TM11-898

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

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

DEPARTMENT OF THE ARMY • MARCH 1951

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United States Government Printing Office

Washington : 1951

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *23 March 1951*

TM 11–898 is published for the information and guidance of all concerned.

[AG 413.44 (20 Mar 51)]

BY ORDER OF THE SECRETARY OF THE ARMY:

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For explanation of distribution formula, see SR 310–90–1.

WARNING

HIGH VOLTAGE

is used in the operation of this equipment

DEATH ON CONTACT

may result if operating personnel fail to observe safety precautions

RESCUE.

In case of electric shock, shut off the high voltage at once and ground the circuits. If the high voltage cannot be turned off without delay, free the victim from contact with the live conductor as promptly as possible. Avoid direct contact with either the live conductor or the victim's body. Use a dry board, dry clothing, or other nonconductor to free the victim. An ax may be used to cut the high-voltage wire. Use extreme caution to avoid the resulting electric flash.

SYMPTOMS.

a. Breathing stops abruptly in electric shock if the current passes through the breathing center at the base of the brain. If the shock has not been too severe, the breath center recovers after a while and normal breathing is resumed, provided that a sufficient supply of air has been furnished meanwhile by artificial respiration.

b. The victim is usually very white or blue. The pulse is very weak or entirely absent and unconsciousness is complete. Burns are usually present. The victim's body may become rigid or stiff in a very few minutes. This condition is due to the action of electricity and is not to be considered rigor mortis. Artificial respiration must still be given, as several such cases are reported to have recovered. The ordinary and general tests for death should never be accepted.

TREATMENT.

a. Start artificial respiration immediately. At the same time send for a medical officer, if assistance is available. Do not leave the victim unattended. Perform artificial respiration at the scene of the accident, unless the victim's or operator's life is endangered from such action. *In this case only*, remove the victim to another location, but no farther than is necessary for safety. If the new location is more than a few feet away, artificial respiration should be given while the victim is being moved. If the method of transportation prohibits the use of the Shaeffer prone pressure method, other methods of resuscitation may be used. Pressure may be exerted on the front of the victim's diaphragm, or the direct mouth-to-mouth method may be used. Artificial respiration, once started, must be continued, without loss of rhythm.

b. Lay the victim in a prone position, one arm extended directly overhead, and the other arm bent at the elbow so that the back of the hand supports the head. The face should be turned away from the bent elbow so that the nose and mouth are free for breathing.

c. Open the victim's mouth and remove any foreign bodies, such as false teeth, chewing gum, or tobacco. The mouth should remain open, with the tongue extended. Do not permit the victim to draw his tongue back into his mouth or throat.

d. If an assistant is available during resuscitation, he should loosen any tight clothing to permit free circulation of blood and to prevent restriction of breathing. He should see that the victim is kept warm, by applying blankets or other covering, or by applying hot rocks or bricks wrapped in cloth or paper to prevent injury to the victim. The assistant should also be ever watchful to see that the victim does not swallow his tongue. He should continually wipe from the victim's mouth any frothy mucus or saliva that may collect and interfere with respiration.

e. The resuscitating operator should straddle the victim's thighs, or one leg, in such manner that:

(*1*) the operator's arms and thighs will be vertical while applying pressure on the small of the victim's back;

(*2*) the operator's fingers are in a natural position on the victim's back with the little finger lying on the last rib;

(*3*) the heels of the hands rest on either side of the spine as far apart as convenient without allowing the hands to slip off the victim;

(*4*) the operator's elbows are straight and locked.

f. The resuscitation procedure is as follows:

(*1*) Exert downward pressure, not exceeding 60 pounds, for 1 second.

(*2*) Swing back, suddenly releasing pressure, and sit on the heels.

(*3*) After 2 seconds rest, swing forward again, positioning the hands exactly as before, and apply pressure for another second.

g. The forward swing, positioning of the hands, and the downward pressure should be accomplished in one continuous motion, which requires 1 second. The release and backward swing require 1 second. The addition of the 2-second rest makes a total of 4

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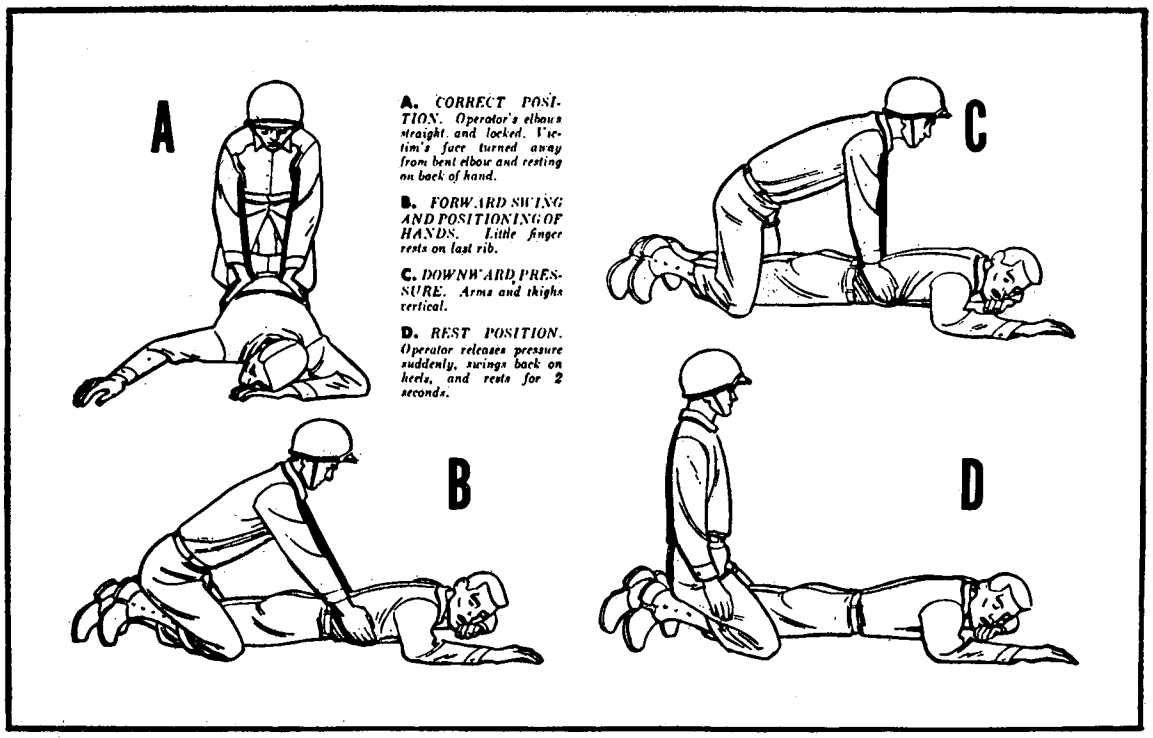

seconds for a complete cycle. Until the operator is thoroughly familiar with the correct cadence of the cycle, he should count the seconds aloud, speaking distinctly and counting evenly in thousands. Example: one thousand and one, one thousand and two, etc.

h. Artificial respiration should be continued until the victim regains normal breathing or is pronounced dead by a medical officer. Since it may be necessary to continue resuscitation for several hours, relief operators should be used if available.

RELIEVING OPERATOR.

The relief operator kneels beside the operator and follows him through several complete cycles. When the relief operator is sure he has the correct rhythm, he places his hands on the operator's hands without applying pressure. This indicates that he is ready to take over. On the backward swing, the operator moves and the relief operator takes his position. The relieved operator follows through several complete cycles to be sure that the new operator has the correct rhythm. He remains alert to take over instantly if the new operator falters or hesitates on the cycle.

STIMULANTS.

a. If an inhalant stimulant is used, such as aromatic spirits of ammonia, the individual administering the stimulant should first test it himself to see how close he can hold the inhalant to his own nostril for comfortable breathing. Be sure that the inhalant is not held any closer to the victim's nostrils, and then for only 1 or 2 seconds every minute.

b. After the victim has regained consciousness, he may be given hot coffee, hot tea, or a glass of water containing ½ teaspoon of aromatic spirits of ammonia. *Do not give any liquids to an unconscious victim.*

CAUTIONS.

a. After the victim revives, keep him LYING QUIETLY. Any injury a person may have received may cause a condition of shock. Shock is present if the victim is pale and has a cold sweat, his pulse is weak and rapid, and his breathing is short and gasping.

b. Keep the victim lying flat on his back, with his head lower than the rest of his body and his hips elevated. Be sure that there is no tight clothing to restrict the free circulation of blood or hinder natural breathing. Keep him warm and quiet.

c. A resuscitated victim must be watched carefully as he may suddenly stop breathing. *Never leave a resuscitated person alone until it is CERTAIN that he is fully conscious and breathing normally.*

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CONTENTS

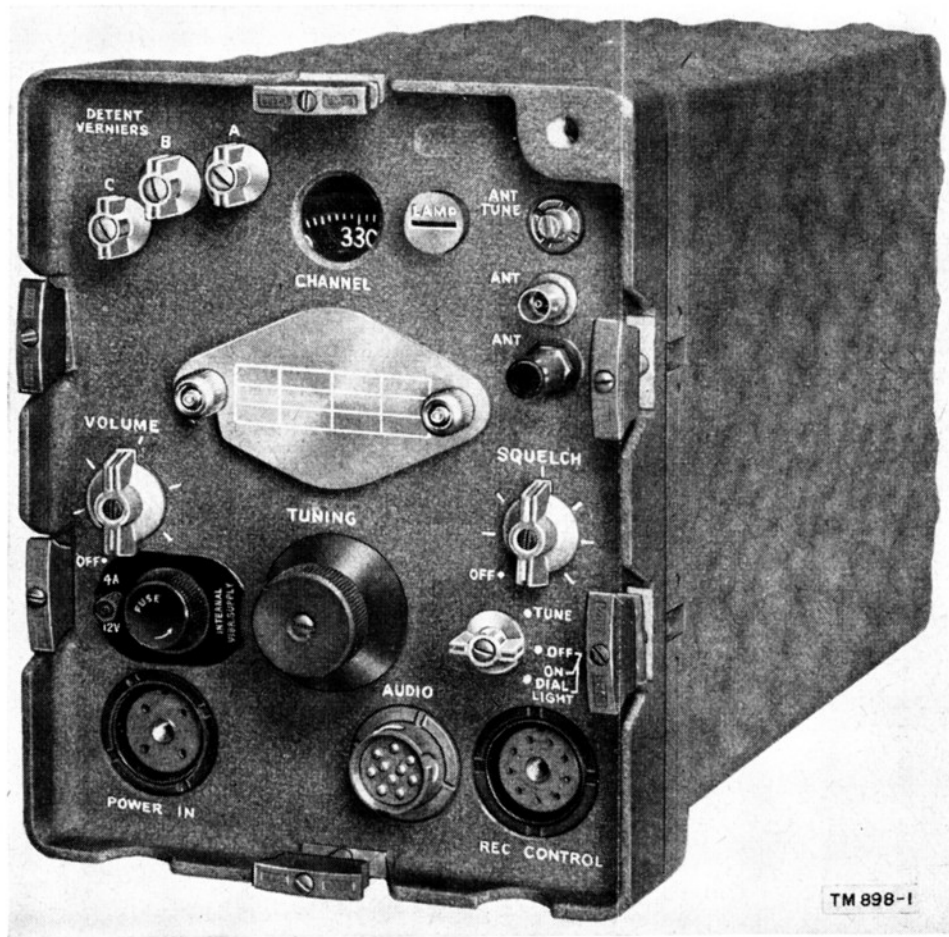


Figure 1. Radio Receiver R–108/GRC, R–109/GRC, or R–110/GRC, over-all view.

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. In addition, a chapter on the disassembly and repacking of the equipment for shipment or limited storage is included. Two appendixes covering a list of references and an identification table of parts are provided.

b. Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC are very similar in structure, function, and detailed circuit and manual arrangement. They differ from each other only in their operating frequency ranges and in those components which determine the frequency range. Accordingly, unless otherwise specified, the discussions in this book apply to all three equipments and reference is made simply to the *receiver.* Where specific differences exist between the units, these differences are described with specific reference to the particular unit involved.

2. Forms and Records

The following standard forms will be used for reporting unsatisfactory conditions of Army matériel and equipment.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5.

b. DA AGO Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700–45–5.

c. DA AGO Form 419, Preventive Maintenance Checklist for Signal Corps Equipment, will be prepared in accordance with instructions on the back of the form.

d. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC (fig. 1) are small, lightweight, f-m (frequency-modulated), superheterodyne receivers designed for use in vehicular or ground installations. The receivers provide for the reception of voice-modulated f-m signals between 20 and 55 mc (megacycles). The receivers are alike except for the tuning range.

b. The frequency coverage of Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC is indicated in the frequency spectrum chart (fig. 2). For comparison, the frequency coverage of other radio equipments with which the receivers described here may be associated in a working system installation is included in the chart. For example, the chart shows that the frequency coverage of the receivers is identical to that of Receiver-Transmitters RT–66/GRC, RT–67/GRC, and RT–68/GRC, respectively. Continuously variable tuning and rapid selection of three detent channels are provided.

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, and PP–282/GRC, respectively), or from an external power source which will provide 6.3 volts and 130 volts dc (direct current) for the filament and plate circuits, respectively. Normally, the receivers are furnished without the vibrator voltage supply unit.

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. Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC 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. Since all external connections are brought to connectors on the front panel, a high degree of flexibility exists.

(1) The audio receiving device may be a headset, the earpiece of a handset, a loudspeaker, a telephone line, the audio input circuits of a transmitter, or of an interphone system, or a combination of these.

(2) The operating power source may be a vibrator type power supply, which derives its operating power from the vehicular storage battery. Specifically, either Power Supply PP–281/GRC, PP–282/GRC, or PP–448/GR may be used, depending on whether a 12-volt, 24-volt, or 6-volt storage battery is involved. Alternatively, an external power source furnishing 6.3 and 130 volts dc may be used.

(3) The control arrangement used depends on the services required 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 operational functions, such as duplex channel operation, message retransmission, or the selection of one or more communication paths, if several equipments are involved.

b. Basic Arrangement. The minimum of additional components required to provide a workable installation is an antenna, a headset, and a power supply. In such a basic installation the components may be connected directly to the panel-mounted connectors by means of suitable cables.

c. Radio Sets AN/GRC–3, AN/GRC–5, and AN/GRC–7. A system using Radio Receiver R–108/GRC as an auxiliary guard 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. Since the three systems are identical, except for frequency range, 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 long range receiver-transmitter, Radio Receiver R–108/GRC as an auxiliary or guard channel receiver, Receiver-Transmitter RT–70/GRC as an auxiliary liaison 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 guard or 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

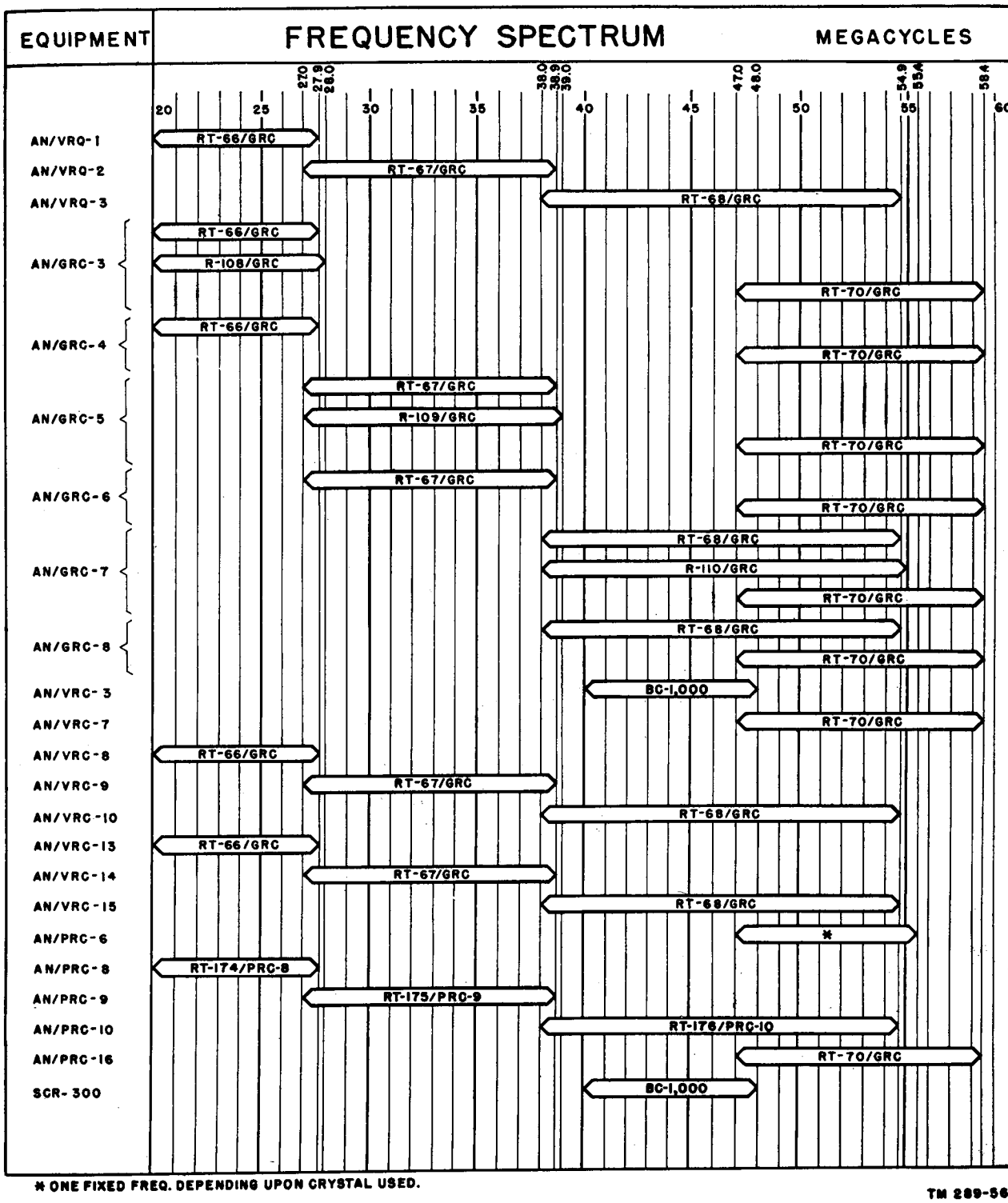


Figure 2. Frequency spectrum chart.

