strong incoming signals. The tube is operated at the self-bias voltage developed across cathode resistor R6, which is bypassed by capacitor C13.

c. The incoming signal frequency and the heterodyne frequency are caused to beat against each other in V2 to produce difference frequencies. Because the oscillator frequency is above the signal frequency by 4.3 mc, regardless of the dial setting, the difference frequency is always 4.3 mc. This is the intermediate frequency of the receiver. This frequency is selected by the fixed tuned plate circuit of V2 (*d* below). In addition to the difference frequency, the mixer also produces sum frequencies and harmonics of the sum and difference frequencies. These are effectively rejected by the tuned plate circuit.

d. The tuned plate circuit of V2 is resonant at 4.3 mc by the primary of T5. The primary tuned circuit consists of the plate coil of the tuning inductance in T5, fixed tuning capacitor C22, and damping resistor R10. The secondary circuit is tuned to resonance by the grid coil of V4 in T5 and fixed capacitor C23. The use of double tuning and damping resistors R10 and R12 provides a broad response to permit a band of 85 kilocycles (kc) to pass through. Alinement adjustment of the tuned circuit is accomplished by means of the powdered-iron cores in the primary and secondary coils. The output of the mixer stage developed across the primary tuned circuit is inductively coupled to the secondary tuned circuit. Coupling from the secondary circuit to the grid of V4 is accomplished through coupling capacitor C24.

e. Plate voltage is applied from the high-voltage supply circuit through the rf filter (L6, C32, and C33) and through voltage-dropping resistor R11, which is bypassed by capacitor C14. Filament voltage is supplied from the regulated 6.3-volt filament supply circuit within the receiver through isolating choke L2.

16. Fixed If. Amplifier Circuit (V4 through V7)

(figs. 11, 12, 13, and 14)

a. First Fixed If. Amplifier V4. The 4.3-mc if. signal is selected from the output of V2 by the double-tuned circuit in tuning assembly T5 and is coupled through capacitor C24 to the grid of the first fixed if amplifier stage V4, a type 1U4 pentode.

(1) Coupling capacitor C24 has the additional function of blocking any dc that may be flowing in the filament-to-grid circuit of V4 from the tuned secondary soil in T5. The grid signal path is returned to ground for signal frequencies through if. bypass capacitor C25. The dc return path for the grid to the filament (pins 1 and 5) is established through grid leak resistor R12 and the filament circuit. The grid leak resistor has the additional function of limiting grid current flow for very strong signals. The tube is operated at the bias voltage determined by the voltage at the center of the filament plus any voltage drop in R12 (due to grid current flow).

(2) The tuned plate circuit of V4 is identical with the components in tuning assembly T5 (par. 15) in circuit arrangement and component values. The primary tuned circuit in T6 includes the plate coil, fixed capacitor C29, and damping resistor R15. The secondary tuned circuit includes the grid coil and fixed capacitor C30. As in the case of tuning assembly T5, double tuning provides a high degree of if. selectivity while maintaining the desired bandwidth. The bandwidth is determined by overcoupling between the primary and secondary coils. In addition, the resistive load provided by R15 flattens out the frequency response of the tuned circuit. The 85-kc band, centered about 4.3 mc, is coupled to the input of second if. amplifier stage V5 through capacitor C31.

(3) Plate and screen voltages are applied through voltage-dropping resistor R16, which is bypassed by filter capacitor C28. Filament voltage is supplied through voltage-dropping resistors R13 and R14 in parallel and through isolating choke coil L5. Capacitors C26 and C27 bypass the filament circuit to ground for signal frequencies.

(4) Alinement of the stage is accomplished by adjusting the powdered-iron cores of the secondary coil T5 and the primary coil in T6 to obtain a peak reading on a meter connected to the grid of limiter stage V8.

b. Second Fixed If. Amplifier V5. The second fixed if. amplifier stage V5, a type 1U4 pentode, is identical with first if. amplifier V4 in circuit arrangement and component values.

(1) The grid circuit is tuned to resonance at the 4.3-mc intermediate frequency by the parallel arrangement of the secondary coil in T6 and fixed capacitor C30. Coupling capacitor C31 applies the output of V4 to the grid of V5. Grid resistor R17 and the filament circuit return the grid to ground for dc and to rf ground through filament bypass capacitor C34. Dc operating bias is provided by the voltage drop in the filament circuit, as measured from pins 1 and 5 of V5 to chassis, and any voltage drop in R17 caused by grid current.

(2) The plate circuit is tuned to resonance at 4.3 mc by T7. The primary tuned circuit includes the plate coil, fixed capacitor C38, and damping resistor R18. The secondary tuned circuit includes the grid coil of V6 and fixed capacitor C39. The output of the second if. amplifier is coupled through coupling capacitor C40 to the grid of third if. amplifier V6. This capacitor also blocks any dc grid current from flowing through the tuned circuit.

(3) Plate and screen voltage is supplied through voltage-dropping resistor R19,

which is bypassed by capacitor C37. Filament voltage is supplied through isolating choke coils L7 and L8. The filament circuit is bypassed for signal frequencies by bypass capacitors C34, C35, and C36.

(4) Alinement of the stage is accomplished by varying the powdered-iron cores of the secondary coil in tuning assembly T6 and the primary coil in T7 until a peak reading is obtained on a meter connected to the grid of limiter stage V8 when a 4.3-mc signal is applied to the input of the if. amplifier circuit.

c. Third If. Amplifier V6. Third if. amplifier stage V6, a 1L4 pentode, is identical with the first and second amplifier stages in circuit arrangement and component values.

(1) The grid circuit is tuned to resonance at 4.3 mc by the parallel arrangement of the secondary coil in T7 and fixed capacitor C39. Coupling capacitor C40 applies the output of V5 to the grid of V6. This capacitor also blocks dc grid current from the tuned circuit. The grid is returned to dc ground by R20 and the filament circuit and to ground for signal frequencies through filament bypass capacitor C41. Dc operating bias is provided by the voltage drop in the filament circuit, as measured from pins 1 and 5 to chassis and any voltage drop in R20 caused by grid current.

(2) The plate circuit is double-tuned to resonance at 4.3 mc by T8. The primary tuned circuit includes the plate coil, fixed capacitor C44, and damping resistor R22. The secondary tuned circuit includes the grid coil of V7 and fixed capacitor C45. Alinement adjustment is obtained by varying the powdered-iron cores of the primary and secondary coils, as described for the other if. stages. The output of the third if. stage is coupled through coupling and dc blocking capacitor C46 to the grid of fourth if. amplifier stage V7.

(3) Plate and screen voltage is applied through voltage-dropping resistor R23, which is bypassed for signal frequencies by capacitor C43. The filament circuit includes isolating choke coils L9 and L11, bypass capacitors C41 and C42, and voltage-dropping resistor R21.

d. Fourth If. Amplifier V7 (figs. 12, 13, and 14). Fourth if. amplifier stage V7, a 1U4 pentode, is identical with the first three stages in circuit arrangement.

(1) The grid circuit is tuned to resonance at 4.3 mc by the parallel arrangement of the secondary coil and fixed capacitor C45 in T8. Coupling capacitor C46 applies the output of V6 to the grid of V7, and also blocks dc grid current from flowing through the tuned circuit. The grid is returned to ground for dc through grid leak resistor R24.

(2) The plate circuit is tuned to resonance at 4.3 mc by T9. The primary circuit includes the plate coil, fixed capacitor C50, and damping resistor R25. The secondary tuned circuit includes the grid coil of V8 and fixed capacitor C51. The output of the fourth if. amplifier stage is coupled through coupling capacitor C52 to the grid circuit of limiter stage V8. Capacitor C52 blocks dc grid current from the grid coil. As in the case of the preceding stages, alinement is accomplished by adjusting the powdered-iron dust cores of the tuning coils.

(3) Plate and screen voltages are applied through voltage-dropping resistor R26, which is bypassed for if. signals by capacitor C49. The filament is bypassed for rf by C48.

(4) In Radio Receivers R–108/GRC and R–109/GRC, a portion of the dc voltage developed in the grid circuit of the fourth if. amplifier stage, V7, and a portion of the dc voltage developed in the grid circuit of V8 are fed through resistors R68 and R69 to a common distribution point. From this point, the voltage is applied as bias for the squelch oscillator (par. 22). Any grid current flowing in V7 and in V8 thus applies a negative bias to the squelch oscillator to cut it off when a signal is present. In Radio Receiver R–108/GRC only, a portion of the voltage derived as described above is also applied as negative voltage to the grid of V1 to

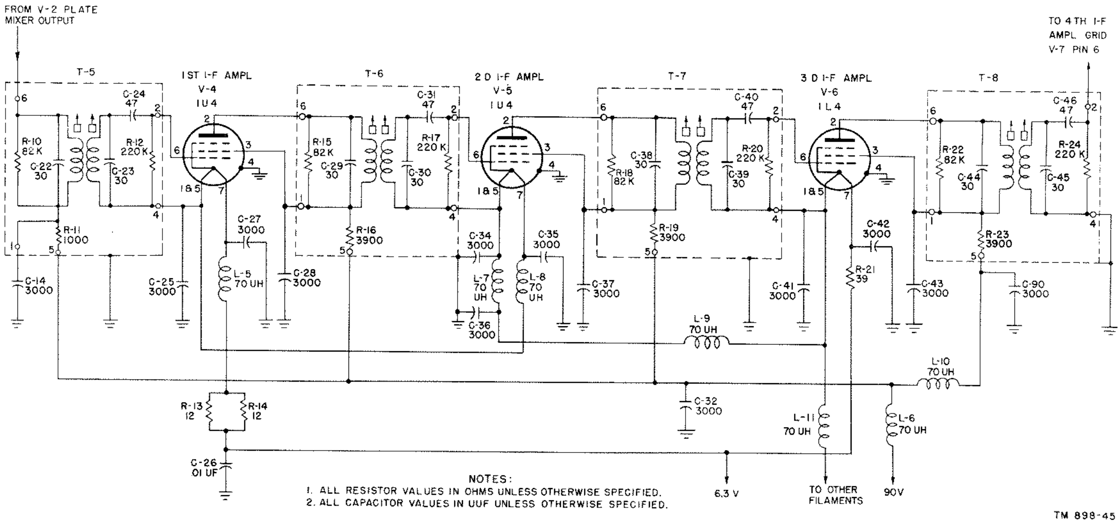


Figure 11. First, second, and third if. amplifier circuits.

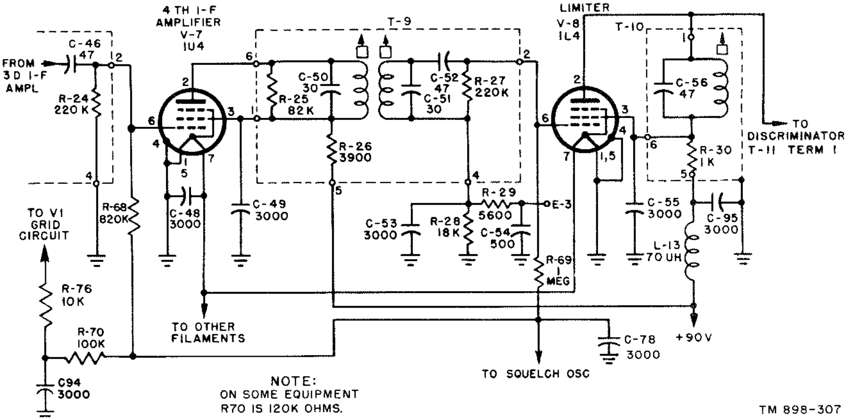


Figure 12. Radio Receiver R–108/GRC, fourth if. amplifier and limiter stages.

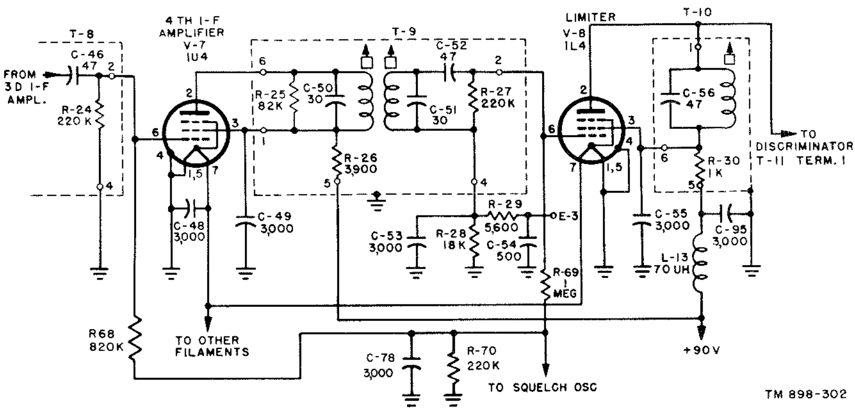


Figure 13. Radio Receiver R–109/GRC, fourth if. amplifier and limiter stages.

reduce receiver gain when large signals are present. Alternating-current (ac) noise and signal voltages are bypassed to ground through C78, and therefore, have little effect on the operation of V11. Resistor R70 is part of the voltage-divider network to assure proper bias voltage to V1 and the squelch oscillator.

(5) In Radio Receiver R–108/GRC, C94 provides additional filtering for the voltage applied to the grid of V1. In Radio Receiver R–110/GRC only, the fourth if. amplifier V7 provides none of the bias for V1 or the squelch oscillator.

17. Limiter Stage V8

(figs. 12, 13, and 14)

Limiter stage V8 uses a type 1L4 pentode tube.

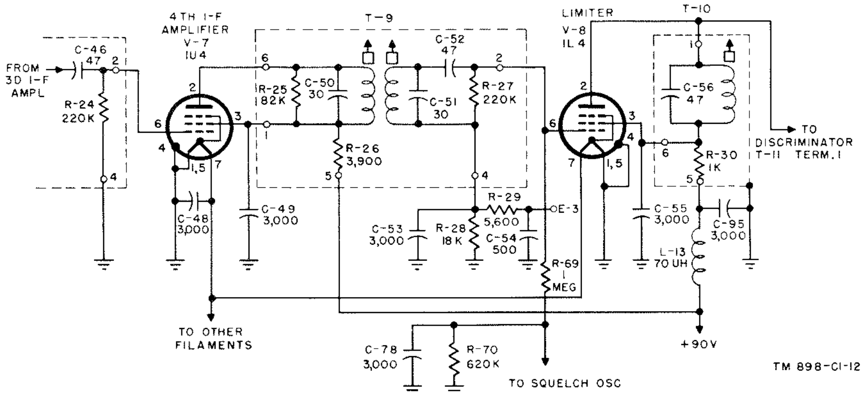


Figure 14. Radio Receiver R–110/GRC, fourth if. amplifier and limiter stages.

This stage has the dual function of providing further amplification to the signal band centered about 4.3 mc and of eliminating any amplitude variations that may have been superimposed upon strong signals.

a. Circuit Details. The grid circuit is tuned to resonance at 4.3 mc by the secondary inductance and fixed capacitor C51 in T9. The signal is coupled to the grid of V8 through coupling and dc grid current blocking capacitor C52.

(1) The series arrangement of grid leak resistors R27 and R28 provides the dc return path for the grid of the tube to ground. The return path to ground for signal frequencies is established through R28 and bypass capacitor C53. In Radio Receivers R–109/GRC and R–110/GRC only, the grid circuit of V8 also is shunted by a votage divider consisting of the series arrangement of R69 and R70, connected between grid and ground.

(2) E3 is a measuring point. This measuring point is used to measure the grid current flowing in V8 when the set is being alined. In Radio Receiver R–108/GRC, the measuring circuit consists of R27 and R28. In Radio Receivers R–109/GRC and R–110/GRC, the measuring circuit consists of R27, R28, R69, and R70. Resistor R29 and capacitor C54 form the meter decoupling circuit.

(3) The plate circuit of the limiter stage is singled-tuned to resonance at 4.3 mc by the inductance and fixed capacitor C56 in tuning assembly T10. The output of the limiter stage is applied by direct connection from the plate of V8 to discriminator tuning assembly T11. The plate impedance of V8 and the discriminator tank circuit in T11 are in separate cans and therefore are magnetically independent of each other.

(4) Plate and screen voltages for V8 are applied through rf filter choke coil L13, which is bypassed for signal frequencies by capacitor C95 and through voltage-dropping resistor R30, which is bypassed by capacitor C55.

(5) In Radio Receivers R–108/GRC and R–109/GRC, a portion of the dc bias developed in the grid circuit of the limiter stage, V8, is coupled through R69, with the voltage developed in the grid circuit of V7, to the grid of squelch oscillator tube V11. In Radio Receiver R–108/GRC only, it is also applied to rf amplifier stage V1. This bias controls the squelch oscillator, depending on the absence or presence of a received signal; in the R–108/GRC, it controls the gain of V1, depending on the strength of the incoming signal. In Radio Receiver

R–110/GRC, the bias developed in the grid circuit of V8 only is applied to the grid of V11.

b. Limiting Action. Limiter stage V8 has the dual functions of amplifying the 4.3-mc band of frequencies and of eliminating or reducing any amplitude variations. Any noise present at the receiver input or in the earlier stages of the receiver is superimposed upon the signal as amplitude variations.

(1) Proper operation of the discriminator circuit requires that the signal applied to it be free of amplitude variations and that the average signal voltage applied to the discriminator remain fairly constant.

(2) When the signal voltage appearing across the grid circuit of any one of the fixed if. stages, V4 through V8, exceeds a certain value, an increase in grid current causes limiting action or cutoff of signal peaks for one half-cycle of the signal voltage, and plate current saturation causes similar limiter action to the other half-cycle of the signal voltage. In this manner, limiting of amplitude variations is accomplished in both the grid and plate circuits. When the average signal level is higher than that necessary to produce the required output, the grid current is increased to the point where grid current rectification occurs. The associated grid leak resistor develops a voltage across it which is negative at the grid of the tube. This negative voltage tends to bias the tube, thereby reducing the gain of the stage accordingly.

(3) While all stages of the if. amplifier-limiter circuit are capable of providing the action described above, the gain of the receiver is such that the signal voltage levels across the grid circuit of the first if. amplifier stages normally are not high enough to start limiting action there. Thus, limiting action is confined to limiter stage V8.

(4) When the receiver is in standby condition and no signal is being received, the noise voltages in the antenna and the internal noises inherent in the rf stages of this and any high-gain circuit are amplified by the several receiver stages. The amplification is sufficient to produce a voltage across the input to limiter V8 to cause limiting action. Grid current rectification causes a reduction in the gain of that stage. Normally, under no-signal conditions that stage operates at reduced gain.

18. Discriminator Circuit V9 and Diode Section of V10

(figs. 15 and 16)

a. Discriminator Function. The discriminator converts frequency variations of the incoming signal into audio frequencies. Frequency variations of the signal from the 4.3-mc center frequency at the input to the discriminator are translated into amplitude variations. The rate with which the frequency varies from 4.3-mc center frequency is translated into the rate at which the amplitude of the output voltage of the discriminator changes. Because the change of the signal frequency from 4.3-mc is at an audio frequency (af) rate, the change in amplitude of the output voltage from the discriminator is at the same af rate.

b. Circuit Arrangement. The discriminator circuit includes the tuned circuit in tuning assembly T11, diode tube V9, the diode section of a type 1S5 diode-pentode tube, V10, the output load resistors (R31 and R32), capacitors, and a dc return path for the diodes established by choke coil L14. The circuit shown in figure 15 differs from a conventional Foster-Seely discriminator in that there is no inductive coupling between the limiter plate load impedance (T10) and the discriminator tank circuit (T11).

(1) The tuned portion of the discriminator tank circuit in T11 consists of a center-tapped coil, shunted capacitors C57 and C58. The inductance of half of the coil is equal to the inductance of the other half. The combined values of C57 and C58 tune the total inductance provided by the coil. Capacitors C57 and C58 also maintain the discriminator balance for signal frequencies and prevent dc plate current in V8 from flowing through the discriminator tank coils. Variable capacitor C67 (associated with the tank circuit) keeps the discriminator in balance. Capacitor C97 and C98, when used, serve to maintain discriminator balance.

(2) The output of limiter stage V8 is coupled

to the electrical center of the discriminator tank circuit by a direct connection from the plate of V8 to the tap between C57 and C58. There is no inductive coupling between the plate load (coil and C56 in T10) of the limiter stage and the tuned circuit of the discriminator, because the two coils are in separate cans and are magnetically independent of each other.

(3) The discriminator rectifier circuit consists of diodes V9 and V10 and rectifier load resistors R31 and R32. The dc return path from the cathode load resistors to the plates is established through choke coil L14. The high impedance of this coil at intermediate frequencies prevents hf currents from flowing through it. It represents an effective short circuit for dc and audio frequencies. Hf currents are bypassed to ground around the load resistors by capacitors C59 and C60. Bypass capacitor C68 places the filament (pin 7) of V10 at ground potential for these frequencies.

c. Discriminator Operation. The operation of the discriminator depends on the connection of the circuit in the form of an unbalanced bridge. The vector relationships of such a circuit are extremely complex, but the following can be shown:

(1) At the center frequency (4.3), the if. voltages applied to the diodes are equal.

(2) When the if. signal goes above 4.3 mc, the voltage applied to V9 increases and the voltage applied to V10 decreases.

(3) When the if. signal goes below its center frequency, the voltage applied to V9 decreases and the voltage applied to V10 increases.

(4) For a modulated signal, the frequency shift above and below the 4.3-mc frequency occurs at an af rate; therefore the changes in voltage across rectifier load resistors R31 and R32 occur at the same af rate. The resulting alternating voltage developed across the discriminator output (taken between terminal 3 of V9 and ground) and delivered to the audio amplifiers through isolating choke coil L15, low-pass filter network R36 and C81, and coupling capacitor C63 represents the af modulation originally transmitted from the distant transmitter. A typical response characteristic, representing the change in discriminator output voltage with changes in frequency of the incoming signal, is shown in figure 16.

d. Discriminator Characteristics. Note that for proper operation, the circuit must be balanced for both signal voltage and dc currents. Signal balance is obtained by adjusting the coil in T11 so that the center or resting frequency, 4.3 mc, of the incoming signal occurs at the midpoint between the two resonant peaks at 4.25 mc and 4.35 mc. Capacitor C97 (and C98, when used) helps to maintain discriminator balance for signal voltages. During alinement procedure, this is accomplished by adjusting the iron dust core of T11 until a 0-volt reading is obtained between test point E5 and the chassis while a 4.3-mc signal is applied to the discriminator input. Proper spacing of the resonant peaks with respect to the center frequency is obtained by adjusting variable capacitor C67. Adjustment of this capacitor alters the frequency at which the series-resonance conditions occur for frequencies below the center frequency and, therefore, effectively alters the peak separation. If the resonant peaks do not occur at 50 kc from the 0-volt center setting of the discriminator, an adjustment of C67 can be made which will shift these peaks relative to the zero setting. The two voltages measured also should be numerically equal to each other within 2.0 volts. Failure to obtain the 0 ±.5-volt reading with 4.3 mc input indicates improper alinement of the discriminator. If the two voltages for the two frequencies (30 kc above and below 4.3 mc) are not numerically within 2.0 volts of each other, then the discriminator is *off* balance. Normally, when a fixed component of the discriminator is defective (for example, balanced capacitors C57 and C58 or balanced resistors R31 and R32), balance in the discriminator suffers. Unbalance is not caused by a defective component and it normally may be restored by adjusting the powdered-iron core of T11 and by adjusting C67, as described above. If the bandwidth is incorrect or if the bandwidth is correct but the center frequency is *off*, the coil should be adjusted. This assumes that the preceding stages of the receiver are properly alined and the oscillator is *on* frequency. Note that the adjustments of the coil in T11 and of C67 are not entirely independent of each other. Adjustment of one may require readjustment of the other.

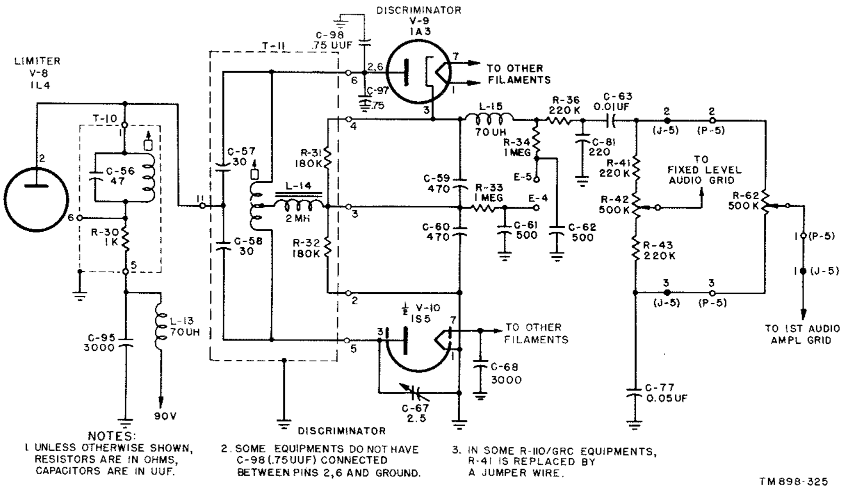


Figure 15. Discriminator circuit.

e. Discriminator Output Circuit. The output of the discriminator is coupled through isolating choke coil L15, isolating and filter resistor R36, and coupling capacitor C63 to the grid circuits of V13 and V12. The low-pass filter composed of R36 and C81 serves to suppress high frequencies, thereby eliminating noise voltages, normally present at the high end of the audio band, and shaping the frequency response of the receiver to compensate for pre-emphasis imparted to the signal by the distant transmitter.

f. Discriminator Measuring Circuits. Test points E4 and E5 are the measuring points provided for determining discriminator operation and discriminator alinement. Test point E4 is connected through isolating resistor R33 to the discriminator center at the junctions of C59, C60, R31, and R32. A meter connected between test point E4 and the chassis effectively measures the voltage across one-half of the discriminator and thus indicates limiter plate tuning. The voltage, measured between test points E5 and the chassis, serves to detremine the overall discriminator output voltage and thus may serve as a measure of discriminator alinement. Each of the two test points, E4 and E5, is connected to the discriminator through an isolating resistor (R33 and R34) and is bypassed to ground for ac frequencies by a capacitor (C61 and C62).

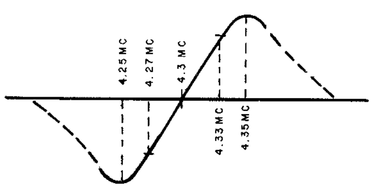


Figure 16. Discriminator response curve.

19. First Audio Amplifier V13

(fig. 17)

a. The first audio amplifier stage uses a type 3Q4 pentode tube V13 in class A audio amplifier circuit with transformer output. The output of the discriminator is brought to the grid of V13 through coupling capacitor C63 (fig. 18) and VOLUME control R62 and pins 1 of chassis connectors P5 and J5.

b. The grid circuit includes a series arrangement of the VOLUME control (R62 and R40) and squelch diode load resistor R39. The bias applied to the amplifier is provided by the voltage developed across R39 by the output of the diode in the squelch oscillator circuit. This bias voltage drives the grid into the cutoff region. The operation of the squelch circuit is described in paragraph 22.

c. The amplified output is coupled through transformer T13 over two paths. The signal voltage developed across winding 7–89 is applied to terminal A of AUDIO connector J7 for use with a headset or the earpiece of a handset and to terminal E of REC CONTROL connector J8. The signal voltage developed across winding 4–5–6 of T13 is applied in push-pull to the grid circuit of audio power amplifier V14.

d. Plate and screen voltages for V13 are obtained through terminals 11 of J5 and P5 which connect the plate and screen circuit of V13 to terminal H of connector J8. When an external connection is placed between terminals H and J of J8, plate and screen voltages are applied to V13. The plate and screen supply circuits for V13 continue from terminals 12 of P5 and J5, and through voltage-dropping and B+ filter resistors R47 and R75, to the junction of the plate (pin 5) of voltage regulator V15 and filter resistors R57 and R60 (fig. 25). By connecting the audio tube plate circuit to this point in the B+ supply, the remainder of the receiver circuits are effectively isolated from the effects of changes in B+ supply loading. Such changes in the B+ supply load occur when the audio tubes are biased on or off under control of the squelch circuit. The connection between terminals H and J of J8 may be a jumper strap, the contacts of an external relay, the coil of an external relay, or the contacts of a switch. The exact nature of the connection depends on the arrangement of the particular system in which the unit is used. Note that no plate or screen voltage exists at tube pins 2 and 4, unless this connection is made. Note also that if the coil of a relay is connected between these terminals, the relay will be energized when V13 draws plate current and will be de-energized when V13 plate current is cut off. The resistance of the relay coil should not exceed 1,000 ohms, and the core should be shunted by a suitable capacitor. When the receiver is in standby condition and the squelch circuit cuts off the audio amplifier plate current, the relay thus connected will be de-energized. When an incoming signal cuts off the squelch circuit, and V13 plate current begins to flow, the external relay will become energized. This arrangement is used when the receiver is used with accessory equipment that requires such control.

e. Capacitor C82, in series with R67, shunts the primary winding terminals 1–2–3 of T13 to de-emphasize the hf end of the audio band and to reduce the noise voltages which may be present at

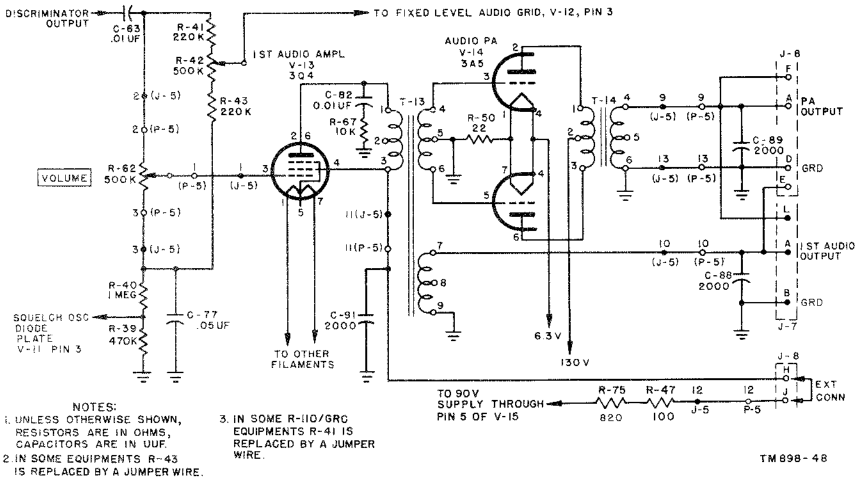


Figure 17. First audio amplifier and audio power amplifier circuits.

that end of the band. Capacitor C77, in the grid circuit, bypasses squelch bias resistors R40 and R39 for audio signals.

20. Audio Power Amplifier V14

(fig. 17)

a. The audio power amplifier stage uses a type 3A5 twin triode tube in a class B push-pull amplifier. The signal voltage developed across the secondary winding (terminals 4, 5, and 6) of T13 is applied in push-pull to the grids of V14. The amplified signals, developed across the primary winding of output transformer T14, are induced in the secondary winding, terminals 4, 5, and 6, of T14, and are routed to terminal L of AUDIO connector J7 and to terminals A, F, and D (ground) of the REC CONTROL connector J8 for connection to a loudspeaker.

b. Plate voltage for V14 is applied to the center tap (terminal 2) of T14 from the 130-volt supply point of the receiver power supply circuit. Plate supply details are shown in figures 23 and 25. Filament voltage is reduced to the required value by voltage-dropping resistor R50.

21. Fixed Level Audio Amplifier V12

(fig. 18)

a. The fixed level audio amplifier stages uses a type 3Q4 pentode tube in a class A audio amplifier circuit. Audio signals developed across the output of the discriminator circuit are routed through low-pass filter R36 and C81 (fig. 15) and through coupling capacitor C63 (fig. 18) to control R42. The movable arm of R42 is connected to the grid of V12. This control is an internal adjustment. It is factory adjusted and should not be touched unless the output of V12 fails to meet the requirements listed in paragraph 5. The grid circuit of V12 includes R42 in series with resistors R41, R43, and squelch diode resistors R40 and R39. Resistor R39 also acts as the load resistor for the squelch diode rectifier in the squelch oscillator circuit (par. 22). Under no-signal conditions, the rectifier diode of V11 applies a voltage across R39, the magnitude and polarity of which are such as to cut off plate current in the fixed level audio amplifier V12. This cutoff bias is removed when an incoming signal cuts off plate current in the squelch oscillator tube. An alternative method of removing squelch bias is to turn the squelch return to its OFF position. Refer to paragraph 22 for squelch circuit details. The grid is returned to ground for signal frequencies through level control R42, voltage-dropping resistor R43, and bypass capacitor C77. (On some equipments, R43 and R41 have been replaced with a jumper wire.)

b. Plate and screen voltages are obtained from the plate (pin 5) of V15 through voltage-dropping resistor R75 and an additional filter section composed of resistor R45 and capacitor C80A. The output of V12 is applied through primary plate winding 1–2–3 to winding 7–8–9 of T12 by induc-

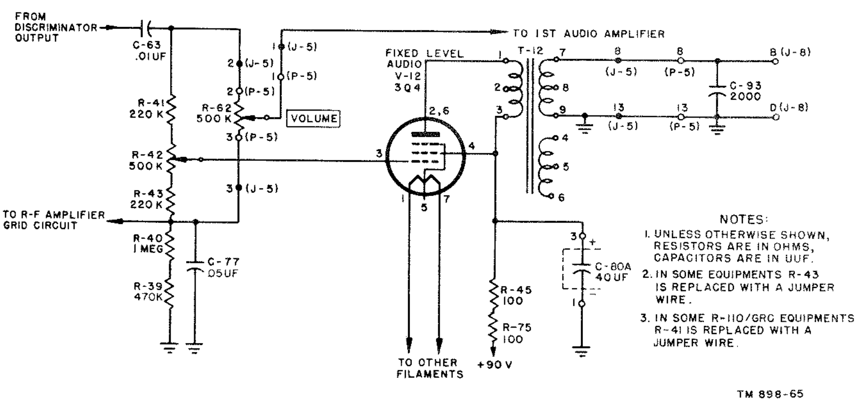


Figure 18. Fixed level audio amplifier circuit.

tive coupling and then through terminals 8 of chassis connectors J5 and P5 to terminal B of J8. Capacitor C93 acts as a hf filter.

22. Squelch Circuit V11

(figs. 19, 20, and 21)

a. The squelch circuit uses a type 1S5 tube V11. The tube combines a pentode and a diode in one envelope. The pentode is arranged to form a tuned plate, tuned grid oscillator. The diode rectifies the oscillator output. The purpose of the squelch circuit is to bias the audio amplifier circuits to cutoff during no-signal conditions of the receiver.

b. In Radio Receiver R–108/GRC and R–109/GRC (figs. 19 and 20), the grid circuit of the oscillator extends through L20A and R74 to the junction of R68 and R69. The end of R68 connects to the grid of the fourth if. amplifier stage, V7, and through V7 grid resistor R24 to ground. The other end of R69 connects to the grid of limiter stage V8 and through V8 grid resistors R27 and R28 to ground. Because R24, in the grid circuit of V7, and resistors R27 and R28, in the grid circuit of V8, are also in the grid circuit of V11, any voltages developed across them are also applied to the grid of V11 and thus determine its operation.

(1) When no signal is present in the receiver, the noise voltages appearing at the input to V7 cause a relatively small grid current to flow through R24. Similarly, the noise voltages appearing at the input to V8 cause relatively small grid current to flow through R27 and R28. The resultant small dc voltage developed across R24, R27, and R28 applies little negative bias to the grid of V11. This bias is low enough to permit V11 to sustain oscillations. Ac components of this bias voltage are bypassed to ground through capacitor C78.

(2) When a signal enters the receiver, the grid current flow in V8 increases, and the voltage drop across R27 and R28 increases proportionately. Similarly, an increased signal at the grid of V7 causes an increase in the grid current flow through R24. When the resultant negative bias voltage applied to the grid of V11 becomes large enough to bias the oscillator to cutoff, the oscillations cease.

(3) In Radio Receiver R–108/GRC only, a portion of the rectified voltage appearing at the junction of R68 and R69 is applied, through R70 and R76, as an agc voltage to the grid circuit of the first rf amplifier stage V1. Ac is bypassed to ground by C78 and C94. The arrangement functions as follows: The signal levels that appear at the grids of V7 and V8 are functions of the signal input level and the overall receiver gain. A large signal entering V1 causes the rectified grid currents to develop relatively large voltage drops across R24 and across the series arrangement of R27 and R28. The resultant voltage appearing at the junction of R68 and R69 is applied as negative bias to the grid of V1, and thus reduces the gain of V1. Conversely, a low-level signal entering the receiver produces a relatively small negative bias voltage at the junction of R68 and R69; consequently, a relatively small negative bias voltage is applied to the grid of V1. The result is that the gain of V1 is not measurably affected at low signal levels.