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. The major components of Radio Sets AN/GRC–3, AN/GRC–5, and AN/GRC–7 are described in separate technical manuals. The manner in which Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC are used as parts of these sets is described in the technical manual for Radio Sets AN/GRC–3 through –8.

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 3 preset frequencies.

Channel spacing — 100 kc (kilocycles)

Number of channels:
- R–108/GRC — 80.
- R–109/GRC — 120.
- R–110/GRC — 170.

Receiver type — F-m, 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 dials — Built-in, 4.3-mc, crystal-controlled oscillator.

Calibration frequencies — Multiples of 4.3 mc.

Accuracy of calibration — Approximately ±.01 percent.

Current drain:
- 6-volt vehicular battery — 4 amperes.
- 12-volt vehicular battery — 4 amperes.
- 24-volt vehicular battery — 4 amperes.

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 d-c supply.

Antenna — Portable whip antenna. Coaxial connector and binding post on front panel.

Sensitivity — Over 25 db (decibels) signal plus noise-to-noise ratio at ½ uv (microvolt) (all ranges) deviation ±15 kc, 1,000 cps (cycles per second).

H-f (high-frequency) 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±10 kc.
- (40 db down) — Less than 180 kc.

Audio output:
- Loudspeaker — 1 watt.
- Phones — 50 mw (milliwatts).
- Fixed level — 30 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 uv to 5.0 uv. OFF position of control disables squelch circuit.

External relay connection — Receiver provides 5 ma (milliamperes) of plate current for operation of an external control relay. Current is controlled by squelch circuit.

6. Physical Characteristics

The dimensions of the over-all receiver with case are as follows:

- Height — 9 inches.
- Width — 7¼ inches.
- Depth — 12 13/16 inches.
- Weight (less vibrator power supply) — 20¼ pounds (approximately)
- Weight (including vibrator power supply) — 25 pounds (approximately)

7. Description of Radio Receivers

a. Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC are small, compact, single-conversion type, superheterodyne receivers (less power supply) designed for the reception of f-m 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 typical one of the three receivers 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 recessed front panel and are immediately accessible. The flange around the four edges of the panel protects the controls from damage due to impact. The flange is provided with cut-outs to accommodate the cables that attach to the receptacles at the front of the panel. Immersion-proof 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 due to vibration and shock.

8. Mechanical Construction

a. Figures 3 through 6 are views of a typical one of the three receivers without the outer case. A disassembled view of the unit is shown in figure 25. The receiver panel-and-chassis assembly consists of four major separable parts. These are the front panel, dial drive, power supply compartment, vertically mounted chassis, and wrap-around frame. No solder connections are made between the chassis and the panel or between any of the separable parts. A multiconnector P–5 and J–5 and two coaxial cables fitted with coaxial plugs P–1, J–1 and P–4, and J–4 establish continuity between the panel controls and connectors and the chassis circuits. The panels of the three receivers, less dial-drive assembly, are completely interchangeable. The dial markings are different for each receiver, since a different frequency range and a different number of channels are involved in each. The dial-drive and detent assemblies, with the exception of the dial scale, are the same for all three receivers. The vertical chassis differs only in the r-f (radio-frequency) determining components. The i-f (intermediate-frequency) and audio circuits are identical in all three receivers.

b. The cast-aluminum front panel mounts the tuning drive assembly and all operating controls and connectors. The controls and their functions are described in detail in paragraph 9. A diamond-shaped plate covers a cut-out in the panel, which provides access to the dial-drive and detent mechanism adjusting screws. Terminal board E–24 on the rear of the front panel mounts the capacitors associated with all external connections.

c. The dial-drive and detent mechanisms are arranged as a subassembly on the mounting plate which is attached by means of machine screws to the front panel, the wrap-around frame, and the power supply compartment. The antenna trimmer C–4 also is mounted on this plate. A U-shaped link joins the shaft of C–4 to the ANT TUNE adjustment control accessible through a cap on the front panel. The dial drive and detent mechanisms are described in detail in paragraph 11.

d. The vertically mounted chassis is attached to projections at the center rear of the dial-drive mechanism assembly plate and the power supply compartment. Large components, such as tubes, two large plug-in electrolytic capacitors C–73 and C–80, transformers, etc. appear on the left side of the chassis. All wiring and some of the small components are located on the right side. Two metal brackets located on the right side of the chassis mount small capacitors and resistors and serve as shields for the i-f and discriminator circuits. The shield located on the lower side of chassis mounts the fixed level audio amplifier VOLUME control and the 6, 12, 24 VOLTS-OFF-EXTERNAL SUPPLY switch S–1. A container with a folded cloth circuit label is mounted toward the rear of the component side of the chassis.

e. The detachable wrap-around frame insures a rigid panel-and-chassis assembly. It is attached by means of machine screws to projections at the rear of the mounting plate for the dial-drive assembly. Slots in the frame hold and thereby reinforce the vertical chassis. A spring-clip, holding the Allen wrenches, is mounted along one edge of the wrap-around frame.

f. The compartment for the plug-in vibrator power supply is located between the mounting plate for the dial-drive assembly and the vertical chassis. The compartment is equipped with an octal male plug J–2 to fit the octal socket connector of the vibrator power supply unit. The plug, attached to the end of a cable, is mounted on the bottom of the compartment (right side of the panel-and-chassis assembly) by means of three machine screws. The plug may be detached from the compartment by removal of these screws.

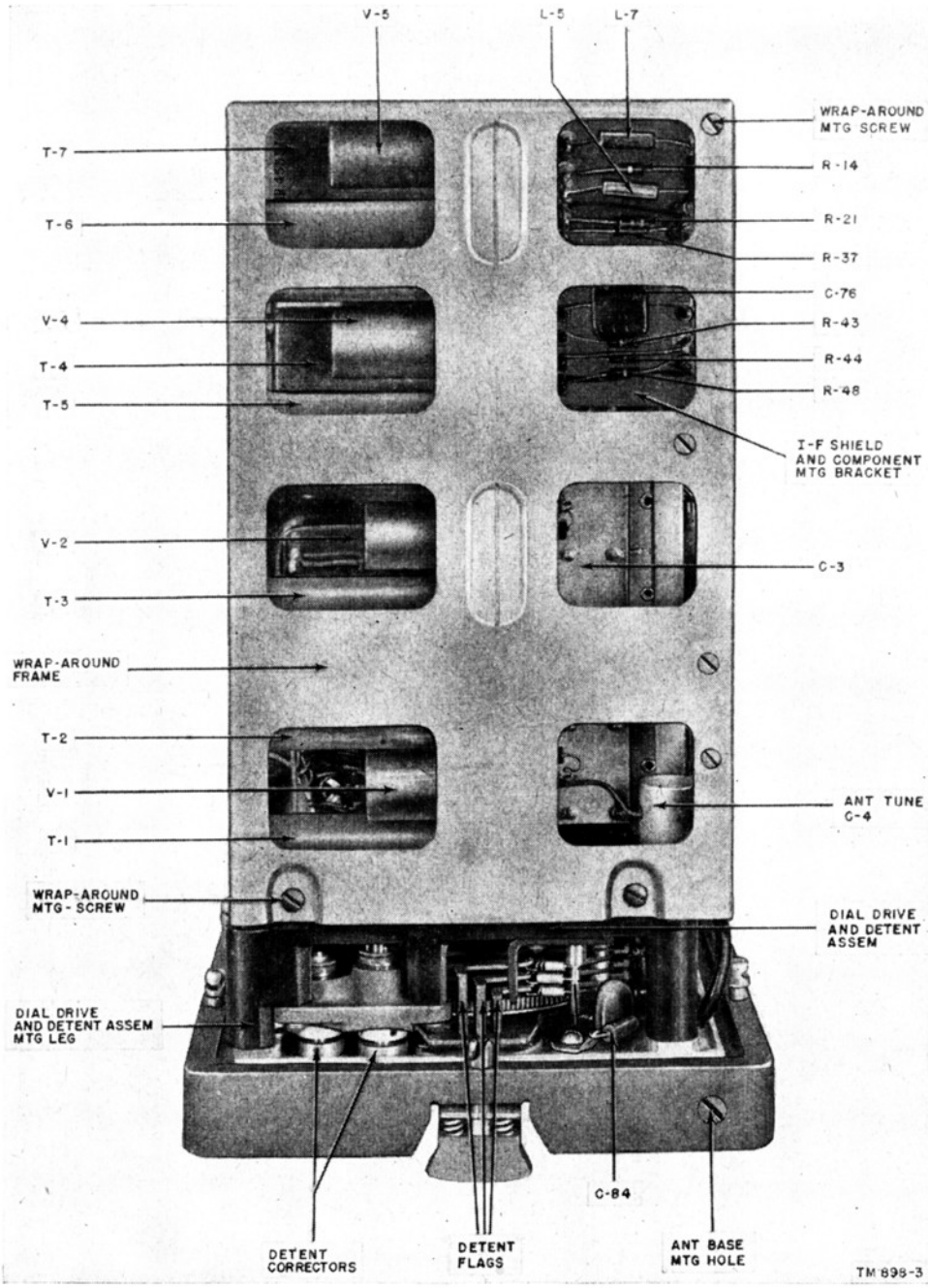


Figure 3. Typical radio receiver, case removed, top view of panel-and-chassis assembly.

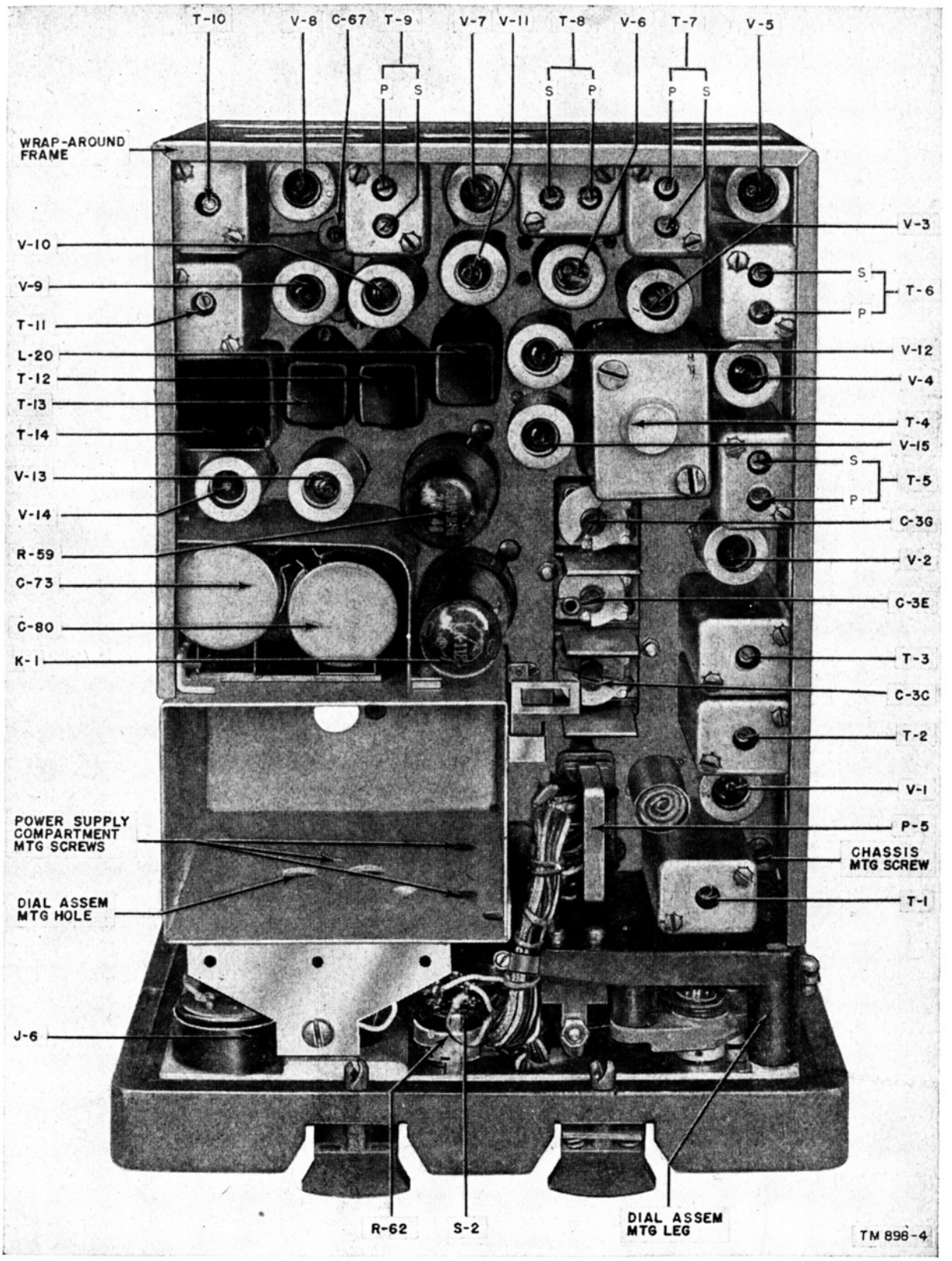


Figure 4. Typical radio receiver, case removed, component (left) side of panel-and-chassis assembly.

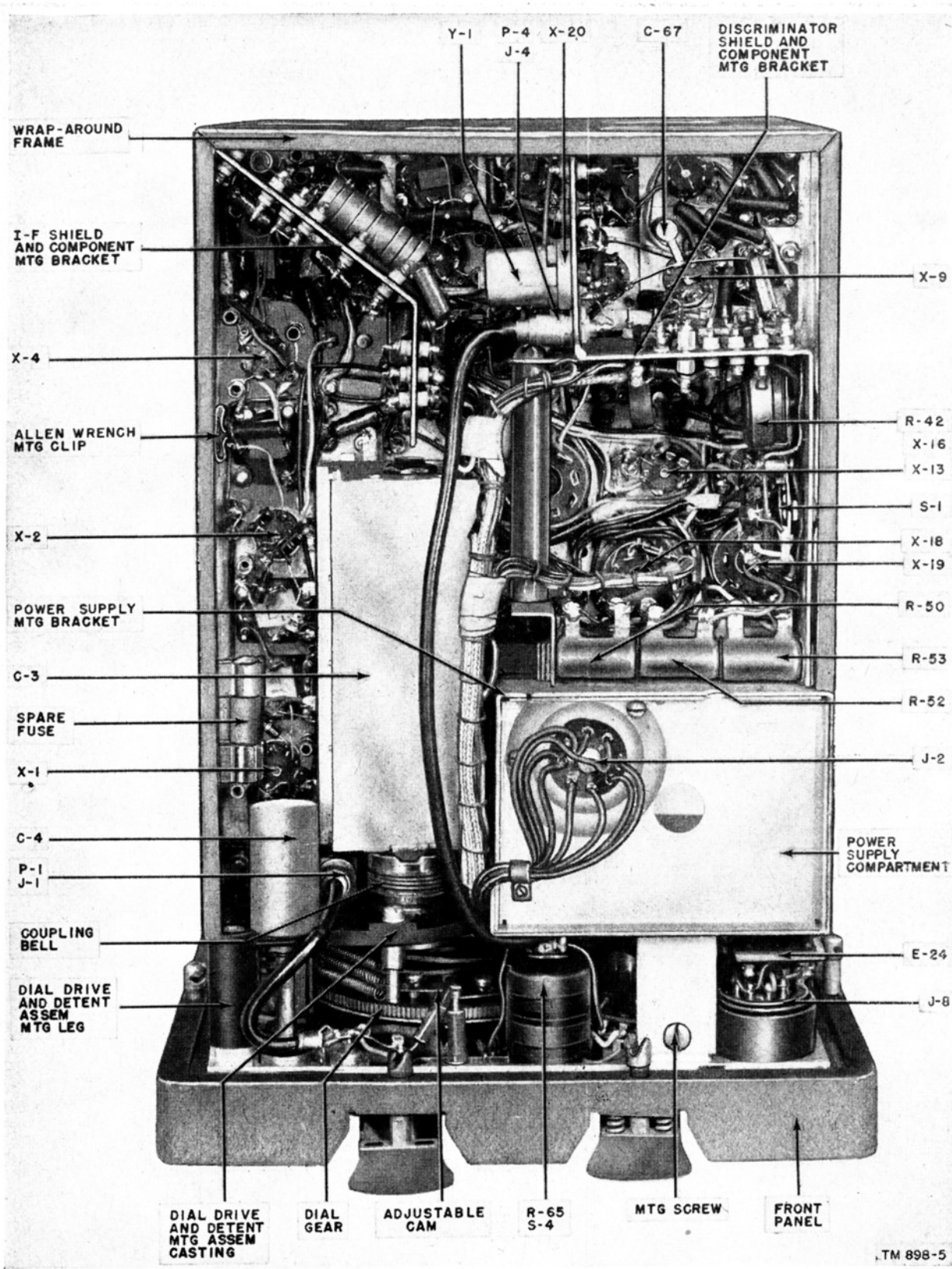


Figure 5. Typical radio receiver, case removed, wiring (right) side of panel-and-chassis assembly.