(4) In Radio Receiver R–109/GRC only (fig. 20), R70 is connected from the junction of R68 and R69 to ground and is therefore in the grid circuit of V11. No agc bias is applied to the grid of V1.

c. In Radio Receiver R–110/GRC only (fig. 21), the grid circuit of the squelch oscillator extends through L20A to the junction of resistors R69 and R70; this shunts V8 grid resistors R27 and R28. Thus any voltages developed in the grid circuit of V8 are also developed across R69 and R70. The portion across R70 is applied to the grid of V11 and thus determines its operation.

d. The output of the oscillator is coupled through capacitor C76 to the plate of the diode section of V11. When the oscillator is operative, its output is rectified by the diode circuit. The rectified voltage is developed across diode load resistor R39. Since diode load resistor R39 is the common dc ground return path for the grid circuits of first audio amplifier V13 and fixed-level audio amplifier V12 (figs. 18, 19, 20, and 21), any voltage developed across it is applied as bias to the grids of these tubes. During a nonsignal period, the squelch oscillator is operative and a negative voltage is developed across R39. This voltage is ap-

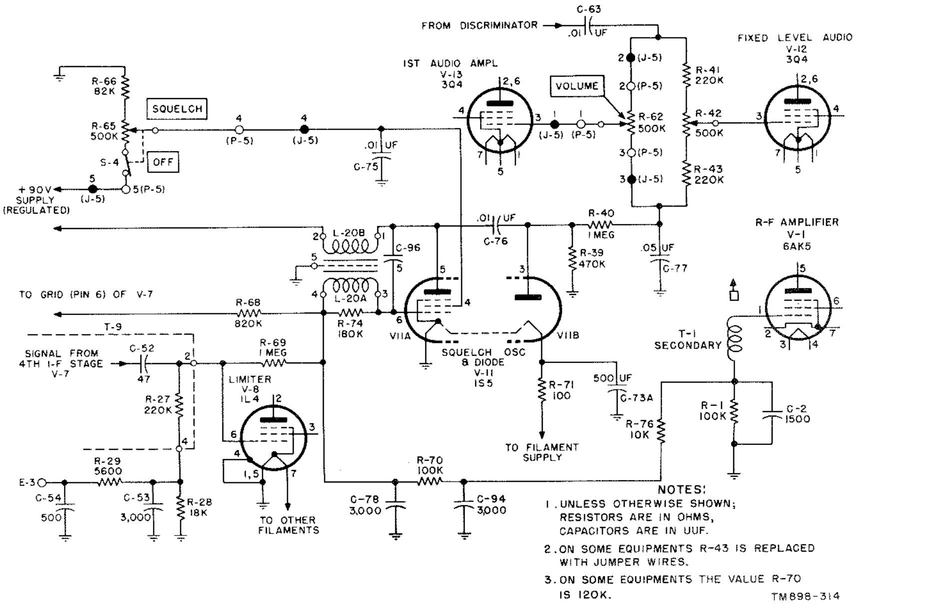


Figure 19. Radio Receiver R-108/GRC, squelch circuit.

plied as negative bias through V40 and potentiometer R62 to the grid of V13 and also through R40, R43, and potentiometer R42 to the grid of V12. The magnitude of this bias voltage is large enough to drive these audio-amplifier tubes to cutoff. When a signal enters the receiver and the squelch oscillator is driven to cutoff, the diode stops conducting, the voltage across R39 disappears, the negative bias is removed from the grids of V12 and V13, and these tubes are returned to operation as conventional class A amplifiers. The audio signal from the output of the discriminator then can pass through the audio amplifiers and provide an audio output. Note that when SQUELCH potentiometer R65 is tuned to its extreme counterclockwise position, switch S4 in the screen circuit of V11 is opened, screen voltage is removed, and the squelch oscillator is disabled.

e. Plate voltage for the oscillator section of V11 is obtained from the regulated power supply circuit. Screen voltage is obtained from the regulated power supply through terminals 5 of chassis connectors J5 and P5, SQUELCH switch S4, SQUELCH potentiometer R65, and terminals 4 of P5 and J5. The screen circuit is bypassed by capacitor C75. This potentiometer and switch S4 are coupled mechanically so that when R65 is in the extreme counterclockwise (OFF) position, the switch opens, disconnects screen voltage from V11, and thus disables the squelch circuit. The level of the signal generated by V11 is determined by two factors:

(1) One is the setting of R65; when in the maximum clockwise position, the full 90 volts is applied to the screen. The amplitude of the oscillator signal then is high and the squelch biasing voltage developed across R39 is relatively large. As R65 is rotated in the counterclockwise direction, the applied screen voltage, the

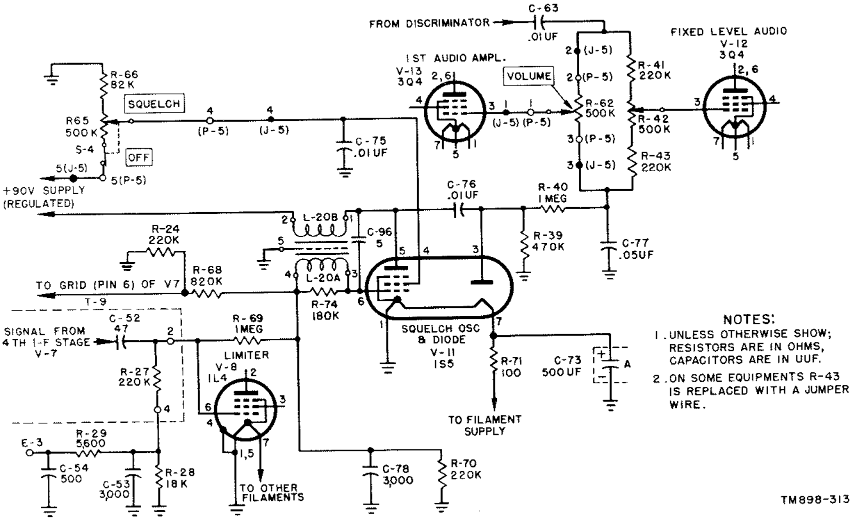


Figure 20. Radio Receiver R–109/GRC, squelch circuit.

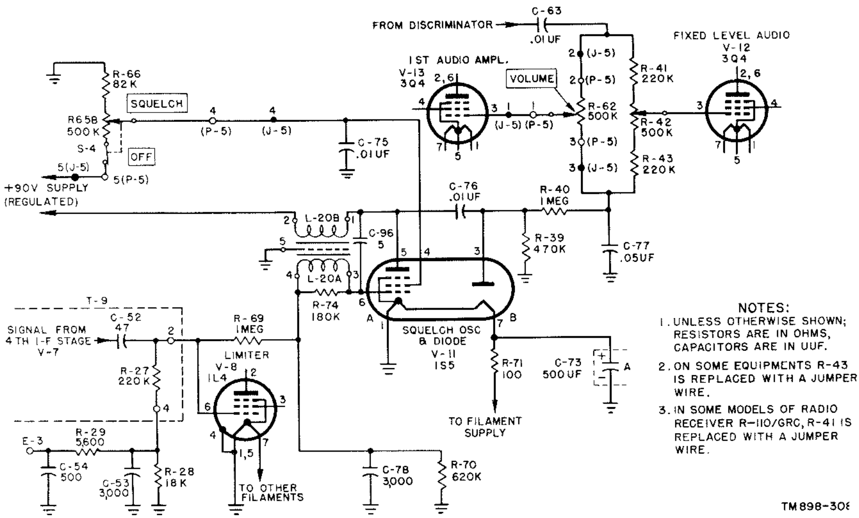


Figure 21. Radio Receiver R–110/GRC, squelch circuit.

level of the generated oscillator output, and the diode output voltage across R39 is decreased accordingly.

(2) The other factor affecting the output of the oscillator is the bias voltage applied to its grid circuit. The greater the negative bias, the lower the amplitude of oscillator output. The magnitude of the bias voltage is a function of the gain of the receiver under the particular condition of operation. The magnitude of the bias voltage also is a function of the relative limiting characteristics of V7 and V8. Limiter operation is described in paragraph 17. When no signal enters the receiver, the noise voltage is amplified by the full gain of the receiver. Because the noise level is relatively low at the grids of V7 and V8, very little grid current flows, and the bias voltage applied to the squelch oscillator is small. This means that the oscillator is operative at low squelch control settings, and it biases the audio amplifier tubes to cutoff. When a threshold signal enters, the limiter grid current rises, and the bias applied to the squelch oscillator is sufficient to cause oscillations to cease. When stronger signals enter the receiver, V7 and V8 grid current increases still further and both tubes start limiting. This increased negative voltage also keeps the squelch oscillator from operating. For any setting of the SQUELCH potentiometer, a certain minimum level of signal is required to produce a bias voltage at the grids of V7 and V8 large enough to disable the squelch oscillator.

f. Radio Receiver R–110/GRC does not use the bias developed in the grid circuit of V7 for operation of the squelch oscillator (fig. 21).

23. Tuning Oscillator (Part of V10)

(fig. 22)

a. The pentode portion of dual purpose tube V10 is used as a crystal-controlled oscillator for generating a fundamental frequency of 4.3 mc and harmonics of 4.3 mc. The pentode is connected as a triode. The 4.3-mc crystal is connected between the control grid and the plate through dc blocking capacitor C70. The oscillator grid circuit includes grid lead resistor R35 and grid lead bypass capacitor C72. Capacitor C72, in conjunction with C74 which is connected from plate to ground, establishes the required capacitance for the crystal circuit and provides the required voltage feed-back ratio for oscillation. The plate circuit extends through coaxial connectors J4 and P4 and through a coaxial cable to the contacts of section A of test switch S3. When this switch is in the TUNE position, the oscillator plate circuit is extended through coupling capacitor C84 to the receiver rf amplifier. The output level of the oscillator can be measured at binding post E6 which is associated with ANT connector J3. When switch S3 (fig. 22) is in either one of the DIAL LIGHT positions, contact A 2 or A 3 grounds the oscillator plate circuit. When the oscillator is operative (S3 in the TUNE position), a portion of the oscillator output is fed by internal capacity coupling to the diode section of V10. Harmonics of the 4.3-mc crystal oscillator are picked up in the antenna circuit of the receiver, fed through the receiver circuits, and mixed in receiver mixer V2 with the output of receiver variable oscillator V3. The resultant intermediate frequency enters the discriminator circuit in the normal manner. In the discriminator circuit, the signal entering from the receiver circuits and the 4.3-mc signal of V10 are mixed and produce a beat note. This beat note may be used for calibration purposes.

b. If the variable mixer oscillator of the receiver is accurately calibrated against the dial, the resultant difference frequency is zero. Slight tuning to either side of the zero position will result in an audio note. This audio beat note enables the operator to make precise frequency adjustments since the highest audio note will be only a very small fraction of a .1 megacycle. The presence of the audio beat note therefore is considered as an accurate index for calibrating the oscillator against the dial. If the receiver oscillator is off frequency, the difference between the resultant intermediate frequency and the 4.3-mc signal applied to the receiver from the tuning oscillator is much greater than that necessary to produce an audio beat note, and no audio signal is heard in the headphones. Calibration of the receiver oscillator then involves adjusting its tuned circuits so as to produce audible beat notes in the headphones for the red dot positions of the tuning dial.

c. The calibration frequencies which can be selected by the tuning circuits of the receiver are tabulated below.

Radio Receiver	Calibration frequency (mc)
R-108/GRC	21.5 and 25.8.
R-109/GRC	30.1, 34.4, and 38.7.
R-110/GRC	38.7, 43.0, 47.3 and 51.6.

d. Plate voltage for the operation of the crystal oscillator is shunt-fed from the 90-volt internal supply circuits through a network consisting of isolating coil L19 and C71.

and V13; the path from V15 to V13 is by way of an external relay (or a jumpered connection) between terminals H and J of J8.

b. One screen and plate circuit branch includes all the rf, if., discriminator, and squelch circuit tubes. This branch path includes rf filter networks consisting of choke coils L6, L10, L12, L13, L18, and L19 and the associated bypass capacitors. The screen supply circuit for squelch tube V11 extends from the regulated 90-volt supply through terminals 5 of P5 and J5, and includes SQUELCH potentiometer R65, the SQUELCH switch S4, and voltage-dropping resistor R66. When the SQUELCH control is in the extreme counterclock-

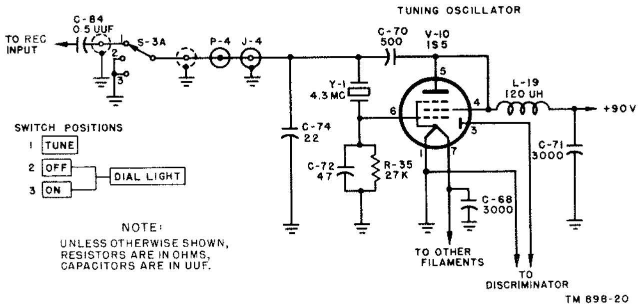


Figure 22. Tuning oscillator circuit.

24. Plate and Screen Supply Circuits
(figs. 23 and 25)

a. The plate and screen supply circuit extends from pin 8 of J2, the output terminal of the vibrator power supply unit (fig. 25), and is routed through voltage-dropping resistor R54 and switch S1B over several paths to the plates and screens of tubes in the receiver. One path extends directly to the plates of audio output tube V14. Another path extends through voltage-dropping resistor R57 and ripple filter circuits R60 and C80C to several branch paths (fig. 23). Voltage regulator tube V15 (par. 25), connected between the junction of R57 and R60 to ground, serves to insure that a uniform voltage is applied to the plates and screens of tubes associated with these branch paths in spite of changes in load conditions or battery input voltages. Another path extends from the junction of R57 and pin 5 of V15 to the plates and screens of audio amplifier stages V12

wise position, switch S4, which is mechanically ganged with the shaft of the SQUELCH potentiometer, is open and no screen voltage is applied to V11. If the SQUELCH potentiometer is rotated in a clockwise direction, increasingly larger screen voltage is applied to that tube. The plate and screen supply for fixed-level audio amplifier tube V12 extends from pin 5 of V15, through voltage-dropping resistor R75 and filter resistor R45. The plate and screen supply for first audio amplified stage V13 extends from pin 5 of V15, through voltage-dropping resistor R75 and filter resistor R47, through pin 12 of J5 and P5, to terminal J of J8, through external jumper to terminal H of J8, through pins 11 of P5 and J5, to V13. The audio circuits are connected to a separate point in the B+ supply to prevent changes in load from affecting the operation of the remainder of the receiver tubes. These changes are caused by the conduction or nonconduction of the audio tubes

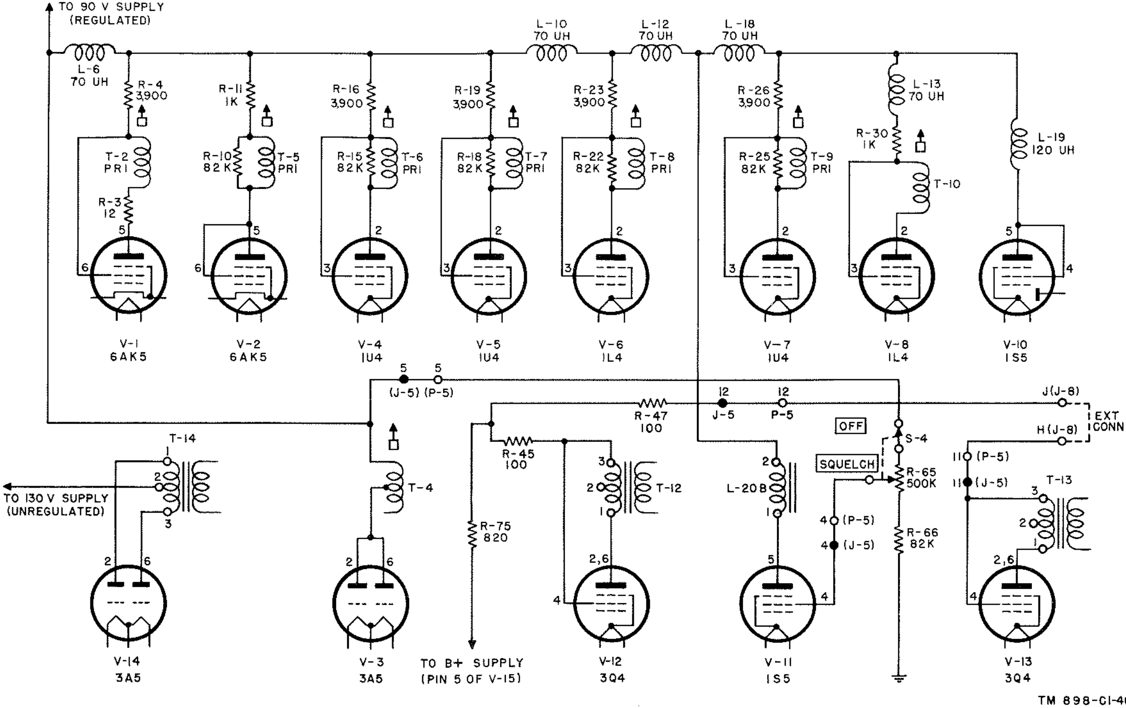


Figure 23. Plate and screen supply circuits.

under control of squelch bias. An improvement in power supply regulation is thus obtained.

25. Filament Circuits

(figs. 24 and 25)

The filament circuits of all tubes except V14 extend through overvoltage relay circuit to terminal 5 of overvoltage relay K1. The filament circuit of V14 extends from terminal 1 of J2 or pin A of J6 (when external supply is used) through switch S1A, directly to the filaments of V14 and through voltage-dropping resistor R50 to ground. It does not include the overvoltage relay.

a. The filaments of the tubes in the receiver are arranged in several 6-volt series-parallel strings as shown in figure 24. The 6-volt tubes, V1 and V2, each represent one string. Isolating chokes and filter capacitors are used throughout to prevent ac currents in one stage from entering tubes in the same or associated strings. This is particularly true of hf circuits. Voltage-dropping resistor R21, in series with V6, resistors R13 and R14 in series with V4 and V5, and resistor R71 in series with V11 drop the 6.3V input to the required value. Ripple filters are inserted in series with filaments of tubes that require a high degree of stability in operation. The filter composed of voltage-dropping resistor R71 and filter capacitor C73A therefore is connected in series with the filament of V11. Similarly, the parallel arrangement of voltage-dropping resistors R44 and R48 and capacitor C37C constitutes a ripple filter for the filament supply of V12 and V13. Resistor R38 and capacitor C73B form a ripple filter for the supply to the receiver oscillator tube V3. The series arrangement of R37 and R38 is shunted across the portions of the filament strings as shown in figure 24 to limit the current flow through V12 and V13 filaments to the required values.

b. The DIAL LIGHT circuit is connected across the unregulated filament supply lead by

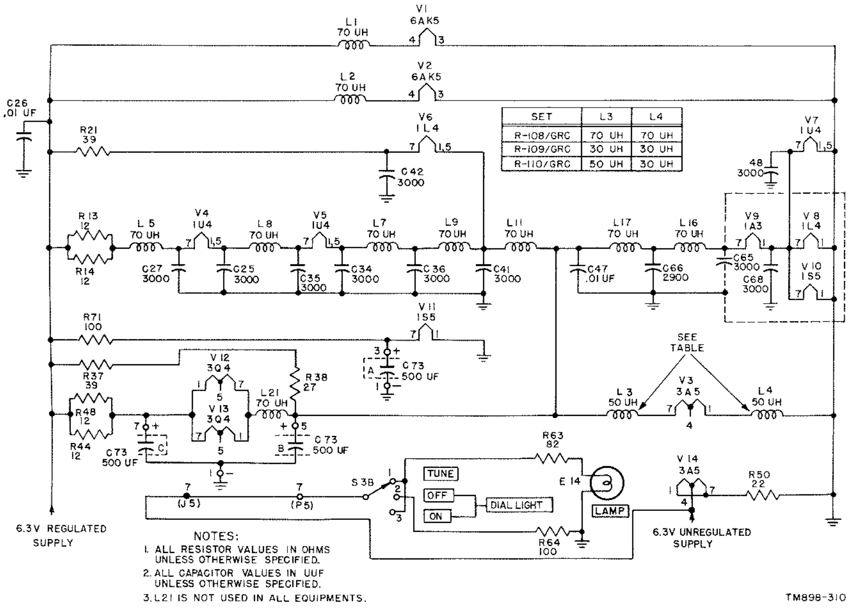


Figure 24. Filament circuits.

switch S3B in either the TUNE or ON positions. Resistor R36 is a voltage-dropping resistor. Resistor R64 represents a dummy load on the filament supply circuit equivalent to that represented by the combination of R63 and the dial lamp; this insures constant drain on the filament supply under all conditions of operation. The dial light illuminates the dial whenever the receiver is to be tuned. It also serves the auxiliary purpose of indicating that the tuning oscillator is turned on and that the filament supply circuit is operative. During operation within a system installation, the dial light goes on whenever S3 is turned to either one of the two positions mentioned above. This is an indication that the filament voltage is being applied to the receiver filaments.

26. Power Supply Circuits Arranged for 24-Volt Operation

(fig. 25)

a. Battery Circuit. The 24-volt storage battery is connected between terminals B (+) and C (−) (ground) of POWER IN connector J6. The battery circuit extends through a 4-ampere fuse, F1, and through contacts of power switch S2 to terminals 15 of chassis connectors P5 and J5. Switch S2 is mechanically coupled to VOLUME control R62, and is turned on when the control is rotated away from its extreme counterclockwise position. The branch circuits which are supplied from this point are described in *b* through *d* below. Capacitor C87 is a battery decoupling filter.

b. Hv Supply Circuit. The vibrator power supply is connected between terminals 3 (+) and 7 (−) of male connector J2. The power supply unit converts the storage battery voltage to the hv plate and screen supply. The output voltage, approximately 135 volts, is developed across terminals 8 (+) and 7 (−) of J2. (The operation of the vibrator power supply unit is described in TM 11-5040, Power Supplies PP-281/GRC, PP-282/GRC, and PP-448/GR.) The voltage is then applied through R54 and section B of S1 to the plate and screen circuits of the set.

(1) One output circuit applies plate voltage directly to V14.

(2) Another path is through R57 and R60 to the plates and screen of V1 through V8, V10, and V11. The screen voltage for V11 is taken from the arm of SQUELCH potentiometer R65.

(3) From the junction of R57 and R60, the hv supply branches off through R75 and extends through R45 to the plate and screen of V12, and through R47 and pins 12 of chassis connectors J5 and P5, to terminal J of REC CONTROL connector J8. The 90-volt potential appearing at this terminal is used to supply the plate and screen of first audio amplifier V13, when a connection is established externally between terminals J and H of J8.

(4) Voltage regulator tube V15, a tube type CB2, is connected from the junction of R57 and R60, across the hv supply, to the chassis. This tube limits the maximum output voltage of the circuit. Resistors R54, R57, R60, R75, R45, R66, and R47 are voltage-dropping and filter resistors. Plug-in electrolytic capacitor C80A, C80B, and C80C serve as power supply ripple filters. Capacitors C83 and C92 are rf filters and serve to prevent interstage coupling of the hf circuits through the common power supply.

c. Filament Supply Circuits. Connector X1 of Power Supply PP-282/GRC provides a strap connection between terminals 3 and 6 of J2 in the power supply compartment of the receiver. This connection arranges a group of voltage-dropping resistors (R53, R73, R58, R61, and R72, and thermal resistor R59) to drop the 24 volts from the storage battery to the 6 volts required by the receiver filaments and dial lamp E14.

(1) The strap connection between terminals 3 and 6 of J2 connects the battery circuit through the voltage-dropping resistors, switch S1A in the 6, 12, and 24 VOLTS position, the filament of tube V14, and voltage-dropping resistor R50, to ground. Depending on setting S3, either E14 is in series with R63 or R64 is shunted across V14 filaments leads and across R50.

(2) The strap connection between terminals 3 and 6 of J5 also connects the battery circuit through voltage-dropping resistor R61; ballast tube R59; over S1C in the 6, 12, and 24 VOLTS position; and resistor R52, which is normally shorted by the closed contacts of thermal overvoltage relay K1; to the series-parallel, 6-volt arrangement of receiver tubes V1 through V13 (par. 25). The ballast tube is essentially a variable resistor; its resistance

(over its normal operating range) depends on the applied voltage. If the battery voltage decreases, the voltage applied across R59 decreases and the resistance of R59 decreases accordingly. The result is a constant current through the circuit and a constant voltage available for the receiver filaments, provided the resistance of the load circuit is constant. If the load varies, R59 tends to maintain a constant current so that the load voltage (filament) will vary correspondingly.

(3) The filament supply circuit is shunted by the series arrangement of resistors R55 and R56 in parallel and the coil (heater element) of thermal relay K1. The normally closed contacts 5–7 of the relay are connected across resistor R52, and the combination is in series with the filament supply circuit. This arrangement serves to protect the filament circuit against an overvoltage condition, which might occur when a filament in the series-parallel filament circuit of the receiver breaks down. As long as the voltage across the heater element does not exceed a certain predetermined value, the shorting contacts remain closed and the circuit arrangement is as described above. The values of R61, R55, and R56, and the value and placement of R59 are selected so that the required voltage is obtained across the relay heater. When the voltage to the receiver filaments (effectively at pin 7 of K1) exceeds 7.5 volts, the voltage across the heater element of K1 increases and causes the relay to operate. Contacts 5 and 7 in K1 open and places resistor R52 in series with the receiver filaments and filament supply circuit. The increased resistance in these circuits drops the filament voltage to a safe value, but maintains it high enough to allow circuit checking. The relay contacts remain open until power is removed from the receiver unit.

d. Dial Lamp Supply Circuit. Power for energizing the dial lamp is obtained for the filament supply circuit, as shown in figure 25. The filament supply circuit extends from pin 1 of J2 through S1, terminals 7 of J5 and P5, to section B of switch S3. When this switch is in either the TUNE or ON position, dial lamp E14, in series with voltage-dropping resistor R63, is effectively shunted across the filament supply circuit. When S3 is in the OFF position, the series combination of R63 and E14 is disconnected and an equivalent load resistor R64 is placed across the filament supply. Other contacts of switch S3, in the TUNE position, turn on the tuning oscillator (par. 27).

27. Power Supply Circuits Arranged for 12-Volt Operation

For operation from a 12-volt storage battery, Power Supply PP–281/GRC is used. The strap connection provided by connector X1 of Power Supply PP–281/GRC joins terminals 3, 5, and 2 of J2, which short-circuits resistors R58, R73, and R61. Since a lower battery voltage is involved, resistor R53, in parallel with R72 and thermal resistor R59, is sufficient to drop the battery voltage to the voltages required by the filaments of the receiver tubes, and by the pilot lamp. In all other respects the power supply circuits remain as described in paragraph 26.

28. Power Supply Circuits Arranged for 6-Volt Operation

For operation from a 6-volt storage battery, Power Supply PP–448/GR is used. The strap connections provided by socket connector X1 of Power Supply PP–448/GR joins terminals 3, 4, and 1 of J2, thereby shorting resistors R58, R73, R53, R72, and R61 and R59 out of the circuit. The receiver filaments and the dial lamp circuits are thus connected by the strap connections directly to the battery circuit. In all other respects the power supply circuits remain as described in paragraph 26.

29. Operation With External 6.3-Volt and 130-Volt Supplies

(fig. 25)

a. For this type of operation, a power supply capable of providing 6.3 and 130 volts dc is used. The external 130-volt supply is connected between terminals D (+) and C (−) of POWER IN connector J6. The 6.3-volt supply is connected between terminals A (+) and C (−) (ground) of J6. Switch S1 is set in the EXTERNAL SUPPLY position; in this position, the fuse is not in the circuit. Fusing must be provided externally.

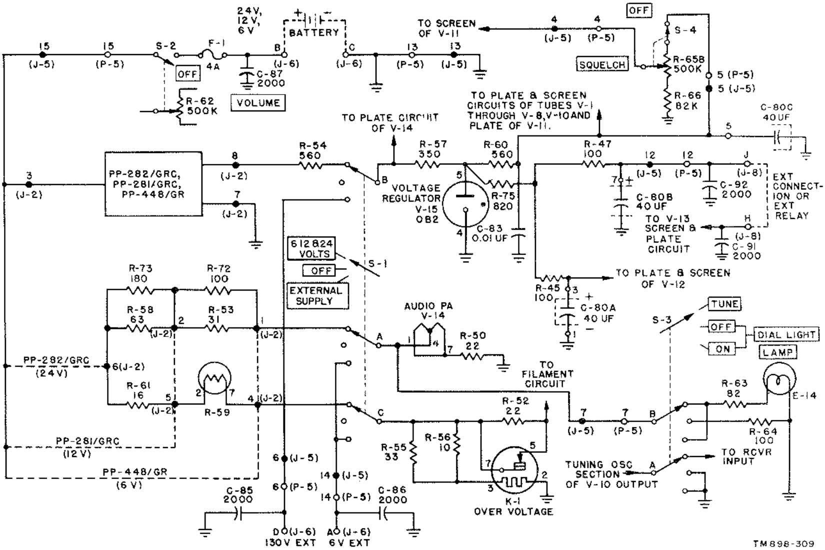


Figure 25. Power supply circuits.

b. The 130-volt supply circuit extends from terminal D of J6, through pins 6 of J5 and P5, section B of S1 directly to the plate circuit of V14, and through the voltage regulator and filter circuits, to the plate and screen circuits of the other receiver tubes (par. 26). Capacitor C85 is a plate supply decoupling filter.

c. The 6.3-volt supply circuit extends from A to J6, through pins 14 of J5 and P5 of S1A and S1C (in the EXTERNAL SUPPLY position). From this point, the filament and dial lamp supply circuits remain as described in paragraph 26. Capacitor C86 serves as a filament supply decoupling filter.

Section II. MECHANICAL THEORY

30. Dial Drive and Detent Mechanism (Equipment Procured on Order No. 18651–Phila–49)

(figs. 26 and 27)

a. General. The TUNING knob controls the position of the four-gang variable tuning capacitor C3, which tunes the receiver rf and hf oscillator circuits to the desired frequency, and it controls the position of the dial, which indicates the channel to which the receiver is tuned. When desired, a detent mechanism may be engaged and operated by means of the TUNING knob to provide for rapid selection of three present channels. The tuning mechanism is provided with tracking and calibration adjustments for the purpose of insuring accurate frequency calibration.

b. Dial Drive. As shown in figure 26, the dial is gear-driven. The ratio of the drive gear (on the TUNING knob shaft) to the large gear (located behind and attached to the calibrated dial) is such that 4.25 revolutions of the TUNING knob are required to turn the dial through its tuning range. As the dial turns, the small gear (located behind the detent mechanism) also turns about the dial axis. The small gear is a drive gear for a sector gear which drives the tuning capacitor.

c. Detent Mechanism. The diamond-shaped plate, located midway between the tuning knob and the channel window, covers a hole in the front panel which gives access to three detent lock screws and a DIAL calibration corrector screw (*d* below). The lock screws are spaced 120° apart in the hub of the dial and are labeled DET A, DET B, and DET C; they lock the detent disks to the dial-drive assembly so that they move with the dial.

(1) The detent mechanism employs single-tooth detent disks (DET A, DET B, and DET C). Each disk may be turned about the dial axis to an angular position (with respect to one end of the dial) corresponding to any particular desired channel on the calibrated dial.

(2) The tooth on each locked detent is associated with a notched latch. There are

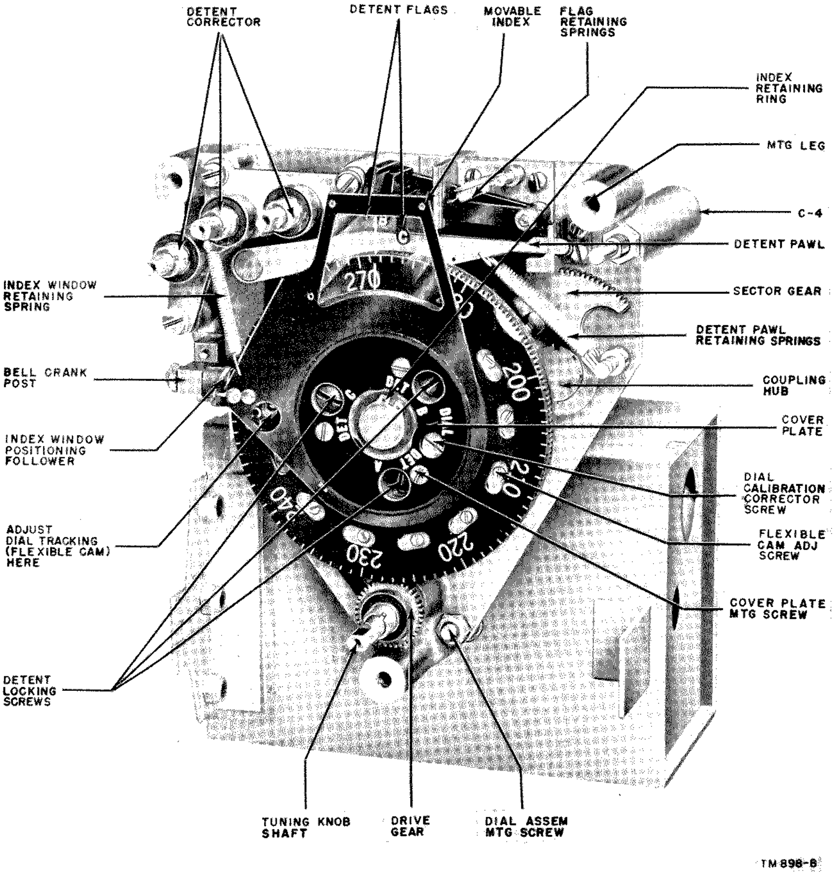


Figure 26. Dial drive and detent assembly, front view (equipments procured on Order No. 18651-Phila-49 only).

three latches, one for each detent. Since the latch is stationary and lies in the path of the detent tooth which is turning with the dial, it functions as a dial stop. Thus each detent-latch combination stops the dial-detent assembly at a definite angular position with respect to the reference point mentioned above, thereby selecting a predetermined channel.

(3) When the dial is set to a channel corresponding to a detent position the tuning knob becomes locked and a small flag drops down into a position in the upper part of the channel window. The flag identifies the detent position. There are three flags, marked A, B, and C, to identify the three detent-selected channels. These letters correspond to those which are marked on the panel above the DETENT VERNIERS knobs and the identification markings for the detent lock screws. The sequence of the identifying letters A, B, and C bears no significance to the sequence in which the detent may be used with respect to in-

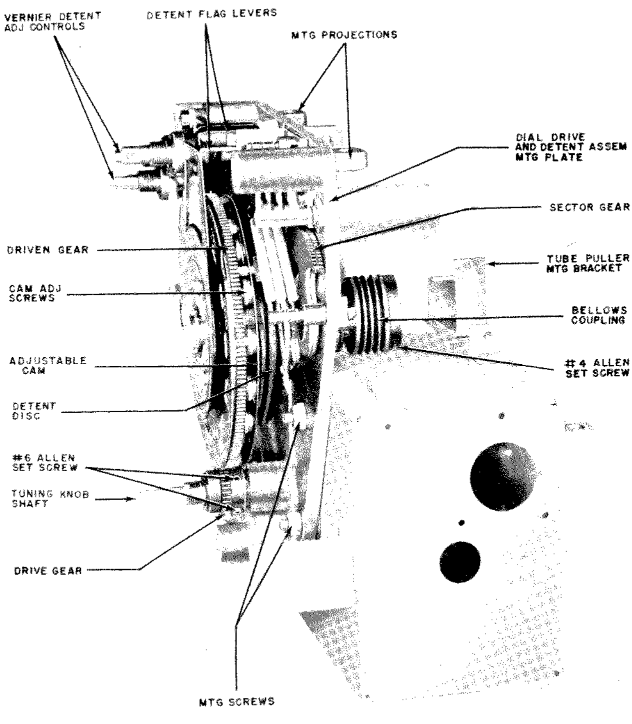


Figure 27. Dial drive and detent assembly, side view (equipments procured on Order No. 18651–Phila–49 only).

creasing dial numbers. Any detent may be used for the low-, medium-, or high-frequency points on the dial.

(4) The three DETENT VERNIERS knobs, located in the upper left-hand corner of the front panel, are used to accurately set the detent mechanism for the three predetermined detent settings of the tuning dial. These verniers control the location of the notched latches with respect to the dial index. This arrangement permits the operator to correct small errors in detent settings.

d. Calibration Corrections. A DIAL calibration corrector screw and a flexible cam (under the large dial gear) are used to provide means for correcting the dial calibration.

(1) The DIAL calibration corrector screw compensates for a uniform error in calibration by rotating the CHANNEL dial with respect to its driving gear.

(2) The flexible cam is used to compensate nonuniform errors in calibration that may be present after the oscillator has been alined. The flexible cam is a disk which is bent by 13 adjusting screws. A follower, which engages the edge of the disk controls the position of the dial index. A spring holds the follower against the surface of the flexible disk. If the flexible disk is warped from its normally flat surface by the adjustment screws, the index window will be moved to compensate for nonuniform calibration errors. The adjustment of this flexible cam is factory preset, and readjustment should not be attempted without proper equipment.

(3) The clockwise tension of the index holds a projection of the index positioning follower lever against the lower surface of the flexible disk, so that the position of the indexes varies in accordance with the curvature of the cam disks.

31. Dial Drive and Detent Mechanism (Equipments Not Procured on Order No. 18651–Phila–49)

(figs. 28 and 29)

The dial drive and detent mechanism on these procurements differs from equipments procured on Order No. 18651–Phila–49 (par. 30) only as described in *a* and *b* below.

a. Index Mark. There is no index window with the calibration mark. The index itself has a calibration mark (fig. 28); this mark is positioned with respect to the markings on the dial plate to correct for dial calibration error.

b. Dial Drive for Equipment Not Procured on Order No. 18651–Phila–49. A recessed screw labeled LOCK adjacent to the DET C screw (fig. 28), secures a small brass wedge against the calibrated dial plate to press it firmly against the large gear. This prevents slippage and backlash. A **T**-shaped index is mounted in place of the index window. This index is mounted by means of a screw and washer against the hum of the dial assembly. An index mark on the curved right arm of the T lines up with the point on the dial to which the receiver is tuned. The hub against which the index is mounted is torsion-spring loaded so that a radial tension in the clockwise direction is imparted to the index. A hook at the left arm of the T engages a pin on the index positioning follower; the pin imparts radial tension to the index positioning follower to hold it against the correction cam. This arrangement adjusts the setting of the index to compensate for dial calibration error.

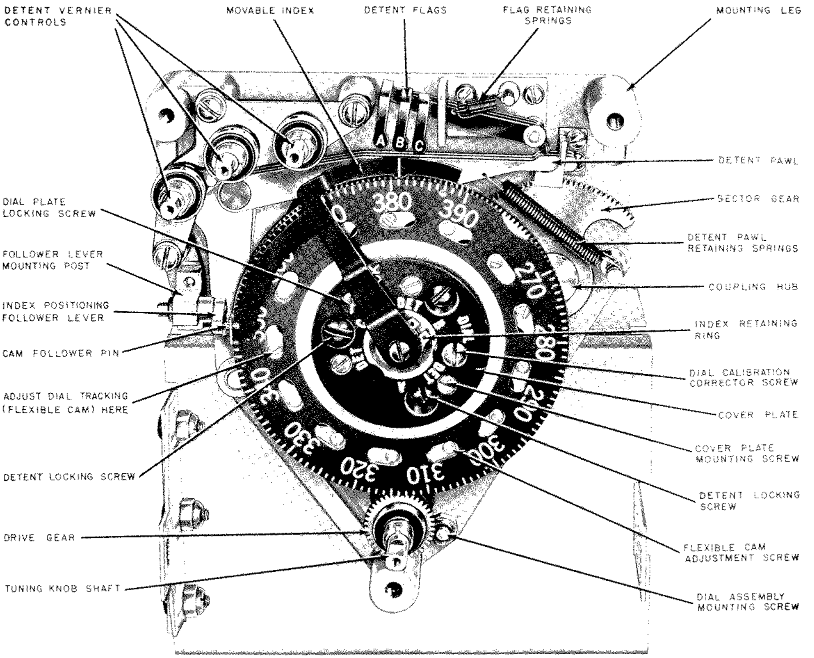


Figure 28. Dial drive and detent assembly, front view (equipments not procured on Order No. 18651–Phila–49).

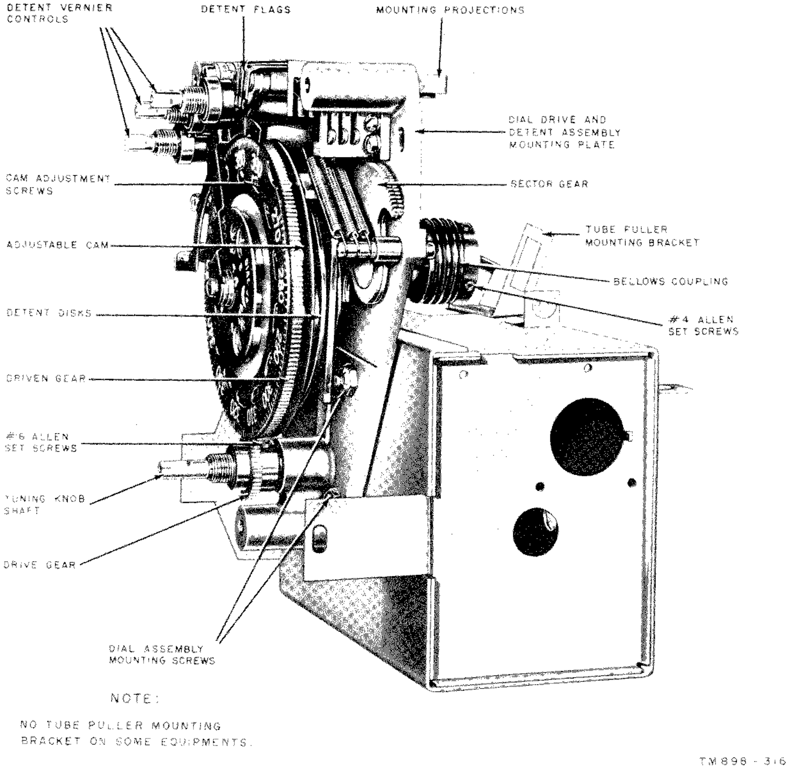


Figure 29. Dial drive and detent assembly, side view (equipments not procured on Order No. 18651-Phila-49).

CHAPTER 3

FIELD MAINTENANCE

Section I. PREVENTIVE MAINTENANCE

32. General

a. Tools and Materials Required. The following tools and materials are not furnished as part of the radio set, but are required for field maintenance.

(1) *Tools.*
1 Tool Equipment TE–41.
1 Tool Equipment TE–113.

(2) *Materials.*
Cheesecloth, bleached, line-free*
Sandpaper, No. 000.*
Cleaning Compound (Federal stock No. 7930–395–9542).

b. Use of Preventive Maintenance Form. DA Form 11–239 is a preventive maintenance check list for the radio receiver. Detailed instructions for use of the form appear on the reverse side of the form. References in the ITEM column are to paragraphs that contain detailed preventive maintenance information. Only those items or portions *not* lined out apply to the equipment.

33. Performing Preventive Maintenance

Every 3 months, perform the following:

a. Observe the general condition of the equipment by operating it. If the controls bind, scrape, are loose, or are not positive acting, repair or replace them.

*Part of Tool Equipment TE–41.

Caution: Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

b. Use cleaning compound to clean dirt and grease from all connectors and controls on the front panel. Clean the frequency indicator window.

Warning: Cleaning compound is flammable and its fumes are toxic. When using, provide adequate ventilation and do not use near a flame.

c. Inspect cables that may be with equipment for cuts or fraying.

d. Inspect J2, J7, J8, and J6 for cracks or breaks.

e. Inspect the case for rust and corrosion.

f. Inspect the seating of fuse, tubes, P5, J5, P4, J4, P1, J1, power supply, and crystal.

g. Inspect C80, C73, and resistors for signs of overheating.

h. Inspect C3 for dirt, alignment of plates, and mounting.

i. Clean with cleaning compound and tighten terminal board E24, if shield, discriminator shield, and dial light switch.

j. Inspect the gasket on back of the front panel for breaks or fraying.

k. Inspect the condition of the moistureproofing and fungiproofing.

l. Inspect the dial glass for cracks.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.
Radio Receiver R108/GRC.	

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

NO	ITEM	CONDITION	NO.	ITEM	CONDITION
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (*receiver,* ~~*transmitter, carrying cases,*~~ *wire and cable,* ~~*microphones, tubes, spare parts,*~~ *technical manuals and accessories*). PAR. 33 a,c		19	~~ELECTRON TUBES – INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS; INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES.~~	
2	~~LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.~~		20	~~INSPECT FILM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.~~	
3	CLEAN DIRT AND MOISTURE FROM ~~ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS,~~ JACKS, PLUGS, ~~TELEPHONES, CARRYING BAGS,~~ COMPONENT PANELS. PAR. 33b		21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR. 33g	
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: ~~TUBES,~~ LAMPS, CRYSTALS, FUSES, ~~CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS.~~ PAR. 33 f		22	~~INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS.~~	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, ~~WORN OR CHIPPED GEARS,~~ MISALIGNMENT, POSITIVE ACTION. PAR. 33a		23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS. PAR. 33h	
6	CHECK FOR NORMAL OPERATION. PAR. 33a		24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 33h	
7	~~CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS.~~		25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS.	
8	INSPECT CASE, ~~MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED~~ METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 33e		26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, ~~BLOWERS, RELAY CASES,~~ AND INTERIOR OF CHASSIS ~~AND CABINETS NOT READILY ACCESSIBLE.~~ PAR. 33i	
9	~~INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN.~~		27	~~INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS.~~	
10	~~INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.~~		28	~~CHECK SETTINGS OF ADJUSTABLE RELAYS.~~	
11	~~INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.~~		29	~~LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER.~~	
12	~~INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES.~~		30	~~INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.~~	
13	~~INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.~~		31	~~CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS.~~	
14	~~CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.~~		32	~~INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE.~~	
15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 33j		33	~~BEFORE SHIPPING OR STORING – REMOVE BATTERIES.~~	
16	~~INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.~~		34	~~INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.~~	
17	~~CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.~~		35	~~INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.~~	
18	~~CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.~~		36	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS. PAR. 33j	
			37	MOISTURE AND FUNGIPROOF. PAR. 33k	
38	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.				

DA FORM 11-239, 1 MAY 51 — REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM898-322

Figure 30. DA Form 11–239.

34. Test Equipment and Materials Required

The test equipment and materials required for troubleshooting are:

a. One of the following power supply combinations:

(1) A 6-volt storage battery and Power Supply PP–448/GR.

(2) A 12-volt storage battery and Power Supply PP–281/GRC.

(3) A 24-volt storage battery and Power Supply PP–282/GRC.

(4) An external supply consisting of a 6.3-volt dc filament supply and a 130-volt dc plate supply.

b. One of the following audio devices:

(1) Handset H–33/PT.

(2) Microphone T–17 with cord and plug and Headset HS–30.

(3) Chest Set Group AN/GSA–6 with Headset-Microphone H–63/U.

c. The following chart lists test equipments with some arbitrary reference symbols which are used in the troubleshooting procedures.

Test equipment	Arbitrary reference symbol	Technical manual
Audio Oscillator TS–382/U	G3	TM 11–2684
Electronic Multimeter TS–505/U	M1	TM 11–5511
Frequency Meter AN/URM–79	M4	TM 11–5094
Frequency Meter Set SCR–211	M4	TM 11–300
Frequency Meter AN/URM–80	M5	TM 11–5095
Frequency Meter TS–174B/U	M5	TM 11–5044
Signal Generator Set AN/URM–48.	G1	TM 11–1257
Rf Signal Generator Set AN/URM–25.	G5	TM 11–5551
Test Facilities Kit MK–153/GRC.		
Electron Tube Test Set TV–2/U or	TV2	TM 11–2661
Electron Tube Test Set TV–7/U	TV7	TM 11–5083
Electronic Multimeter ME–6A/U or	M2	TM 11–5549
Multimeter TS–352/U	M2	TM 11–5527

d. Electrical components, as follows:

(1) Shunting unit, complete with test clips, consisting of a .0062-microfarad (μf) capacitor in series with a 2,700-ohm, ½-watt resistor.

(2) Mica, .0062-μf capacitor.

(3) Two alligator-type test clips.

(4) Resistor, 600 ohms ±1%, ½ watt.

(5) Mica, .001-μf capacitor.

e. Cables and connectors as follows:

(1) Two 4-inch leads with alligator clips on each end.

(2) Battery clips.

(3) Connector, a plug to mate with J8.

(4) Connector, a plug to mate with J7.

(5) Connector, a receptacle to mate with J6 and wire.

(6) Jumper wire.

f. The following tools are either mounted on the receiver or are furnished as spare parts packed separately.

(1) Allen wrenches.

(2) Tube puller.

35. Troubleshooting Data

To help the repairman in detecting and correcting faults the following illustrations are provided to show the location of components and normal electrical measurements at different points in the receiver.

Figure	Description
23	Plate and screen supply circuits.
24	Filament circuits.
25	Power supply circuits.
32	Test setup connections.
33	Receiver chassis, top view.
34	Receiver chassis, left-side view.
35	Receiver chassis, right-side view.
36	Receiver chassis, bottom view of top and rear edges.
37	Receiver chassis, bottom view of bottom and side edges.
38	Receiver chassis, bottom view of tube socket layout.
39	Terminal board E24 and if shield, component location.
40	Discriminator shield and mounting bracket, component location.
41	Radio receiver, front panel, rear view.
42	Radio receiver, front panel, schematic diagram.
43	Voltage and resistance measurements.
44	Receiver chassis, disassembled.
45	Power supply compartment, assembly details.
46	MIL STD resistor color codes.
47	MIL STD capacitor color codes.
48	Radio Receiver R–108/GRC, schematic diagram.
49	Radio Receiver R–109/GRC, schematic diagram.
50	Radio Receiver R–110/GRC, schematic diagram.

36. Troubleshooting Procedure

The tests listed in *a* through *d* below aid in isolating the source of trouble. To be effective, the procedures should be followed in the order given. Trouble should be localized to a particular stage. Then the trouble should be isolated within the stage by appropriate voltage and resistance checks. The service procedure is summarized as follows:

a. Visual Inspection. The purpose of visual inspection is to locate any visible trouble. Through this inspection the technician will frequently discover the trouble, or clues to the trouble. This inspection is valuable in avoiding additional damage to the receiver and in eliminating future failures.

b. Input Resistance Measurement. These measurements prevent further damage to the receiver from possible short circuits. Since this test gives an indication of the condition of bypass capacitors its function is more than preventive.

c. Operational Test. Equipment performance at the time of failure is important because it frequently indicates the location of trouble. In many instances, the information gained will determine the exact nature of the fault.

d. Signal Substitution. The principal advantage of the signal substitution method (par. 45) is that it usually enables the repairman to localize a trouble accurately and quickly to a given stage when the general location of the trouble is not immediately evident from the above tests.

Note. In all these 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 jarring the set. It is possible that the trouble is not in the receiver but in the installation, or the trouble may be caused by external conditions. In this event, test the installation, if possible.

37. Visual Inspection

Remove the receiver chassis from the case and check the following:

a. The seating of P4 (fig. 44).

b. The seating of P1 (fig. 44).

c. The seating of the power supply clamp. In many cases, the vibrator power supply becomes loose because of vibration. This situation may be corrected by fastening the clamp in the correct position (fig. 31).

d. The seating of tubes, relay, and electrolytic capacitors.

e. The seating of S1 (fig. 5).

f. The condition of F1. (A blown fuse usually indicates another fault.)

g. The condition of wiring and connections. Note any poorly soldered connections and charred wiring.

h. The conditions of components that may indicate that they are overheating.

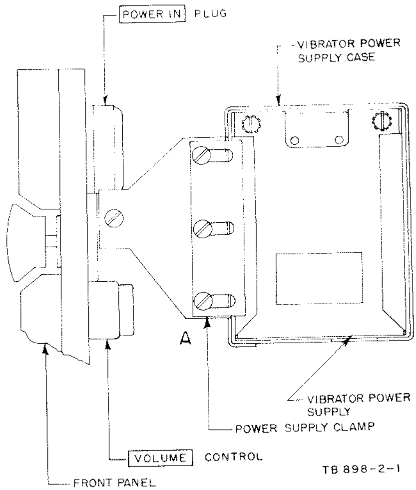


Figure 31. Correct position of power supply clamp.

38. Checking Key Circuits for Shorts

a. First check the vibrator power supply for shorts in accordance with TM 11-5040, Power Supplies PP-281/GRC, PP-282/GRC and PP-448/GR. Then use Electronic Multimeter TS-505/U (M1) or an equivalent meter to check the resistance between each of the points indicated in the following table and chassis. The required readings shown in the table should be obtained before applying power to the equipment. For these measurements, power should be disconnected from the equipment and the vibrator power supply unit should be removed from its compartment on the receiver.

b. If the required readings are not obtained, refer to the schematic diagrams (figs. 48–50) and to the power supply circuit functional diagram (fig. 25) to determine which part or parts may be responsible for the trouble. Incorrect readings may be caused by shorted or leaky bypass capacitors, defective switch contacts or connector pins, burned resistors, or a wire or lug on one of the parts shorted to the chasis. Check each capacitor in the affected circuit section for leakage or a short, and replace it if necessary. Check the wires, the lugs on components, and the contacts on switches. Do not apply power until the trouble has been cleared and all the readings in the table have been obtained.

Point of measurement	Switch position and condition of test	Nominal required reading (ohms)
Term. A of J6 (fig. 34).	S1 in 6, 12, and 24 VOLTS or OFF position.	Infinity.
	S1 in EXTERNAL SUPPLY position.	15.
Term. B of J6.	VOLUME control R62 in extreme counterclockwise position (OFF).	Infinity.
	VOLUME control in any clockwise position.	Infinity.
Term. C of J6.		0.
Term. D of J6.	S1 in 6, 12, and 24 VOLTS position.	Infinity.
	S1 in OFF position	Infinity.
	S1 in EXTERNAL SUPPLY position and SQUELCH in OFF position.	Infinity.
	S1 in EXTERNAL SUPPLY position and SQUELCH in any clockwise position.	582 K.
Term. 1 of J2 (fig. 35).	S1 in OFF or EXTERNAL SUPPLY position.	Infinity.
	S1 in 6, 12, and 24 VOLTS position.	23.
Term. 4 of J2	S1 in OFF or EXTERNAL SUPPLY position.	Infinity.
	S1 in 6, 12, and 24 VOLTS position.	5.
Term. 7 of J2		0.
Term. 8 of J2	S1 in 6, 12, and 24 VOLTS position and SQUELCH in OFF position.	Infinity.
	S1 in 6, 12, and 24 VOLTS position and SQUELCH in any clockwise position.	582 K.
	S1 in OFF or EXTERNAL SUPPLY position.	Infinity.
Term. J of J8 (fig. 35).	SQUELCH in OFF position	Infinity.
	SQUELCH in any clockwise position.	582 K.
Term. H of J8.		Infinity.

39. Bench Setup for Operational Checks

(fig. 32)

If the receiver is to be tested alone it is necessary to install a vibrator power supply, a source of operating power, audio receiving devices (a headset and loudspeaker), measuring instruments, and test signal sources. Test instrument and signal source connections are made in accordance with individual test procedures. External connections are to be made as shown in figure 32.

a. Audio Connections.

(1) Connect a headphone (or meter M2 when specified) between terminals E and D (ground) of J8 (REC CONTROL).

(2) Connect a loudspeaker (meter M2 when specified) between terminals A and D of J8.

(3) Connect a headphone (meter M2 when specified) between terminals B and D of J8.

Note. It is not necesseary to use duplicate meters, headphones, or loudspeakers. The same unit may be used to make listening or measurement checks at several points in succession.

(4) Connect a jumper strap between terminals H and J (B+) of connector J8.

b. Power Connections Using Plug-In Vibrator Unit.

(1) Install Power Supply PP–281/GRC, PP–282/GRC, or PP–448/GR in the power supply compartment, and fasten the clamp. Make sure to check that the input voltage rating of the unit used and the voltage rating of the storage battery available for these tests agree.

(2) Check to see that a 4-ampere fuse is installed in the holder on the front panel.

(3) Fit one end of a heavy-duty, two-conductor cable with battery clips for connection to the storage battery. Fit the other end of the cable with a four-prong connector to mate with the POWER IN connector, J6, on the receiver panel.

(4) Connect the + terminal on the storage battery to terminal B of J6. Connect the − terminal of the battery to terminal C (ground) of J6.

(5) Turn switch S1 to the 6, 12, and 24 VOLTS position. Power will be applied when the VOLUME control is turned clockwise away from the OFF position.

c. Power Connections Using External Supply.

(1) Make sure that the internal power selector switch, S1, is in the OFF position at this time. The setting of the VOLUME control is immaterial, since the power switch, S2, is not in the external supply circuit. Also, fuse F1 is not in the external supply circuit. Switch S1 provides the only internal means for turning the external power on or off.

(2) Connect the 6-volt filament supply between terminals A (+) and C (−) (ground) of J6. Connect the 130-volt plate supply between terminals D (+) and C (−) (ground) of J6. Use heavy-duty leads, one end equipped with connectors suitable for attachment to the particular power supply sources used, and the other with a four-prong connector to mate with female connector J6, Turn internal switch S1 to the EXTERNAL SUPPLY position to turn on power to the receiver.

d. Antenna Connections. Connect G1 (rf signal generator) as shown in figure 32. Set up the signal generator for an rf output of 1 microvolt modulated at 1 kc with 15-kc deviation.

40. Interchangeable Tubes

A preferred type electron tube, type 5654/6AK5W, has been developed as a direct replacement for tube type 6AK5. These tubes may be used interchangeably in the rf amplifier stage. The older type tubes should be used until stocks are exhausted.

41. Tube Replacement Procedures

a. Methods of Testing. Improper methods of tube testing have resulted in the needless discard of many serviceable tubes. The following procedures are to be used as a guide for tube testing and substitution.

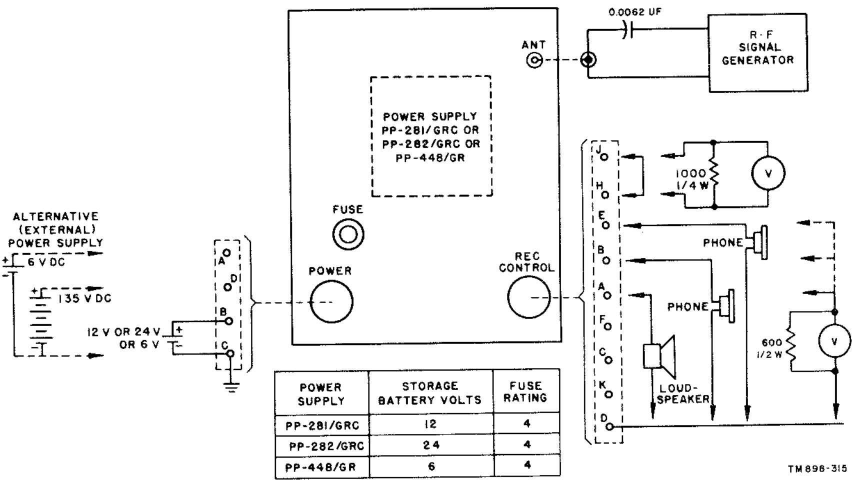
(1) Inspect all cabling, connections, and the general condition of the equipment before testing the tubes.

(2) Isolate the trouble to a particular section of the receiver.

(3) If a tube tester is available, remove and test one tube at a time. Substitute new tubes only for those that are defective.

(4) If a tube tester is not available, troubleshoot by the tube substitution method.

(*a*) Replace the suspected tubes, one at a time, with new tubes. Note the sockets from which the original tubes were re-



POWER SUPPLY	STORAGE BATTERY VOLTS	FUSE RATING
PP-281/GRC	12	4
PP-282/GRC	24	4
PP-448/GR	6	4

Figure 32. Test setup connections.

moved. If the equipment becomes operative, discard the last tube removed. Some circuits, for example, oscillator circuits (V10 and V3), may functions with one tube and not another, even though both tubes are new. If practicable, retain any removed tube until its condition is checked by a tube tester.

(*b*) Reinsert the remaining orginal tubes, one at a time, in their original sockets. If equipment failure occurs during this step, discard the last original tube. *Do not leave a new tube in a socket if the equipment operates satisfactorily with the original tube.*

(*c*) If the spare tube supply is limited:

1. Substitute a new tube for one original tube. If the equipment continues to be inoperative, replace the new tube with the original. Similarly check each original tube, in turn, until the equipment becomes operative.

2. Often it is possible to remove a tube from another section of the equipment without affecting the section being checked. In this case, troubleshoot the defective section by using this tube as a substitute.

b. General Rules for Discarding Tubes. As a general rule, discard tubes under the following conditions:

(1) A test in a tube tester or other instrument shows that the tube is defective.

(2) The tube defect is obvious; for example, the glass envelope is broken, the filament is open, or a connecting prong or lead is broken.

c. Precautions on Tube Discard.

(1) Do not discard tubes merely because the tubes have been used for a specified length of time. Satisfactory operation in a circuit is the final proof of tube quality. The tube in use may work better than a new one.

(2) Do not discard tubes merely because they fall on or slightly below the minimum acceptability value when checked in a tube tester. A certain percentage of new tubes fall near the low end of the acceptability range of tube specification, and therefore, start their operational life at a value fairly close to the tube tester *retention limit.* These tubes may perform satisfactorily over a long period of operational life at their *near limit value.*

42. Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in the receiver. It lists symptoms that the repairman observes while making a few tests. The signal substiution tests outlined in paragraph 45 can then be used to supplement this procedure and to determine the defective stage. After the trouble has been localized to a stage or circuit, a tube check and voltage and resistance measurements of the stage or circuit should ordinarily be sufficient to isolate the defective parts.

Symptom	Probable trouble
1. Power is turned on, pilot light does not go on, and there is no noise.	Defective power supply. Defective fuse. Defective VOLUME-OFF switch.
2. No noise from speaker or earphones with SQUELCH control in OFF position.	Defective V12, V13, or V14. Defective T12 or T13. Defective C63.
3. Receiver output and noise very weak.	Defective C80. V1 through V7 defective.
4. Rushing noise, but no signal output with SQUELCH control in OFF position.	Defective V1 through V3.
5. Rushing noise, but signal output is weak.	Defective V1.
6. Receiver output is weak and distorted.	Defective V9 and V10. Defective C63. Defective R62.
7. Audio output is distorted	Discriminator misaligned.
8. Receiver will not squelch	Defective V11. SQUELCH control defective.
9. In TUNE position, dial light does not go on.	Defective dial light. Defective S3.
10. In TUNE position, zero-beat notes are not heard or are not heard near red dot.	Defective V10. Defective V3.
11. Output is noisy when VOLUME control is turned.	Defective VOLUME control.

43. Resistance Measurements

These checks are intended to serve as a guide for locating defective components or wiring. For these checks, disconnect power from the receiver. Disconnect all external connections. Use a vtvm (M1) for all measurements.

a. Make the applicable measurements indicated in figure 43. These measurements are made from the socket terminal to ground. The required resistance readings for the tube pins are shown below the guide line. Note that the infinity and zero readings are just as significant as the readings that show numerical resistance values. Also, the capacitor charge indications are significant in determining whether or not the capacitor in the circuit being checked is defective. It is not necessary to make all measurements shown in figure 43 but only those indicated at the tube socket associated with the stage found to be defective by the signal substitution and the other trouble sectionalization checks.

b. If the resistance measurements made in accordance with *a* above fail to reveal the cause of the trouble, make the point-to-point resistance measurements listed in the following table. The table supplements the data given in figure 43. It covers measurements that cannot be made to ground but must be made point to point. These measurements are also grouped on a stage-by-stage basis or on a functional circuit basis. It is not necessary to make all measurements shown in the table, but only those indicated for the stage or circuit thought to be defective.

Circuit or stage	Point of measurement	Normal reading (ohms)	Probable trouble
Plate supply circuit	From term. 5 of C80 (X18) to term. 5 of V15 (X15).	560	R60.
	From term. 1 of C80 (X18) to chassis	0	Defective wiring.
	From term. 4 of V15 (X15) to chassis	0	Defective wiring.
	From term. 5 of V15 to term. 8 of J2 with S1 in 6, 12, and 24 VOLTS position.	910	Defective R57, R54, or S1.
	Same as above (S1 of OFF or EXTERNAL SUPPLY position).	Infinity	Shorted S1 contacts.
	From term. 7 of J2 to chassis	0	Broken connection.
Filament supply circuit.	From term. 5 to term. 7 of K1 (X17)	0	Contacts of relay K1 open.
	From term. 7 to K1 (X17) to chassis (S3 in OFF position).	17.5	Defective R55, R56, K1, or receiver filament circuit.
	From term. 7 of K1 (X17) to term. 4 of J2 (S1 in 6, 12, and 24 VOLTS position).	0	Defective wiring or open contacts of S1.
	Same as above (S1 on OFF or EXTERNAL SUPPLY position).	Infinity	Shorted contacts of S1.
	Between term. 1 and 2 of J2 (S1 in OFF or EXTERNAL SUPPLY position).	23	R53 or R72.
	Between term. 2 and 6 of J2 (S1 in OFF or EXTERNAL SUPPLY position).	47	R58 or R73.
	Between term. 5 and 6 of J2 (S1 in OFF or EXTERNAL SUPPLY position).	16	R61.
	Between term. 4 and 5 of J2 (S1 in OFF or EXTERNAL SUPPLY position).	1	R59.
Battery input circuits	From term. B of J6 to term. 3 of J2 (VOLUME control in OFF position).	Infinity	Defective power switch S2.
	Same as above (VOLUME control in clockwise position).	0	Defective S2 or F1.
	From term. C of J6 to chassis	0	Broken connection.
External supply circuits.	From term. A of J6 to term. 5 of K1 (X17) (S1 in EXTERNAL SUPPLY position).	0	Defective wiring or S1.
	Same as above (S1 in 6, 12. and 24 VOLTS or OFF position).	Infinity	Defective S1.
	From term. A of J6 to term. 4 of V14 (S1 in EXTERNAL SUPPLY position).	0	Defective S1.
	Same as above (S1 in 6, 12, and 24 VOLTS or OFF position).	Infinity	Defective S1.
	From term. D of J6 to term. 5 of V15 (X15) (S1 in EXTERNAL SUPPLY position).	350	Defective S1 or R57.
	From term. D of J6 to term. 5 of V15 (X15) (S1 in 6, 12, and 24 VOLTS or OFF position).	Infinity	Defective S1.

Circuit or stage	Point of measurement	Normal reading (ohms)	Probable trouble
External relay circuit	From term. J of J8 to term. 5 of V15 (X15)	920	Defective R75 or R47.
RF amplifier VI	Test point E6 to chassis	05	Primary coil in T1 defective.
	Between term. 4 and 5 of T1	0	Defective secondary coil in T1.
	Between term. 5 and 6 of V1	0	Defective R3 or coil in T2.
	Between term. 3 of T1 and chassis	0	Broken ground connection.
	Between term. 5 of T2 and chassis	0	Broken ground connection.
	Between term. 4 of V1 and term. 7 of P5	0	Defective L1.
	Between term. 6 of V1 and term. 5 of V15		Defective L6, R60, or R4.
Mixer stage V2	Between term. 1 of V2 and term. 1 of T3	0	Defective coil in T3.
	Between term. 1 of T3 and term. 4 of T2	0	Defective coil in T3 or connection.
	Between term. 5 and 6 of V2	0	Defective wire.
	Between term. 5 of V2 and term. 5 of V15	1, 600	Defective primary coil in T5, R10, R11, L6, or R60.
	Between term. 2 and 7 of V2 to chassis	220	Broken wire.
	Between term. 4 of V2 and term. 7 of P5	0	Defective L2.
Oscillator V3	Between term. 2 and 6 of V3	0	Defective wire.
	Between term. 2 of V3 and term. 1 of T4	0	Defective coil in T4.
	Between term. 6 of T4 and term. 5 of V15	560	Defective coil in T4 or R60.
	Between term. 3 and 5 of V3	0	Defective wire.
	Between term. 3 of V3 and term. 1 of V2	100K	Defective R7.
	Between term. 1 of V3 and term. 4 of T4	0	Defective wire.
	Between term. 7 of V3 and term. 1 of V6	0	Defective L3 or L11.
First if. amplifier V4	Between term. 6 and 1 of V4	202K	Defective R12.
	Between term. 2 and 3 of V4	0	Defective primary coil in T6.
	Between term. 3 of V4 and term. 5 of V15	4, 460	Defective R16, L6, or R60.
	From term. 7 of V4 to term. 5 of K1 (X17)	6	Defective L5, R13, or R14.
	From term. 5 of V4 to term. 7 of V5	0	Defective L8.
Second if. amplifier V5	From term. 6 of V5 to term. 1 of V5	220K	Defective R17.
	Between term. 2 and 3 of V5	0	Defective primary coil in T7.
	From term. 3 of V5 to term. 5 of V15	4, 460	Defective R19, L6, or R60.
	From term. 5 of V5 to term. 5 of V6	0	Defective L7 or L9.
Third if. amplifier V6	From term. 6 to term. 1 of V6	220K	Defective R20.
	Between term. 2 and 3 of V6	0	Defective primary coil in T8.
	From term. 3 of V6 to term. 5 of V15	4, 500	Defective R23, L10, L6, or R60.
	From term. 7 of V6 to term. 5 of K1 (X17)	39	Defective R21.
Fourth if. amplifier V7	From term. 6 to term. 1 of V7	180K	Defective R24.
	From term. 2 to term. 3 of V7	0	Defective primary coil in T9.
	From term. 3 of V7 to term. 5 of V15	4, 500	Defective R26, L18, L12, L10, L6, or R60.
	From term. 7 of V7 to term. 7 of V8	0	Defective wire.
Limiter stage V8	From term. 6 of V8 to test point E3	190K	Defective R27, R29, R70, R76, R68, or R69.
	From term. 2 to term. 3 of V8	0	Defective coil in T10.
	From term. 2 of V8 to term. 1 of T11	0	Defective wire.
	From term. 3 of V8 to term. 5 of V15	1, 600	Defective R30, L13, L18, L12, L10, L6, or R60.
Discriminators V9 and V10.	From term. 2 of V9 to term. 3 of V10	0	Defective discriminator coil in T11.
	From term. 6 to term. 3 of T11	1	Defective discriminator coil or L14 in T11.
	From term. 5 of T11 to term. 3	1	Defective discriminator coil on L14 in T11.
	From term. 3 of V9 to term. 7 of V10	360K	Defective R33 or R32.
	From term. 3 of V9 to test point E4	1.18 meg	Defective R31 or R33.
	From term. 2 or 4 of T11 to term. 3 of T11	180K	Unbalanced R31 or R32.
	From term. 3 of V9 to test point E5	1 meg	Defective L15 or R34.
	From term. 1 of V9 to term. 2 of T11	0	Defective wiring.
	From term. 7 to V9 to term. 7 of V12	0	Defective L16 or L17.