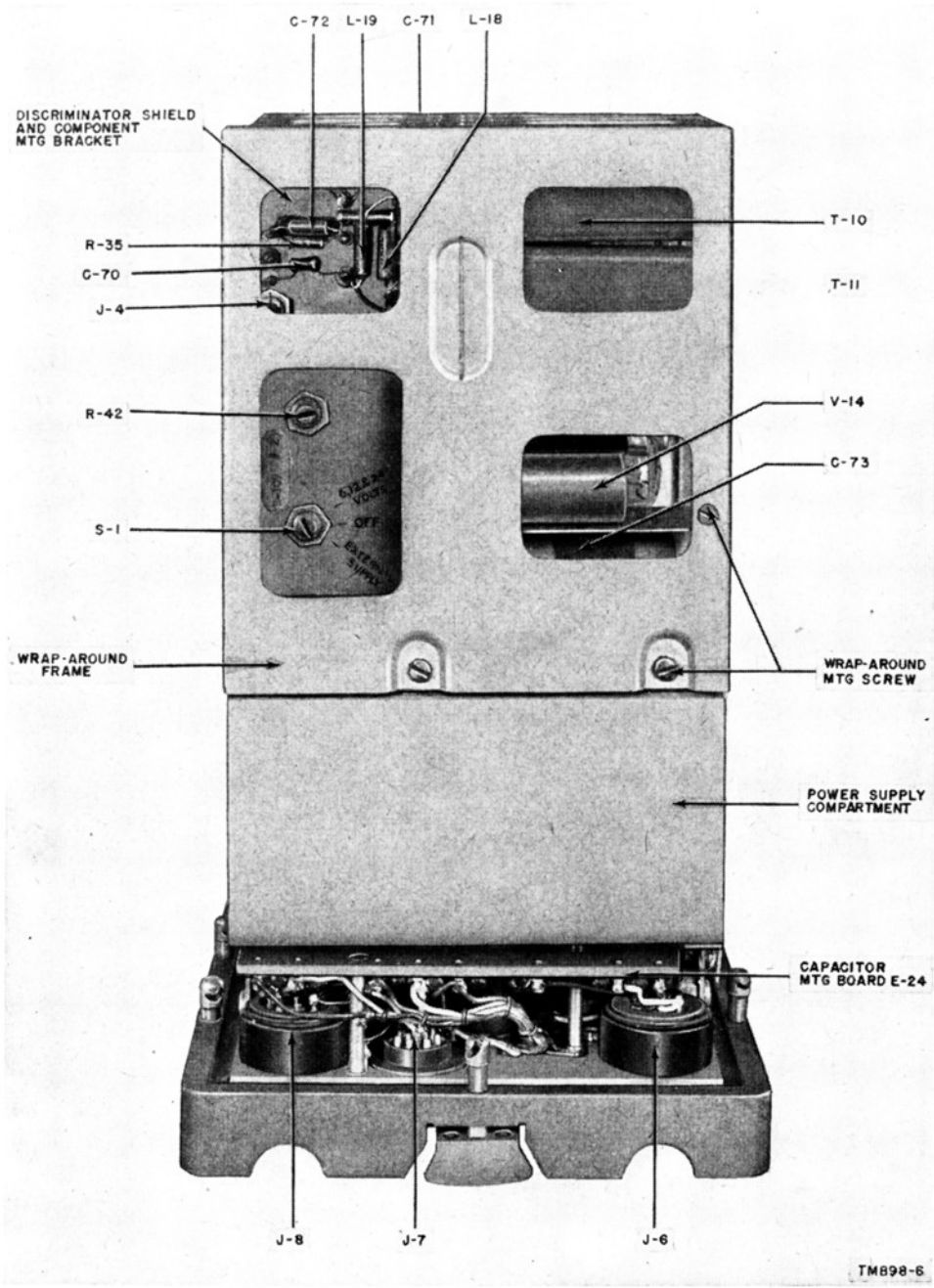


Figure 6. Typical radio receiver, case removed, bottom view of panel-and-chassis assembly.

9. Panel Controls and Connectors
(fig. 7)

All operating controls and external cable connectors appear on the front panel of the receiver. The location of the controls and connectors is indicated in figure 7. It should be noted that this figure applies equally to all three receivers. The following table lists the controls, connectors, and other panel-mounted facilities and indicates the function of each. The table also applies to the three units.

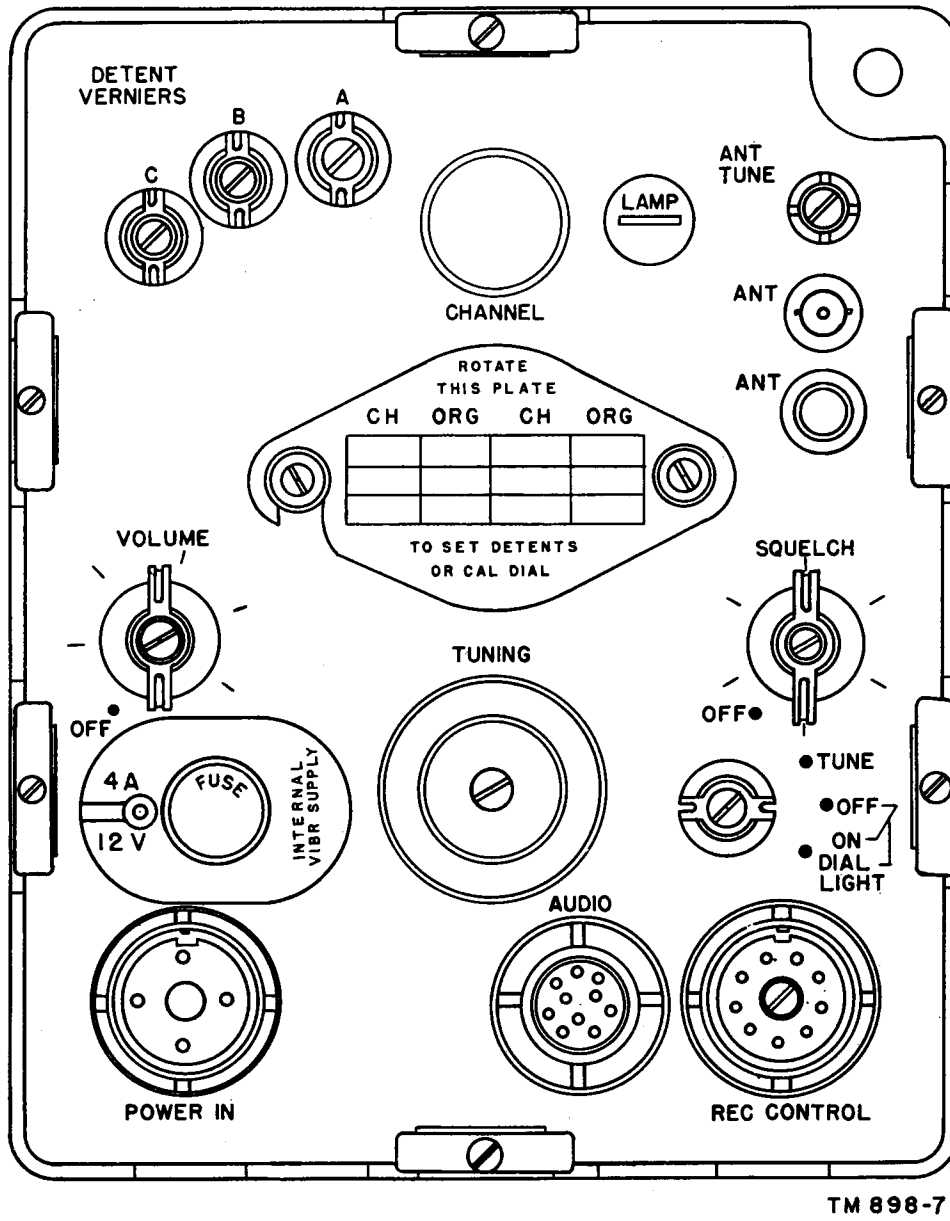


Figure 7. Typical radio receiver, location of panel controls and connectors.

Control	Function
VOLUME control (R–62).	This potentiometer serves to adjust the receiver audio output levels. Maximum volume is obtained when the control is in the extreme clockwise position.
Power OFF switch (S–2).	This SPST (single-pole, single throw) switch is ganged to the VOLUME control potentiometer R–62. It serves to apply or remove 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.
SQUELCH sensitivity (R–65 and S–4).	This switch and potentiometer assembly serves to adjust the degree of the receiver squelch. In the maximum counterclockwise direction of rotation of the knob, the switch is turned OFF and the squelch (or receiver noise quieting circuit) is disabled, providing no quieting action. In the clockwise direction of rotation of the knob, the switch is closed, and increasingly stronger signals are required to disable the squelch and to restore the receiver audio-amplifier circuits to normal operation. For any setting of the potentiometer, a particular signal level is necessary below which the receiver audio circuits are inoperative and above which signals may be heard.
ANT TUNE (C–4)	This antenna trimmer capacitor is adjusted by means of a screw driver. The trimmer capacitor tunes the input circuit of the r-f stage for variations in antenna circuits.
TUNE-DIAL LIGHT (ON-OFF) switch (S–3).	Controls the operation and output connection of the tuning oscillator V–10, pentode section and the operation of the dial lamp E–14 as follows: In the TUNE position, the output of the crystal controlled tuning oscillator is connected to the input of the r-f amplifier and to the ANT connector. The dial lamp is lit. In the DIAL LIGHT OFF position, the output of the tuning oscillator is grounded and the dial lamp is turned off. In the DIAL LIGHT ON position, the tuning oscillator output remains grounded, but the dial lamp is turned on.
TUNING knob	Controls the selection of the receiver operating channel. Continuously variable tuning over the entire range of the receiver is provided. A detent mechanism permits the rapid and accurate selection of any one of three preset frequencies within the tuning range. Rotation of the knob rotates the CHANNEL dial and (with detent set) actuates the detent flags.
CHANNEL dial and window.	The dial, actuated by the tuning knob, is calibrated in major divisions representing 10-channel (1-mc) steps and in minor subdivisions representing 1-channel (100-kc) intervals. The dial numbers are channel numbers. When divided by 10 the channel numbers give the operating frequency in mc. A detent flag appears in the window whenever the dial is set on a point which has been preset by the detents.
DETENT VERNIERS A, B, C.	These controls, on the upper left-hand corner of the panel, provide a fine adjustment of each of the three detent frequency settings.
Diamond-shaped cover plate.	This cover plate is held in place by two thumbscrews. Removal of one screw and loosening the other 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.	Three detent adjustment screws, marked DET A, DET B, and DET C (corresponding to DETENT VERNIERS A, B, and C) are located under the diamond-shaped cover plate. These screws serve to lock the detent mechansim for three frequencies within the tuning range of the receiver.
DIAL adjustment screw.	A DIAL adjustment screw, located under the 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.	The 4-ampere fuse in the vehicular primary supply circuit of the receiver is accessible by removing the FUSE cap over the fuse holder. The cap serves also as a fuse extractor.

Control	Function
Battery voltage indicator plate.	Serves to show the voltage of the external supply required to operate the receiver depending on the setting of the internal voltage selector switch (6, 12, and 24 VOLTS-OFF-EXTERNAL SUPPLY) S–1 and the rating of the vibrator power supply unit which is plugged into the power supply compartment.
Dial LAMP	A small, flange base type, 1.35-volt dial lamp located under the cap marked LAMP serves to illuminate the dial during receiver tuning or dial calibration. The lamp is lighted when the TUNE-DIAL LIGHT (ON-OFF) switch is in either the TUNE or DIAL LIGHT ON position.
ANT connector (J–3) (upper connector).	A small pin-type coaxial connector which connects the lead from the antenna to the antenna circuit within the receiver.
ANT binding post (E–6) (lower connector).	Directly connected to J–3, serves for interconnection with other units as alternative connection to a single-wire type antenna lead.
Antenna base mounting hole.	An antenna base mounting hole, located in the extreme upper right-hand corner of the panel, serves to mount an antenna base (Mounting MT–652/GR). A small pin inside the hole serves to hold the Dzus fastener type plug at the end of the antenna base.
POWER IN connector (J–6).	This 4-pin connector serves to connect either the vehicular storage battery or the external power supply to the receiver power supply circuits.
AUDIO connector (J–7).	This male, compression type, 10-pin connector serves to bring the receiver output to the front panel for application to external headset and loudspeaker.
REC CONTROL connector (J–8).	This female type, 9-pin connector parallels the phone and loudspeaker connections of J–7 and, in addition, provides for connection to the fixed level audio output of the receiver and to an external control relay or other control circuit, as required by a particular installation.

10. Internal Controls

The following table lists the controls located inside the receiver. These controls are not changed during normal operation of the equipment but are set during initial installation, when the mode of operation is decided upon, or thereafter when the mode of operation is to be changed.

Control	Function
Fixed level output gain control (R–42).	This screw driver adjustment control (fig. 6) determines the audio output level from the fixed-level audio amplifier (V–12) of the receiver.
Voltage selector switch (S–1).	This three-pole, three-position screw driver adjustment switch (fig. 6) serves to arrange the receiver filament and plate voltage circuits to permit operation from any one of the following types of power sources.

Position of S–1	Function
6, 12, and 24 VOLTS	Arranges 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 so as to provide the required 6.3 volts to the receiver filaments.
OFF	Disconnects the plate and filament supply circuits within the receiver from the plate and filament supplies (internal or external).
EXTERNAL SUPPLY.	Connects the plate and filament supply circuits within the receiver to POWER IN connector J–6 for connection to external 6-volt and 130-volt power sources.