Circuit or stage	Point of measurement	Normal reading (ohms)	Probable trouble
First audio amplifier V13.	From term. 3 of V13 to term. 3 of J5 (with VOLUME control R62 in OFF position).	0	Defective arm, R62, or wiring.
	From term. 3 of V13 to term. 2 of J5 (with R62 in extreme clockwise position).	0	Defective R62 or wiring.
	From term. 3 of V13 to term. 3 of V11 (R62 in extreme counterclockwise position).	1 meg	Defective R40.
	From term. 2 to term. 3 of J5	500K	Defective R62.
	From term. 2 to term. 4 of V13	1,000	Defective primary (winding 1–2–3) of T13.
	From term. 4 of V13 to term. H of J8	0	Defective wiring.
	From term. A of J7 to chassis	25	Defective winding 7–8–9 of T14.
	From term. 7 of V13 to term. 1 of V12	0	Defective wiring.
	From term. 1 of X19 to chassis	0	Defective wiring.
	From term. 1 of V13 to term. 7 of V12	0	Defective wiring.
	From term. 1 of V13 to term. 5 of C73 (X19)	0	Defective wiring.
	From term. 7 of V13 to term. 7 of C73 (X19)	0	Defective wiring.
Audio power amplifier V14.	From term. 3 to term. 5 of V14	600	Defective winding 4–5–6 of T13.
	From term. 3 or term. 5 of V14 to chassis	300	Defective T13.
	From term. 2 to term. 6 of V14	700	Defective winding 1–2–3 or T14.
	From term. 2 of V14 to term. 5 of X15	350	Defective R57.
	From term. 4 of V14 to term. 1 of J2 (S1 in 6, 12, and 24 VOLTS position).	0	Defective wiring or S1.
	Same as above (S1 in OFF or EXTERNAL SUPPLY position).	Infinity	Defective S1.
Fixed level audio amplifier V12.	From term. 3 of V12 to term. 2 of P5 (R42 in extreme clockwise position).	200K	Defective R41, R42, R43, or R62.
	From term. 3 of V12 to term. 3 of P5 (R42 in extreme clockwise position).	380K	Defective R41, R42, R43, or R62.
	From term. 2 or 6 of V12 to term. 4 of V12	1,700	Defective winding 1–2–3 of T12.
	From term. 4 of V12 to term. J of J8	200	Defective R45 or R47.
	From term. 4 of V12 to term. 5 of V15	920	Defective R45 or R75.
	From term. B of J8 to chassis	25	Defective winding 7–8–9 of T12.
Tuning oscillator V10	From term. 4 to term. 5 of V10	0	Defective wiring.
	From term. 6 of V10 to chassis (S3 in TUNE position).	27K	Defective R35.
	From term. 6 of V10 to switch S3 side of C84 (S3 in TUNE position).	Infinity	Defective Y1, J4, P4, coaxial cable, or S3.
	From term. 6 of V10 to switch S3 side to C84 (S3 in either DIAL LIGHT position).	Infinity	Defective S3.
Squelch circuit V11	From term. 6 to term. 1 of V11	150K	Defective L20A, R69, R27, R28, R70, R76, R1, R68, R24, C94, C2, or C78.
	From term. 6 of V11 to term. 6 of V7	820K	Defective L20A or R68.
	From term. 5 of V11 to term. 5 of V10	300	Defective L18, L19, or L20B.
	From term. 4 of V11 to term. 5 of V15 (SQUELCH control in extreme clockwise position).	560	Defective R65, S4, or R60.
	Same as above (SQUELCH control in OFF position).	Infinity	Defective S4.
	From term. 3 of V11 to term. 3 of V13 (VOLUME control in OFF position).	1 meg	Defective R40 or R62.
	From term. 3 of V11 to term. 3 of V12 (R32 in extreme clockwise position).	1.4 meg	Defective R40, R43, R42, R41, or R62.
	From term. 3 of V11 to term. 1 of V1	750K	

Note. Some equipments have R41 and R43 replaced with a jumper wire; the resistances will therefore vary from those given above.

44. Dc Voltage Measurements

a. Make the dc voltage measurements indicated in figure 43. These measurements serve to locate faults that are not readily determined by the resistance measurements of the preceding paragraph, that is, defective capacitors, partially shorted transformer and coil winding, etc. For these measurements, turn the power on. As before, turn switch S1 to either the 6, 12, and 24 VOLTS or the EXTERNAL SUPPLY position, depending on whether the vibrator power supply or an external supply is used for making the test. Reconnect all test circuit connections as described in paragraph 39. All voltage measurements shown in figure 43, except the filament voltages, are measured to ground. Filament voltages are measured between the filament terminals of the socket. Refer to the schematic diagram for the particular receiver (figs. 48, 49, or 50) to identify the circuit components involved in a particular measurement. Note especially those circuits that are changed by the setting of the switches. Note that screen voltage is not applied to squelch tube V11 until the SQUELCH control is turned clockwise. Note also that no power is applied to the first audio amplifier stage, V13, unless the jumper strap is connected between terminals H and J of J8. The required readings are shown above the guide lines from the socket terminals. Use Electronic Multimeter TS-505/U (M1) as a voltmeter.

b. The data given in (1) through (3) below supplement the measurements indicated in figure 43. Except where otherwise stated, all measurements are made between the test point indicated in the table and the chassis.

(1) For the following measurements, turn the SQUELCH control to the OFF position. Measure between the indicated test point and the chassis. The dc voltage readings are obtained under a no-signal condition of the receiver.

Point of measurement	Circuit or stage involved	Nominal voltage reading (volts dc)
E3	Limiter grid (V8)	0 to .4
E4	Discriminator circuit	0
E5	Discriminator circuit	0
E6 (S3 in TUNE).	Tuning oscillator output (V10)	0

(2) For measurements at oscillator grids, measure between points indicated and the chassis under the conditions outlined in (1) above. These measurements check whether oscillations are being sustained. Failure to get a reading points to a defective crystal or other part.

Point of measurement	Circuit or stage	Nominal reading (volts dc)
V3, pin 3	Receiver oscillator	−3 to −7
V10, pin 6	Tuning oscillator:	
	S3 in TUNE position	−24
	S3 in OFF position	0
	S3 in ON position	0
V11, pin 6	Squelch oscillator:	
	SQUELCH control in ON position.	−1.1
	SQUELCH control in OFF position.	−.1

(3) The following measurements are a summary of the measurements made in paragraph 54 of discriminator output voltages.

(*a*) Connect M1 between test point E4 (fig. 40) and chassis or test point E5 (fig. 40) and chassis as indicated.

(*b*) Connect a 4.3-mc generator, G5 through a .01-μf capacitor between pin 6 of V7 and the chassis.

(*c*) Adjust the generator to each of the frequencies indicated below and to an output level of .1 volt root mean square for each frequency.

(*d*) The following readings should be obtained for a properly balanced discriminator.

Frequency (kc)	Normal reading (volts dc)	
	At test point E4	At test point E5
4, 370	8	10
4, 330	15	10
4, 300	22	0
4, 230	27	−10
4, 270	27	−10

45. Signal Substitution

a. General. The purpose of the signal substitution or signal tracing checks described in *a* through *e* below is to localize trouble to a particular stage or part within the circuit. The data thus obtained serve also to determine whether a particular stage needs alinement.

b. Test Equipment. The test equipment should be connected as shown in figure 32. The connections for the test meters and signal source are to be made as indicated in the stage gain chart (*d* below) for the particular circuit under test.

c. Procedure. The procedure of signal tracing described here consists of connecting the meter to the limiter grid circuit for if. and rf measurements or to the audio output connection for af measurements. It also requires connecting the signal generator to each of the preceding stages to which the meter is connected. For each connection of the signal generator, determine the level of the test signal required to obtain the given reading on the meter. By comparing the values thus obtained with the data given in the stage gain chart, it can be determined whether or not a particular stage provides the required gain. Failure to provide the required gain may be caused by either a faulty component or tube within the stage or to improper alinement. The signal generator and meter connections, the test signal frequency and the required test levels are indicated in the chart in *d* below.

(1) For signal tracing purposes, the receiver is sectionalized into three major groups as follows: the audio amplifier stages, the if. stages including the limiter and the discriminator, and the rf stages including the oscillator, the mixer, and the rf amplifier.

(2) The following switch and control settings apply for all measurements on the receiver circuits.

Switch or control	Setting
SQUELCH	OFF.
DIAL LIGHT switch (S3)	OFF position (except when zero-beating the test signal generator with the built-in tuning oscillator).
VOLUME	Maximum clockwise direction.
6, 12, and 24 VOLTS-OFF-EXTERNAL SUPPLY (S1).	6, 12, and 24 VOLTS if vibrator is used. On EXTERNAL SUPPLY if external supply is used.
CHANNEL dial	To correspond to the test frequency used. See chart in *d* below.

d. Stage Gain Chart.

(1) *Rf and If. circuits.* Connect the test signal generator (G5 for if. measurements and G1 (without modulation) for rf measurements) between the grid of the indicated stage and the chassis. Connect meter M1 between the grid (pin 6) of V8 and the chassis. (The meter thus connected will be referred to as the *limiter meter.*) The table of stage-by-stage gain readings follows:

Signal generator at grid of	Approx input (µv)	Signal generator frequency (mc)	Limiter meter M1 reading (volts dc)
V7	100, 000	4. 3 (G5)	0. 5
V6	8, 700±20%	4. 3 (G5)	. 5
V5	870±45%	4. 3 (G5)	. 5
V4	1, 500±75%	4. 3 (G5)	6. 5
V2	500+100%−50%	4. 3 (G5)	6. 5
R–108/GRC (V1)	30	20. 0 (G1)	6. 5
	10	28. 0 (G1)	6. 5
R–109/GRC (V1)	30	28. 0 (G1)	6. 5
	10	39. 0 (G1)	6. 5
R–110/GRC (V1)	30	39. 0 (G1)	6. 5
	10	55. 0 (G1)	6. 5
ANT jack of R–108/GRC	3	20. 0 (G1)	6. 5
	1. 5	28. 0 (G1)	6. 5
ANT jack of R–109/GRC	3	28. 0 (G1)	6. 5
	1. 5	39. 0 (G1)	6. 5
ANT jack of R–110/GRC	3	39. 0 (G1)	6. 5
	1. 5	55. 0 (G1)	6. 5

(2) *Audio circuits.* Apply an rf signal (G5) to the ANT connector at any convenient frequency within the tuning range of the receiver. Tune in the signal with the dial. Adjust the signal level to 1 millivolt. Apply 1,000-cps modulation at 15-kc deviation. Set the VOLUME control to the extreme clockwise position, and the SQUELCH control to the extreme counterclockwise position. Use meter M2 to make measurements between the indicated test points and chassis. Connect 600-ohm loads between terminal pairs E and D, A and D, and B and D of J8. Readings obtained should be as shown in the following chart.

Meter M2	Output
E and D	5 volts.
A and D	25 volts.
B and D	3 volts.

e. Analysis. Compare the signal generator output levels required to obtain the readings shown in the chart. The readings given are nominal values. Nonuniformity in tubes, tolerances of components, etc., may be responsible for as much as 10-percent reading variations between sets. Interpret the test results with this fact in mind. In general, the fault in the circuit group lies between the point at which the abnormal reading is first obtained and the preceding test point. A fault may be indicated by the absence of a reading or by a drastic reduction or increase in a reading. Refer to the schematic diagrams (figs. 48–50) to identify the stage to which the trouble has been localized. An excessively high signal generator output level required to provide the reference reading may be caused by a defective tube or circuit component or to misalinement of the stage.

f. Further Trouble Localization Checks. When trouble has been traced to a given stage or a portion of a stage, do the following:

(1) Turn off the power by setting the VOLUME control in the OFF position (extreme counterclockwise) and pull the tube of the defective stage out of its socket.

(2) Test the tube by means of a tube checker, and, if defective, replace it with a good one. If a tube checker is not available, substitute a tube known to be good.

(3) Realine the stage or stages that show low gain or after any repairs have been made on a tuned stage. Realine the discriminator circuit (par. 54) if any part which contributes to the balance of the circuit has been replaced. If gain measurements are consistently low and alinement fails to improve the condition, check the mechanical alinement of the dial (par. 57). Check for the possibility of broken tuning slugs, defective capacitors or lugs, defective dial detent screws, mechanical misadjustment of the dial, or a loose coupling between the dial and the variable capacitor.

(4) If realinement fails to clear the trouble, measure the resistances at the tube socket of the defective stage. Note that the information given is merely a guide and should suggest other tests, measurements, and procedures for localizing the trouble to a defective part or wiring. Replace any component found to be defective.

(5) If the resistance measurements fail to localize the trouble, turn on the power and measure the tube socket voltages.

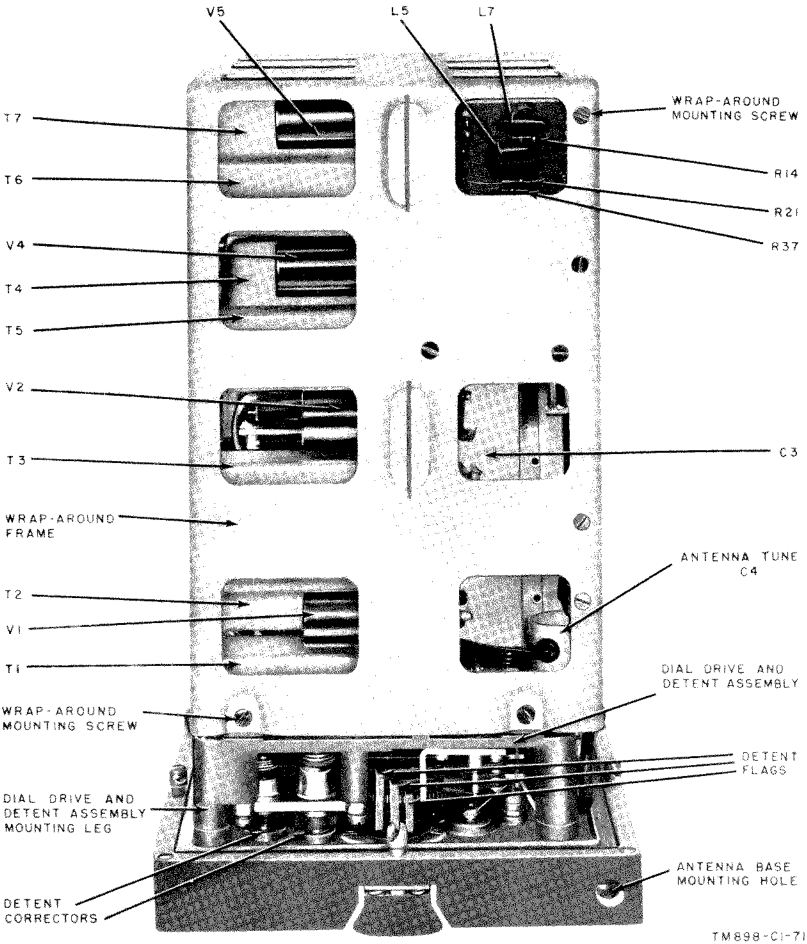


Figure 33. Receiver chassis, top view.

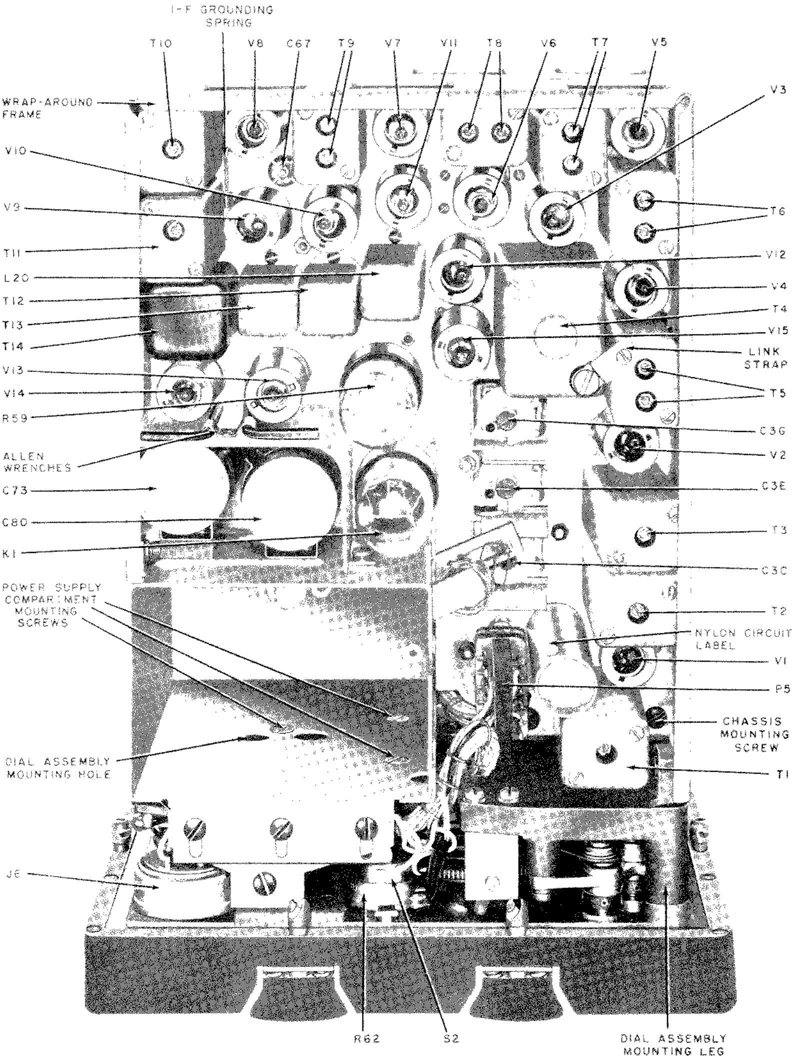


Figure 34. Receiver chassis, left-side view.

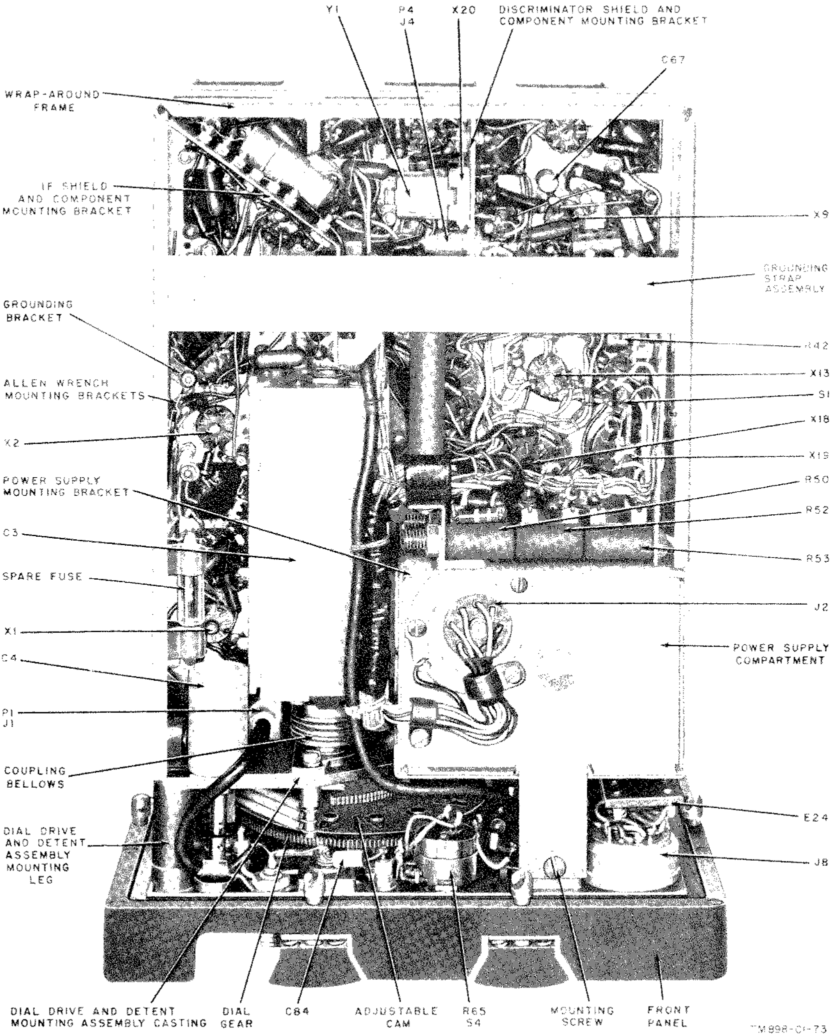


Figure 35. Receiver chassis, right-side view.

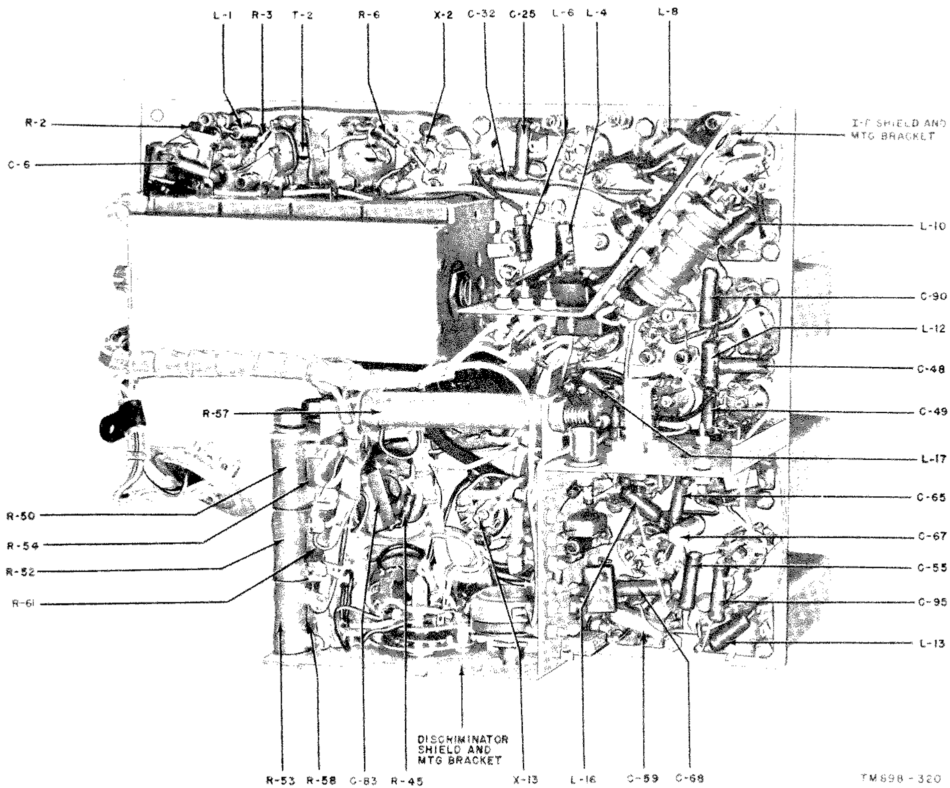


Figure 36. Receiver chassis, bottom view of top and rear edges.

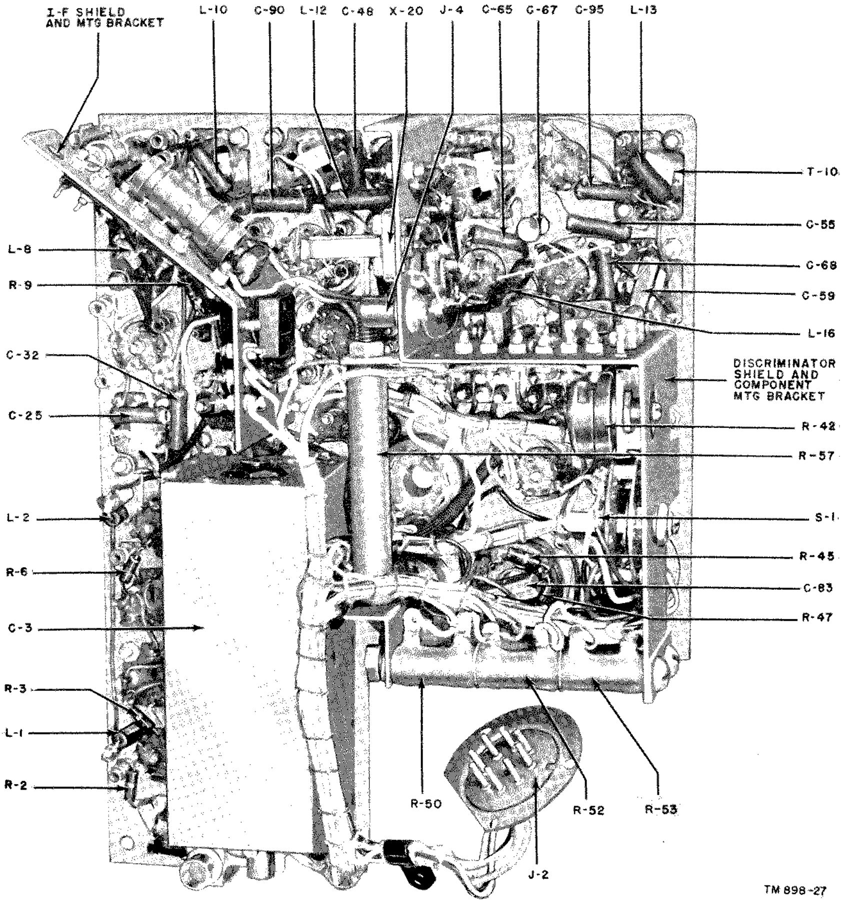


Figure 37. Receiver chassis, bottom view of bottom and side edges.

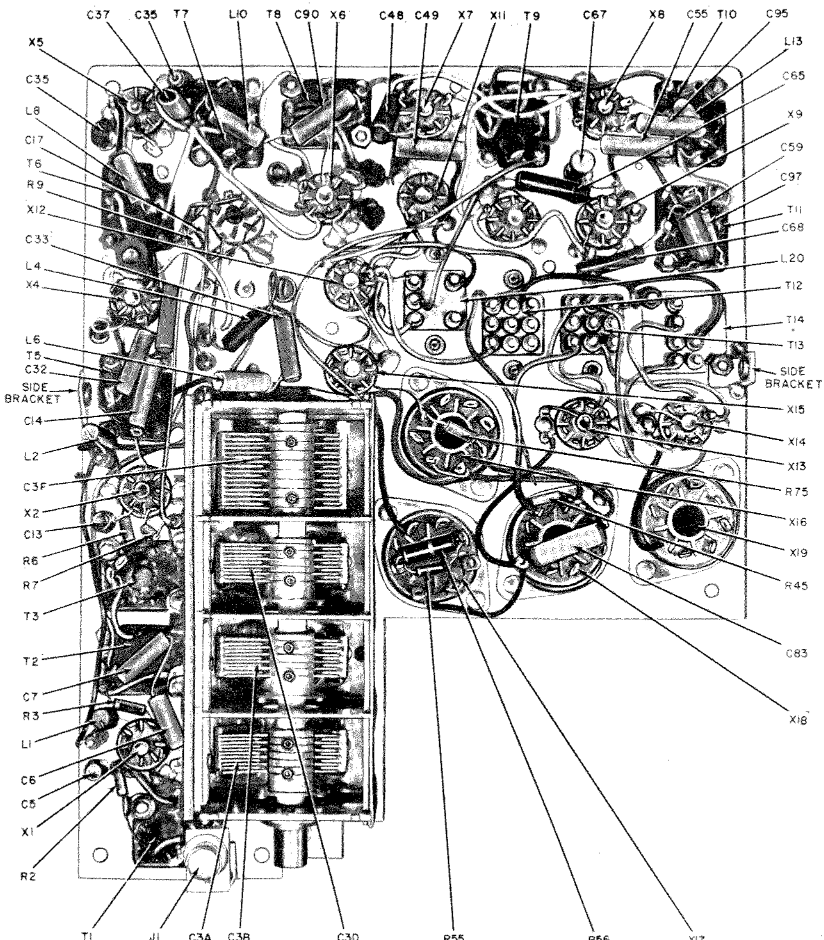


Figure 38. Receiver chassis, bottom view of tube socket layout.

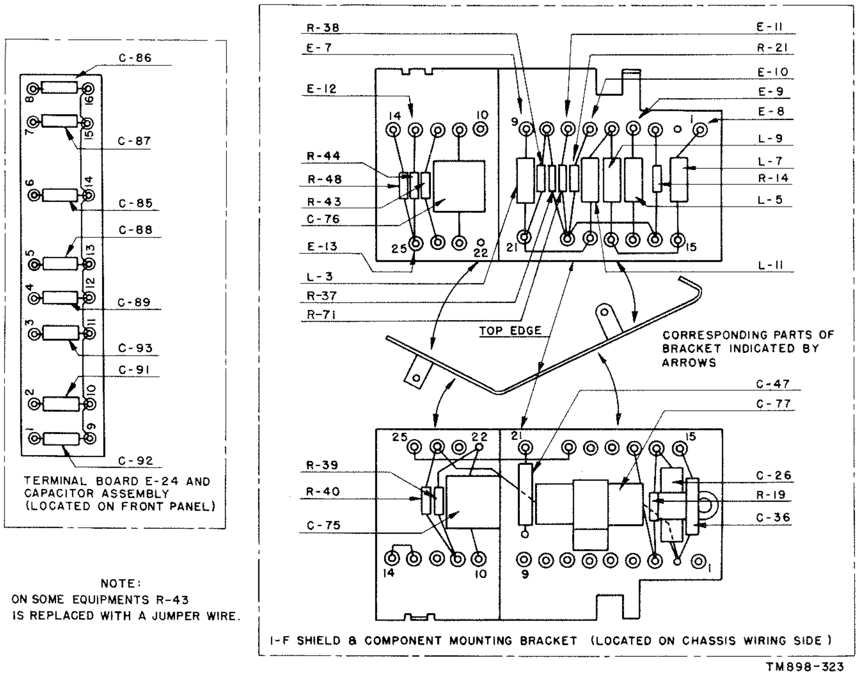
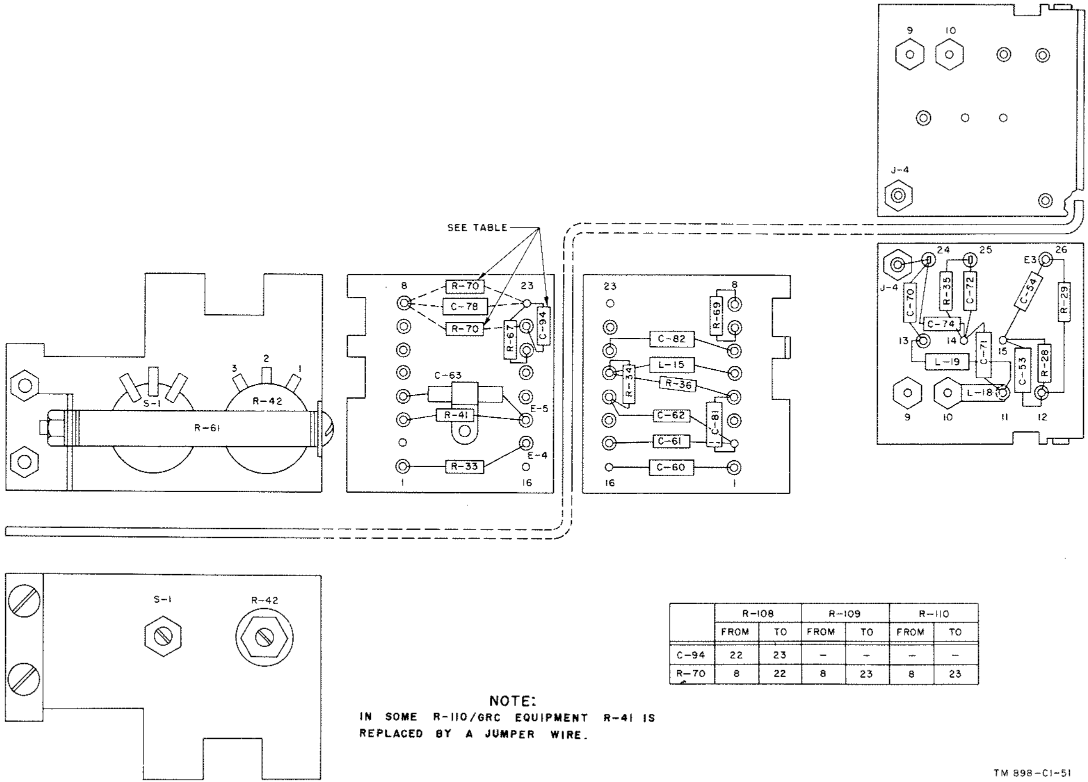


Figure 39. Terminal board E24 and if. shield, component location.



	R-108		R-109		R-110	
	FROM	TO	FROM	TO	FROM	TO
C-94	22	23	–	–	–	–
R-70	8	22	8	23	8	23

NOTE:
IN SOME R-110/GRC EQUIPMENT R-41 IS REPLACED BY A JUMPER WIRE.

Figure 40. Discriminator shield and mounting bracket, component location.

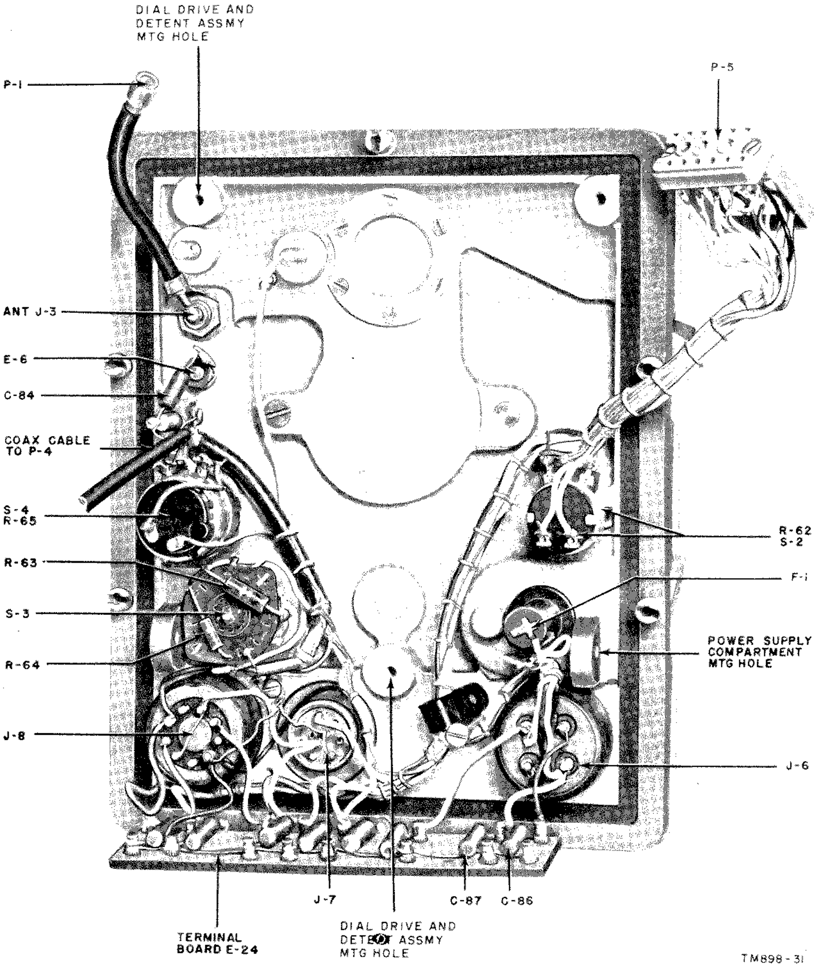
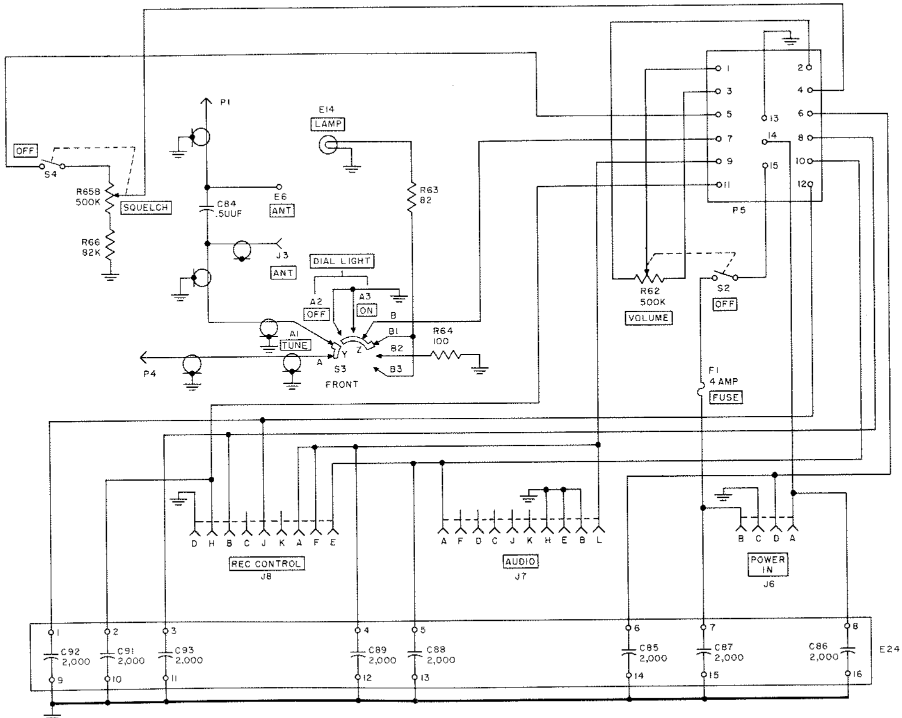


Figure 41. Radio receiver, front panel, rear view.



NOTES:
1. ALL WAFER SWITCH SECTIONS ARE VIEWED FROM KNOB END AND IN EXTREME COUNTERCLOCKWISE POSITION.
2. SWITCH S3 IS IN TUNE POSITION.

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Figure 42. Radio receiver, front panel, schematic diagram.

46. Disassembly

(fig. 44)

Caution: The assembly is intricate and the parts are delicate. Careless handling may cause damage to the coupling and other parts. Side pressure on the coupling may damage the coupling or the variable capacitor and throw the unit out of alinement.

a. General. All tuning controls, tubes, and most of the component parts are accessible without disassembly of the unit. For most purposes, it is necessary only to remove the outer case. Under certain conditions, particularly if parts are to be replaced on the panel, or when major repairs are required for some of the components mounted on the chassis, it is necessary to disassemble the unit as described in the following paragraphs. For disassembly purposes, the unit may be regarded as being composed of the following subassemblies:

(1) Outer case.
(2) Wrap-around frame.
(3) Panel.
(4) Dial-drive and detent assembly plus power supply compartment.
(5) Chassis.

Note. The dial-drive and detent assembly and the power supply compartment, although detachable from each other, should be treated as a single unit. Only when absolutely necessary should any attempt be made to take the two apart.

b. Outer Case. To remove the outer case, loosen the six Dzus fasteners on the front panel and pull out the chassis.

c. Removal of Vibrator Power Supply Unit (fig. 31). To remove the vibrator power supply unit from the power supply compartment on the receiver chassis, proceed as follows:

(1) Loosen the three screws that hold the latch to the power supply compartment. Turn the screws about ½ turn to the left.
(2) Slide off the latch located on the component side (left side of panel-and-chassis assembly when in the operating position) of the main chassis.
(3) Pull at the handle of the vibrator power supply unit and remove it from its compartment.

d. Chassis Cover Frame (*Wrap-Around*). The wrap-around frame must be removed to facilitate access to wiring and small parts of the chassis and to permit removal of the panel.

(1) Remove the four machine screws that hold the frame to the panel-and-chassis assembly. Two of these screws attach the frame to projections from the dial-drive assembly, at the top of the assembly (fig. 33). The other two screws, accessible from the bottom of the assembly (fig. 5), attach the frame to brackets on the power supply compartment.
(2) Remove the three screws that hold the wrap-around frame to each of the two shields (if. shield, fig. 33) and discriminator shield (fig. 35) and to the heat reflector shield around electrolytic capacitors C80 and C73 (fig. 34).
(3) Remove the 1-inch wide bracket by removing the four screws that hold the bracket to the wrap-around frame, if. shield, and component mounting bracket. Remove the screws from the wrap-around frame that hold the grounding brackets near X2 and T14. Remove the screws at the rear of the wrap-around frame that hold the wrap-around frame to the distributor shield and component mounting bracket.
(4) Spread the end of the frame to disengage the projections on the chassis from the slits in the wrap-around frame.
(5) Remove the frame.

e. Panel-And-Chassis Connectors. All connections from the front panel to the chassis assembly are made by means of plugs and cables. There are no solder connections.

(1) Disengage connectors P1 and J1. Coaxial connector P1 is attached to the short piece of coaxial cable, which in turn is connected to the ANT connector on the front panel (fig. 41). Connector J1, which is mounted on a bracket at the edge of the chassis adjacent to the back of the dial-drive assembly, is connected to the antenna input circuit.
(2) Disengage connectors P4 and J4. Coaxial connector P4 is attached to the end of the long coaxial cable, which in turn is connected to the DIAL LIGHT switch on the panel. Mating connector J4 (fig.

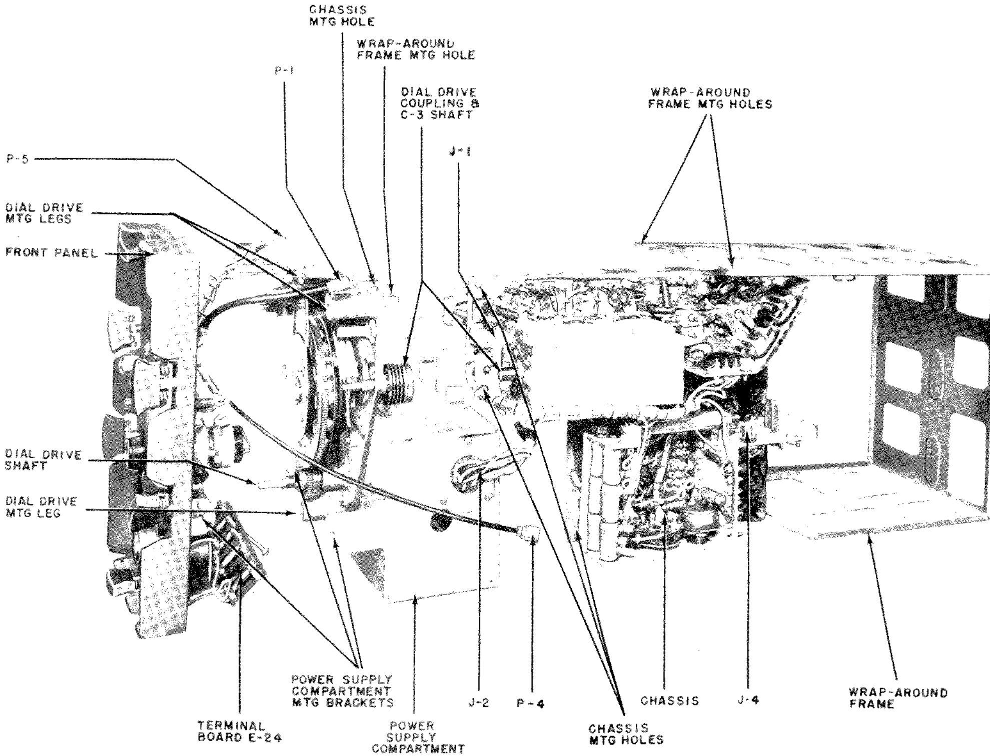


Figure 44. Receiver chassis, disassembled.

44) is mounted near the tuning oscillator crystal on the large resistor and capacitor bracket.

(3) Disengage multiconnectors P5 and J5. These 15-pin connectors are located on the component side of the chassis (figs. 41 and 44) in the angle formed by the power supply compartment and the dial-drive assembly. To disengage these connectors, pull at the handle on P5. Do not pull on the cable.

f. Panel. To remove the panel, proceed as follows:

(1) Remove the screw on the face of the tuning knob, and pull the knob off the shaft.

(2) Remove the screws on the faces of each of the three detent adjusting knobs on the upper left-hand corner of panel, and pull the knobs off the shafts.

(3) Using a spanner wrench, unscrew and remove the castellated nuts that hold the shaft of the dial-drive mechanism and the detent adjustment controls to the panel.

(4) Remove the screw that holds the dial assembly to the front panel. This screw is accessible through the lower hole of two holes that are located on the side of the power supply compartment (fig. 34) to which the dial-drive assembly is attached.

(5) Remove the two screws that hold the power supply compartment to the front panel. These screws are located on the mounting brackets at each end of the compartment.

(6) Place the receiver on the bench with the front panel facing upward. Carefully lift the front panel off the rest of the assembly.

g. Power Supply Compartment and Dial-Drive and Detent Assembly. To gain access to some of the chassis-mounted parts, it may at times be desirable to remove the assembly composed of the dial-drive and detent mechanism and the power supply compartment. It should be noted that this assembly must not be detached unless it is absolutely necessary to do so for repair or replacement purposes. Detachment of this assembly involves uncoupling the dial-drive bellows coupling from the variable capacitor shaft. Subsequently, repositioning of the capacitor shaft with respect to the coupling is a complicated procedure involving calibrated signal generators. The procedure for removing the assembly from the chassis is as follows:

(1) Using a hexagonal wrench, remove the large nut that holds the bracket on the right side of the power supply compartment to the large resistor assembly (R50, R52, and R53, fig. 35).

(2) Turn the assembly component (left) side up, and remove the screw that holds the left edge of the chassis to the bracket on the power supply compartment.

(3) Remove the screw that holds the chassis to the power supply compartment near the corner.

(4) Turn the unit wiring (right) side up, and remove the three screws on the bottom of the power supply compartment that hold the retaining ring for J2 to the power supply compartment.

(5) Remove the screws that hold the cable clamps on the power supply compartment and on the dial-drive and detent assembly casting.

(6) Slip the retaining ring for J2 over the cable and withdraw the cable and J2 from the power supply compartment.

(7) Loosen the two No. 6 Allen setscrews that hold the dial-drive assembly bellows coupling to the variable capacitor shaft. To gain access to these screws, rotate the dial until the cutout on the dial plate lines up with the drive gear to which the tuning knob is attached.

(8) Remove the two screws on the component sides of the chassis that hold the chassis assembly to the projection from the back of the dial-drive and detent assembly casting.

(9) Unsolder the lead from variable capacitor C3, which is connected to antenna trimmer capacitor C4.

Caution: Rotate capacitor coupling while pulling gently to remove dial-drive and detent assembly from chassis.

47. Replacement of Parts

When replacing parts in Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC, observe the precautions given below.

a. Tagging Leads. Tagging leads is essential to assure that correct rewiring will be made when a part is replaced. Before unsoldering leads from transformers, tube sockets, panel connectors, or other parts, tie together the leads that are attached to each of these parts. With small tags or short pieces of adhesive tape, identify all wires in accordance with their numbered connections. Identify every lead that is to be removed.

b. Parts and Substitution. When damaged parts must be replaced, identical parts should be used. If identical parts are not available and the damaged component is beyond repair, a substitution must be made. The part substituted must have identical electrical properties and must be of equal or higher voltage and current rating.

c. Location. Relocation of substituted parts may develop certain difficulties, such as hum, noise, or cross talk, and is not recommended.

d. Mounting. Mount the new or replaced part in the same mounting position as that formerly occupied by the damaged part. Fasten all mountings securely.

e. Soldering. Before soldering any connection, carefully scrape all parts that will be touched by the soldier until all traces of rust, corrosion, and paint or varnish are removed. Clean all parts to be soldered. Wrap the wire around the solder lug so that it is mechanically secure. Use very little solder and sufficient heat to make the solder flow evenly around the connections. In the case of coaxial cables or shielded leads, make sure that the shield is properly soldered to the ground lug. The same applies to bonded connections between metal subassembly frames and the chassis plate. Make sure that the ground lug is securely bonded to the chassis. Be sure to clean away all particles or splashes of solder.

48. Special Repair Procedures

Most of the parts in the receiver are readily accessible and can be replaced without special instructions. Most of the small components, namely, resistors, small capacitors, and small choke coils, are wired point-to-point directly to the lugs of sockets and terminals of tuning units. In replacing these parts, be careful not to damage adjacent components. Special procedures for replacing or repairing sockets, connectors, and some of the more complicated subassemblies are given in the following paragraphs. Since the unit is very compact and many of the components are sandwiched in between mechanical parts, it may be necessary to disassemble the unit (par. 46) before the repair and replacement procedures described below can be followed. In many cases, disassembly of the unit before the part is replaced or resoldered will prevent damage to other parts.

a. Sockets. All sockets are attached to the chassis with rivets. To replace a socket, proceed as follows:

(1) Disassemble the chassis (par. 46) from the rest of the unit to prevent possible damage by the tools used in removing the part.
(2) Remove the tube shield and tube or other part plugged into the socket.
(3) Unsolder the wires connected to the socket.
(4) Drill out the two rivets fastening the socket to the chassis.
(5) Substitute a new socket and fasten it with machine screws, lockwashers, and nuts, or if feasible with rivets. Make sure that the socket is keyed the same way as the socket which was removed.
(6) Resolder the wires and components to the socket.
(7) Clean the chassis thoroughly to remove solder drops or metal chips.
(8) Check the new connections with those shown on the schematic diagram (figs. 48, 49, or 50).

b. Stand-Off Insulators. To remove the stand-off insulators, unsolder the leads attached to the insulator and drill out the rivet that holds it to the chassis.

c. Panel Connectors. A spanner wrench or long-nosed pliers are necessary for removing the panel connectors. The procedure is as follows:

(1) Disengage the panel (par. 46) from the rest of the assembly to gain access to the rear of the panel (fig. 41).
(2) Unsolder all wires.
(3) Insert the teeth of the spanner wrench into the notches in the nut of the connector on the front panel. Turn the spanner wrench in the counterclockwise direction until the nut is removed. Remove the lockwasher.
(4) Remove the connector from the rear of the panel.
(5) In selecting a new connector, make sure that the new part has a rubber gasket properly seated in the groove.
(6) Resolder all wires to the new connector.

(7) Clean thoroughly to remove solder drops.
(8) Recheck the new connections with those shown in the schematic diagram (figs. 48, 49, or 50).
(9) Reinsert the connector from the rear of the panel.
(10) Reinsert the nut, using the spanner wrench.
(11) Screw the nut back on to the connector. Check the assembly for tightness.
(12) Reassemble the panel to the rest of the unit.

d. Switch. The panel-mounted switch, S3, may be removed as follows:

(1) Disconnect the panel from the rest of the assembly (par. 46).
(2) Unsolder panel wiring from the switch, making sure to tag the leads to permit proper replacement. Unless the switch is to be replaced, it is not necessary to remove the resistors and the strapping connections wired to the switch.
(3) Remove the control knob by removing the knob retaining screw.
(4) Remove the castellated nut, using a spanner wrench or long-nosed pliers. The switch can now be removed from the rear of the panel. When working the switch away from the panel be sure not to damage it. When replacing the switch make sure that the key on the switch fits into the keying hole in the panel casting. Be careful in handling the switch, since the wafer is fragile.
(5) Examine the contacts to make sure that they are properly made and that the switch turns freely to its operating positions. The TUNE position of test switch S3 is a spring-return position. Check whether the switch is returned from this position to the adjacent ON position.
(6) Restore the castellated mounting nut and the knob.
(7) Resolder all connections and check against the schematic diagram for the particular unit (figs. 48–50). Clean away all solder drops.
(8) Reattach the panel to the rest of the assembly.

e. Other Panel-Mounted Components.

(1) Terminal board E24 mounted on the rear of the front panel mounts a number of small capacitors (fig. 39). To gain access to the capacitors for replacement, remove the mounting screws near the ends of the board, and tilt the board back. Save the screws and the spacers.
(2) To detach the fuse holder, remove the two mounting screws from the front of the panel. Remove the marker plate first by unscrewing the fuse holder cap and lifting the marker away from the panel. Two such plates are provided to cover all power supply possibilities. when restoring the plate, make sure that the correct voltage reference faces the operator.
(3) To detach the SQUELCH or VOLUME control, remove the castellated nut that holds the part to the panel, unsolder the panel wiring, and replace it as described in (1) above.

f. If. and Discriminator Shields and Component Mounting Brackets. Two metal shields, which also mount small resistors, capacitors, and components, are attached to the wiring side of the chassis by means of machine screws. The components and test points mounted on these shields are shown in figures 39 and 40. To gain access to the components on the side facing away from the chassis, it is merely necessary to remove the wrap-around frame from the panel-and-chassis assembly (par. 46). In some cases, particularly to gain access to parts mounted on the side facing the interior of the chassis or to tube socket V5, it may be necessary to detach the shield. Note that tube socket X5 is mounted under the if. shield (fig. 35). To detach the shield, simply remove the two mounting screws that hold the board to the chassis. Tilt the shield back. After the defective component has been replaced, remount the shield by replacing the mounting screws. Be careful not to damage the wiring during this procedure.

49. Repair and Replacement of Dial-Drive and Detent Mechanism

(figs. 26, 27, 28, and 29)

a. General. The dial-drive and detent mechanism and the power supply compartment are supplied as an integral assembly. Although the two are detachable from each other, the tolerances of fits are so close that it is inadvisable to separate the two from each other, unless it is absolutely necessary to do so (for example, if the compartment is badly damaged and it is desired to salvage the dial-drive and detent mechanism). The dial-drive and detent mechanism is a complex assembly that involves very close fit tolerances of small parts. For this reason, is is not advisable to take this mechanism apart. Removal and replacement of easily replaceable parts are described in the following paragraphs. Included in this category are springs, index, and dial marking plate. If gears, cam, cam follower, and other similar parts are damaged, it is best to replace the entire unit. To make any repairs or replacements on the dial mechanism (except adjustment of dial and detent screws under the diamond-shaped panel-mounted cover), it is necessary to remove the front panel (par. 46). In the following paragraphs, assume that the front panel has been removed.

b. Removal of Index Window (Equipments Procured on Order No. 18651-P-49) (fig. 26). The index window is held to the main shaft of the mechanism by the engraved cover plate, which identifies the positions of the detent locking screws, DET A, DET B, and DET C, and of the dial adjustment screw. To remove the index window, proceed as follows:

(1) Remove and save the three small screws and lockwashers that hold the engraved cover plate in place. Each of the screws is located just above the engraving DET on the plate.

(2) Remove the cover plate by gently prying it out of position with the edge of a knife or blade.

(3) Slide off the tension spring, which supplies the necessary tension to the index window. The spring is mounted between a post to the left of the middle detent adjustment control and a small hole just above the follower pin (left end of index).

(4) Lift off the index window, being careful not to damage the follower pin or to warp the thin aluminum index window frame.

c. Removal of Index (Equipment not Procured on Order No. 18651-P-49) (fig. 28). The index is held to the shaft within the main shaft of the mechanism by a screw and a washer. The vertical section of the index T has two notches that fit into grooves on a mounting stud. This stud is free to rotate but is loaded within the shaft by means of a torsion spring. A hook on the end of the left horizontal arm of the T latches on to a pin projecting from the follower lever. The clockwise force of the torsion spring in the mounting stud (shaft of mechanism) and the counterclockwise pull of the follower lever, which is actuated by the cam plate under the large gear, position the index as required to correct calibration errors. Note that bends in the vertical arm of the index T and a bend in the right horizontal arm of the T are made to clear the engraved cover plate (marked DET A, DET B, DET C) and the calibrated dial plate, respectively. To remove the screw and washer, disengage the index from the follower pin. Save the screw and washer. When the index is removed, the torsion spring within the dial shaft will release. Be careful not to damage or warp the thin brass index. Do not remove the stud unless the spring shows no tension.

d. Replacement of Index Tension Spring (Equipment Procured on Order No. 18651-P-49).

(1) Hook one end of the spring over the supporting post near the detent adjustment control, and the other end through the small hole above the follower pin.

(2) Gently pull down the index frame so that the circular rim of the index window frame rests over the hub of the assembly, and the follower pin rests in the slot of the cam follower. Press down the index window frame to fit over the hub.

e. Replacement of Index (Equipment not Procured on Order No. 18651-P-49) (fig. 28). Two possible ways for replacing the index are outlined below. Use the method that is most convenient.

(1) The method outlined below involves removal of the follower post and lever, and use of the index to tighten the torsion spring.

(*a*) Remove the upper of the two screws, located on the back of the dial-drive and detent assembly mounting plate, that hold the follower assembly (post and lever) to the mounting plate. Loosen, but do not remove, the lower screw.

(*b*) Rotate the follower assembly away to disengage the pin from the index.

(*c*) Place the round end of the vertical arm of the index T over the dial shaft so that the two notches on the index fit into the grooves on the shaft.

(*d*) Replace the washer and mounting screw to secure the index to the dial shaft.

(*e*) Rotate the index in a counterclockwise direction, making 4 to 6 revolutions about the axis. This will tighten the torsion spring.

(*f*) Now hold the index to prevent the spring from unwinding; replace the follower to its normal position; and restore the mounting washer and screw.

(*g*) Release the index, and make sure that the notch on the index arm engages the pin on the longer arm of the follower lever. The pin on the shorter arm of the lever should ride under the cam plate under the large dial gear. Tighten all screws. If the replacement has been made properly, the index will return to this position if it is rotated with the fingers in the counterclockwise direction, and then released.

(2) The following method makes it unnecessary to remove the follower assembly, and involves the use of a screw driver to tighten the spring tension.

(*a*) With a screwdriver, rotate the stud in the dial shaft in the counterclockwise direction, between 4 and 6 turns.

(*b*) Hold the stud with the fingers to prevent releasing the spring again. Fit the index into the grooves on the stud.

(*c*) Hold the index against the stud, and rotate it to engage the hook on the index with the pin from the follower.

f. Replacement of Detent Flag Tension Springs. A small spring holds each of the three detent flags in the operated position. The spring is connected between a small hole in the flag (just to the right of the slotted supporting bracket) and a supporting post mounted on the small grooved bracket.

(1) Hook one end of the spring into the hole on the flag. If necessary, push down interfering flags with finger.

(2) Hook the other end of the spring over the corresponding notch in the supporting post.

Note. The procedures described in the following paragraphs should be attempted only by mechanically skilled personnel, and then only if absolutely necessary and if equipped with proper tools. Very close tolerances of fit are involved.

g. Removal of Drive Gear (figs. 27 and 29).

(1) Replace the knob on the shaft of the dial-drive mechanism.

(2) Rotate the tuning dial until the cutout in the dial lines up with the drive gear to which the tuning knob is attached. When so positioned, the lowest channel number and the highest channel number will be equally spaced away from the drive gear shaft.

(3) Use a No. 6 Allen setscrew wrench to loosen the two setscrews that hold the drive gear to the shaft. These screws are identified by green paint. The other screws, marked with red paint, should not be touched. Note that the hub of the drive gear is located on the underside of the gear.

(4) Carefully remove the drive gear by sliding it off the shaft, together with the sealing bushing found in front of the drive gear.

h. Removal of Dial and Detent Disk Assembly (figs. 27 and 29).

(1) Turn the drive mechanism into any undetented dial position. Remove the index as described in *b* or *c* above.

(2) Remove the retaining **C**-ring washer from the shaft on which the detent assembly turns, using a pair of pointed long-nosed pliers. Note the small pin hole at each end of the washer. Save the ring washer and the corrugated tension washer found under it.

(3) Loosen the bell crank post located to the left of the dial by unscrewing one of its mounting screws and by loosening the other.

(4) Turn the post until the crank clears the cam.

(5) Lift off the dial and detent assembly.

i. Disassembly of Detent Mechanism. The detent assembly is held together with a large retaining **C**-ring (Waldes *Tru Arc*).

(1) Loosen the three detent locking screws DET A, DET B, and DET C.

(2) Remove the retaining ring with a pair of No. 6 Tru Arc pliers. A spring washer is located immediately below the retaining ring. Remove this ring.

(3) With the retaining ring removed, the detent disks can be lifted off.

Note. The disk associated with DET A is farthest away from the dial. The middle disk is associated with DET B. The disk nearest the dial is associated with DET C. The shoulder of each of these disks is assembled facing the dial.

(4) As each disk is lifted off, a pair of brakeshoes is exposed and may be removed if necessary.

j. Removal of Detent Supporting Frame (figs. 27 and 29). As a rule, it should not be necessary to remove the detent supporting casting from the chassis to reach any part during the repair procedure. The gear which is attached to the variable capacitor shaft through the flexible coupling is pinned to the shaft with 1/16-inch x 5/8-inch groove pin. The flexible coupling is attached to the variable gang capacitor shaft with No. 4 Allen setscrews.

k. Removal of Power Supply Compartment. Three large screws, which are inserted through the interior of the power supply compartment, hold the power supply compartment to the casting of the drive and detent assembly (fig. 34). The three screws are distributed in a triangular formation at the lower end of the casting. It is possible to remove the three nuts and screws by using an open-ended hexagonal wrench and a right-angle screwdriver. The nuts are easily accessible when the dial and detent disk assembly has been removed as described in *h* above.

50. Alinement of Dial and Variable Gang Capacitor

The flexible coupling at the rear of the dial-drive mechanism casting is attached to the variable gang capacitor shaft by means of two No. 6 Allen setscrews. Normally, it is inadvisable to detach this coupling from the capacitor shaft, because positioning of the shaft with respect to the coupling so as to retain the required dial calibration is a very elaborate and difficult process involving the use of accurately calibrated signal generators. If the setscrews for locking the shaft of the variable gang capacitor to the bellows coupling have become loosened, the following procedure will aid in properly resetting the capacitor to its correct angular location.

a. Using a No. 6 Allen setscrew wrench, loosen the two setscrews on the bellows coupling adjacent to the gang capacitor. Use the short length of the setscrew wrench to loosen and tighten the setscrews. Leave the wrench in place while rotating the dial. This will simplify the process of loosening and tightening the setscrew and will prevent slippage of either the dial or the capacitor shaft while the screw adjustment is made.

b. Set the dial accurately at its middle frequency setting. Loosen the two button-head screws at the front of the gang capacitor near the bellows coupling. Similarly, loosen the two button-head machine screws at the rear of the capacitor. These four screws hold the cover over the gang capacitor. Remove the cover.

c. Rotate the gang capacitor by hand exactly to its 1/2-mesh (90°) position. The fact that the capacitor is 90° meshed may be determined by sighting along the frame notches on the capacitor and along the rotating plates. Tighten the setscrews in the coupling.

d. Perform the electrical tests described in paragraph 55. When these tests show that the mechanical adjustment described above has been made properly, and the dial calibration is correct, replace the capacitor cover and tighten the four button-head screws that hold the cover in place.

51. Reassembling Equipment

(fig. 44)

In general, the procedure for reassembling the equipment follows the reverse of the procedure for disassembling the unit (par. 46). In the reassembly procedure described in the following paragraphs, it is assumed that all five parts (outer case, panel, wrap-around frame, and the power supply compartment and dial-drive and detent mechanism assembly) have been detached from each other during the disassembly and repair procedures. If the equipment has been only partially disassembled, follow the applicable steps, and omit the rest. If at any time during the disassembly or repair procedure the flexible bellows coupling has been detached from the variable capacitor shaft, or the setscrews have been loosened or removed it will be necessary to recouple and recheck the capacitor setting and dial calibration as described in paragraph 50.

a. Power Supply Compartment and Dial-Drive and Detent Assembly. To reattach the dial-drive and detent assembly with the power supply compartment to the receiver chassis, proceed as follows:

(1) Place the receiver chassis wiring side up.

(2) Position the assembly so that the variable capacitor shaft fits into the bellows coupling collar, and the two projections from the back of the dial-drive and detent assembly casting line up over the holes at the edge of the chassis in front of the variable capacitor. When properly positioned, the power supply compartment will fit into the cutout in the receiver chassis.

(3) Restore the two machine screws, lockwashers, and nuts that hold the chassis to the projections from the back of the casting. Do not tighten at this time.

(4) Before tightening the screws, slightly shift the assembly back and forth to make sure that the following conditions are met:

  (*a*) The capacitor shaft rests freely in the coupling without bending or twisting the bellows.

  (*b*) The small bracket near the bottom edge of the compartment fits over the large machine bolt which mounts the three large resistors.

  (*c*) The two mounting brackets on the sides of the compartment line up with the mounting holes on the chassis. One hole is located near socket X14. The other hole is located near trimmer capacitor C3C.

(5) Restore the large nut over the resistor mounting hole ((4)(*b*) above).

(6) Restore the two lockwashers and screws that attach the chassis to the power supply compartment mounting brackets ((4)(*c*) above).

(7) Tighten all mounting screws.

(8) Reset the capacitor and the dial, and tighten the two Allen setscrews in the coupling collar (par. 50).

b. Panel. To replace the panel, proceed as follows:

(1) Place the unit so that the dial-drive assembly faces up.

(2) Place the panel over the dial-drive and detent assembly so that the drive shaft and the three detent adjustment shafts fit through their corresponding holes in the panel.

(3) Restore the three mounting screws that attach the panel to the legs on the dial-drive and detent assembly casting. One of these screws fits through the hole within the power supply compartment. Each of the other two fit through a leg at the top of the casting.

(4) Restore the two mounting screws that attach the mounting brackets from the power supply compartment to the projections on the sides of the panel.

(5) Using a spanner wrench, restore the castellated nuts on the dial-drive shaft and on the shafts of the detent adjustment controls.

(6) Restore the knobs and knob mounting screws.

c. Wrap-Around Frame. To restore the wrap-around frame, slip the frame over the top and bottom edges of the assembly so that the long side of the frame fits over the top of the assembly, and the short side fits over the bottom of the assembly. When properly installed, the mounting holes on the frame will line up with the two projections at the top of the dial-drive casting and with the small brackets on the rear wall of the power supply compartment. Restore the seven mounting screws. Make sure that the projections at the edges of the chassis fit into the slits in the wrap-around frame.

d. Connectors. Restore the connections between coaxial connectors P1 and J1 and P4 and J4. Restore the connection between multiconnectors P5 and J5.

e. Plug-In Components. Make sure that the ballast lamp, thermal relay, voltage regulator, all tubes, and plug-in electrolytic capacitors C73 and C80 are properly installed in their sockets. Make sure that tube shields are installed over all tubes.

52. Preliminary Procedures

a. Switch and Control Settings.

Control	Position
SQUELCH switch	OFF.
VOLUME control	Extreme clockwise (maximum gain).
6, 12, and 24 VOLTS-OFF-EXTERNAL SUPPLY switch.	In either of the two ON positions, depending on whether the vibrator supply or external 130-volt supply is used.

b. Test Connections. Unless otherwise called for under the alinement procedures, the test connections are the same as described in paragraph 39.

c. Check of Tuning Oscillator Operation.

(1) Connect a vacuum-tube voltmeter, M1, between the grid (pin 6) of tuning oscillator V10 and chassis.

(2) Turn the DIAL LIGHT switch to the TUNE position, and observe whether the following requirement is met.

Requirement: The meter should read approximately 24 volts.

(3) Turn the DIAL LIGHT switch to the ON or OFF position.

Requirement: The meter, connected as before, should read 0 volt.

(4) If the above requirements are not met, trouble in the tuning oscillator or S3 is indicated. Clear the trouble before proceeding (pars. 34–45).

53. Alinement of If. and Limiter Stages

a. Setting If. Reference Level (Ref. A). The proper meter reading for alinement of the if. amplifier and limiter stages of the receiver is .5 volt. This reference level hereafter will be referred to as *reference A*.

(1) Connect the 4.3-mc test signal generator, G5, in series with a .01-μf capacitor between the grid (pin 6) of fourth if. amplifier stage V7 and chassis.

(2) Connect meter M1 between the grid (pin 6) of tube V8 and chassis. The meter thus connected will be referred to as the *limiter meter*.

(3) Set the signal generator frequency to 4.3 mc.

(4) Adjust the test signal level to .1 volt.

Requirement: The limiter meter should read approximately .5 volt dc.

(5) If the above requirement is not met, check the possibility of misalinement of stage V7. Leave the test equipment connected as before and proceed as follows:

(*a*) Connect the shunting unit (the series arrangement of a .0062-μf capacitor and a 2,700-ohm ½-watt resistor) between the plate (pin 2) of V7 and chassis.

(*b*) Adjust the tuning slug of T9 marked S (secondary) until the limiter meter shows a peak reading.

(*c*) Shift the connection of the shunting unit to the grid of limiter stage V8 and adjust the slug of T9 marked P (primary) until the limiter meter again shows a peak reading.

(*d*) Repeat (*a*) through (*c*) above until no further peaking is possible for either connection of the shunting unit.

(*e*) Remove the shunting unit and repeat the check in (4) above, and observe whether the requirement is met.

Note. Because of the shunting effect of the shunting unit, the test signal generator output will have to be increased for the tuning adjustments of T9.

(*f*) If the reading is still not obtained, troubleshooting for V7 is indicated.

b. Alinement Procedure.

(1) Connect generator G5 and meter M1 as described in *a*(1) and (2) above and adjust the frequency and level as described in *a*(3) and (4), respectively.

(2) Connect the shunting unit (the series arrangement of a .0062-μf capacitor in series with a 2,700-ohm ½-watt resistor) between the plate of V7 and chassis.

(3) Adjust the tuning slug of T9 marked S until the limiter meter shows a peak reading.

(4) Shift the connection of the shunting unit to the grid of limiter stage V8 and adjust the slug marked P of T9 until the limiter meter shows a peak reading.

(5) Shift the signal generator connection to pin 6 of V6.

(6) Adjust the test signal level to obtain reference A reading on the limiter meter.
(7) Shift the shunting unit connection to the plate (pin 2) of V6, and adjust the slug marked S of T8 to obtain a peak reading on the limiter meter.
(8) Shift the shunting unit connection to pin 6 of V7, and adjust the slug marked P on T8 until limiter meter shows a peak reading.
(9) Shift the test signal generator connection to pin 6 of V5.
(10) Adjust the test signal level to obtain reference A reading on the limiter meter.
(11) Shift the shunting unit connection to the plate of V5.
(12) Adjust the tuning slug marked S at T7 to obtain peak reading on the limiter meter.
(13) Shift the shunting unit connection to pin 6 of V6 and adjust the P slug on T7 to obtain a peak reading on the limiter meter.
(14) Shift the signal generator connection to pin 6 of V4.
(15) Adjust the level as before.
(16) Shift the shunting unit connection to pin 2 of V4 and adjust slug S on T6 for a peak reading on the limiter meter.
(17) Shift the shunting unit connection to pin 6 of V5 and adjust slug P on T6 for a peak reading on the limiter meter.
(18) Shift the signal generator connection to pin 1 of V2 and adjust the level as before.
(19) Shift the shunting unit connection to pin 5 of V2 and adjust slug S on T5 to obtain a peak reading on the limiter meter.
(20) Shift the shunting unit connection to pin 6 of V4 and adjust slug P on T5 to obtain a peak reading on the limiter meter. Remove the shunting unit connection.
(21) Adjust the test signal level to obtain the reference B reading (par. 55) on the limiter meter. Note the level required to obtain that reading.

Requirement: For a properly alined if. amplifier limiter circuit, the test signal level should be approximately 500 microvolts when the reference B limiter meter reading is obtained.

54. Discriminator Alinement

a. Connect signal generator G5 through a .006-μf blocking capacitor between pin 6 of V7 and chassis.

b. Connect the limiter meter between the grid (pin 6) of V8 and chassis.

c. Connect meter M2 (hereafter called the *discriminator meter*) between test point E5 and chassis.

d. Adjust the level of the signal generator to obtain a reading of +.5 volts dc on the limiter meter.

e. Adjust the tuning slug in tuning assembly T11 to obtain a zero reading on the discriminator meter.

f. Raise the frequency of the test signal above 4.3 mc until a peak reading is obtained on the discriminator meter. Note the frequency and the meter reading.

g. Lower the frequency of the signal below 4.3 mc until a peak reading is again obtained on the discriminator meter. Note the frequency and the meter reading.

Requirement: Each of the two peaks noted in *f* and *g* above should occur at approximately 50 $\pm$5 kc from the setting of the signal generator for which the zero discriminator meter reading (*e* above) is obtained. (If not, refer to *l* below.) The difference between the numerical values (disregarding signs) of the two peak readings should not be greater than 2 volts dc. (If not, refer to *h* below.) The two peak readings should be of opposite polarity (one should be + and the other −). Each of the two peak readings should be approximately 15 volts dc.

h. If the meter readings at the peaks are not within 2 volts of each other, proceed as follows:

(1) Readjust the test signal frequency to the peak at which the lower of the two voltage readings was obtained (*f* and *g* above).
(2) Adjust the tuning slug of T10 until the meter reading is increased by about one-half the difference between the two peak readings of *f* and *g* above.
(3) Check the discriminator meter readings at both peaks as before, and observe whether the peak readings are now within 2 volts of each other.
(4) If the peak readings still are not within 2 volts of each other, again adjust the

signal generator frequency for the lower of the two readings and repeat the steps in (1) through (3) above. This procedure may have to be repeated several times before the two peak readings are brought to within 2 volts of each other.

i. Return the signal generator to 4.3 mc. Adjust the signal generator frequency to zero-beat with the tuning oscillator of the receiver. (Test switch in TUNE position.) Observe whether the discriminator meter still reads zero as in *e* above. The meter reading should be zero.

j. If the meter reading is not zero, readjust the tuning slug of T11 for zero deflection of the discriminator meter, and repeat the steps in *f* through *g* above, and if necessary, *h* above.

k. If the discriminator is badly out of adjustment and the above procedure fails to produce the required results, proceed as follows:

(1) Connect meter M1 between test point E4 and chassis. (The meter thus connected will be referred to as the *alinement meter*, since if desired, all alinement of the rf and if. circuits may be made for a peak deflection on this meter.)

(2) Tune the signal generator for zero beat with the tuning oscillator (4.3 mc).

(3) Adjust the tuning slug of T10 for a peak reading on the alinement meter.