11. Dial Drive and Dentent Mechanism
(figs. 8 and 9)

a. General. The TUNING knob controls the position of the four-gang variable tuning capacitor C–3 which tunes the receiver r-f and h-f oscillator circuits to the desired frequency, and 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 preset 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 9, the dial is gear driven. The ratio of the drive gear (on the TUNING knob shaft) to the large gear (lo-

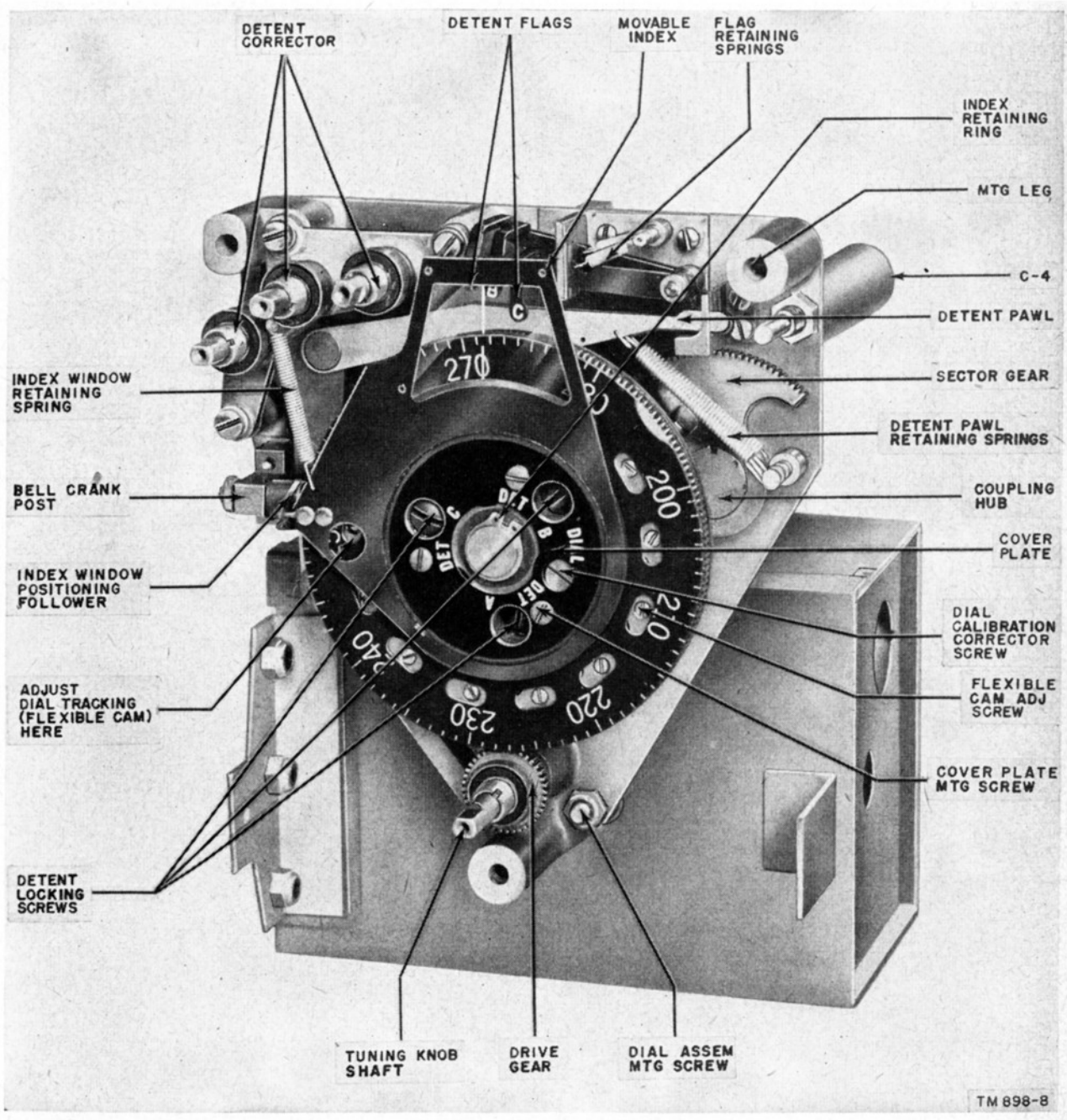


Figure 8. Dial drive and detent assembly, front view.

cated 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 lockscrews are spaced 120° apart in the hub of the dial and are labeled DET A, DET B, and DET C. They lock the detent discs to the dial-drive assembly so that they move with the dial.

(1) The detent mechanism employs three single-tooth detent discs (DET A, DET B, and DET C). Each one of these discs 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 three latches, one for each detent. Since the latch is stationary and lies in the path of the detent tooth which is turning

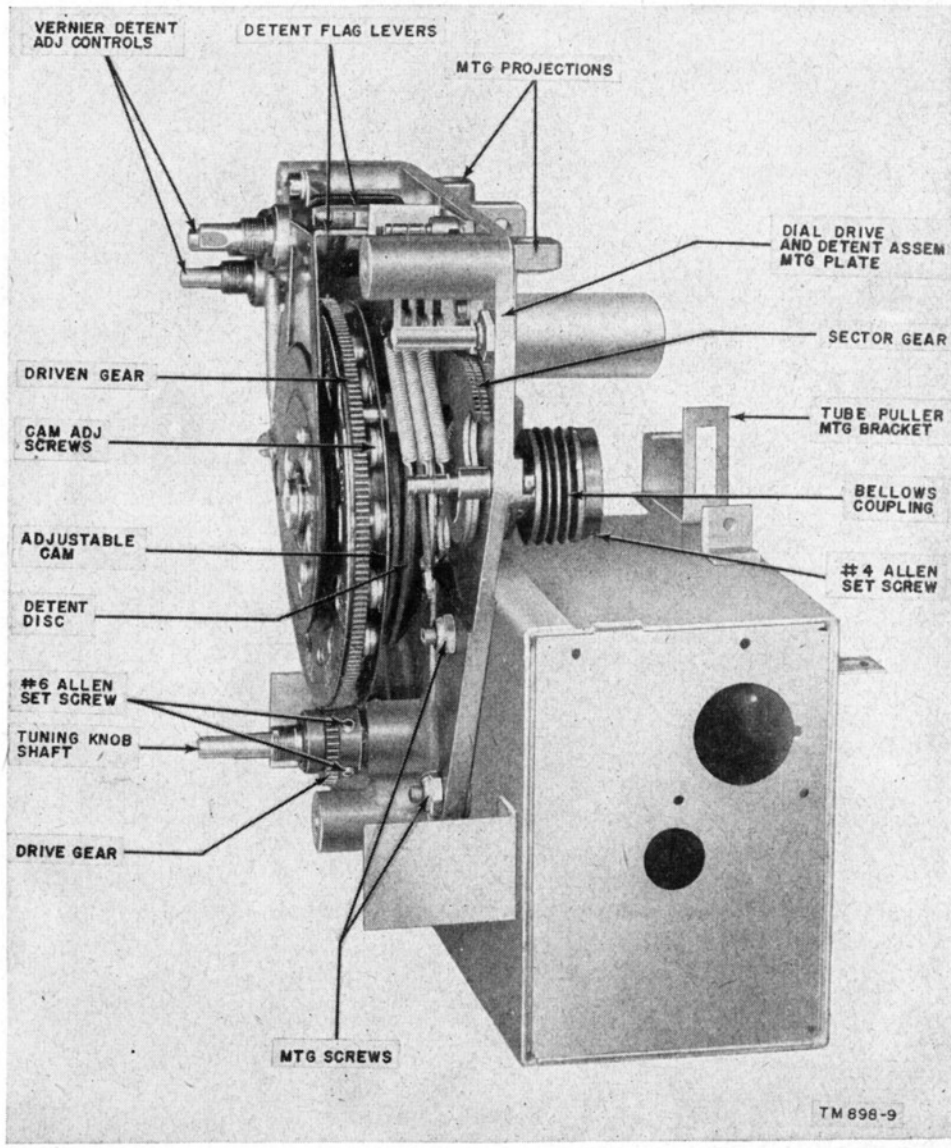


Figure 9. Dial drive and detent assembly, side view.

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, respectively, to identify the three detent-selected channels. These letters correspond to those which are marked on the panel above the DETENT VERNIER knobs and the identification markings for the detent lockscrews. 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 increasing dial numbers. Any detent may be used for the low, medium, or high frequency points on the dial.

(4) The three DETENT VERNIER 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 for 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 disc which is bent by 13 adjusting screws. A follower, which engages the edge of the disc, controls the positioning of the dial index. A spring holds the follower against the surface of the flexible disc. If the flexible disc 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.

12. Additional Equipment Required

a. 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 source of plate and filament power, an antenna with mounting components, connecting cables, a headset, and a loudspeaker.

b. The items listed above are normally supplied as components of the radio set of which the receiver is a part. Detailed information is given in the technical manual for the particular radio set.

c. The following components are the minimum required to place the receiver in operation.

(1) In a vehicular installation, one of the vibrator type power supplies, 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 provided as part of the receiver assembly. In other installations an external source of 6.3 and 130 volts dc may be used if available.

(2) The following antenna components assembled will form a vehicular antenna suitable for use with the receiver.

Mast Section MS–116–A.
Mast Section MS–117–A.
Mast Section MS–118–A.
Mast Section AB–24/GR.
Mast Base AB–15/GR.

(3) Headset HS–33 or Chest Set Group AN/GSA–6.

(4) Suitable power and r-f cables and connectors.

13. Spare Parts

The following parts are supplied as running spares with each receiver:

1 fuse, Buss AGU–4, 4 amperes (fig. 5).

14. Tools and Materials

The following tools and materials are supplied with each receiver:

3 Allen wrenches Nos. 8, 6, and 4 (fig. 5).

1 tube puller, Kellem type 11–16 (fig. 9).

1 circuit label, folded in a compartment on the chassis.

2 instruction books.

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 paragraphs 18 through 36. These descriptions apply also to Radio Receivers R-109/GRC and R-110/GRC, except as noted in paragraph 37, which covers the difference between the three receivers. These differences consist, essentially, in the values of padder capacitors in the r-f circuits, and in the values of padder capacitors and isolating chokes in the variable oscillator circuit. Schematic diagrams for the three receivers are given in figures 35 through 37.

15. Block Diagram
(fig. 10)

a. GENERAL. The signal path of Radio Receiver R-108/GRC, R-109/GRC, or R-110/GRC is shown in the functional block diagram (fig. 10). Complete schematic diagrams for the equipments are shown in figures 35 through 37. The block diagram shows that the equipment consists of a single-conversion superheterodyne type of receiver, including a single r-f amplifier stage V-1; a variable oscillator V-3; a mixer stage V-2; a four-stage 4.3-mc i-f amplifier circuit V-4 through V-7; a single limiter stage V-8; an f-m discriminator V-9 and V-10 (diode section); and two parallel audio paths V-12 and V-13, V-14. The unit also includes provisions for including a vibrator type power supply unit and circuits for utilizing this vibrator power supply in conjunction with a suitable storage battery to provide the plate, screen, and filament voltages for operating the equipment. Auxiliary circuits provided include a tuning oscillator V-10 (pentode section), and a squelch circuit V-11.

b. SIGNAL PATH. The function of the receiver is to receive f-m r-f signals, to convert them into a 4.3-mc i-f signal and then, by means of an f-m discriminator, into the original audio signals. The audio signals are then applied to an external a-f device, such as a headset or a loudspeaker.

(1) *Input circuit.* Signal voltages from the antenna are developed across the antenna coil. The signal voltages are applied to the r-f amplifier stage V-1 the input and output circuits of which are tuned for a desired frequency band by sections of the r-f TUNING capacitor C-3. The amplified output of this stage is coupled to the receiver mixer stage V-2. With the squelch circuit operative the gain of the r-f amplifier stage is controlled by the squelch circuit (par. 28).

(2) *Mixer stage.* The mixer stage combines the output of the variable oscillator V-3 with the amplified output of the first r-f amplifier stage V-1, to produce the intermediate frequency of 4.3 mc.

(3) *I-f amplifier and limiter.* The grid circuit of the mixer stage is tuned by another section of the gang TUNING capacitor C-3. The difference frequency band at the output of mixer stage V-2 is amplified in a five-stage fixed tuned i-f amplifier V-4 to V-8. The first four stages are conventional i-f amplifiers. The fifth stage V-8 is also designed to function as a limiter to eliminate any amplitude variations of the signal. Amplitude variations represent noise and are undesirable. Proper functioning of the discriminator which follows the limiter stage requires that the level of the applied signal be fairly uniform for variations in the level of the incoming signal. A portion of the d-c grid bias delivered at the limiter stage is fed to the squelch circuit to provide squelching action as described in paragraph 28.

(4) *Discriminator.* The output of the limiter stage V-8 is applied to the discriminator V-9 and V-10 (diode section). This discriminator is a tuned circuit using a diode type 1A3 and the diode por-

tion of a type 1S5 tube as rectifiers. The term discriminator is typical for f-m receivers and signifies a circuit which corresponds to the detector in a-m (amplitude-modulated) receivers. The discriminator performs a function corresponding to that of the a-m detector, in that it extracts the intelligence or audio modulation from the incoming f-m signal. Since in frequency modulation the intelligence to be *detected* appears as variations in frequency (that is, shifts of the carrier from a center frequency) instead of amplitude variations, the discriminator is a frequency sensitive device. Thus, the discriminator converts the variations from a center frequency (in this case 4.3 mc) of the incoming signal into audio signals.

(5) *Audio amplification.* The a-f signals that appear at the output of the discriminator are amplified in two separate audio amplifier circuits.

(*a*) One circuit is a two-stage audio amplifier V–13 and V–14 with gain adjustable by means of the front panel-mounted VOLUME control R–62. The output of the first stage V–13 is connected to pins A of the AUDIO connector J–7 and to pin E of the REC CONTROL connector J–8 and is used to provide enough volume to operate a headphone. The output of a push-pull audio power amplifier stage V–14 is connected to pin L of the AUDIO connector and to pins F and A of the REC CONTROL connector and has sufficient output to drive a loudspeaker.

(*b*) The other amplifier circuit, a one-stage amplifier V–12, serves to provide an audio output for use in systems application. No panel adjustment of volume is provided and it is for this reason that the stage is referred to as a fixed level stage. However, an internal potentiometer R–42 provides screw driver adjustment of the gain of the amplifier for the required level without disassembling the panel-and-chassis assembly. The output of this stage is connected to pin B of the REC CONTROL connector J–8.

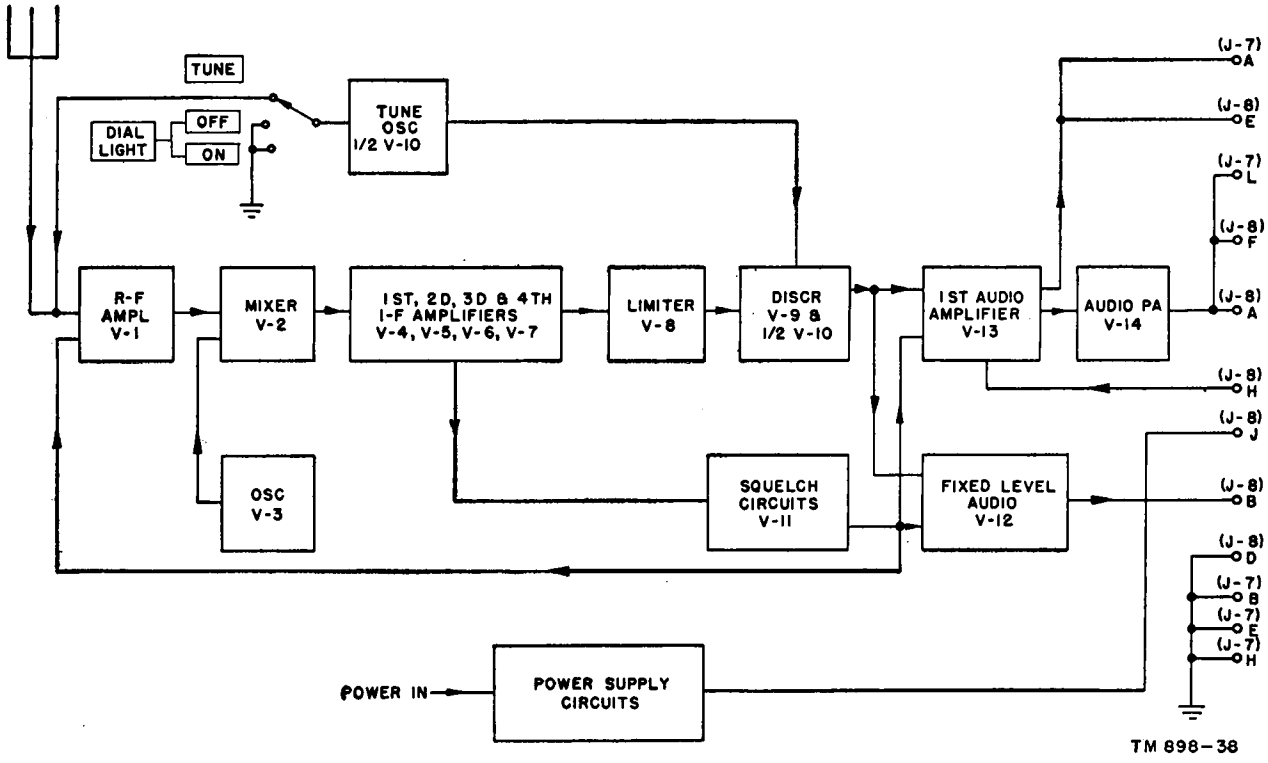


Figure 10. Typical radio receiver, block diagram.

(6) *Squelch oscillator V–11.* It is characteristic of very sensitive receivers, such as the one under discussion, that in the absence of signals a rushing noise is heard in the receiver phones and loudspeaker. The noise is the result of thermal agitation in the vacuum tubes and receiver components and of external electrical disturbances. A squelch circuit is used to suppress this noise during no-signal intervals. In Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC, the squelch circuit consists of a carrier-switched, 20-kc (approximately) oscillator and a diode rectifier V–11. Squelch action is adjustable by means of the panel-mounted SQUELCH control R–65. The squelch circuit can be disabled for test purposes and for reception of very weak or fading signals by turning the SQUELCH control to its OFF position (S–4).

16. Frequency Conversion

A single variable-tuned oscillator V–3 is provided to beat with the incoming signal to produce the intermediate frequency of 4.3 mc. The grid and plate circuit of the r-f amplifier stage V–1, the grid circuit of the mixer stage V–2, and the plate circuit of the variable oscillator V–3 are all tuned by sections of the gang r-f TUNING capacitor C–3. The arrangement is such that for any setting of the dial the oscillator frequency is exactly 4.3 mc above the incoming carrier frequency, so that in the mixer plate circuit the difference frequency is the desired 4.3-mc intermediate frequency.