(4) After the above adjustment has been made, disconnect the alinement meter.

(5) Proceed with the tests and adjustments in *a* through *j* above.

l. If the peaks (*f* and *g* above) do not occur 50 kc from the zero center setting of the discriminator, the peaks may be shifted relative to the zero center frequency as follows:

(1) Determine which of the two peaks is farther away from the zero center frequency.

(2) Tune the signal generator to that frequency.

(3) Slightly adjust discriminator capacitor C67, and then readjust the signal generator frequency to obtain each peak reading.

(4) Note whether the peak reading is now closer or farther away from the center frequency.

(5) Continue the adjustment of C67 until the resonant peak occurs 50 kc away from the center frequency.

(6) Recheck the center frequency and the distribution of the two resonant peaks about the center frequency.

m. After the above adjustments have been completed, check the discriminator alinement as follows:

(1) Adjust the signal generator for zero beat with the tuning oscillator (4.3 mc).

(2) Raise the signal generator frequency to 4.33 mc and observe the discriminator meter reading.

(3) Lower the signal generator frequency to 4.27 mc and again observe the discriminator meter reading.

Requirements: The two meter readings should be within 2 volts of each other.

55. Alinement Checks of Oscillator and Rf Amplifier Circuits

a. Determination of Rf Reference Level (Reference B). For alinement of the rf stages, the signal generator output level must be high enough to override the noise level inherent in the particular receiver and yet not so high as to make the reference reading insensitive to changes of signal level. For this reason, a new reference level must be established. This reference level will hereafter be referred to as *reference* B, and will be used for all adjustments on the rf and oscillator circuits.

(1) Connect test signal generator G5 to the grid (pin 1) of the mixer stage V2 through a .0062-μf capacitor.

(2) Connect limiter meter M1 between the grid (pin 6) of V8 and chassis.

(3) Adjust the test signal frequency to 4.3 mc and for zero beat with the tuning oscillator (test switch in TUNE position).

(4) Adjust the test signal level to obtain reference B (approx. 6.5 volts).

Requirement: The test signal level required to obtain reference B reading of the limiter meter should be approximately 500 microvolts but will vary widely between sets.

b. Check of Receiver Oscillator Alinement Using Calibration Points.

(1) Connect a pair of headphones between terminals E and D of J8.

(2) Turn the DIAL LIGHT switch on the receiver panel to the TUNE position.

(3) Turn the receiver dial to the calibrate point (red dot) nearest the hf end of

the dial. The calibration point frequencies for the three receivers are listed in table I.

Table I. Calibration Point Frequencies

Radio Receiver	Operating range (mc)	Calibration point frequencies (mc)
R-108/GRC	20 to 28	21. 5 25. 8
R-109/GRC	27 to 39	30. 1 34. 4 38. 7
R-110/GRC	38 to 55	38. 7 43. 0 47. 3 51. 6

(4) Rotate the receiver dial in the vicinity of the red dot to obtain a zero-beat note in the headphones, and note the position of the hairline on the dial window relative to the red dot.

Requirement: The zero-beat note should be obtained when the hairline on the dial window is within one-half of a division of the red dot.

(5) Turn the receiver dial to the calibrate frequency point (red dot) nearest the lf end of the dial.

(6) Rotate the dial in the vinicity of the red dot to obtain a zero-beat note in the headphones. Note whether the requirement following *b*(4) above is met.

(7) Repeat the above procedure for each red-dot position of the dial (table I) and note whether the requirement following *b*(4) above is met.

(8) If no beat note is obtained at the calibrate points, or if the calibration error requirement following *b*(4) above is not met, proceed with the alinement of the receiver oscillator (par. 56).

c. Check of Oscillator Alinement and Dial Tracking, Using Crystal Calibrator. The following checks are based on the use of Signal Generator Set AN/URM-48 (G1).

(1) Connect G1 to the ANT connector on the receiver panel.

(2) Place DIAL LIGHT switch on the receiver panel in the TUNE position.

(3) Turn the receiver dial to the highest integral mc setting (28 mc, 39 mc, or 55 mc for Radio Receiver R-108/GRC, R-109/GRC, or R-110/GRC, respectively).

(4) Adjust the signal generator frequency to the dial frequency.

(5) Rotate the dial to obtain a zero-beat note in the headphones.

Requirement: The zero-beat note should be obtained when the dial is within one-half of the division of the signal generator frequency.

(6) Repeat the above procedures for each integral setting of the dial, and for each setting observe whether the above requirement is met.

Requirement: At each mc point on the dial, the zero-beat note should be obtained when the dial is within one-half of a division of the signal generator frequency.

(7) If the above requirement is met, the dial calibration is correct. If the requirement is not met, the dial calibration error is excessive. In that case, the receiver oscillator must be realined as described in paragraph 56 and dial calibration corrected as described in paragraph 57.

d. Check of Rf Circuit Alinement. The following checks are made to determine whether the rf circuits of the receiver need alinement, and to provide preparatory procedures for such alinement, if necessary.

(1) Connect the signal generator G1 to the ANT connector on the front panel.

(2) Set the dial to the highest integral mc position.

(3) Place the DIAL LIGHT switch to the TUNE position.

(4) Adjust the signal generator frequency to the dial frequency until a zero-beat note is heard in the headphones.

(5) Return the DIAL LIGHT switch to the ON or OFF position.

(6) Adjust the output level of the signal generator to obtain reference B reading on the limiter meter.

(7) Connect discriminator meter M1 between test point E4 and chassis and note its reading.

Requirement: The discriminator meter should read 0 ± 3 volts.

(8) If the discriminator meter reads more than ± 3 volts, the discriminator circuit is not in proper alinement. It is necessary then to repeat the alinement of the discriminator circuit as described in paragraph 54 before proceeding with the alinement of the rf amplifier circuits.

(9) Slightly tune the receiver dial to each side of the point to which the zero-beat note was obtained in (4) above to observe whether or not the limiter meter shows a peak reading at or near this point.

Requirement: The limiter meter should show a peak reading at the point on the dial at or near which a zero-beat note was obtained in (4) above.

(10) If the above requirement is not met, recheck the alinement of the if. amplifier, limiter, and discriminator circuits (pars. 53 and 54) before proceeding with the checks and adjustments of rf stage alinement.

(11) Readjust the signal generator frequency for zero beat with the tuning oscillator and adjust the level to obtain reference B reading on the limiter meter. Determine the signal generator output level required to obtain that reading. Compare the level obtained with the values in table II.

(12) Reduce the signal generator output level to zero and observe the limiter meter reading obtained with zero signal input. The limiter meter should read approximately .75 volt. This reading may be taken as a measure of the sensitivity of the receiver.

(13) Turn the receiver dial to the lowest mc setting and adjust the signal generator frequency to correspond with that frequency.

(14) Adjust the signal generator frequency for zero beat with the tuning oscillator.

(15) Check the reading of the discriminator meter when the zero-beat note is obtained.

Requirement: Discriminator meter should read 0 ±3 volts.

(16) Slightly tune the receiver dial to each side of the point at which zero beat was obtained, and observe the limiter meter reading.

Requirement: The limiter meter should show a peak reading at or near the point on the dial at which the zero-beat note with the tuning oscillator was obtained.

(17) Readjust the signal generator frequency for zero beat with the tuning oscillator and adjust the level to obtain reference B reading on the limiter meter.

(18) Determine the signal generator output level required to obtain that reading. Compare the level obtained with the values shown in table II.

Requirement: The signal generator output levels required to obtain the reference B reading at the high and low ends of the dial should be as shown in table II.

Table II. Reference B Signal Generator Output Levels

Radio Receiver	Test frequency (mc)	Signal generator output level (uv)
R–108/GRC	20	3
	28	1. 5
R–109/GRC	27	3
	39	1. 5
R–110/GRC	38	3
	55	1. 5

(19) Reduce the signal generator output level to zero, and observe whether the limiter meter reads approximately .75 volt at this point.

(20) If the signal generator output levels required for the reference B reading on the limiter meter are not approximately as listed in table II, proceed as follows:

(*a*) Tune the receiver to the highest mc setting on the dial. Adjust the signal generator to this frequency.

(*b*) With a screwdriver, adjust the setting of trimmer capacitor C4 to obtain a peak reading on the limiter meter at this frequency (par. 53).

(*c*) Recheck the signal generator output levels required to obtain reference B reading on the limiter meter at the high- and low-frequency ends of the dial.

(*d*) If the required signal generator output levels are not approximately equal to those listed in table II, procced with the alinement of the rf amplifier circuits (par. 58). If, however, the required signal generator output levels are obtained, alinement of rf amplifier circuit is not necessary.

56. Rf Amplifier and Oscillator Alinement

Three procedures for adjusting the receiver oscillator are the procedure for the alinement of the rf and oscillator stages; procedure for alinement of the oscillator; and procedure for the alinement of the oscillator and dial by means of the crystal—calibrated signal generator.

a. Alinement of Rf Amplifier and Oscillator Circuits.

(1) Rotate each of the three rf trimmer capacitors (C3C, C3E, and C3G), which are located above the variable gang capacitor and are on the left side of the chassis (fig. 34), until the plates are one-half meshed.

(2) Turn the tuning dial to the lowest frequency.

(3) Remove the cap on top of the oscillator coil assembly (T4, fig. 34). This cap should be removed only in a dry location, since the unit is sealed to keep out moisture.

(4) Connect the signal generator G1 to the ANT connector on the front panel.

(5) Tune the signal generator to the frequency corresponding to the dial setting.

(6) Turn the DIAL LIGHT switch to the TUNE position.

(7) Using a screwdriver, adjust the tuning slug of T4 to obtain a zero-beat note in the headphone.

(8) Return the DIAL LIGHT switch to the ON or OFF position.

(9) Adjust the tuning slugs of T3, T2, and T1, in that order, to obtain maximum deflections of the limiter meter for each adjustment.

(10) Rotate the tuning dial to the highest tuning frequency.

(11) Tune the signal generator to this frequency.

(12) Turn the DIAL LIGHT switch to the TUNE position.

(13) Adjust trimmer capacitor C3G (fig. 34) to obtain a zero-beat note in the headphone.

(14) Return the DIAL LIGHT switch to the ON or OFF position.

(15) Adjust trimmer capacitors C3E and C3C (fig. 34) for maximum deflections of the limiter meter.

(16) Adjust antenna trimmer capacitor C4 for a peak reading of the limiter meter.

(17) Repeat the adjustments in (2) through (16) above until no further improvement is obtained.

(18) This completes the preliminary adjustments of the receiver oscillator and the receiver rf amplifier stages. For more precise adjustment, proceed with the adjustments described in *b* below.

b. Alinement of Receiver Oscillator, Using Markings on Dial.

(1) Disconnect the signal generator from the ANT connector on the panel.

(2) Place the DIAL LIGHT switch to the TUNE position.

(3) Turn the tuning dial to the calibrate frequency (red dot) at the high end of its tuning range.

(4) Adjust trimmer capacitor C3G (fig. 34) to obtain a zero-beat note in the headphones.

(5) Turn the dial to the calibrate frequency nearest the low end of the tuning dial.

(6) Adjust the tuning slug of T4 to obtain a zero-beat note in the headphone.

(7) Repeat the adjustment of C3G with the dial at the highest calibration point and, the adjustment of T4 with the dial at the lowest calibration point until a zero-beat note is obtained at both calibrate points.

c. Adjustments of Oscillator and Dial Using Calibrated Signal Generator. The following adjustment involves the use of signal generator G1 and insures a more precise adjustment of the receiver oscillator than that obtainable with the procedures outlined in *a* and *b* above.

(1) Connect signal generator G1 to the ANT connector.

(2) Set the signal generator frequency to the receiver frequency.

(3) Check the dial calibration as follows:

(*a*) Place the DIAL LIGHT switch to the TUNE position.

(*b*) Rotate the dial until a zero-beat note is obtained at or near the highest integral mc position of the dial.

(*c*) Observe whether the hairline on the dial window is within one-half of a division from the mc marker on the dial when a zero-beat note is heard.

(*d*) Rotate the dial to the next integral mc position and again note whether the zero-beat note is obtained within one-half of the division of the integral mc marker on the dial.

(*e*) Repeat the above procedures for each integral mc setting of the dial.

(4) If the zero-beat notes are not obtained when the hairline on the dial window is within one-half of the division of the integral mc markings on the dial, proceed as follows:

(*a*) Loosen and rotate the front panel detent cover plate. Remove the left cover plate screw from the front panel. Rotation of the cover plate exposes the dial and detent adjustment screws.

(*b*) Turn the screw marked DIAL (figs. 27 and 29) and note the range of adjustment of the dial reading. Set the screw at the point that sets the dial at the center of these limits.

(*c*) Turn the dial to the highest mc position.

(*d*) Turn the DIAL LIGHT switch to the TUNE position.

(*e*) Adjust trimmer capacitor C3G (fig. 34) to obtain a zero-beat note in the headphone.

(*f*) Turn the dial to its lowest mc setting and adjust the slug of T4 (fig. 34) to obtain a zero beat in the headphone.

(*g*) Repeat the adjustments of the trimmer capacitor at the high end of the dial, and of T4 at the low end of the dial until no further improvement is noted.

(5) Recheck the dial error at each mc setting as described in (3) above, and note whether the maximum dial calibration error at any of the mc settings exceeds the required limits of one-half of the dial division.

(6) If the dial calibration error requirements are met, the adjustment of the oscillator and the dial calibrator is now complete. If the requirements still are not met, proceed with the adjustment of the variable cam on the dial as described in paragraph 57.

57. Correction of Dial Calibration Cam

Adjustment of the dial calibration cam should not be attempted unless signal generator G1 is available. This signal generator supplies frequencies at each mc setting of the dial over the entire range covered by the particular receiver being tested. Do not attempt adjustment of the variable cam unles it is certain that the dial error exceeds the specified limits (one-half of a division and that adjustment of the dial screw under the detent cover plate was not able to remedy the error (par. 56). To insure that the correct frequency is selected for the checks described below, perform the dial calibration described in paragraph 56. After this has been done, proceed as follows:

a. Radio Receiver R–108/GRC. For this receiver, the dial adjusting screws line up with the hole in the index window frame for 22-, 24-, 26-, and 28-mc settings of the dial. For these frequencies, the procedure is the same as outlined in *b* below. For 21-, 23-, 25-, and 27-mc settings of the dial, the adjustment procedure is as follows:

(1) Note the magnitude of the dial error.

(2) Turn the dial to one side of the frequency to expose the nearest adjusting screw.

(3) Correct the setting by amount equal to approximately one-half of the dial error.

(4) Turn the dial to the odd mc setting and observe the magnitude of the error.

(5) Turn the dial in the other direction to expose the other adjacent screw.

(6) Turn this screw until the error has been corrected.

(7) Repeat the adjustment of the two screws adjacent to the mc position of the dial until the error is corrected.

b. Radio Receiver R–109/GRC. At each mc point on the dial, adjust the variable cam adjusting screw, which is accessible by means of a screwdriver, through the hole exposed when the cover plate screw has been removed. Adjust this screw by an amount which will correct the dial error. Turn the screw clockwise to move the index mark to the right. Turn the screw counterclockwise to move the index mark to the left. In Radio Receiver R–109/GRC, the variable cam adjusting screws line up with this hole at each mc setting of the tuning dial.

c. Radio Receiver R–110/GRC. The adjusting screw lines up, or nearly lines up, with the hole in the index window frame for 38-, 41-, 42-, 45-, 48-, 51-, 52-, and 55-mc settings of the dial. For these frequencies, the procedure is the same as for Radio Receiver R–109/GRC (*a* above).

(1) For adjustments at 39 and 40 mc on the dial, proceed as follows:

(*a*) Note the magnitudes of the dial errors at 39 and 40 mc.

(*b*) Turn the dial to a setting between 39 and 40 mc, at which an adjustment screw lines up with the hole in the index window frame.

(c) Adjust this screw until the dial errors at 39 and 40 mc are equal and opposite in direction (one is above the mc mark, and the other is below the mc mark on the dial).

(2) For adjustments at 43 and 44 mc, 46 and 47 mc, 49 and 50 mc, and 53 and 54 mc, use the procedure outlined in (1) above, except that the dial error is noted at each frequency of the pair, and the dial is turned to bare the adjustment screw between that pair.

(3) Repeat the above procedures until the dial error at each mc setting of the dial is less than one-half of a scale division.

58. Final Rf Circuit Alinement

After the receiver oscillator and the dial calibration have been check and adjusted as described in the preceding paragraphs, aline the rf circuits as follows:

a. Connect signal generator G1 to the ANT connector on the front panel.

b. Turn the receiver dial to the highest mc setting on the dial.

c. Tune the signal generator to this frequency.

d. Adjust the signal generator to obtain a zero reading on the discriminator meter, M1 (connected between test point E5 and chassis).

e. Check to see that the test switch is in either of the DIAL LIGHT positions for the following adjustments.

f. Adjust trimmer capacitors C3E and C3C (fig. 34) and ANT TUNE capacitor C4 (on front panel), in succession to obtain peak readings on the limiter meter in each case.

g. As the adjustment of trimmer capacitor is made, the signal generator output level should be adjusted from time to time to maintain the limiter meter reading at approximately .1 volt above the noise level (no signal input).

h. Turn the receiver dial to the lowest mc frequency.

i. Adjust the tuning slugs of T1, T2, and T3 to obtain peak readings on the limiter meter in each case.

j. Repeat the adjustment of trimmer capacitors at the high end of the dial and the transformers at the low end of the dial until no further improvement in peaking is obtainable.

Caution: Be careful not to touch the trimmer of receiver oscillator C3G while making these adjustments.

Section V. FINAL TESTING

59. General

a. After the receiver has been repaired and alined, it must be checked to see if it meets certain requirements. If the unit meets the requirements in this section, it is suitable for return to service.

b. Unless stated otherwise, set up the equipment as shown in figure 32. Use frequency meter M5 to check signal generator G1.

60. Test Equipment Required for Final Testing

Item	Common name	Technical manual
Frequency Meter AN/URM-80	M5	TM 11-5095
or		
Frequency Meter TS-174/U	M5	
Audio Oscillator TS-382A/U	G3	TM 11-2684A
Signal Generator AN/URM-48	G1	TM 11-1257
Electronic Multimeter TS-505/U	M1	TM 11-5511
Electronic Multimeter ME-6A/U	M2	TM 11-5549
Multimeter TS-352/U	M3	TM 11-5527
Power Supply PP-281/GRC	Power supply	TM 11-5040
Power Supply PP-282/GRC	Power supply	TM 11-5040
Power Supply PP-448/GR	Power supply	TM 11-5040
Headset HS-30	Headphones	
Loudspeaker LS-166/U	Loudspeaker	
Battery (for power supply being used)		
Capacitor, 6,200 $\mu\mu f$		
Resistor, 600 ohms, ½ watt		
Resistor, 1,000 ohms, ¼ watt		

61. Overall Receiver Sensitivity

a. Connect meter M2, shunted by the 600-ohm resistor, between terminals A and D of J8.

b. Set the controls as follows:

(1) SQUELCH switch to OFF.

(2) DIAL LIGHT switch to the ON or OFF position.

(3) S1 to 6, 12, and 24 VOLTS position.

(4) VOLUME control to extreme clockwise position.

c. Adjust the frequency of the dial to the lowest frequency shown in the chart below.

d. Adjust the signal generator G1 output to 1.0 microvolt (μv).

e. Frequency modulate the signal generator output. The modulation frequency should be 1,000 cycles at 15-kc deviation.

f. Adjust the VOLUME control on the front panel until meter M2 reads 7.75 volts ac. This voltage reading is equivalent to 100 milliwatts. Remove the modulation from the signal generator output. The voltage reading for the R–108/GRC and the R–109/GRC should be not less than .45 volts (or a 17:1 ratio). The voltage reading for the R–110/GRC should be not less than .775 volt (or a 10:1 ratio) when measured at the frequencies listed in the chart below.

Radio Receiver	Frequencies (mc)		
R–108/GRC	20	24	28
R–109/GRC	27	33	38
R–110/GRC	38	46	54

62. Overall Selectivity

a. Set M3 on the dc volts scale and connect it between the grid (pin 6) of tube V8 and the chassis.

b. Adjust the rf signal generator G1 to a frequency .5 mc less than the highest frequency on the receiver dial.

c. Tune in with receiver dial. This is done by varying the dial setting until the limiter meter shows a maximum reading.

d. Adjust the signal generator output level to produce the reference B, 6.5 volts dc (par. 45) reading on M3. Note the signal generator output level at the reference B reading.

e. Double the signal generator output level (a 6-db increase).

f. Tune the receiver to a frequency above the mc setting in *b* above, until a meter reading of 6.5 volts dc is obtained on M3. Note the change in frequency for which this occurs. For example, if the original reading occurred at 27.5 mc and the new reading occurred at 27.55 mc, the change in frequency is .05 mc.

g. Tune the receiver to a frequency below the mc reading obtained in *b* above, until a meter reading of 6.5 volts dc (reference B) is obtained again on M3. Note the change in frequency from the center frequency for which this occurs (*f* above).

h. Add the two changes in frequency obtained in *f* and *g* above. This is the overall receiver bandwidth at points that are 6 db below the center frequency. The bandwidth should be about 85 kc.

i. Compute the difference between the two changes in frequency noted in *f* and *g* above. This difference from the center of the if. is a measure of symmetry and should not be greater than 15 kc.

63. Limiting Action

a. Connect M2 across terminals A and D of J8 shunted with a 600-ohm resistor.

b. Adjust the rf signal generator frequency to 24 mc for Radio Receiver R–108/GRC, 33 mc for Radio Receiver R–109/GRC, and 46 mc for Radio Receiver R–110/GRC.

c. Adjust the signal generator output level to .75 μv for the R–108/GRC and the R–109/GRC and 2 μv for the R–110/GRC. Modulate the signal with 1,000 cycles at 15-kc deviation.

d. Adjust the VOLUME control until M2 reads 7.75 volts output.

e. Raise the signal generator output level to 10,000 μv and observe the change in meter reading. The meter reading should not be greater than 10.9 volts.

64. Overall Receiver Frequency Response

a. Tune the receiver and the unmodulated signal generator output to the frequencies listed in paragraph 63*b*.

b. Adjust the signal generator output level to 10μv.

c. Connect M2 shunted with a 600-ohm resistor across terminals A and D of J8.

d. Connect M3 between test point E5 and the chassis.

e. Adjust the frequency of signal generator G1 to obtain a reading of 0 volt on M3.

f. Modulate the test signal with a 1,000-cycle signal at 15-kc deviation using signal generator G3.

g. Adjust the VOLUME control to obtain a 7.75 volts ac reading on M2.

h. Leaving the setting of the VOLUME control constant, adjust the modulating frequency of the signal generator to 400, 2,000, 3,500, and 5,000 cycles, successively, maintaining a deviation of 15 kc for each frequency and maintaining the signal generator output level at 10 μv. For each modulating frequency, observe the reading of the output meter. The approximate readings at the audio frequencies applied as modulation to the rf signal should be as shown in the chart below.

Audio modulation frequency (cps)	Af output reading (volts)
400	7.75 to 9.75.
1,000	7.75.
2,000	Between 7.75 and 3.46.
3,500	1.95.
5,000	.775.

i. Apply a 1,000-cycle modulation to the test signal under the conditions previously specified and turn the VOLUME control to the maximum clockwise position. Observe the reading of meter M2. The output should be at least 17.3 volts ac.

j. Shift the M2 and load resistor connections to terminals E and D of J8, leaving the test signal generator connections as before. M2 should read at least 4.8 volts ac.

k. Shift M2 and the load resistor connections to terminals B and D of J8, leaving the test connection and adjustments as before. The meter should read at least 4.2 volts ac. If this requirement is not met, adjust potentiometer R42 (fig. 5) to obtain the required output level.

65. Squelch Sensitivity

a. Minimum Squelch Sensitivity.

(1) Disconnect the strap between terminals H and J of J8 and in its place connect a 1,000-ohm resistor. Place M1 across the resistor.

(2) Apply the unmodulated output of the signal generator G1 to the ANT connector (SQUELCH control in the OFF position).

(3) Adjust the signal generator to some convenient frequency within the tuning range of the receiver and tune the receiver until M3 connected between test point E5 and chassis reads 0 volt.

(4) Reduce the signal generator output level to 0.

(5) Turn the SQUELCH control to its maximum clockwise position and note the reading of meter M1. The meter should read 0 volt.

(6) Raise the signal generator output level until M1 reads at least 4 volts. The signal input level should be between 4 and 80 μv to obtain the 4-volt reading on meter M1.

b. Maximum Squelch Sensitivity.

(1) Reduce the test signal generator output level to zero.

(2) Adjust the SQUELCH control until meter M1, connected as in *a* above, reads approximately .5 volt or less.

(3) Raise the rf signal input level until M1 reads at least 4 volts. The signal generator output level should not be more than .5 μv.

66. Listening Test

For this test, a signal from a transmitter operating in the frequency range of the receiver under test is needed. Proceed as follows:

a. Connect a pair of headphones between terminals E and D of J8.

b. Connect another pair of headphones between terminals B and D of J8.

c. Connect a loudspeaker between terminals A and D of J8.

d. Turn the SQUELCH control until the noise in the headphones and loudspeaker almost disappears.

e. Turn the VOLUME control to its maximum clockwise position.

f. Have someone turn on the test transmitter and talk into the microphone.

g. Listen in the headphones and to the loudspeaker for quality of speech. Clear, good quality speech should be heard. The volume of background noise should be low.

67. Tests for Spurious Rf Oscillation

The following checks should be performed as final tests after the receiver has been tested and repaired as outline in paragraphs 32 through 58.

The tests determine whether or not undesirable rf oscillations, exceeding maximum permissible levels, exist in the unit.

a. Quantitative Test. This check should be performed in a screen room free from extraneous signals and with the antenna circuit open. Proceed as follows:

(1) Turn the SQUELCH control to OFF position.

(2) Set meter M1 on the dc volts scale and connect it between the grid (pin 6) of tube V8 and the chassis. Set M3 on the dc scale and connect it between test point E5 and the chassis in the discriminator circuit.

(3) Connect the loudspeaker between terminals A and D of J8.

(4) Slowly rotate the TUNING dial from one end of its range to the other.

(5) Listen for whistling, squealing, or sudden quieting in the loudspeaker. Observe M1 and M3 readings.

(*a*) There should be no squeals, whistles, or burbling noises audible in the loudspeaker.

(*b*) Abrupt quieting in the audio output should not be noticeable.

(*c*) There should be no sudden changes in the readings of meters M1 and M3.

(6) Use a rubber mallet to tap the set as the step described in (4) above is being performed. The set should not break into microphonic oscillations.

(7) Connect meter M2, shunted by a 600-ohm resistor, between terminals A and D of J8. Measure the audio output level while rotating the TUNING dial from one end of its range to the other. The reading should not change abruptly by more than 3 db.

(8) If the above requirements are not met, the receiver is in a state of spurious oscillation. Perform the stage gain measurements (par. 45). Check the dressing of the connecting leads. Attempt to realine the stage or stages that show excessive gain.

b. Quantitative Checks with 10-OHM Antenna Load. Connect a 10-ohm noninductive resistor between the ANT binding post and ground, and repeat the checks outlined in *a* above. The requirements stated in *a*(5) and (7) above should be met. If the requirements are not met, perform the additional checks recommended in *a*(8) above.

CHAPTER 4

REPACKAGING FOR SHIPMENT AND DEMOLITION TO PREVENT ENEMY USE

68. Disassembly

Disconnect the cables connected to the POWER IN, AUDIO, REC CONTROL, and ANT connectors.

69. Field Repackaging

a. General. These instructions provide a procedure for field packaging, packing, and marking of the receiver for zone of interior and intertheater movement.

b. Estimated Material Requirements.

Materials	Quantity
Waterproof barrier material	9 sq ft.
Fiberboard, corrugated, single-faced	18 sq ft.
Tape, paper, gummed	3 ft.
Tape, water-resistant, pressure-sensitive	12 ft.
Strapping, steel	4 ft.
Shipping box, wooden	1.

c. Material Requirements of Box. The receiver should be packed in a box 14¼ inches high by 8¼ inches wide by 10 inches deep. The packed weight of the equipment is 38.6 pounds.

d. Component Packaging. Package the manuals and receiver as follows:

(1) *Manuals.* Package each manual within a close-fitting bag fabricated of waterproof barrier material. Seal the seams with water-resistant pressure-sensitive tape.

(2) *Receiver.* Wrap each receiver in two thicknesses of single-faced flexible corrugated fiberboard. Each thickness of single-faced flexible corrugated fiberboard shall be applied separately and secured with gummed paper tape.

e. Packing.

(1) Place the packaged receiver within a close-fitting nailed wooden box. Place the manuals, packaged as specified in *d*(1) above, between the contents and the lid of the shipping container.

(2) Shipping containers should be fitted with a sealed waterproof case liner.

(3) Strap shipping containers on intertheater movements only.

(4) Mark shipping containers in accordance with SR 55-720-1, section II, Transportation and Travel, Preparation for Oversea Movement of Units (POM).

70. Demolition to Prevent Enemy Use

When given the order to do so, destroy the equipment by using any or all of the methods given below.

a. Smash. Smash tubes, coils, and capacitors; use sledges, axes, handaxes, pickaxes, hammers, crowbars or heavy tools.

b. Cut. Cut the wiring; use axes, handaxes, and machetes.

c. Burn. Burn cords, resistors, capacitors, coils, wiring, and manuals; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend panels and chassis.

e. Explode. If explosives are necessary, use grenades or TNT.

f. Disposal. Bury or scatter the destroyed parts in slit trenches, fox holes, or other holes, or throw them into streams.

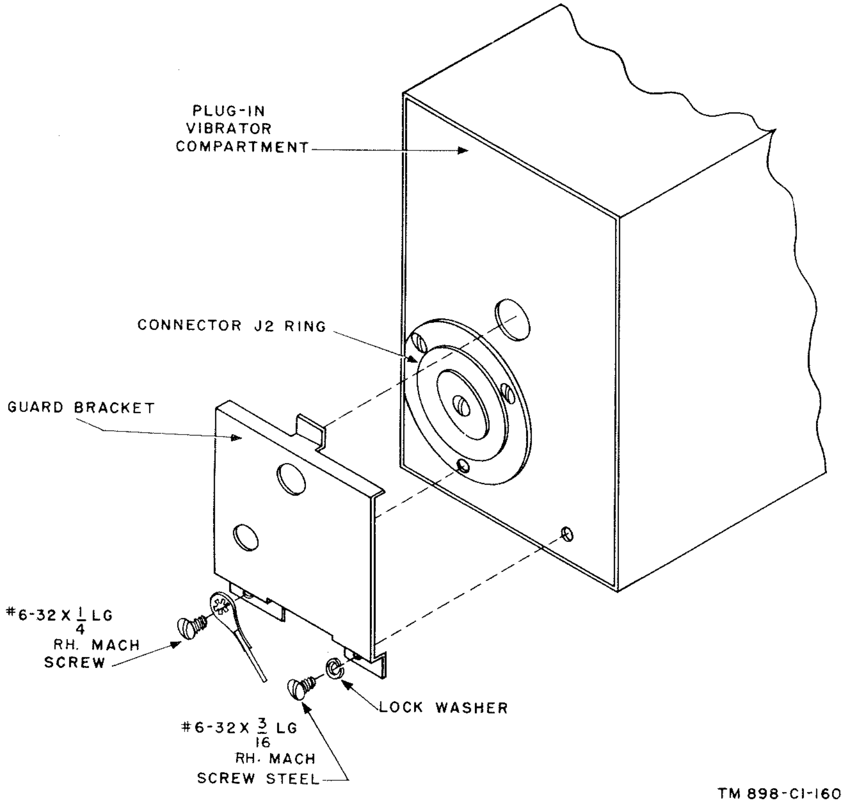
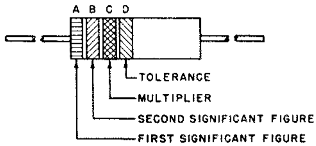


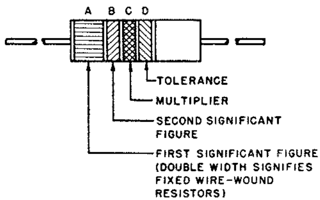
Figure 45. Power supply compartment, assembly details.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED)

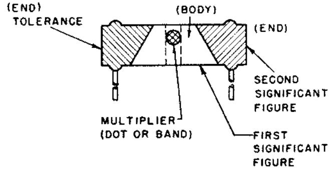


RC-COMPOSITION

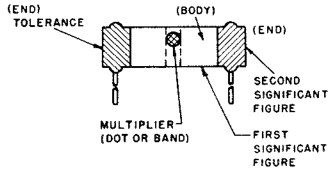


RU-WIRE-WOUND

RADIAL-LEAD RESISTORS (UNINSULATED)



RZ-COMPOSITION



RZ-COMPOSITION

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 BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

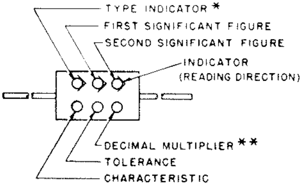
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

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-R1

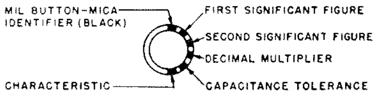
Figure 46. MIL-STD resistor color codes.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)

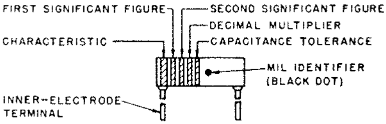


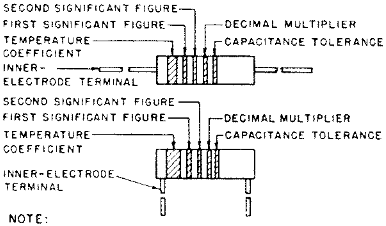
* BLACK DOT: MICA DIELECTRIC
SILVER DOT: PAPER DIELECTRIC
**INDICATES NUMBER OF ZEROS ON PAPER TYPE.

MICA (CM) AND PAPER (CN)



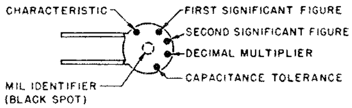
BUTTON-MICA (CB)





NOTE:
SPOTS MAY BE USED INSTEAD OF BANDS; TEMPERATURE COEFFICIENT MARKING IS LARGER.

CERAMIC-TEMPERATURE COMPENSATING (CC)



NOTES:
1. SPOTS MAY BE USED ON TUBULAR CAPACITORS; CHARACTERISTIC SPOT IS LARGER AND MIL IDENTIFIER IS ON SIDE DIAMETRICALLY OPPOSITE COLOR SPOTS.
2. MIL IDENTIFIER OF DISK TYPE IS ON REVERSE SIDE; CHARACTERISTIC SPOT IS LARGER OR SPACE BETWEEN CHARACTERISTIC AND TOLERANCE SPOTS IS THREE TIMES SPACE BETWEEN ADJACENT SPOTS.
3. TOLERANCE: YELLOW, +100%, -20%.

CERAMIC-GENERAL PURPOSE (CK)

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.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-C1

Figure 47. MIL-STD capacitor color codes.

INDEX

[AG 413.44 (5 Jan 56)]

By Order of *Wilber M. Brucker*, Secretary of the Army:

MAXWELL D. TAYLOR,
General, United States Army,
Chief of Staff.

Official:

JOHN A. KLEIN,
Major General, United States Army,
The Adjutant General.

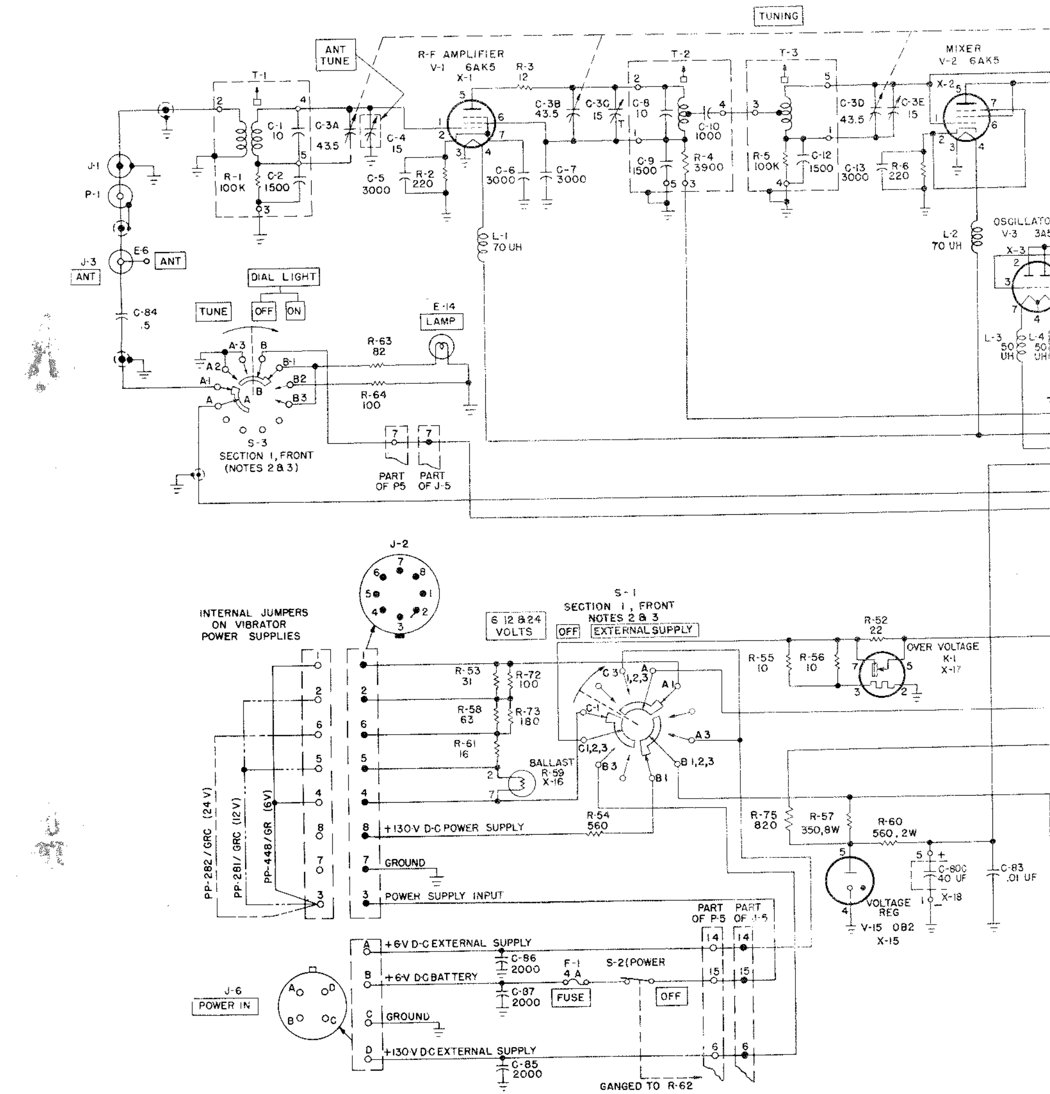
DISTRIBUTION:

Active Army:

CNGB (1)
Tec Svc, DA (1) except CSIGO (30)
Tec Svc Bd (1)
Hq CONARC (5)
CONARC Bd (Incl ea Test Sec) (1)
Army AA Comd (2)
OS Maj Comd (5)
OS Base Comd (5)
Log Comd (5)
MDW (1)
Armies (5)
Corps (2)
Tng Div (2)
Ft & Cp (2)
Gen & Br Svc Sch (5) except Sig Sch (25)
Gen Depots (2) except Atlanta Gen Depot (None)
Sig Sec, Gen Depots (10)
Sig Depots (20)
Trans Terminal Comd (2)
OS Sup Agencies (2)
Sig Fld Maint Shops (3)
Sig Lab (5)
Mil Dist (1)
Units organized under following TOE's:
5-215R (2)
5-217R (2)
5-218R (2)
6-100R (2)
6-135R (2)
6-200R (2)
6-300R (2)
6-415R (2)
6-501R (2)
6-535R (2)
6-537R (2)
6-538R (2)
6-558R (2)
6-575R (2)
6-615R (2)
6-616R (2)
6-617R (2)
7-2R (2)
7-11R (2)
7-12R (2)
7-14R (2)
7-15R (2)
7-16R (2)
7-25R (2)
7-26R (2)
7-27R (2)
7-31R (2)
7-32C (2)
7-34C (2)
7-35C (2)
7-36C (2)
7-95R (2)
7-96R (2)
9-65R (2)
9-66R (2)
9-67R (2)
11-7R (2)
11-16R (2)
11-57R (2)
11-127R (2)
11-128R (2)
11-500R (AA-AE) (2)
11-557C (2)
11-587R (2)
11-592R (2)
11-597R (2)
17-2R (2)
17-17R (2)
17-22R (2)
17-25C (2)
17-26C (2)
17-27C (2)
17-32R (2)
17-35R (2)
17-36R (2)
17-37C (2)
17-45R (2)
17-46R (2)
17-51R (2)
17-52R (2)
17-55R (2)
17-56R (2)
17-57R (2)
17-62R (2)
17-115R (2)
17-116R (2)
17-117R (2)
17-125R (2)
17-126R (2)
17-127R (2)
44-75C (2)
44-76C (2)
44-77C (2)
44-275R (2)
44-276R (2)
44-277R (2)
57-57C (2)

NG: State AG (6); units—same as Active Army except allowance is one copy to each unit.
USAR: None.
For explanation of abbreviations used, see SR 320-50-1.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1956 O—371908



TUNING
ANT TUNE
R-F AMPLIFIER
V-1 6AK5
X-1
R-3 12
T-1
T-2
T-3
MIXER
V-2 6AK5
X-2
C-1 10
C-2 1500
C-3A 43.5
C-3B 43.5
C-3C 15
C-3D 43.5
C-3E 15
C-4 15
C-5 3000
C-6 3000
C-7 3000
C-8 10
C-9 1500
C-10 1000
C-12 1500
C-13 3000
R-1 100K
R-2 220
R-4 3900
R-5 100K
R-6 220
L-1 70 UH
L-2 70 UH
L-3 50 UH
OSCILLATOR
V-3
X-3
J-1
P-1
J-3 ANT
E-6
ANT
C-84 .5
DIAL LIGHT
TUNE
OFF
ON
E-14 LAMP
R-63 82
R-64 100
S-3
SECTION 1, FRONT
(NOTES 2 & 3)
PART OF P5
PART OF J-5
J-2
INTERNAL JUMPERS ON VIBRATOR POWER SUPPLIES
6 12 & 24 VOLTS
OFF
EXTERNAL SUPPLY
S-1
SECTION 1, FRONT
NOTES 2 & 3
R-52 22
OVER VOLTAGE
K-1
X-17
R-55 10
R-56 10
R-53 31
R-72 100
R-58 63
R-73 180
R-61 16
BALLAST
R-59
X-16
R-54 560
R-75 820
R-57 350,8W
R-60 560, 2W
C-80C 40 UF
X-18
C-83 .01 UF
VOLTAGE REG
V-15 OB2
X-15
PP-282 / GRC (24 V)
PP-281/ GRC (12V)
PP-448/GR (6V)
+130 V D-C POWER SUPPLY
GROUND
POWER SUPPLY INPUT
PART OF P-5
PART OF J-5
+6V D-C EXTERNAL SUPPLY
C-86 2000
+6V D-C BATTERY
C-87 2000
F-1 4 A
FUSE
S-2 (POWER
OFF
J-6
POWER IN
GROUND
+130 V D-C EXTERNAL SUPPLY
C-85 2000
GANGED TO R-62

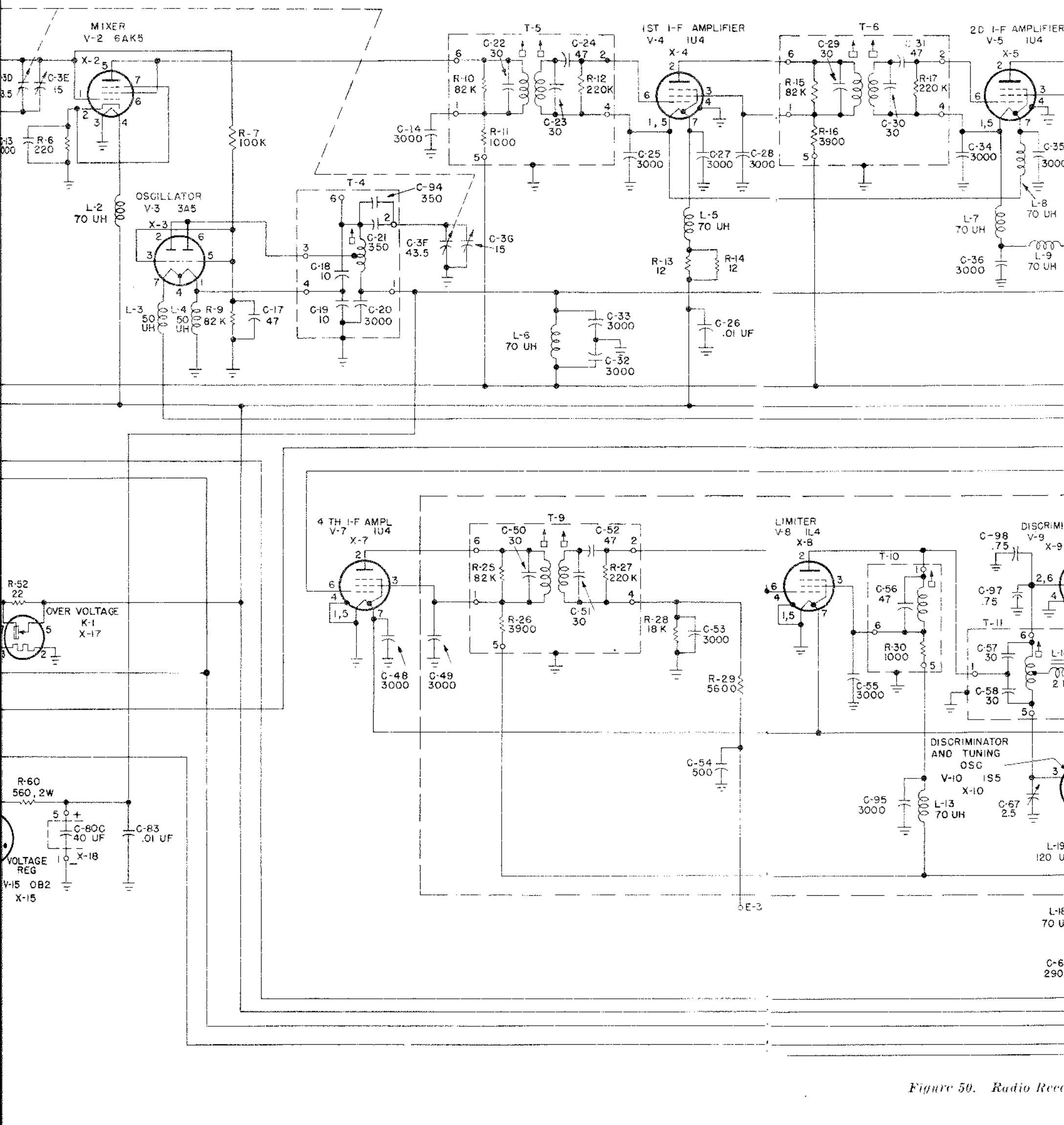


Figure 50. Radio Rece

NOTES

1. UNLESS OTHERWISE SHOWN, RESISTORS
AND 1/2 WATT, CAPACITORS ARE IN
2. ALL WAFER SWITCH SECTIONS VIEWE
END AND IN EXTREME COUNTERCLOCKW
3. ROTOR SECTIONS OF WAFER SWITCH
BY A LETTER A, B ETC, AND CONTACTS
BY A LETTER AND A NUMBER. THE LETT
THE ROTOR SECTION THRU WHICH THE
PLETE A CIRCUIT, THE NUMBER INDICA
POSITION IN WHICH THE CONTACT IS IN
CIRCUIT.
4. E-3 TO E-5 ARE TEST POINTS.
5. SWITCH S-1 SHOWN IN VEHICULAR P
6. SWITCH S-3 SHOWN IN TUNE POSITI
7. ON SOME EQUIPMENT R-43 IS REPLA
JUMPER WIRE.
8. ON SOME EQUIPMENT C-7 IS CONNE
PIN 4 OF V1 AND GROUND.

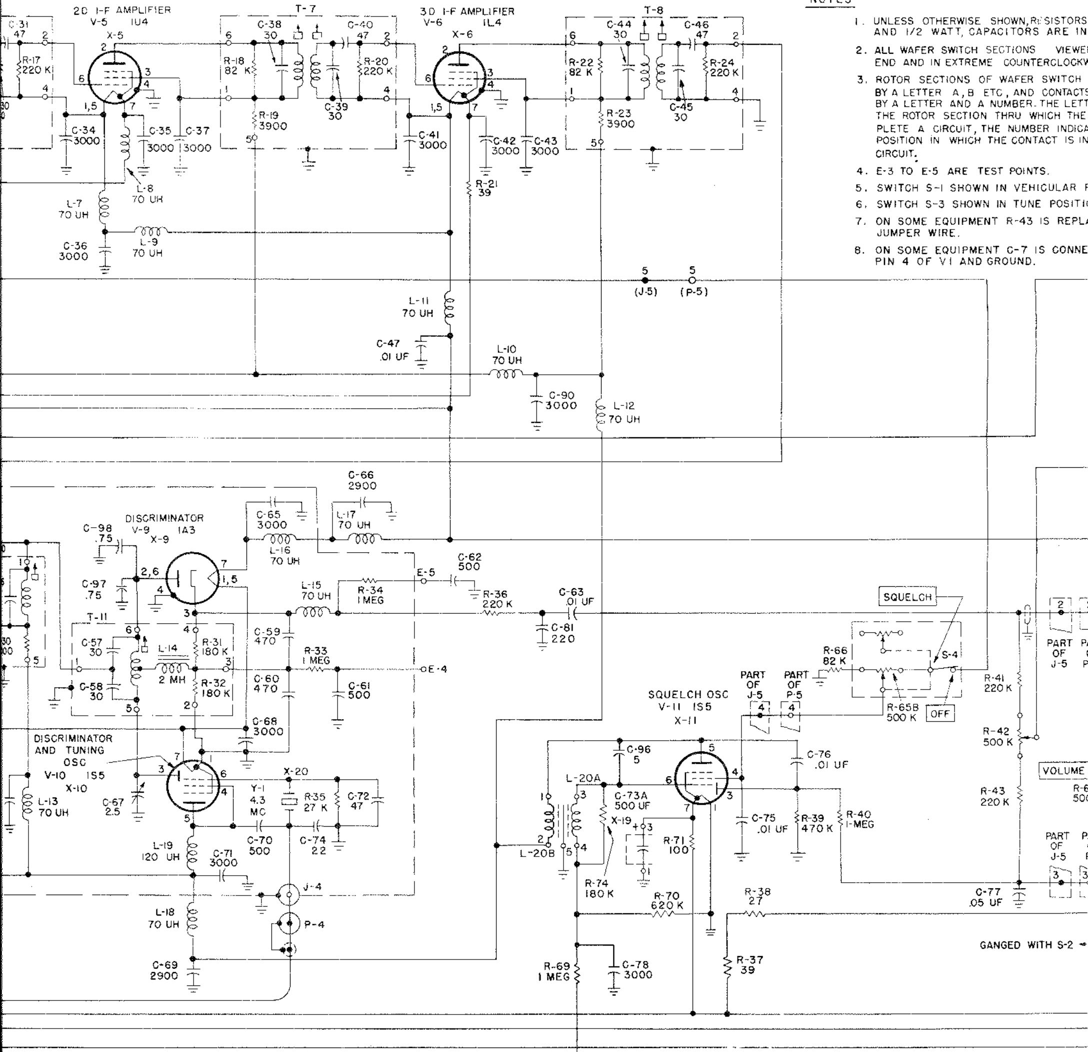
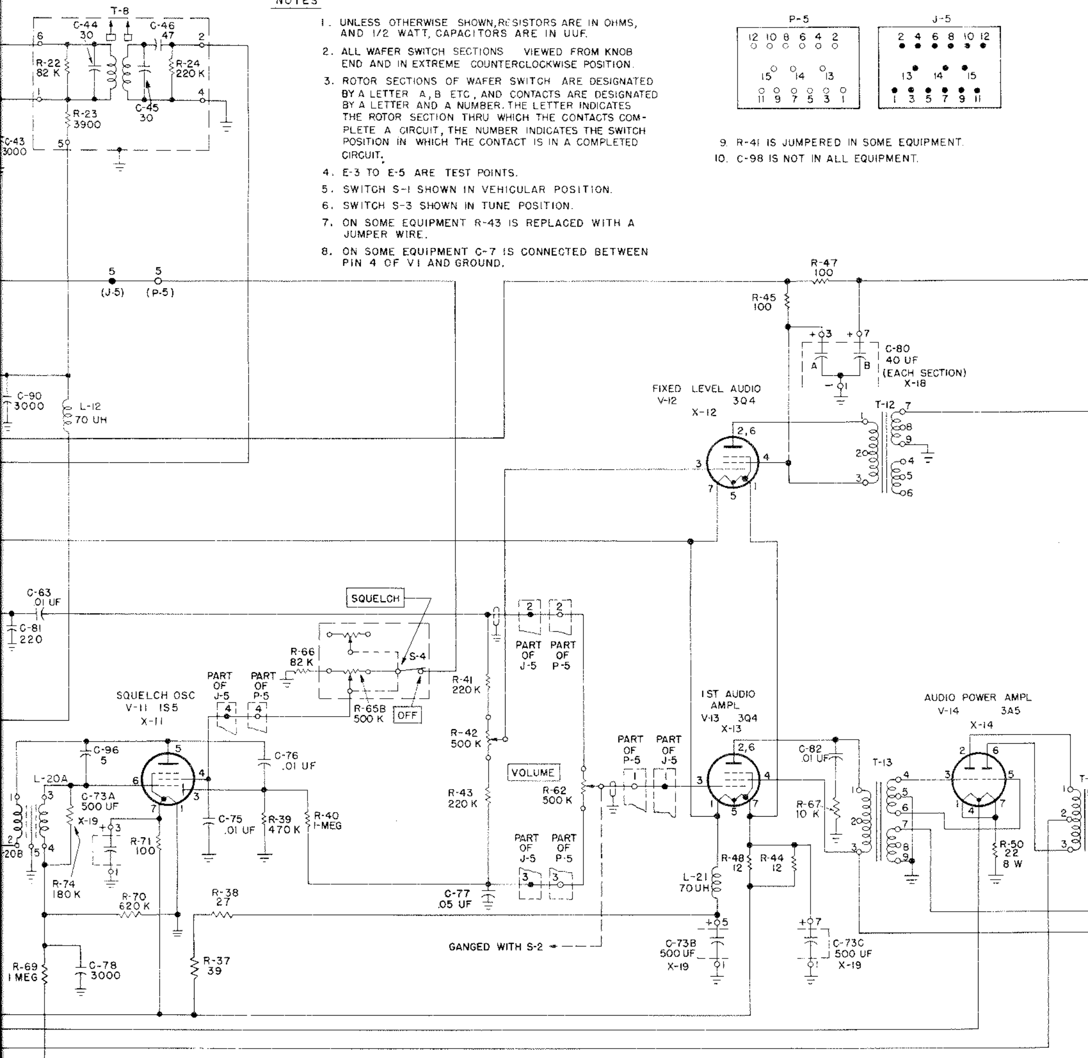


Figure 50. Radio Receiver R-110/GRC, schematic diagram.

NOTES

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, AND 1/2 WATT, CAPACITORS ARE IN UUF.
2. ALL WAFER SWITCH SECTIONS VIEWED FROM KNOB END AND IN EXTREME COUNTERCLOCKWISE POSITION.
3. ROTOR SECTIONS OF WAFER SWITCH ARE DESIGNATED BY A LETTER A, B ETC, AND CONTACTS ARE DESIGNATED BY A LETTER AND A NUMBER. THE LETTER INDICATES THE ROTOR SECTION THRU WHICH THE CONTACTS COMPLETE A CIRCUIT, THE NUMBER INDICATES THE SWITCH POSITION IN WHICH THE CONTACT IS IN A COMPLETED CIRCUIT.
4. E-3 TO E-5 ARE TEST POINTS.
5. SWITCH S-1 SHOWN IN VEHICULAR POSITION.
6. SWITCH S-3 SHOWN IN TUNE POSITION.
7. ON SOME EQUIPMENT R-43 IS REPLACED WITH A JUMPER WIRE.
8. ON SOME EQUIPMENT C-7 IS CONNECTED BETWEEN PIN 4 OF V1 AND GROUND.
9. R-41 IS JUMPERED IN SOME EQUIPMENT.
10. C-98 IS NOT IN ALL EQUIPMENT.



WN, RESISTORS ARE IN OHMS,
TORS ARE IN UUF.

IONS VIEWED FROM KNOB
UNTERCLOCKWISE POSITION.

AFER SWITCH ARE DESIGNATED
AND CONTACTS ARE DESIGNATED
BER. THE LETTER INDICATES
RU WHICH THE CONTACTS COM-
NUMBER INDICATES THE SWITCH
CONTACT IS IN A COMPLETED

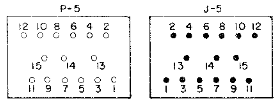
POINTS.

VEHICULAR POSITION.

TUNE POSITION.

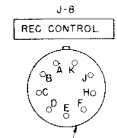
R-43 IS REPLACED WITH A

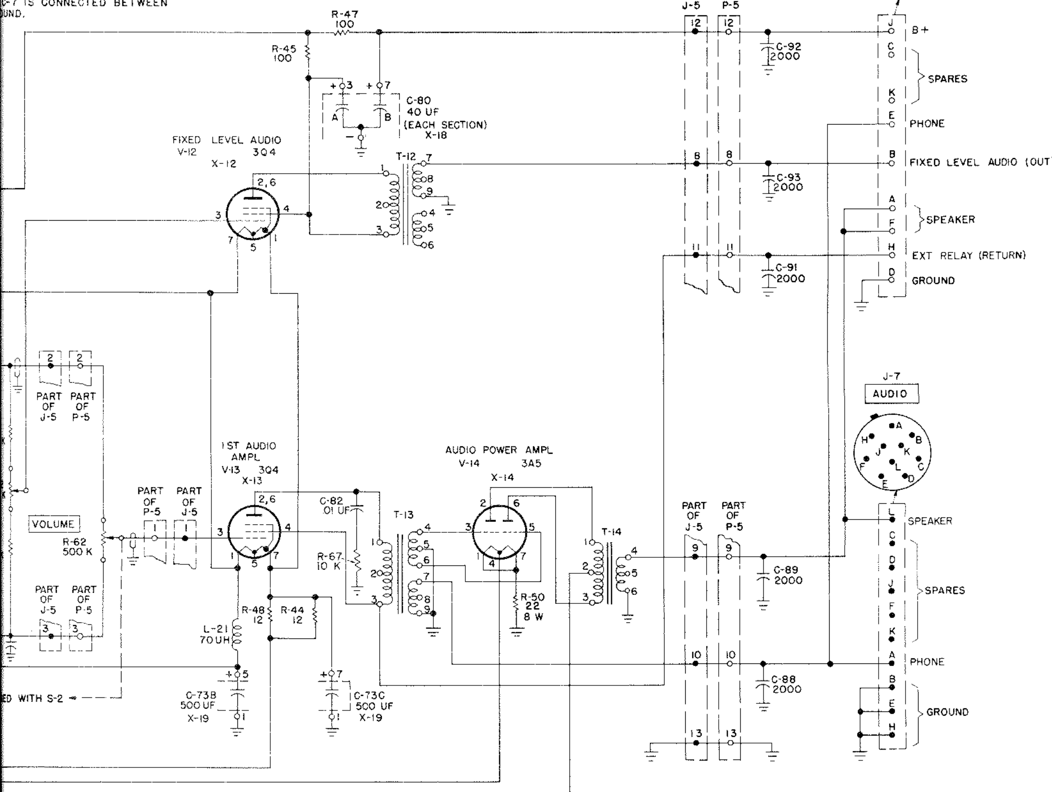
C-7 IS CONNECTED BETWEEN
UND.



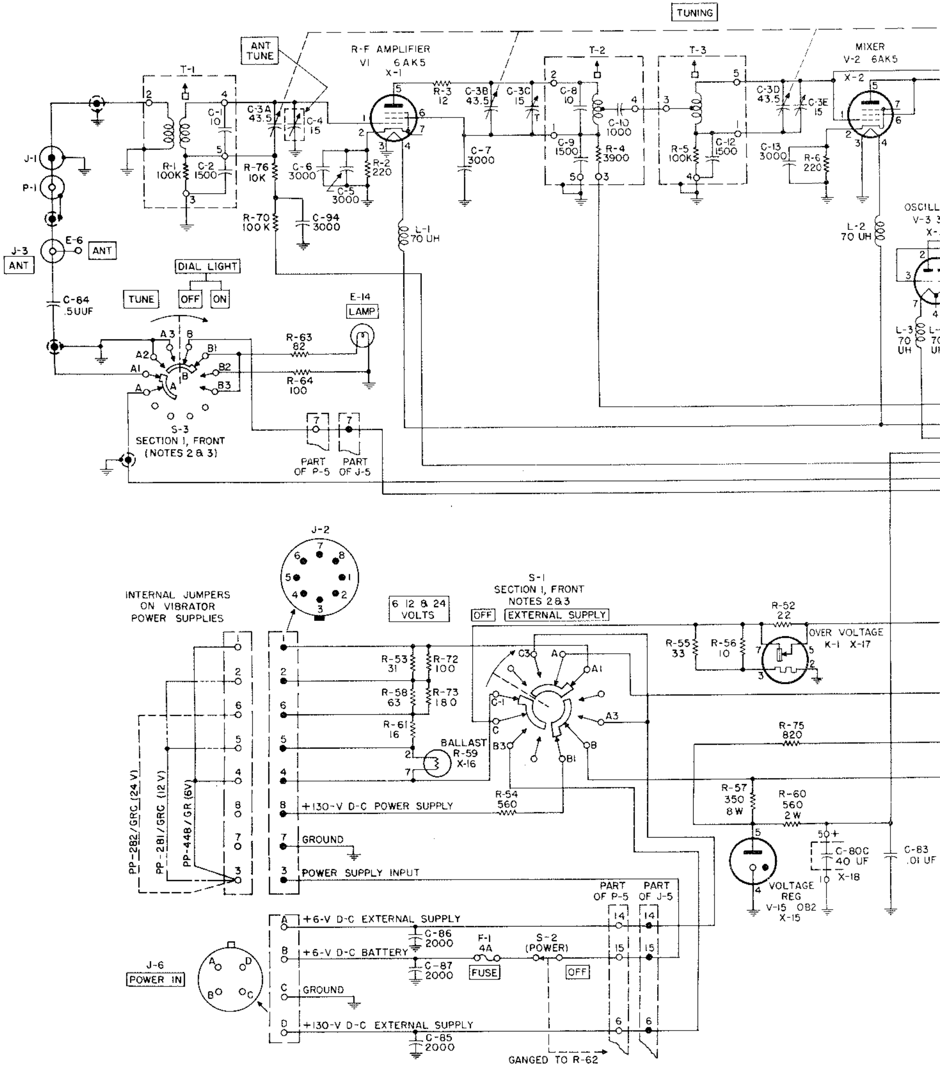
9. R-41 IS JUMPERED IN SOME EQUIPMENT.

10. C-98 IS NOT IN ALL EQUIPMENT.





TM898-319



TUNING
ANT TUNE
T-1
R-F AMPLIFIER
VI 6AK5
X-1
T-2
T-3
MIXER
V-2 6AK5
X-2
OSCILL
J-1
P-1
J-3
ANT
E-6
ANT
DIAL LIGHT
TUNE
OFF
ON
E-14
LAMP
R-63 82
R-64 100
S-3
SECTION 1, FRONT
(NOTES 2 & 3)
PART OF P-5
PART OF J-5
C-64 .5UUF
L-1 70 UH
L-2 70 UH
J-2
INTERNAL JUMPERS ON VIBRATOR POWER SUPPLIES
6 12 & 24 VOLTS
S-1
SECTION 1, FRONT
NOTES 2 & 3
OFF
EXTERNAL SUPPLY
OVER VOLTAGE
K-1 X-17
BALLAST
R-59
X-16
+130-V D-C POWER SUPPLY
GROUND
POWER SUPPLY INPUT
PP-282/GRC (24 V)
PP-281/GRC (12 V)
PP-448/GR (6V)
VOLTAGE REG
V-15 OB2
X-15
C-80C 40 UF
X-18
C-83 .01 UF
J-6
POWER IN
+6-V D-C EXTERNAL SUPPLY
+6-V D-C BATTERY
GROUND
+130-V D-C EXTERNAL SUPPLY
F-1 4A
FUSE
S-2 (POWER)
OFF
PART OF P-5
PART OF J-5
GANGED TO R-62

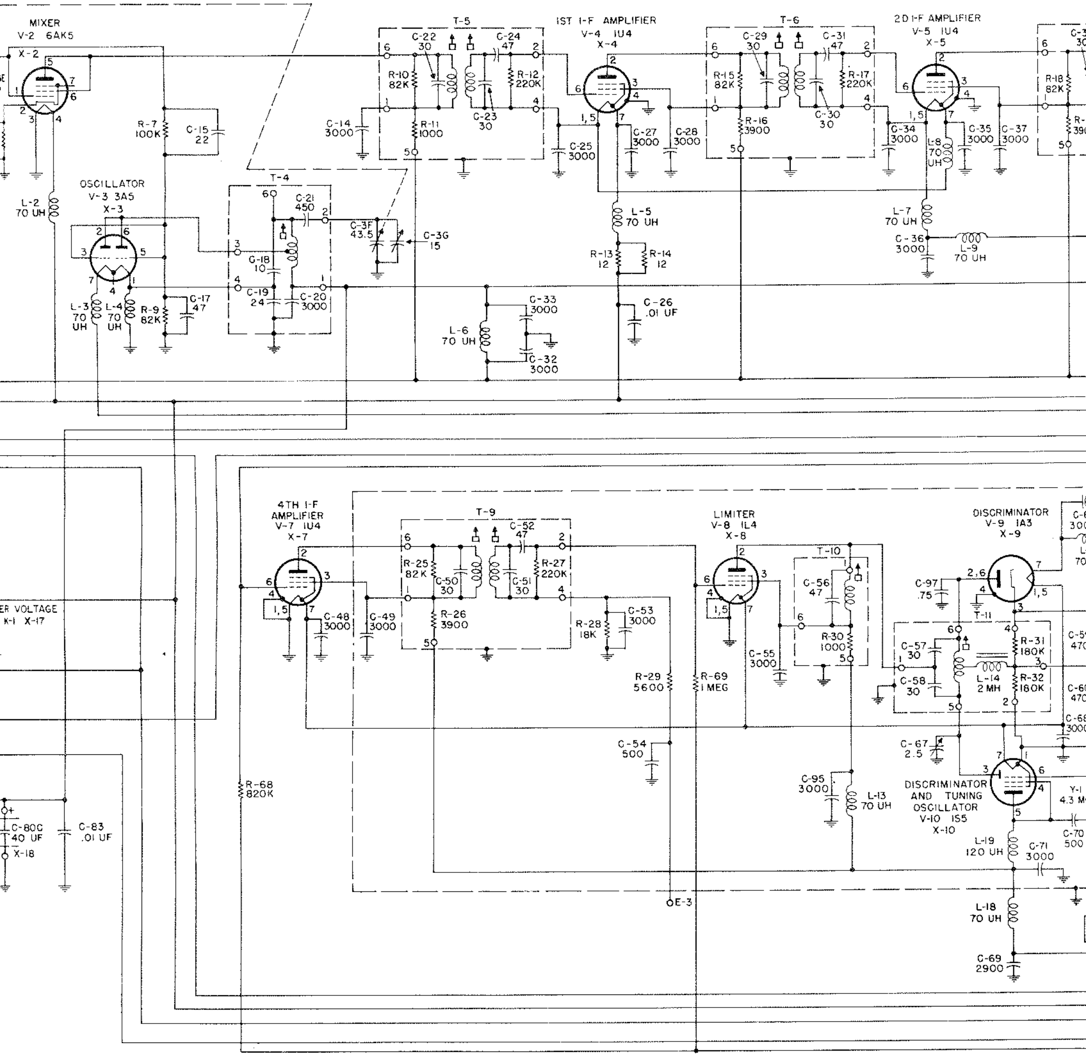
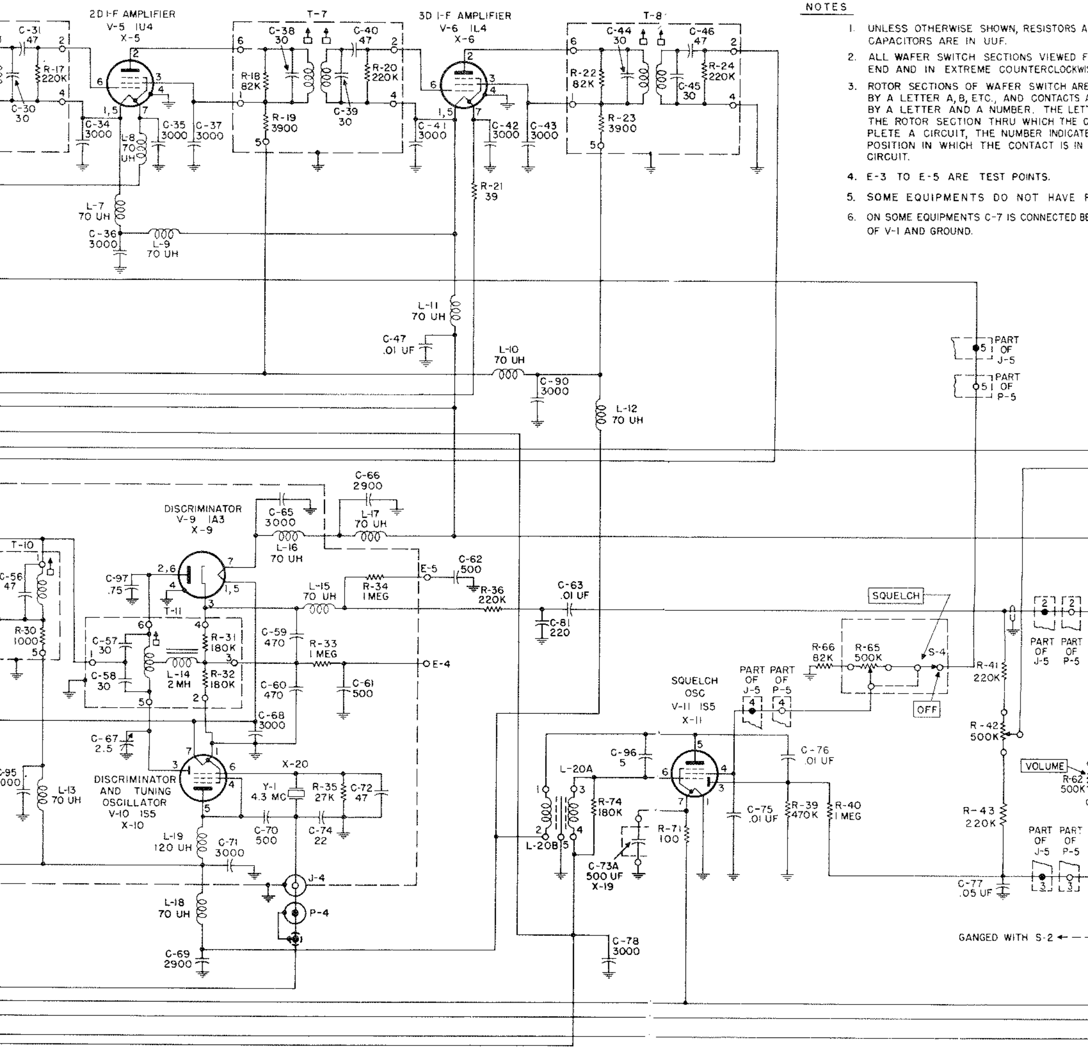


Figure 48. Radio Receiver R-108/GRC



NOTES

1. UNLESS OTHERWISE SHOWN, RESISTORS A
CAPACITORS ARE IN UUF.
2. ALL WAFER SWITCH SECTIONS VIEWED F
END AND IN EXTREME COUNTERCLOCKWIS
3. ROTOR SECTIONS OF WAFER SWITCH ARE
BY A LETTER A, B, ETC., AND CONTACTS A
BY A LETTER AND A NUMBER. THE LET
THE ROTOR SECTION THRU WHICH THE C
PLETE A CIRCUIT, THE NUMBER INDICATE
POSITION IN WHICH THE CONTACT IS IN
CIRCUIT.
4. E-3 TO E-5 ARE TEST POINTS.
5. SOME EQUIPMENTS DO NOT HAVE F
6. ON SOME EQUIPMENTS C-7 IS CONNECTED BE
OF V-1 AND GROUND.