17. Test Circuits

A calibrating circuit associated with the receiver includes a crystal-controlled, 4-3-mc oscillator, part of V–10, the output of which is very rich in harmonics, and a test switch S–3 which connects this oscillator to the antenna circuit of the receiver at the point of entry of the antenna into the receiver assembly. This oscillator generates a signal for use in calibrating the receiver at frequency settings on the dial which are multiples of 4.3 mc. When the test switch is in the TUNE position, the oscillator is connected as described above and generates a 4.3-mc frequency. The harmonics of this signal are selected by the tuned circuit of the receiver. The particular harmonic selected depends upon the frequency to which the receiver is tuned. The particular frequencies which can be selected are identified on the panel above the dial calibrations by red dots. Simultaneously, a portion of the 4.3-mc output of the tuning oscillator is applied to the discriminator circuit. The harmonic frequency of the tuning oscillator is routed through the receiver r-f and i-f circuits to the discriminator the same as any other radio signal. In the discriminator circuit the two signals are made to beat against each other and to produce a difference frequency. If the variable mixer oscillator of the receiver is accurately calibrated against the dial, the resultant difference frequency is zero frequency. 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 tenth of a megacycle. Therefore the presence of the audio beat note 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 transmitter 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. Calibrating the receiver oscillator then becomes the problem of adjusting its tuned circuits so as to produce audible beat notes in the headphones for the red dot positions of the tuning dial.

18. Antenna Circuit
(fig. 11)

a. The antenna lead is plugged into the upper panel-mounted ANT connector J–3 or connected to the lower ANT connector which is binding post E–6. A coaxial cable connects the antenna lead through panel-and-chassis connectors P–1 and J–1 to the untuned primary winding (terminal 2) in tuning assembly T–1.

b. Inductive coupling transfers the signal to the secondary coil winding in T–1. This winding (terminals 4 and 5) is tuned to parallel resonance at the dial frequency by section A of the r-f gang TUNING capacitor C–3. The inductance of the secondary winding of T–1 is adjusted by means of the iron dust core. The capacity of the parallel-resonant circuit in T–1 is adjusted by means of trimmer capacitor C–4, which is accessible from

the front of the panel, where it is identified as ANT TUNE. Capacitor C–1, shunted across the tuned circuit, serves as a padding capacitor of the temperature compensating type. The signal selected by this resonant circuit is applied directly to the grid (pin 1) of r-f V–1. The tuned circuit thus tunes the grid of V–1 to resonance at the dial frequency.

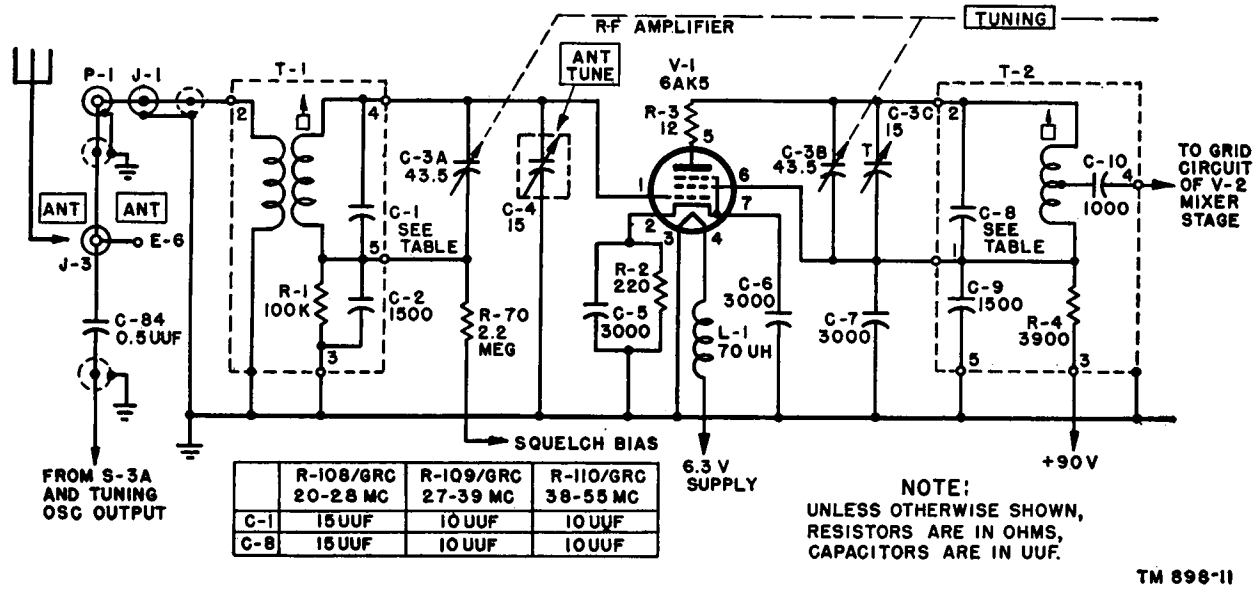
19. R–f Amplifier Stage V–1

(fig. 11)

a. The receiver r-f stage V–1 uses a type 6AK5 pentode tube to provide a high signal-to-noise ratio. The grid (pin 1) circuit is tuned to resonance at the dial frequency by the tuned secondary circuit of T–1 (par. 18), which is returned to ground for rf through bypass capacitor C–2 and dc through grid leak resistor R–1. During stand-by conditions, when no signal enters the circuit and the squelch circuit is operative (SQUELCH control not fully counterclockwise), the squelch bias voltage developed across R–1 serves to reduce the gain of V–1. In this connection, R–1 is part of a voltage divider network across the squelch circuit. When the squelch circuit is turned off, either by the entry of a received signal or by means of the SQUELCH control (when in the extreme counterclockwise (OFF) position), the tube is self-biased because of the plate current flow through cathode (pin 2) resistor R–2, which is bypassed for rf by capacitor C–5. Resistor R–1 limits grid current flow during reception of strong signals. To reduce wiring inductance, V–1 has two cathode connections. Cathode resistor R–2 and bypass capacitor C–5 are connected to one cathode terminal (pin 2). Bypass capacitor C–6, connected to the other terminal (pin 7), serves to further balance out the wiring inductance.

b. During stand-by, when the squelch circuit is operative, a bias voltage developed by the diode portion of squelch tube V–11 is applied across a voltage divider network which includes R–70 and R–1. The portion of the voltage developed across R–1 reduces the gain of V–1. When a signal is being received, a bias voltage developed at the limiter grid, V–8, disables the squelch circuit (par. 28). The output of the squelch diode is cut off, and the bias voltage across R–1 is removed. V–1 is thus restored to normal operation. For details of squelch circuit operation, refer to paragraph 28. By turning the SQUELCH control to its extreme counterclockwise (OFF) position, the squelch can be disabled with the same effect on the operation of V–1 as described above. Since the values of the squelch circuit resistors (including R–70) are very high, their shunting effect on the d-c grid path R–1 and on the a-c return path C–2 is negligible during periods of signal reception.

c. The plate circuit of V–1 includes the parallel-resonant circuit composed of the tuning inductance (terminals 1 and 2) in tuning assembly T–2, section B of ganged r-f tuning capacitor C–3, trimmer capacitor C–3C, and padder capacitor



	R-108/GRC 20-28 MC	R-109/GRC 27-39 MC	R-110/GRC 38-55 MC
C-1	15 UUF	10 UUF	10 UUF
C-8	15 UUF	10 UUF	10 UUF

Figure 11. Antenna and r-f amplifier circuits, functional diagram.

C–8. Trimmer capacitor C–3C is used for the alinement of the stage at the h-f end of the tuning range. The powdered iron core of the inductance in T–3 is used for alinement at the l-f (low-frequency) end.

d. Voltage for the plate (pin 5) and the screen (pin 6) is fed from the regulated plate supply circuit through the r-f filter consisting of r-f choke coil L–6 and r-f filter capacitors C–32 and C–33. The supply voltage is brought to terminal 3 of T–2, where it is distributed through voltage dropping resistor R–4 and then through terminal 1 to the screen grid (pin 6), and through the tuning inductance in T–2 and isolating and parasitic suppressor resistor R–3, to the plate (pin 5). Capacitors C–9 and C–7 are r-f bypasses for the plate and screen supply voltages, respectively. Filament voltage is obtained from the filament supply circuit, through isolating choke coil L–1.

e. The output of V–1 is taken from a tap on the tuning inductance in T–2 and is coupled through coupling capacitor C–10 to a similar tap on the V–2 grid circuit tuning inductance in T–3. The selection of the tap is made in manufacture to insure proper match between the plate circuit impedance of V–1 and the grid circuit impedance of V–2. Capacitor C–10 serves also to block dc from the grid circuit of V–2. This method of coupling is used to insure the less-than-critical coupling required for this stage.

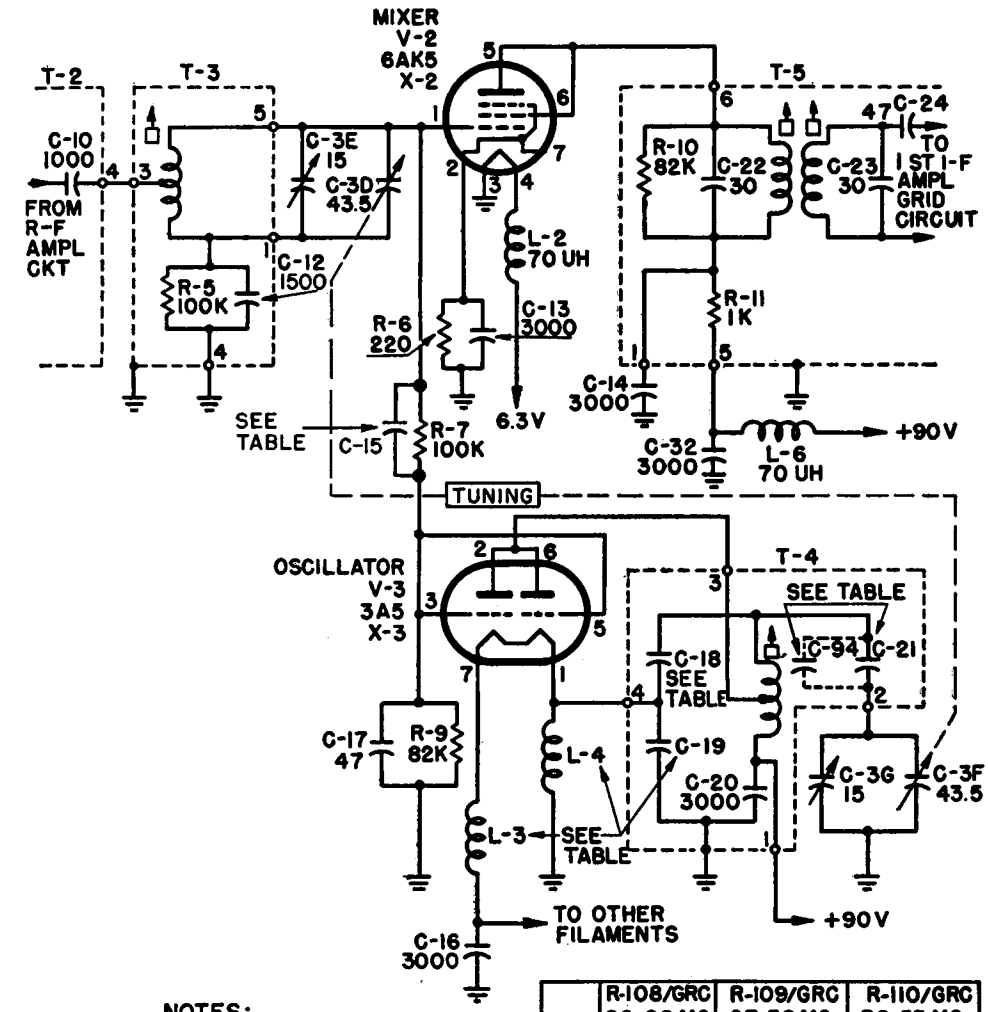
20. Receiver Variable Oscillator V–3
(fig. 12)

The self-excited variable receiver oscillator uses a type 3A5 twin triode tube V–3 in a modified Colpits circuit. To obtain maximum transconductance the two triode sections of the tube are connected in parallel by joining the two plates (pins 2 and 6) and the grids (pins 3 and 5).

a. Tuned Circuit. The oscillator is tuned to resonance by the parallel-resonant circuit composed of the coil inductance in T–4 and section F of the variable gang capacitor C–3 in series with the capacitor C–21. Capacitor C–21 provides the series padding necessary for tracking of the oscillator to the other tuned circuits of the receiver. Capacitor C–21 also provides temperature compensation at the l-f 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 C–18 and C–19. 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 h-f end of the oscillator frequency range is alined by means of variable trimmer capacitor C–3G connected across C–3F. For a particular setting of the tuning capacitor, selected during operation by means of the TUNING control on the front panel, 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 (fig. 8).

b. Colpits Arrangement. The arrangement of the oscillator into a modified Colpits circuit is apparent from figure 12. Capacitors C–18 and C–19 constitute the conventional Colpits voltage dividing circuit to the junction of which the filament circuit of the tube is tied. The plate of the tube is tied to a tap on the inductance, while the grid is effectively connected through capacitor C–17 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 oscillatory feedback is determined by the ratio of the values of capacitors C–18 and C–19. Oscillatory feedback from the plate-filament to the grid circuit is accomplished through capacitor C–17. The oscillator output is taken from the grid of V–3 through decoupling resistor R–7 to the control grid (pin 1) of mixer tube V–2. In Radio Receiver R–108/GRC, resistor R–7 is shunted by capacitor C–15 serving to establish the amount of coupling.

c. Plate and Filament Supply. Plate voltage for V–3 is taken from the 90-volt supply circuit (junction of R–60 and C–80) at the output of the voltage regulator tube V–15 and applied through the inductance in T–4 to the plates (pins 2 and 6). Capacitor C–20 is a plate supply bypass. Its high value places the junction of the 90-volt supply lead and terminal 1 of the coil at ground potential for radio frequencies. Filament current is supplied through isolating choke L–3 and is bypassed by capacitor C–16. The other side of the filament is returned to ground through isolating choke L–4.



NOTES:
1. ALL RESISTOR VALUES IN OHMS UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITOR VALUES IN UUF UNLESS OTHERWISE SPECIFIED.

	R-108/GRC 20-28 MC	R-109/GRC 27-39 MC	R-110/GRC 38-55 MC
C-15	22 UUF		
C-18	15	10 UUF	10 UUF
C-19	39	24	10
C-21	250	450	350
C-94	——	——	350
L-3	50 UH	30 UH	50 UH
L-4	50 UH	30 UH	50 UH

TM 898-12

Figure 12. Receiver variable oscillator and mixer circuits, functional diagram.

Resistor R–9 in the grid circuit limits the grid current of the oscillator tube and provides self-bias for the operation of V–3. In this connection capacitor C–17 serves also as an r-f bypass.

21. Receiver Mixer V–2

(fig. 12)

a. The mixer stage uses a type 6AK5 pentode tube V-2. The tube is arranged as a triode, since the screen grid (pin 6) is tied to the plate (pin 5), and the suppressor grid is tied internally to the cathode (pins 2 and 7). Injection of both signal voltage from the r-f amplifier V–1, and of the heterodyne frequency from the receiver oscillator V–3, takes place at the control grid (pin 1) of V–2. The signal voltage from the plate circuit of V–1 is coupled through C–10 in tuning unit T–2 to a tap (terminal 3) on the coil (terminals 5 and 1) in tuning unit T–3. The coil provides the inductive element of the parallel-resonant circuit, which tunes the grid of V–2 to resonance at the

dial frequency. The capacitive element of this tuned circuit includes section D of the variable gang capacitor C–3 and trimmer capacitor C–3E. For alinement at the l-f end of the tuning range, the inductance of the coil in T–3 is adjustable by means of a powdered iron core. For alinement at the h-f end of the tuning range, adjustment is made by means of trimmer capacitor C–3E.

b. The grid circuit is returned to ground for d-c through grid leak resistor R–5 and for rf through bypass capacitor C–12. Resistor R–5 functions also to limit grid current flow for strong incoming signals. The tube is operated at the self-bias voltage developed across cathode resistor R–6, which is bypassed by capacitor C–13.

c. The incoming signal frequency and the heterodyne frequency are caused to beat against each other in V–2 to produce difference frequencies. Since 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 V–2 (*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 high Q of the tuned circuit.

d. The tuned plate circuit of V–2 is resonant at 4.3 mc by the primary of T–5. The primary tuned circuit consists of the plate coil (terminals 6 and 1) of the tuning inductance in T–5, fixed tuning capacitor C–22, and damping resistor R–10. The secondary circuit is tuned to resonance by the grid coil of V–4 in T–5 and fixed capacitor C–23. The use of double tuning and damping resistors R–10 and R–12 provides a broad response to permit a band of 85 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 (pin 6) of V–4 is accomplished through coupling capacitor C–24, which has the additional function of blocking d-c grid-to-filament current in V–4 from passing through the grid coil.

e. Plate potential is applied from the high-voltage supply circuit through the r-f filter (L–6, C–32, and C–33) and through voltage-dropping resistor R–11, which is bypassed by capacitor C–14. Filament voltage is supplied from the regulated 6.3-volt filament supply circuit within the receiver through isolating choke L–2.