Figure 48. Radio Receiver R-108/GRC, schematic diagram.

...WN, RESISTORS ARE IN OHMS,
...

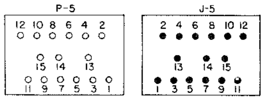
...TIONS VIEWED FROM KNOB
...OUNTERCLOCKWISE POSITION.

...TER SWITCH ARE DESIGNATED
...AND CONTACTS ARE DESIGNATED
...MBER. THE LETTER INDICATES
...U WHICH THE CONTACTS COM-
...UMBER INDICATES THE SWITCH
... CONTACT IS IN A COMPLETED

... POINTS.

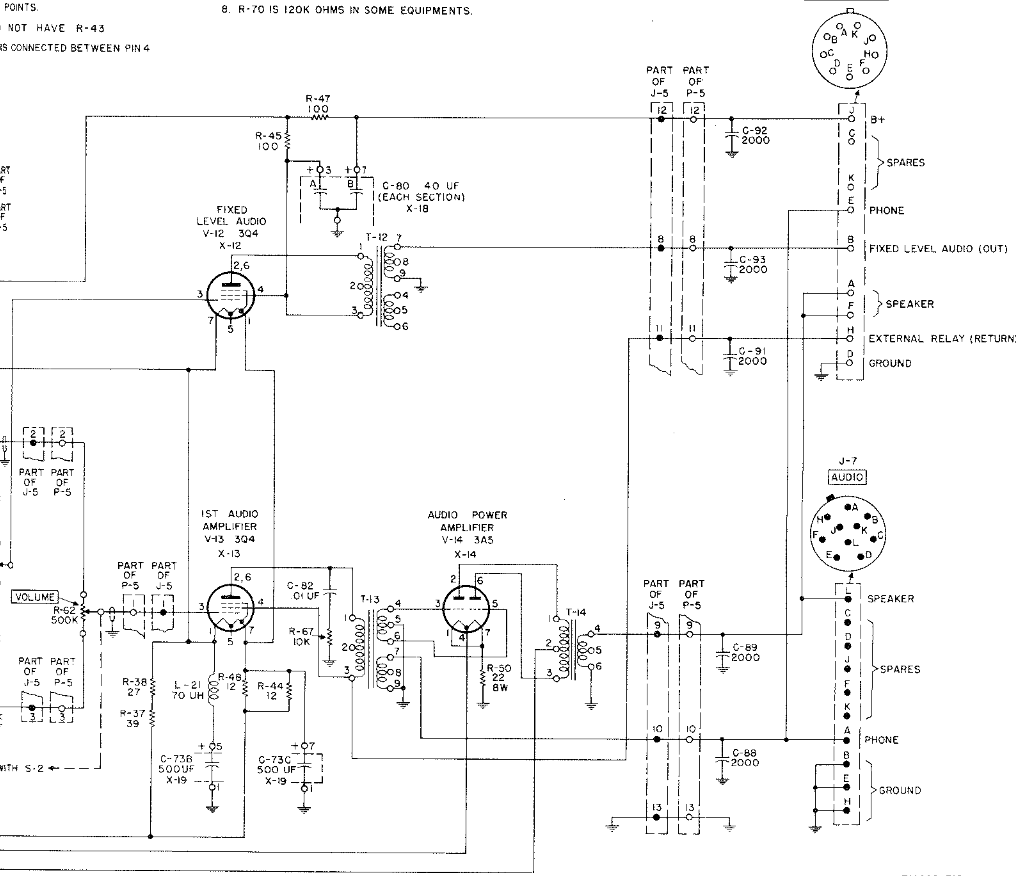
... NOT HAVE R-43

...IS CONNECTED BETWEEN PIN 4



7. SOME EQUIPMENTS DO NOT HAVE L-21.

8. R-70 IS 120K OHMS IN SOME EQUIPMENTS.



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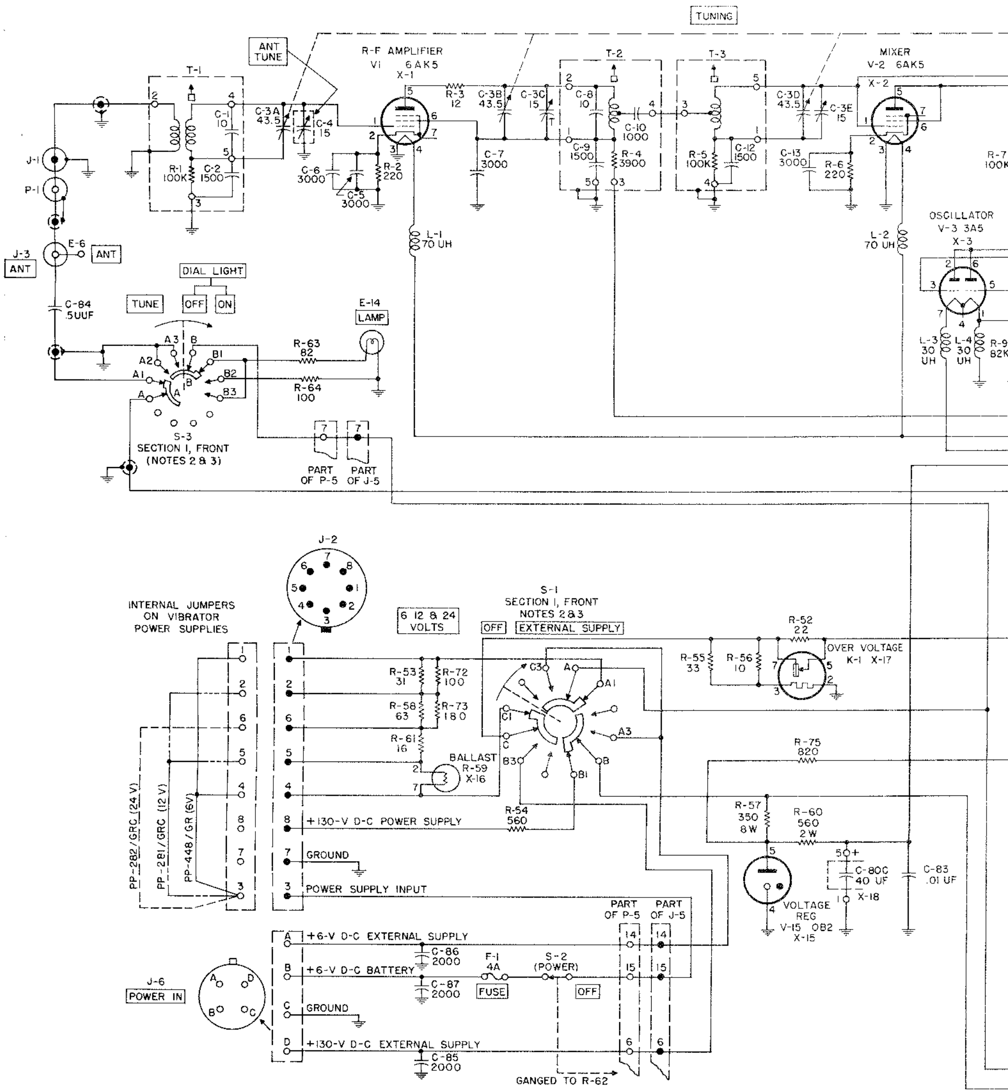


TUNING
ANT TUNE
R-F AMPLIFIER
V1 6AK5
X-1
T-1
T-2
T-3
MIXER
V-2 6AK5
X-2
C-1 10
C-2 1500
R-1 100K
C-3A 43.5
C-4 15
C-3B 43.5
C-3C 15
C-3D 43.5
C-3E 15
R-3 12
R-2 220
C-6 3000
C-5 3000
C-7 3000
C-8 10
C-9 1500
C-10 1000
R-4 3900
R-5 100K
C-12 1500
C-13 3000
R-6 220
R-7 100K
L-1 70 UH
L-2 70 UH
OSCILLATOR
V-3 3A5
X-3
L-3 30 UH
L-4 30 UH
R-9 82K
J-1
P-1
J-3 ANT
E-6
ANT
C-84 .5UUF
DIAL LIGHT
TUNE
OFF
ON
E-14 LAMP
R-63 82
R-64 100
S-3
SECTION 1, FRONT
(NOTES 2 & 3)
PART OF P-5
PART OF J-5
J-2
INTERNAL JUMPERS ON VIBRATOR POWER SUPPLIES
6 12 & 24 VOLTS
S-1
SECTION 1, FRONT
NOTES 2&3
OFF
EXTERNAL SUPPLY
R-53 31
R-72 100
R-58 63
R-73 180
R-61 16
BALLAST
R-59
X-16
R-54 560
R-52 22
OVER VOLTAGE
K-1 X-17
R-55 33
R-56 10
R-75 820
R-57 350 8W
R-60 560 2W
C-80C 40 UF
X-18
C-83 .01 UF
VOLTAGE REG
V-15 OB2
X-15
PP-282/GRC (24 V)
PP-281/GRC (12 V)
PP-448/GR (6V)
+130-V D-C POWER SUPPLY
GROUND
POWER SUPPLY INPUT
+6-V D-C EXTERNAL SUPPLY
C-86 2000
+6-V D-C BATTERY
C-87 2000
F-1 4A
FUSE
S-2 (POWER)
OFF
GROUND
+130-V D-C EXTERNAL SUPPLY
C-85 2000
GANGED TO R-62
J-6
POWER IN

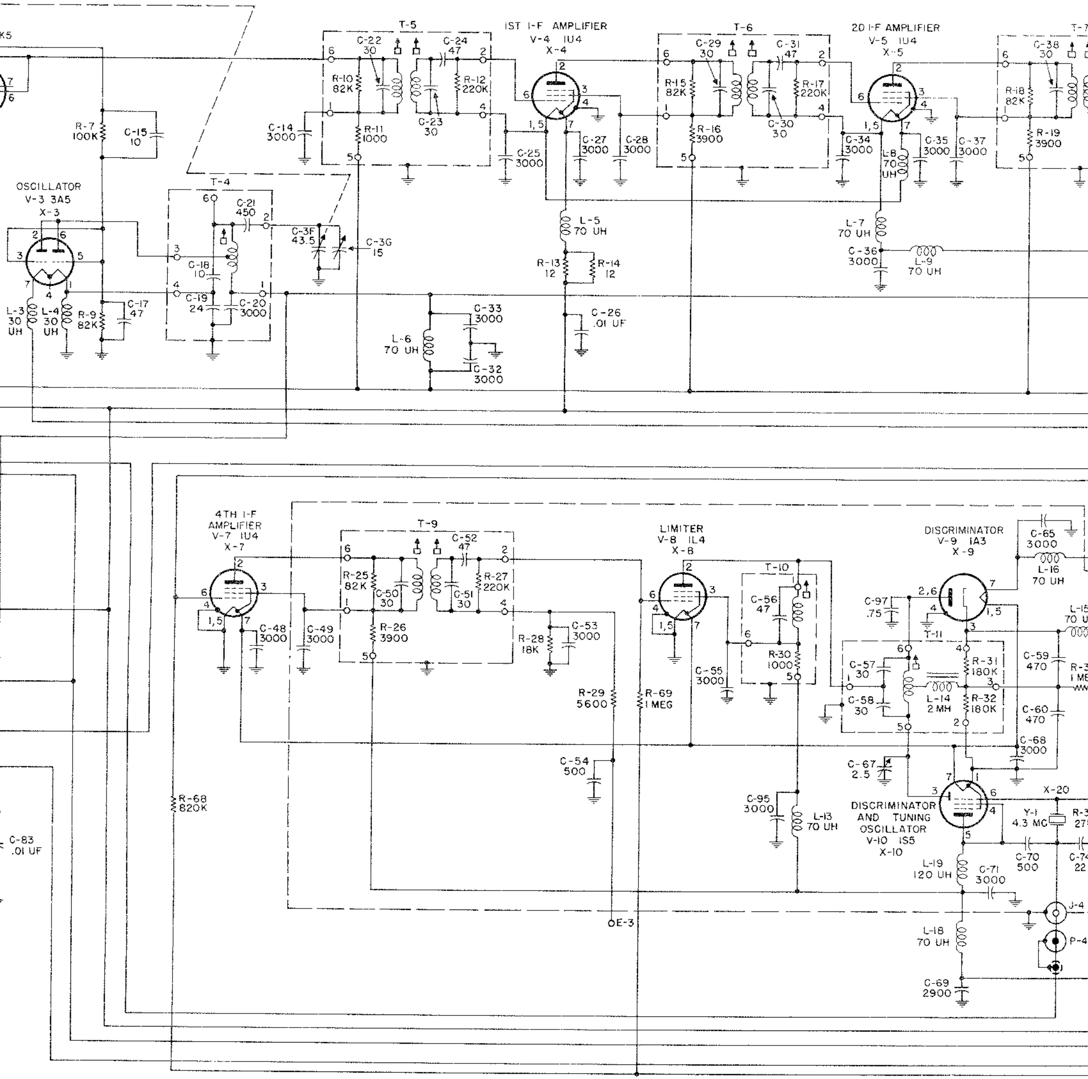
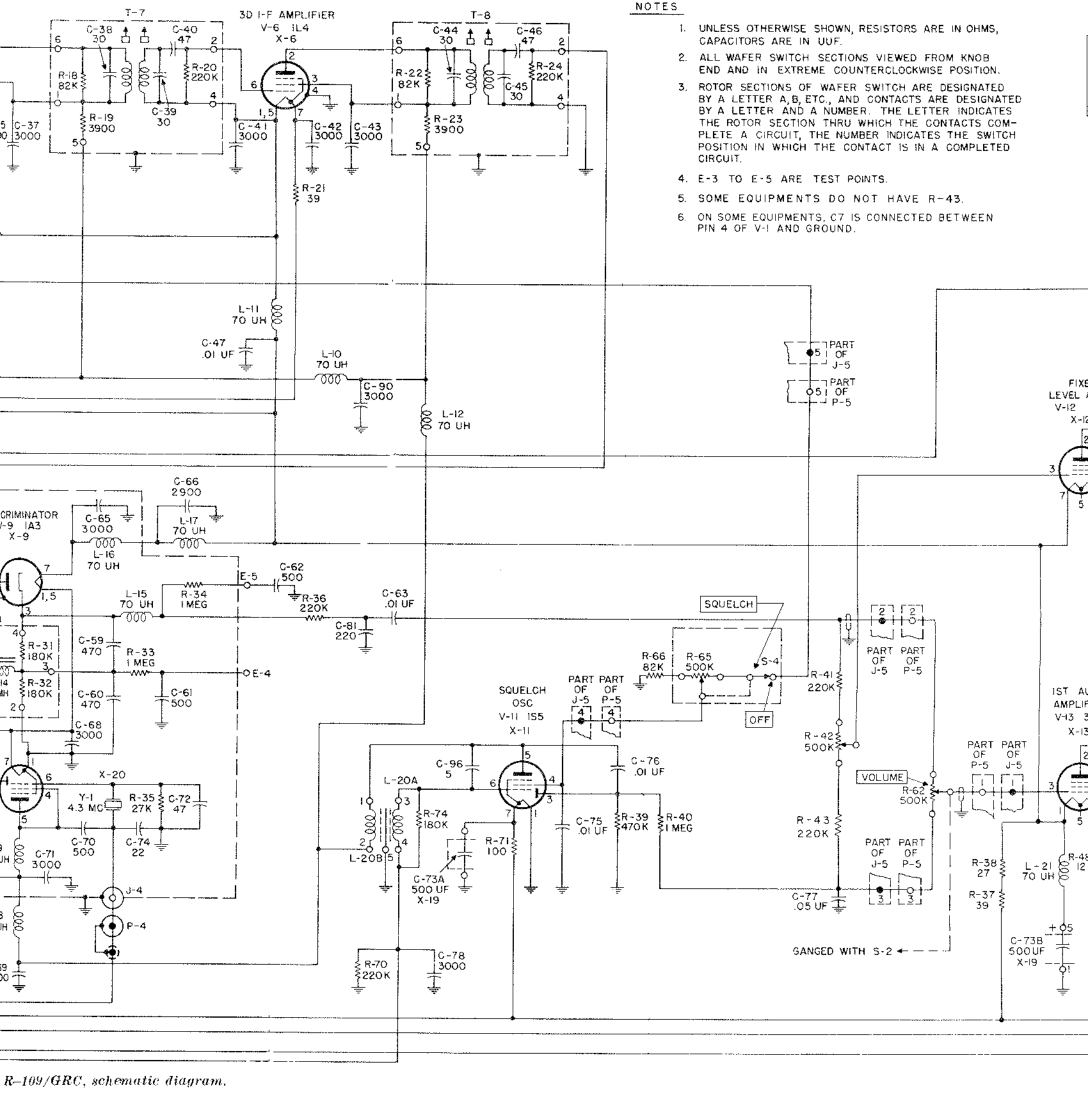


Figure 49. Radio Receiver R-109/GRC, schemat



NOTES

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. ALL WAFER SWITCH SECTIONS VIEWED FROM KNOB END AND IN EXTREME COUNTERCLOCKWISE POSITION.
3. ROTOR SECTIONS OF WAFER SWITCH ARE DESIGNATED BY A LETTER A, B, ETC., AND CONTACTS ARE DESIGNATED BY A LETTER AND A NUMBER. THE LETTER INDICATES THE ROTOR SECTION THRU WHICH THE CONTACTS COMPLETE A CIRCUIT, THE NUMBER INDICATES THE SWITCH POSITION IN WHICH THE CONTACT IS IN A COMPLETED CIRCUIT.
4. E-3 TO E-5 ARE TEST POINTS.
5. SOME EQUIPMENTS DO NOT HAVE R-43.
6. ON SOME EQUIPMENTS, C7 IS CONNECTED BETWEEN PIN 4 OF V-1 AND GROUND.

R–109/GRC, schematic diagram.

RESISTORS ARE IN OHMS,

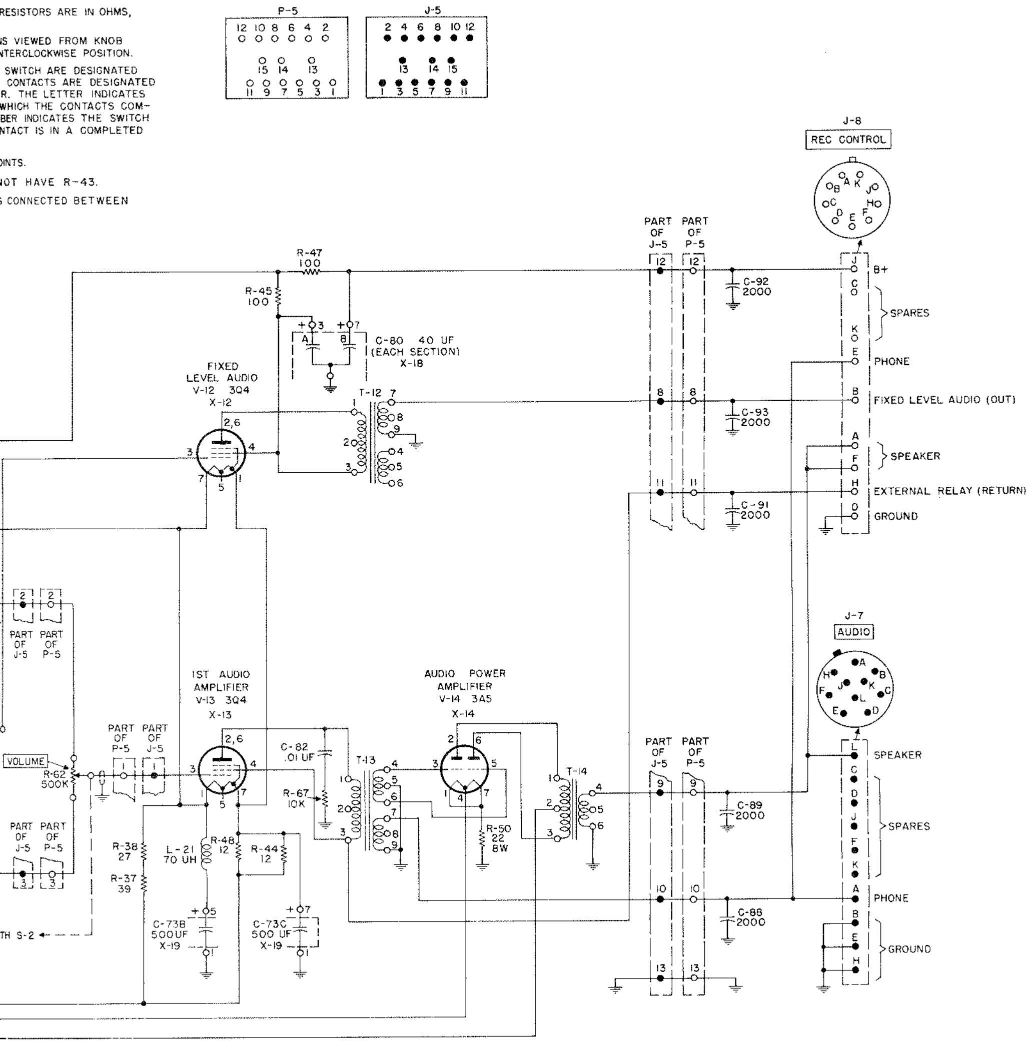
NS VIEWED FROM KNOB
NTERCLOCKWISE POSITION.

SWITCH ARE DESIGNATED
CONTACTS ARE DESIGNATED
R. THE LETTER INDICATES
WHICH THE CONTACTS COM-
BER INDICATES THE SWITCH
NTACT IS IN A COMPLETED

DINTS.

NOT HAVE R-43.

S CONNECTED BETWEEN



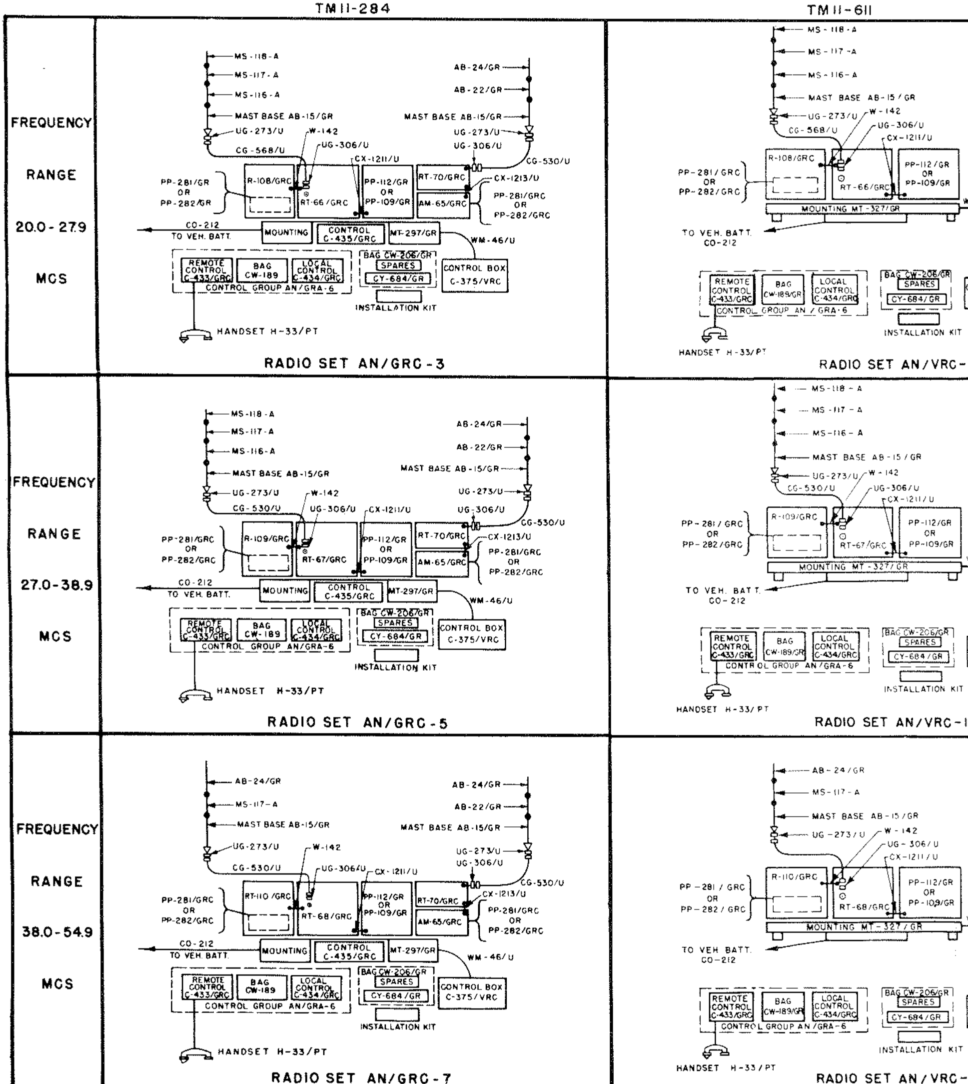
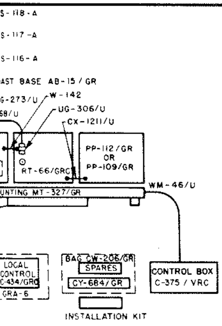
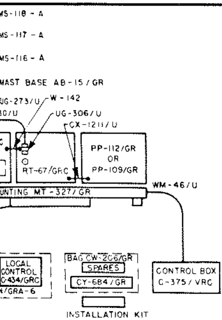


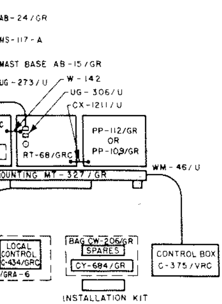
Figure 3. Systems using Radio Receiver R–



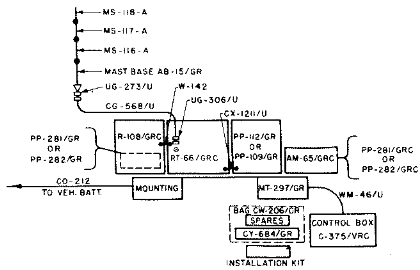
RADIO SET AN/VRC-16



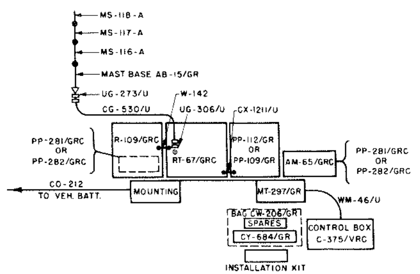
RADIO SET AN/VRC-17



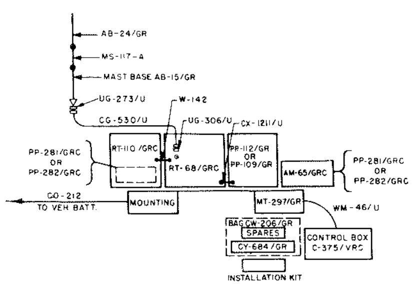
RADIO SET AN/VRC-18



RADIO SET AN/VRC-20



RADIO SET AN/VRC-21



RADIO SET AN/VRC-22

NOTE:
FULL NOMENCLATURE AND DESCRIPTIONS ARE GIVEN IN TECHNICAL MANUALS WHOSE NUMBERS APPEAR OVER EACH COLUMN.

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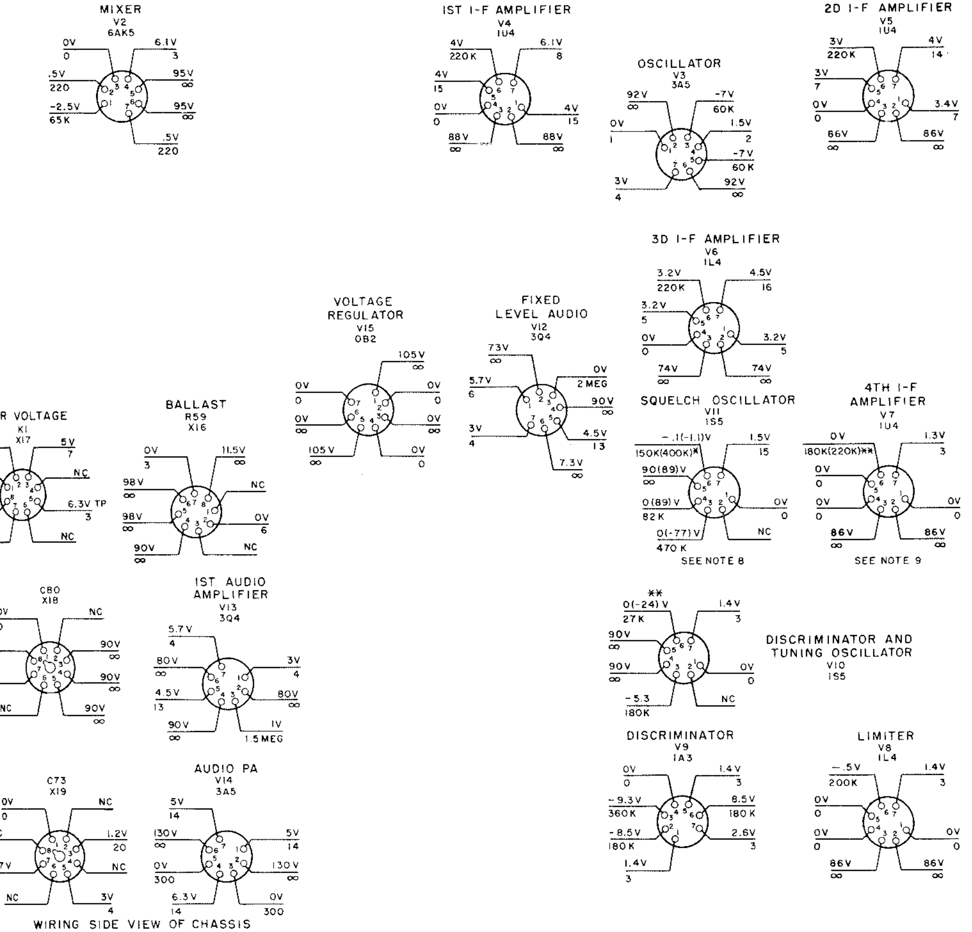
ing Radio Receiver R-108/GRC, R-109/GRC, or R-110/GRC.



SUREMENT NOTES:

5. SQUELCH CONTROL IN COUNTERCLOCKWISE [OFF] POSITION; VOLUME CONTROL IN EXTREME COUNTER-CLOCKWISE POSITION WITH POWER TURNED "ON"; NO SIGNAL ENTERING RECEIVER UNLESS OTHERWISE SPECIFIED.
6. VOLTAGE AT V11 ENCLOSED IN ( ) OBTAINED WITH SQUELCH CONTROL IN EXTREME CLOCKWISE POSITION.
7. VOLTAGE AT V10 ENCLOSED IN ( )** TAKEN WITH V1 INSTALLED AND S3 IN [TUNE] POSITION.

ON.

RESISTANCE MEASUREMENT NOTES

1. RESISTANCE MEASUREMENTS MADE BETWEEN INDICATED POINTS AND CHASSIS ARE SHOWN BELOW GUIDE LINES.
2. VOLUME CONTROL IN [OFF] POSITION.
3. SQUELCH CONTROL IN [OFF] POSITION.
4. POWER SUPPLY PP-281/GRC NOT INSTALLED WITH S1 IN [6,12 AND 24 VOLTS] POSITION.
5. ALL EXTERNAL CONNECTIONS REMOVED.
6. ELECTROLYTIC CAPACITORS C73 AND C80 REMOVED.
7. RESISTANCE AT V1 ENCLOSED IN ( ) APPLIES ONLY TO THE R-108/GRC.
8. RESISTANCE AT V11 ENCLOSED IN ( )* APPLIES ONLY TO THE R-110/GRC.
9. RESISTANCE AT V7 ENCLOSED IN ( )** APPLIES ONLY TO THE R-110/GRC.

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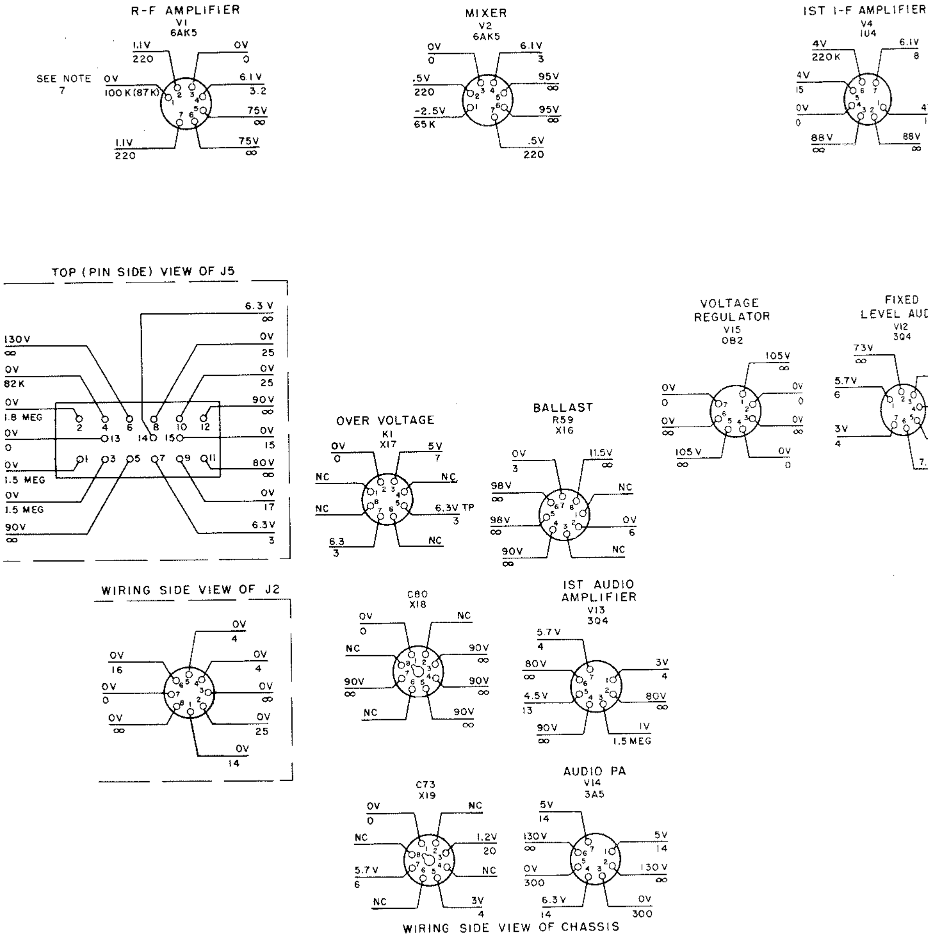
Figure 43. Voltage and resistance measurements.



VOLTAGE MEASUREMENT NOTES:

1. VOLTAGE MEASUREMENTS MADE BETWEEN INDICATED POINTS AND CHASSIS ARE SHOWN ABOVE GUIDE LINES. NC MEANS NO CONNECTION.
2. VOLTAGE READINGS ARE OBTAINED WITH A VACUUM TUBE VOLTMETER.
3. POWER OBTAINED FROM EXTERNAL 130-VOLT AND 6.3-VOLT SOURCE; S1 IN EXTERNAL SUPPLY POSITION.
4. TP MEANS TIE POINT.
5. SQUELCH CONTROL IN COUNTERCLOCKWISE OFF POSITION; VOLUME CONTROL IN EXTREME COUNTER-CLOCKWISE POSITION WITH POWER TURNED "ON"; NO SIGNAL ENTERING RECEIVER UNLESS OTHERWISE SPECIFIED.
6. VOLTAGE AT V11 ENCLOSED IN ( ) OBTAINED WITH SQUELCH CONTROL IN EXTREME CLOCKWISE POSITION.
7. VOLTAGE AT V10 ENCLOSED IN ( )** TAKEN WITH Y1 INSTALLED AND S3 IN TUNE POSITION.

R

1. RESISTANCE MEASUREMENTS INDICATED POINTS AND CHASS BELOW GUIDE LINES.
2. VOLUME CONTROL IN OFF PO
3. SQUELCH CONTROL IN OFF
4. POWER SUPPLY PP-281/GRC NO WITH S1 IN 6,12 AND 24 VOLT
5. ALL EXTERNAL CONNECTIONS

Figure 43. Voltage and resistance measurements.