22. Fixed I–f Amplifier Circuit V–4 through V–7

(figs. 13 and 14)

a. First Fixed I-F Amplifier V–4. The 4.3-mc i-f band is selected from the output of the receiver mixer V–2 by the double-tuned circuit in tuning assembly T–5 (par. 21), and coupled through capacitor C–24 to the grid (pin 6) of the first fixed i-f amplifier stage V–4, a type 1U4 pentode.

(1) Coupling capacitor C–24 has the additional function of blocking any dc which may be flowing in the filament-to-grid circuit of V–4 from the tuned secondary coil in T–5. The grid signal path is returned to ground for signal frequencies through i-f bypass capacitor C–25. The dc return path for the grid to the filament (pins 1 and 5) is established through grid leak resistor R–12. 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 drop in the filament circuit, as measured from pins 1 and 5 of the tube to chassis, and any voltage drop in R–12 due to grid current flow.

(2) The tuned plate circuit of V–4 is identical in circuit arrangement and component values to the components in tuning assembly T–5 (par. 21). The primary tuned circuit in T–6 includes the plate coil (terminals 1 and 6), fixed tuning capacitor C–29, and damping resistor R–15. The secondary tuned circuit includes the grid coil and fixed tuning capacitor C–30. As in the case of tuning assembly T–5, double tuning provides a high degree of i-f 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 R–15 flattens out the frequency response of the tuned circuit. The 85-kc band, centered about 4.3 mc, selected by the tuned circuit, is coupled to the input

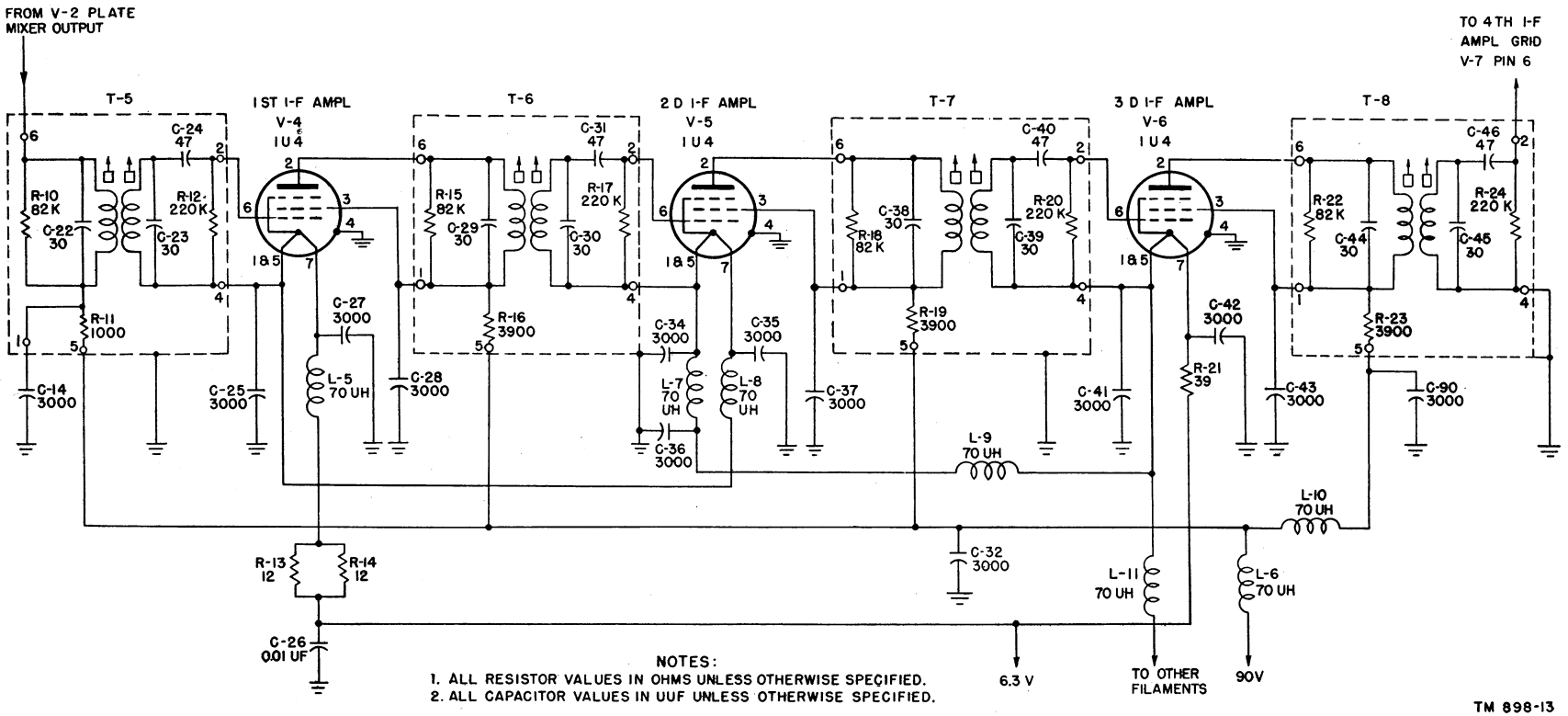


Figure 13. First, second, and third i-f amplifier circuits, functional diagram.

of the second i-f amplifier stage V–5 through capacitor C–31.

(3) Plate and screen voltages are applied through voltage-dropping resistor R–16, which is bypassed by filter capacitor C–28. Filament voltage is supplied through voltage-dropping resistors R–13 and R–14 in parallel, and through isolating choke coil L–5. Capacitors C–26 and C–27 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 T–5 and the primary coil in T–6 to obtain a peak reading on a meter connected to the grid of the limiter stage V–8.

b. Second Fixed I-F Amplifier V–5. The second fixed i-f amplifier stage V–5, a type 1U4 pentode, is identical in circuit arrangement and component values to the first i-f amplifier V–4.

(1) The grid circuit is tuned to resonance at the 4.3-mc intermediate frequency by the parallel arrangement of the secondary coil in T–6 and fixed tuning capacitor C–30. Coupling capacitor C–31 applies the output of V–4 to the grid (pin 6) of V–5. Grid resistor R–17 returns the grid to the filament for dc and to ground through filament bypass capacitor C–34. D-c operating bias is provided by the voltage drop in the filament circuit, as measured from pins 1 and 5 of V–5 to chassis, and any voltage drop in R–17 due to grid current.

(2) The plate circuit is tuned to resonance at 4.3 mc by T–7. The primary tuned circuit includes the plate coil, fixed tuning capacitor C–38, and damping resistor R–18. The secondary tuned circuit includes the grid coil of V–6, and fixed tuning capacitor C–39. The output of the second i-f amplifier is coupled through coupling capacitor C–40 to the grid (pin 6) of third i-f amplifier V–6. This capacitor serves also to block any d-c grid current from flowing through the tuned circuit.

(3) Plate and screen voltage is supplied through voltage dropping resistor R–19 which is bypassed by capacitor C–37. Filament voltage is supplied through isolating choke coils L–7 and L–8. The filament circuit is bypassed for signal frequencies by bypass capacitors C–34, C–35, and C–36.

(4) Alinement of the stage is accomplished by varying the powdered iron cores of the secondary coil in tuning assembly T–6 and the primary coil in T–7 until a peak reading is obtained on a meter connected to the grid of limiter stage V–8, when a 4.3-mc signal is applied to the input of the i-f amplifier circuit.

c. Third I-F Amplifier V–6. The third i-f amplifier stage V–6, a type 1U4 pentode, is identical in circuit arrangement and component values to the first and second i-f amplifier stages.

(1) The grid circuit is tuned to resonance at 4.3 mc by the parallel arrangement of the secondary coil in T–7 and fixed tuning capacitor C–39. Coupling capacitor C–40 applies the output of V–5 to the grid (pin 6) of V–6. This capacitor also functions to block d-c grid current from the tuned circuit. The grid is returned for dc to filament (pins 1 and 5) by R–20 and to ground for signal frequencies through filament bypass capacitor C–41. D-c 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 R–20 due to grid current.

(2) The plate circuit is double-tuned to resonance at 4.3 mc by T–8. The primary tuned circuit includes the plate coil (pins 6 and 1), fixed tuning capacitor C–44, and damping resistor R–22. The secondary tuned circuit includes the grid coil of V–7, and fixed tuning capacitor C–45. Alinement adjustment is obtained by varying the powdered iron cores of the primary and secondary coils, as described for the other stages. The output of the third i-f stage is coupled through coupling and d-c blocking capacitor C–46 to the grid (pin 6) of the fourth i-f amplifier stage V–7.

(3) Plate and screen voltage is applied through voltage-dropping resistor R–23, which is bypassed for signal frequencies by capacitor C–43. The filament circuit includes isolating choke coils L–9 and

L–11, bypass capacitors C–41 and C–42, and voltage-dropping resistor R–21.

d. Fourth I-F Amplifier V–7 (fig. 14). The fourth i-f amplifier stage V–7, a type 1U4 pentode, is identical in circuit arrangement and component values to the first three stages.

(1) The grid circuit is tuned to resonance at 4.3 mc by the parallel arrangement of the secondary coil and fixed tuning capacitor C–45 in T–8 (fig. 13). Coupling capacitor C–46 applies the output of V–6 to the grid (pin 6) of V–7, and also blocks d-c grid current from flowing through the tuned circuit. The grid is returned to ground for dc through grid leak resistor R–24. A-c grid return to ground is made by a direct ground connection from the secondary tuned circuit in T–8 (pin 4).

(2) The plate circuit is tuned to resonance at 4.3 mc by T–9 (fig. 14). The primary circuit includes the plate coil, fixed tuning capacitor C–50, and damping resistor R–25. The secondary tuned circuit includes the grid coil of V–8 and fixed tuning capacitor C–51. The output of the fourth i-f amplifier stage is coupled through coupling capacitor C–52 to the grid circuit of the limiter stage V–8. C–52 serves also as a d-c grid current blocking capacitor. As in the case of the preceding stages, alinement of the stage is accomplished by adjusting the iron dust cores of the tuning coils.

(3) Plate and screen voltages are applied through voltage-dropping resistor R–26, which is bypassed for i-f signals by capacitor C–49. The filament is bypassed for intermediate frequency by C–48.

(4) A portion of the d-c voltage developed by grid current rectification in the grid circuit of the fourth i-f amplifier V–7, is applied through R–68 to squelch tube V–11 as bias for the squelch oscillator (par. 28). A-c noise and/or signal voltages routed through R–68 to V–11 are bypassed to ground by capacitor C–78 and therefore have relatively little effect on the operation of V–11.

23. Limiter Stage V–8
(fig. 14)

The limiter stage V–8 uses a type 1L4 pentode tube. 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 which 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 tuning capacitor C–51 in T–9. The signal is coupled to the grid (pin 6) of V–8 through coupling and d-c grid current blocking capacitor C–52.

(1) The series arrangement of grid leak resistor R–27 and measuring resistor R–28 provides the d-c return path for the grid of the tube to ground. The return path to ground for signal frequencies is established through bypass capacitor C–53, which also serves to bypass measuring resistor R–28 for signal frequencies.

(2) Measuring point E–3 is a stand-off insulator type terminal. The measuring circuit includes voltage divider network R–29 and R–28, meter bypass capacitor C–54, and measuring resistor bypass capacitor C–53. The voltage drop across R–28, effectively measured when a meter is connected between E–3 and chassis, serves to determine the amount of grid current flowing in V–8. This measuring point and the grid current flow serve as a reference value for all alinement adjustments and stage gain measurements made on the r-f and i-f portions of the receiver.

(3) The plate circuit of the limiter stage is single-tuned to parallel-resonance at 4.3 mc by the inductance and the fixed tuning capacitor C–56, in tuning assembly T–10. The output of the limiter stage is applied by direct connection from the plate (pin 2) of V–8 to the discriminator tuning assembly T–11 (terminal 1). Note that the plate impedance of V–8 and the discriminator tank circuit in T–11 are in separate cans and therefore are magnetically independent of each other.

(4) Plate and screen potentials for V–8 are applied through r-f filter choke coil L–13, which is bypassed for signal frequencies by capacitor C–95, and through voltage-dropping resistor R–30, which is bypassed by capacitor C–55.

b. Limiting Action. Limiter stage V–8 has the dual functions of amplifying the 4.3-mc band of frequencies and of eliminating or reducing any amplitude variations which may have been superimposed upon the signal in its travels from the distant transmitter through the air and through the preceding stages of the receiver. It should be noted that 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 caused by bursts of noise, static, and other causes, and that for wide variations in the strength of incoming signals, the average signal voltage applied to the discriminator input circuit remain fairly constant. The circuit parameters of the i-f amplifier and limiter stages are arranged to make both of these functions possible.

(2) When the signal voltage appearing across the grid circuit of any one of the fixed i-f stages V–4 through V–8, exceeds a certain value, an increase in grid current causes limiting action or cut-off of signal peaks for one half-cycle of the signal voltage, while 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 20 to 30 volts across the discriminator input, the grid current is increased to the point where grid current rectification occurs. The d-c grid current then flows through the associated grid leak resistor and develops a voltage across it which is negative at the grid (pin 6) of the tube. This negative voltage tends to bias the tube, thereby reducing the gain of the stage accordingly.

(3) While inherently all stages of the i-f 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 fixed i-f amplifier stages normally are not high enough to start limiting action there. Thus, limiting action is confined to the limiter stage V–8 and its designation as such is derived from this fact.

(4) When the receiver is in stand-by condition and no signal is being received, the noise voltages in the antenna and the internal noises inherent in the r-f 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 the limiter V–8 to cause limiting action, with grid current rectification to take place. Grid current rectification causes a reduction in the gain of that stage. Normally, under no-signal conditions that stage operates at reduced gain.

(5) When very strong signals are received, the signal voltage across V–7 is increased to the point where grid current rectification and a consequent reduction in the gain of that stage takes place.

(6) The following is a summary of the limiting action described above. The limiter stage V–8 eliminates any amplitude variations in the incoming signal of normal strength. Such amplitude variations represent noises and are undesirable. In addition, it is necessary for the proper functioning of the discriminator circuit that the signal applied to it be approximately uniform in level regardless of the strength of the incoming signal. Grid current flowing through R–27 in the grid circuit of that tube biases the tube and reduces the gain of the stage. Thus, the receiver normally operates at reduced gain due to limiting action which takes place in V–8. The net result is that the output voltage of V–8 is kept fairly constant.

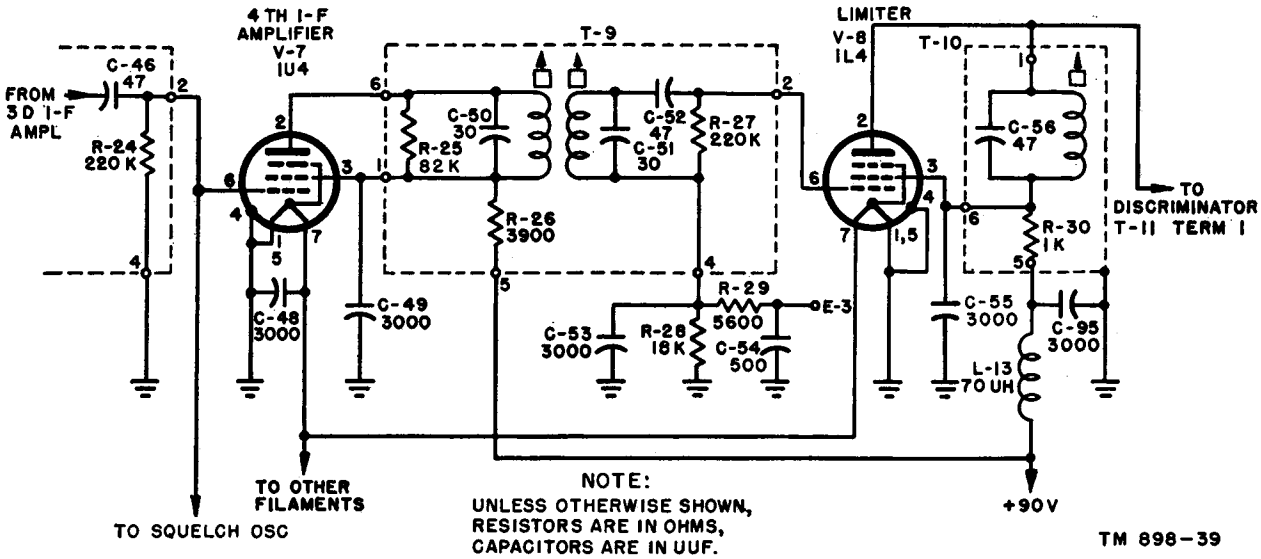


Figure 14. Fourth i-f amplifier and limiter circuits, functional diagram.

24. Discriminator Circuit V–9 and the Diode Section of V–10

(figs. 15 and 16)

a. Discriminator Function. Figure 15 is a functional diagram of the discriminator circuit used in Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC. The discriminator functions to convert frequency variations of the incoming signal into audio frequencies for application to the a-f amplifier stages. 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 variations of the voltage at the output of the discriminator change. Since the change of the signal frequency from 4.3 mc is at an a-f rate, the change in amplitude of the output voltage from the discriminator is at the same a-f rate.

b. Circuit Arrangement. The discriminator circuit includes the tuned circuit in tuning assembly T–11, diode tube V–9 type 1A3, the diode section of a type 1S5 diode-pentode tube V–10, and the output load resistors (R–31 and R–32), capacitors, and a d-c return path for the diodes established by choke coil L–14. The circuit shown in figure 15 differs from a conventional Foster-Seely discriminator in that there is no inductive coupling between the limiter V–8, plate load impedance (T–10), and the discriminator tank circuit (T–11).

(1) The tuned portion of the discriminator circuit in T–11 consists of a center tapped coil, shunted by two capacitors, C–57 and C–58. The inductance of one half of the coil is equal to the inductance of the other half. The combined values of C–57 and C–58 tune the total inductance provided by the coil to resonance at a frequency slightly above 4.3 mc. Capacitors C–57 and C–58 have the additional functions of maintaining the discriminator balance for signal frequencies and of blocking d-c plate current from V–8 from flowing through the discriminator tank coils. Variable capacitor C–67 is associated with the tank circuit for the purpose described in *c* below.

(2) The output of limiter stage V–8 is impedance coupled to the electrical center of the discriminator tank circuit by a direct connection from the plate (pin 2) of V–8 to the center tap between C–57 and C–58. Electrically, the junction of the two capacitors (terminal 1 of T–11) is equivalent to the electrical center of the tuning inductance in T–11. There is no inductive coupling between the plate load impedance (coil and C–56 in T–10) of the limiter stage and the tuned circuit of the discriminator, since the two coils are in separate cans and are magnetically independent of each other.

(3) The discriminator rectifier circuit consists of diodes V–9 and V–10 and rectifier load resistors R–31 and R–32. The d-c return path from the cathode load resistors to the plates is established through choke coil L–14. The high impedance of this coil at intermediate frequencies prevents h-f currents from flowing through it. It represents an effective short circuit for dc and audio frequencies. H-f currents are bypassed to ground around the load resistors by capacitors C–59 and C–60. Bypass capacitor C–68 places the filament (pin 7) of V–10 at ground potential for these frequencies.

c. Discriminator Operation. The operation of the discriminator depends on two facts: the arrangement and impedance configuration of the tank circuit, and the arrangement of the discriminator rectifier load resistors as described above. The impedance configuration of the tank circuit is such that the voltages applied to the two diodes are equal when a center (4.3 mc) frequency is applied to the junction of C–57 and C–58. The larger voltage is applied to V–9 when the intermediate frequency is above 4.3 mc. The larger voltage is applied to V–10 (diode section) when the applied i-f signal is below 4.3 mc. The manner in which this is accomplished is described below.

(1) The discriminator tank circuit (C–57, C–58, and the coil in T–11) is actually tuned to resonance at a frequency above 4.3 mc, namely, 4.35 mc. The capacitive reactance provided by variable capacitor C–67 is adjusted to series resonance with the inductive reactance between terminals 1 and 5 of T–11 of the tank circuit at 4.25 mc. The voltages applied to the two diodes at 4.3 mc are equal in magnitude, and the rectified currents in the load resistors are equal in magnitude and opposite in polarity. The net voltage at the output of the discriminator, taken between pin 3 of V–9 and ground, is zero.

(2) As the input frequency from the limiter shifts above 4.3 mc and approaches the resonant frequency of the tank circuit, 4.35 mc, the voltage at the plate of diode V–9 is increased to approximately twice the input from the limiter. The resultant voltage drop across R–31 is larger than that across R–32 and the net voltage at the output of the discriminator is positive at pin 3 of V–9.

(3) As the input frequency from the limiter shifts below 4.3 mc and approaches the series resonant frequency (C–67 in series with the inductive reactance of T–11), 4.25 mc, the voltage at the plate of V–10 is increased. The resultant voltage drop across R–32 is larger than that across R–31 and the net voltage at the output of the discriminator is negative at pin of V–9.

(4) At the center frequency of 4.3 mc halfway between the two ranges (4.35 and 4.25 mc), the voltage applied to V–9 is equal to that applied to V–10. The resultant voltages across R–31 and R–32 are equal and opposite in polarity, and the net output voltage of the discriminator is zero.

(5) The vector diagrams and the discriminator characteristic curve of figure 16 illustrate the principles discussed above. Vector diagram A illustrates the voltage relationships for a 4.3-mc signal applied to the discriminator. Vector OA is the voltage applied to the junction of C–57 and C–58 from the limiter tube. OB and OC are the voltages applied to the rectifier diode plates (V–9 and V–10, respectively). The d-c voltages across rectifier load resistors R–31 and R–32 are proportional to OD and OE, respectively. The vector relationships of the voltages for frequencies above and below resonance are shown in diagrams B and C, respectively, of figure 16. A typical response characteristic, representing the change in discriminator output voltage with changes in frequency of the incoming signal, is shown in diagram D of figure 16.

(6) Since, for a modulated signal, the frequency shift above and below the 4.3-mc frequency occurs at an a-f rate, the changes in voltage across rectifier load resistors R–31 and R–32 occur at the same a-f rate. The resulting alternating voltage developed across the discriminator output (taken between terminal 3 of V–9 and ground) and delivered to the audio amplifiers through isolating choke coil

L–15, low-pass filter network R–36 and C–81, and coupling capacitor C–63 represents the a-f modulation originally transmitted from the distant transmitter.

d. Discriminator Characteristics. An important point to be noted about the discriminator is that for proper operation the circuit must be balanced for both signal voltage and for d-c currents. In addition, the resonance relationships, outlined in *c* above, must be maintained. Signal balance is obtained by adjusting the coil in T–11 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 and 4.35 mc. During alinement procedure, this is accomplished by adjusting the iron dust core of T–11 until a zero-volt reading is obtained between test point E–5 and 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 the variable capacitor, C–67. 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. Thus, if the resonant peaks do not occur 50 kc from the zero-volt center setting of the discriminator, an adjustment of C–67 can be made which will shift these peaks relative to the zero setting. For a properly adjusted and operating discriminator circuit, the voltage measured at test point E–5, when a 4.3-mc signal of 2 volts is applied to the grid of V–8, is zero ±.5 volt. For a signal which is either 30 kc above or 30 kc below the 4.3-mc center frequency, the voltage measured between test point E–5 and chassis should be +15 volts minimum at 30 kc above 4.3 mc, and −15 volts minimum at 30 kc below 4.3 mc. The two voltages thus measured also should be numerically equal to each other within 5.0 volts. Failure to obtain the zero ±.5-volt reading 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 5.0 volts of each other, then the discriminator is *off* balance. Normally, when a fixed component of the discriminator, for example, the balanced capacitors C–57 and C–58 or the balanced resistors R–31 and R–32, is defective, balance in the discriminator suffers. Unbalance which is not caused by a defective component normally may be restored by adjusting the powdered iron core of T–11 and by adjustment of C–67, as described above. If the bandwidth is correct but the center frequency is *off*, adjustment of the coil is in order. If the bandwidth is incorrect, adjustment of C–67 is in order. This

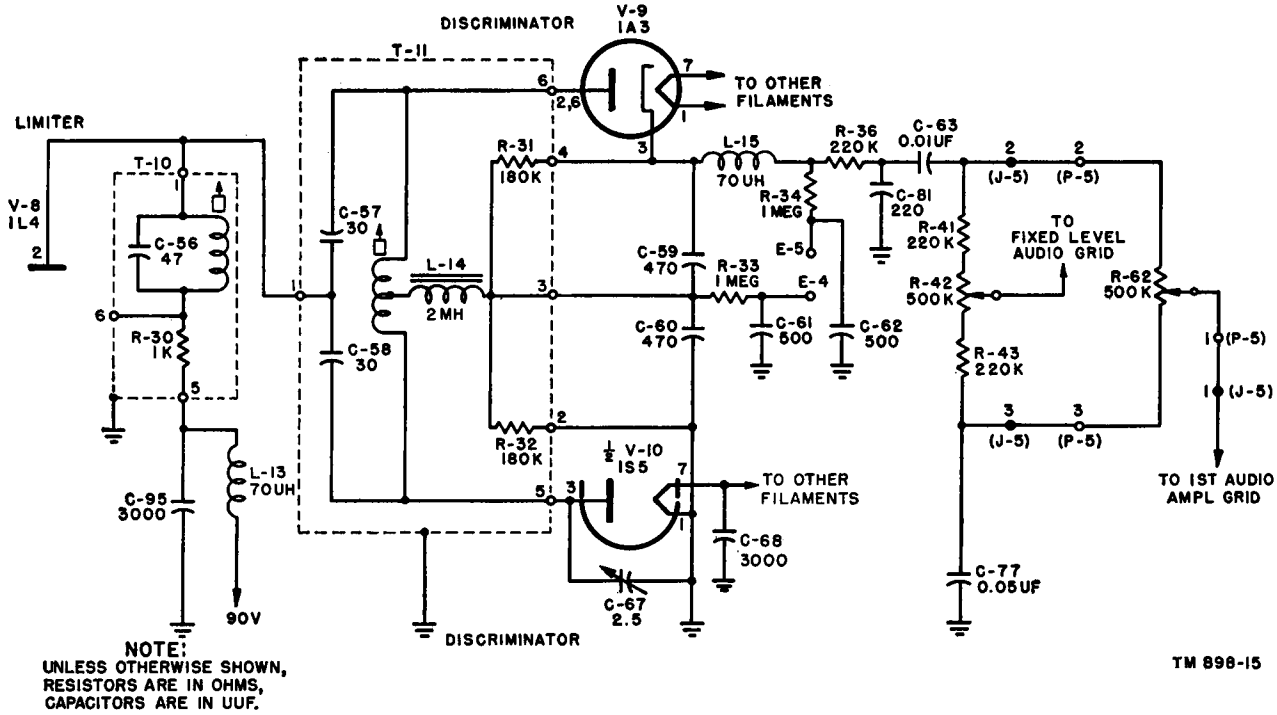


Figure 15. Discriminator circuit, functional diagram.

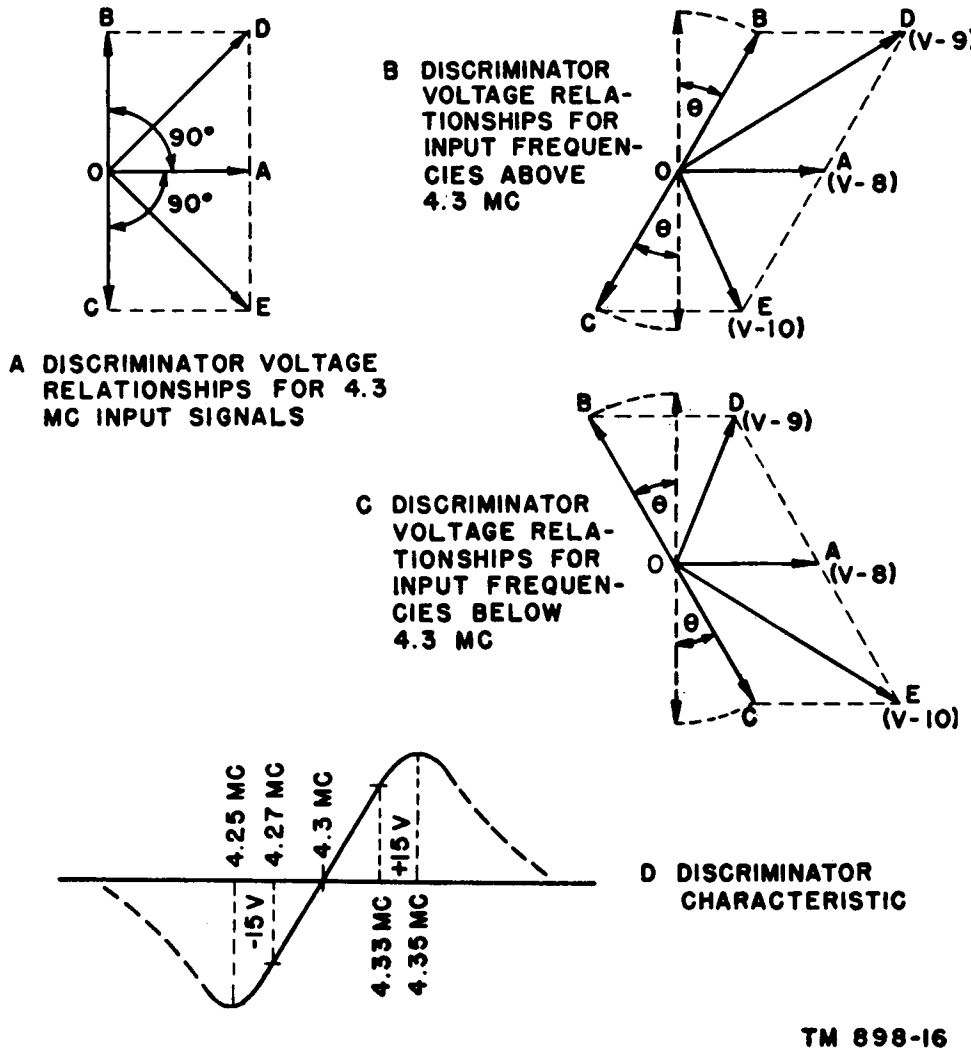


Figure 16. Discriminator operation, vector diagram.

assumes of course that the preceding stages of the receiver are properly alined and the oscillator is *on* frequency. A point to be noted is that the adjustments of the coil in T–11 and of C–67 are not entirely independent of each other. Adjustment of one may require readjustment of the other.

e. Discriminator Output Circuit. The output of the discriminator is coupled through isolating choke coil L–15, isolating and filter resistor R–36, and coupling capacitor C–63 to the grid circuits of V–13 and V–12. The low-pass filter composed of R–36 and C–81 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 preemphasis imparted to the signal by the distant transmitter.

f. Discriminator Measuring Circuits. Two measuring points are provided for determining discriminator operation and discriminator alinement. These are test points E–4 and E–5. Test point E–4 is connected through isolating resistor R–33 to the discriminator center at the junctions of C–59 with C–60 and R–31 with R–32. A meter connected between that test point and chassis effectively measures the voltage across one half of the discriminator and thus indicates limiter plate tuning. The voltage, measured between test points E–5 and the chassis, serves to determine the over-all discriminator output voltage and thus may serve as a measure of discriminator alinement. Each of the two test points, E–4 and E–5, is connected to the discriminator through an isolating resistor (R–33 and R–34, respectively) and

is bypassed to ground for a-c frequencies by a capacitor (C–61 and C–62, respectively).

g. Tuning Oscillator Input. When the tuning oscillator (part of V–10) is turned on by means of panel switch S–3, a portion of its output is applied by capacitive coupling inside the tube to the diode portion of V–10. This 4.3-mc signal is then rectified by the discriminator rectifier circuits. This signal is made to beat with another signal entering the discriminator through the limiter, V–8. The resultant audio voltage output is used in the alinement of the receiver tuned circuits. For a detailed description of the tuning oscillator and the use of that oscillator in receiver alinement and testing, refer to paragraphs 29 and 30.

25. First Audio Amplifier V–13
(fig. 17)

a. The first audio amplifier stage uses a type 3Q4 pentode tube V–13 in Class A audio amplifier circuit with transformer output. The output of the discriminator is brought to the grid (pin 3) of V–13 through low-pass filter R–36 and C–81 (fig. 15), through coupling capacitor C–63 (fig. 17) and VOLUME control R–62 and pins 1 of chassis connectors P–5 and J–5. Low-pass filters R–36 and C–81 serve to block h-f noises from the input of the amplifier. The VOLUME control, located on the front panel, is connected into the circuit through pins 2, 3, and 1 of chassis connectors P–5 and J–5.

b. The grid circuit includes a series arrangement of the VOLUME control, R–62, squelch voltage-dropping resistor R–40 and squelch diode load resistor R–39. The bias applied to the amplifier is provided by the voltage developed across R–39 because of the output of the diode in the squelch oscillator circuit. This latter bias voltage drives the grid into the cut-off region. The operation of the squelch circuit is described in paragraph 28.

c. The amplified output is coupled through transformer T–13 over two paths. The signal voltage developed across winding 7–8–9 is applied through pins 10 of J–5 and P–5 to terminals A of AUDIO connector J–7 for use with a headset or the earpiece of a handset and to terminal E of REC CONTROL connector J–8. The signal voltage developed across winding 4–5–6 of T–13 is applied in push-pull to the grid circuit of the audio power amplifier, V–14.

d. Plate and screen voltages for V–13 are obtained through terminals 11 of J–5 and P–5 which connect the plate and screen circuit of V–13 to terminal H of connector J–8. When an external connection is placed between terminals H and J of J–8, plate and screen voltages are applied to V–13. The connection between terminals H and J of J–8 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. Also note that if the coil of a relay is connected between these terminals, the relay will be energized when V–13 draws plate current and will be de-energized when V–13 plate current is cut off. The relay coil should not exceed 1,000 ohms resistance and should be shunted by a suitable capacitor. When the receiver is in stand-by 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 V–13 plate current begins to flow, the external relay will become energized. This arrangement is used when the receiver is used with accessory equipment requiring such control.

e. Capacitor C–82, in series with R–67, shunts the primary winding terminals 1–2–3 of T–13 to deemphasize the h-f end of the audio band and to reduce the noise voltages which may be present at that end of the band. Capacitor C–77, in the grid circuit, bypasses squelch bias resistors R–40 and R–39 for audio signals.

26. Audio Power Amplifier V–14
(fig. 17)

a. The audio power amplifier stage, V–14, 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 interstage transformer T–13 is applied in push-pull to the grid (pins 3 and 5) of V–14. The amplified signals, developed across the center tapped primary winding of output transformer T–14, are induced in the secondary winding, terminals 4, 5, and 6, of T–14, and are routed through terminals 9 of J–5 and P–5 to terminal L of AUDIO connector J–7 and to terminals A and F of the REC CONTROL connector J–8 for connection to a loudspeaker.

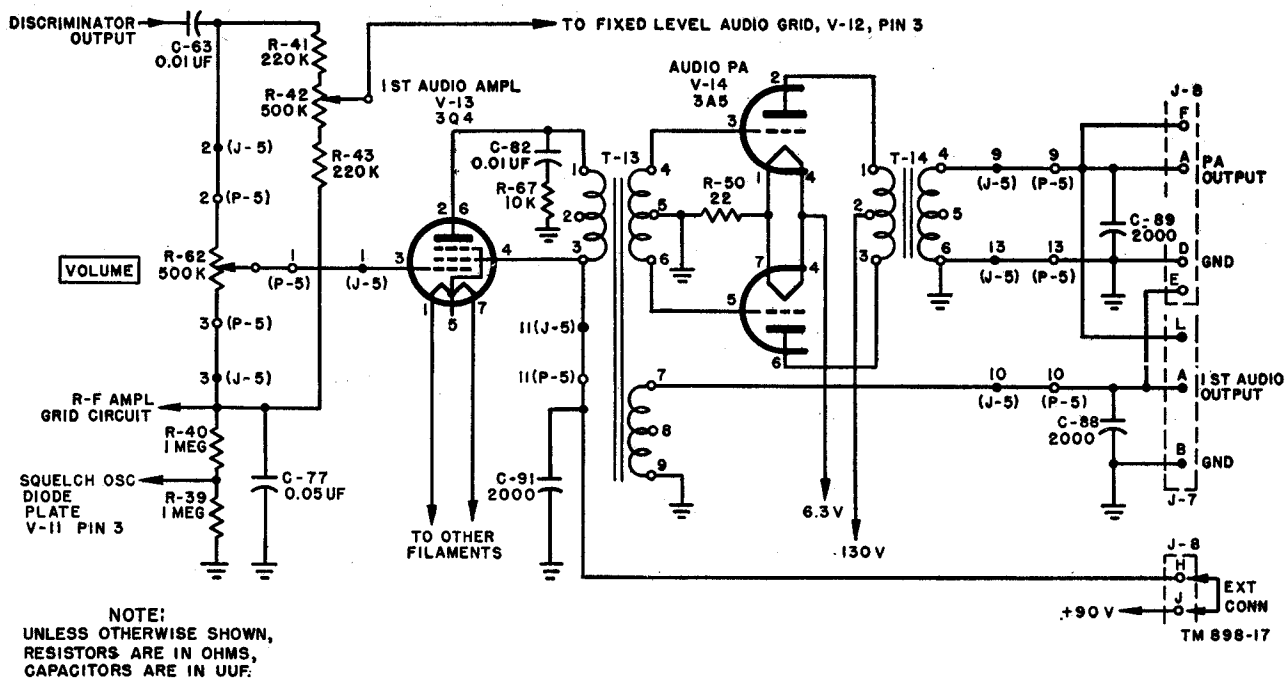


Figure 17. First audio amplifier and audio power amplifier circuits, functional diagram.

b. Plate voltage for V–14 is applied to the center tap (terminal 2) of T–14 from the 130-volt supply point of the receiver power supply circuit. Plate supply details are shown in figures 21 and 23. Filament voltage is reduced to the required value by voltage dropping resistor R–50.

27. Fixed Level Audio Amplifier V–12
(fig. 18)

a. The fixed level audio amplifier, V–12, 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 R–36 and C–81 (fig. 15) and through coupling capacitor C–63 (fig. 18) to level adjustment control R–42, the movable arm of which is connected to the grid (pin 3) of V–12. This control is an internal adjustment. It is factory adjusted and should not be touched unless the output of V–12 does not meet the requirements of paragraph 5. The grid circuit of V–12 includes potentiometer R–42, in series with resistors R–41, R–43 and squelch diode resistors R–40 and R–39. R–39 also acts as the load resistor for the squelch diode rectifier in the squelch oscillator circuit (par. 28). Under no-signal conditions the rectifier diode of V–11 applies a voltage across R–39, the magnitude and polarity of which are such as to cut off plate current in the fixed level audio amplifier V–12. This cut-off 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 28 for squelch circuit details. The grid is returned to ground for signal frequencies through level control R–42, voltage-dropping resistor R–43, and bypass capacitor C–77.

b. Plate and screen potentials for V–12 are obtained from the 90-volt receiver supply circuit through a filter composed of resistor R–45 and section A of a triple section electrolytic plug-in capacitor C–80. The output of V–12 is applied through primary plate winding 1–2–3 to winding 7–8–9 of T–12 by inductive coupling and through terminals 8 of chassis connectors J–5 and P–5 to terminal B of J–8. Capacitor C–93 acts as a h-f filter.

28. Squelch Circuit V–11
(fig. 19)

a. The carrier-operated squelch circuit uses a tube type 1S5, V–11. 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 cut off and reduce the

gain of the r-f amplifier stage during no-signal conditions of the receiver and to remove the bias from these circuits when an on frequency signal enters the receiver. Details of operation of the squelch circuit are described in the following paragraphs.

b. The oscillator circuit includes grid winding L–20A (terminals 3 and 4) shunted by damping resistor R–74 (180K), and plate winding L–20B (terminals 1 and 2) of coil assembly L–20. When operative, the oscillator generates a frequency in the region of 30 kc. To sustain oscillations, regenerative feedback is provided partially through coupling between the plate winding L–20B and the grid winding L–20A, partially through coupling capacitor C–96 (5 uuf), and partially through the capacity in the wiring. No capacitor is shown connected across either of the two windings, since tuning is accomplished by the interelectrode capacitance of the tube and the stray capacitance in the wiring. The grid circuit of the oscillator is connected through L–20A and R–68 to the grid (pin 6) of the fourth i-f amplifier stage V–7, and through R–69 to ground. Since R–24, in the grid circuit of V–7, is in parallel with R–68 and R–69 connected in series, any d-c voltage developed across R–24 also is applied across R–68 and R–69 in series. The portion of the d-c voltage developed across R–69 is then applied as grid bias for V–11. This sets the operating point for this tube, and determines whether or not the oscillator is operative. When no signal is present in the receiver, the noise voltages appearing at the input to V–7 are high enough to cause grid current (dc) to flow through R–24. Part of the d-c voltage developed across this resistor is applied across R–69 as negative bias for V–11. This bias voltage is small enough to permit oscillation. A-c voltages are bypassed to ground through capacitor C–78. When a signal enters the receiver, the grid current flow in V–7 increases and the voltage drop across R–24 increases proportionately. The increased negative bias voltage across R–69 is now large enough to bias the oscillator to cut-off, and oscillations cease.

c. The output of the oscillator is coupled through capacitor C–76 to the plate (pin 3) of the diode section of V–11. When the oscillator is operative its output is rectified by the diode circuit. The rectified voltage is developed across diode load resistor R–39. R–39 is shunted by a voltage divider network consisting of the series arrangement of R–40, R–70, and R–1. This voltage divider is tapped at the junction of R–70 and R–1 for connection through the grid coil in T–1 to the grid (pin 1) of r-f amplifier stage V–1. Another tap on the voltage divider (at the junction of R–40 and R–70) is connected through VOLUME control R–62 to the grid of the first audio amplifier stage, V–13, and through grid resistor R–43, and fixed level audio control R–42 to the grid of the fixed level audio amplifier stage

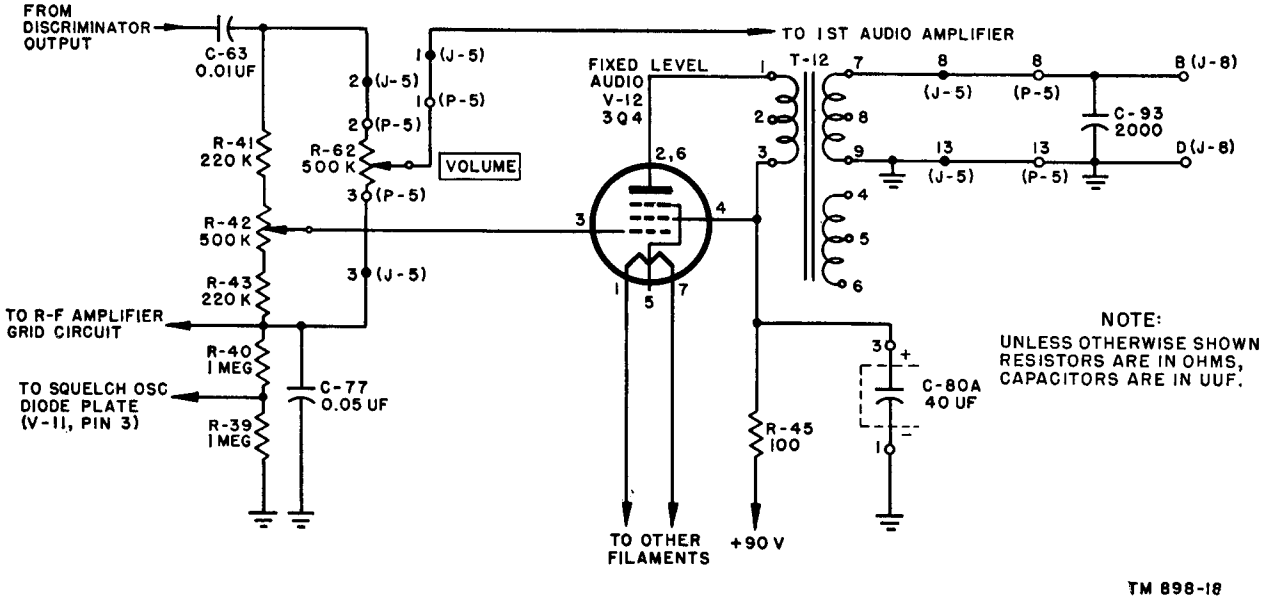


Figure 18. Fixed level audio amplifier circuit, functional diagram.

V–12. The squelch bias voltage applied to the grids of V–12 and V–13, therefore, is that portion of the diode output voltage which is across the series arrangement of R–70 and R–1. Similarly, the squelch bias voltage applied to the grid of V–1 is that portion of the diode output voltage which is across R–1. The values of the voltage divider resistors (R–70 and R–1) are chosen so that squelch bias voltage applied to V–1 will vary a desired amount when the front panel SQUELCH control is varied. Note that the squelch bias voltages applied to the grid of these three tubes are direct current since h-f ripple voltages are filtered out by capacitor C–77 in the audio circuits and C–2 in the r-f circuit. Another point to be noted is that the magnitude of the voltage developed across diode load resistor R–39 and, therefore, the magnitudes of squelch bias voltages applied to V–1, V–12, and V–13 are proportional to the amplitude of the squelch oscillator output. The manner in which the amplitude of the oscillator output is controlled is described in paragraph *e* below.

d. Plate voltage for the oscillator section of V–11 is applied from the 90-volt supply circuit through voltage-dropping resistor R–45, which is bypassed by capacitor C–80A, and through coil L–20B (terminals 1 and 2) of the oscillator coil assembly L–20. Capacitor C–80 also acts as a plate supply filter capacitor. Screen voltage is obtained from the 90-volt supply circuit through voltage-dropping resistor R–47, which is bypassed by section B of electrolytic capacitor C–80, switch S–4, and potentiometer R–65. The screen circuit is bypassed by capacitor C–75. Potentiometer R–65 is the SQUELCH potentiometer mounted on the front panel. This potentiometer and switch S–4 are coupled mechanically so that when R–65 is in the extreme counterclockwise (OFF) position, the switch is opened and disconnects screen voltage from V–11; thereby disabling the squelch circuit. R–66, in series with R–65, functions to apply screen voltage to V–11 as soon as the SQUELCH control is turned on. The level of the signal generated by V–11 is determined by two factors. One is the setting of R–65; when this potentiometer is in its maximum clockwise position, the full 90 volts is supplied to the screen. The amplitude of the oscillator then is high and the squelch biasing voltage developed across R–39 is relatively large. As R–65 is rotated in the counterclockwise direction, the applied screen voltage, the level of the generated oscillator output, and the diode output voltage across R–39 are decreased accordingly. The other factor affecting the output level of the oscillator is the bias voltage applied to its grid circuit. The greater the negative bias, the lower the amplitude of the oscillator output. The magnitude of the bias voltage is a function of the gain of the receiver under the particular condition of operation. When r-f amplifier V–1 is biased toward cut-off (that is, under no-signal conditions and squelch on) the gain imparted to noise voltages is that of all the receiver stages with the gain of the r-f amplifier reduced. When the r-f amplifier is fully operative, the magnitude of the bias voltage applied to the squelch oscillator is determined by the full gain of the receiver. When a signal of threshold level enters the receiver, the fourth i-f amplifier grid current increases and a larger bias voltage is developed in the grid resistors of that stage. It is seen that the setting of the SQUELCH potentiometer, the r-f gain and the gain of the remainder of the receiver, and the squelch oscillator output level are interrelated. The lower the bias voltage developed across R–39, the lower the level of the signal required to disable the squelch circuit.

e. Under no-signal conditions, when the oscillator is operative, the squelch bias voltage applied to V–12 and V–13 (in the manner described above) is sufficient to drive these tubes to cut off and the bias voltage applied to V–1 reduces its gain. When a signal of sufficient magnitude enters the receiver, it is coupled through V–1 to the receiver mixer, V–2, reaches the grid circuit of the fourth i-f amplifier tube V–8, and biases down squelch oscillator V–11 to stop oscillations. The rectified voltage disappears from across R–39 and cut-off bias is removed from the three tubes (V–1, V–12, and V–13). These tubes are returned to normal operation as Class A amplifiers. For any setting of the SQUELCH potentiometer a certain minimum level of the signal is required to produce a bias voltage at the input of the fourth i-f amplifier large enough to disable the squelch oscillator. When the SQUELCH switch is in the OFF position, the oscillator is automatically disabled as described above and r-f amplifier V–1 and audio amplifiers V–12 and V–13 are operated at full gain.

29. Tuning Oscillator (Part of V–10)
(fig. 20)

a. The pentode portion of dual purpose tube V–10 is used as a crystal-controlled oscillator for generating a fundamental frequency of 4.3 mc and hormonics of 4.3 mc. The pentode is connected as a triode since the screen grid (pin 4) and the plate (pin 5) are connected together. The 4.3-mc crystal is connected between the control grid (pin 6) and the plate through the series-blocking capacitor C–70. The oscillator grid circuit includes grid leak resistor R–35 and grid leak capacitor C–72. Capacitor C–72, in conjunction with C–74 which is connected from plate to ground, establishes the required capacitance for the crystal circuit and provides the required voltage feedback ratio for oscillation. The plate circuit extends through coaxial connectors J–4 and P–4 and through a coaxial cable to the contacts of section A of test switch S–3. When this switch is in the TUNE position, the oscillator plate circuit is extended through coupling capacitor C–84 to the ANT connector J–3 on the front panel and through another coaxial cable and connectors P–1 and J–1 to the input circuit of the receiver r-f amplifier. The output level of the oscillator can be measured at binding post E–6 which is associated with the ANT connector, J–3. When switch S–3 is in either one of the DIAL LIGHT positions, contact A–2 or A–3 grounds the oscillator plate circuit and oscillations cease. When the oscillator is operative (S–3 is in the TUNE position), a portion of the oscillator output is fed by internal capacity coupling to the diode section of V–10. Harmonics of the 4.3-mc crystal oscillator are picked up in the antenna circuit of the receiver, are fed through the receiver circuits, and are mixed in receiver mixer V–2 with the output of the receiver variable oscillator, V–3. 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 capacity-coupled to the diode of V–10 are mixed and produce a beat note. This beat note may be used for calibration purposes.

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

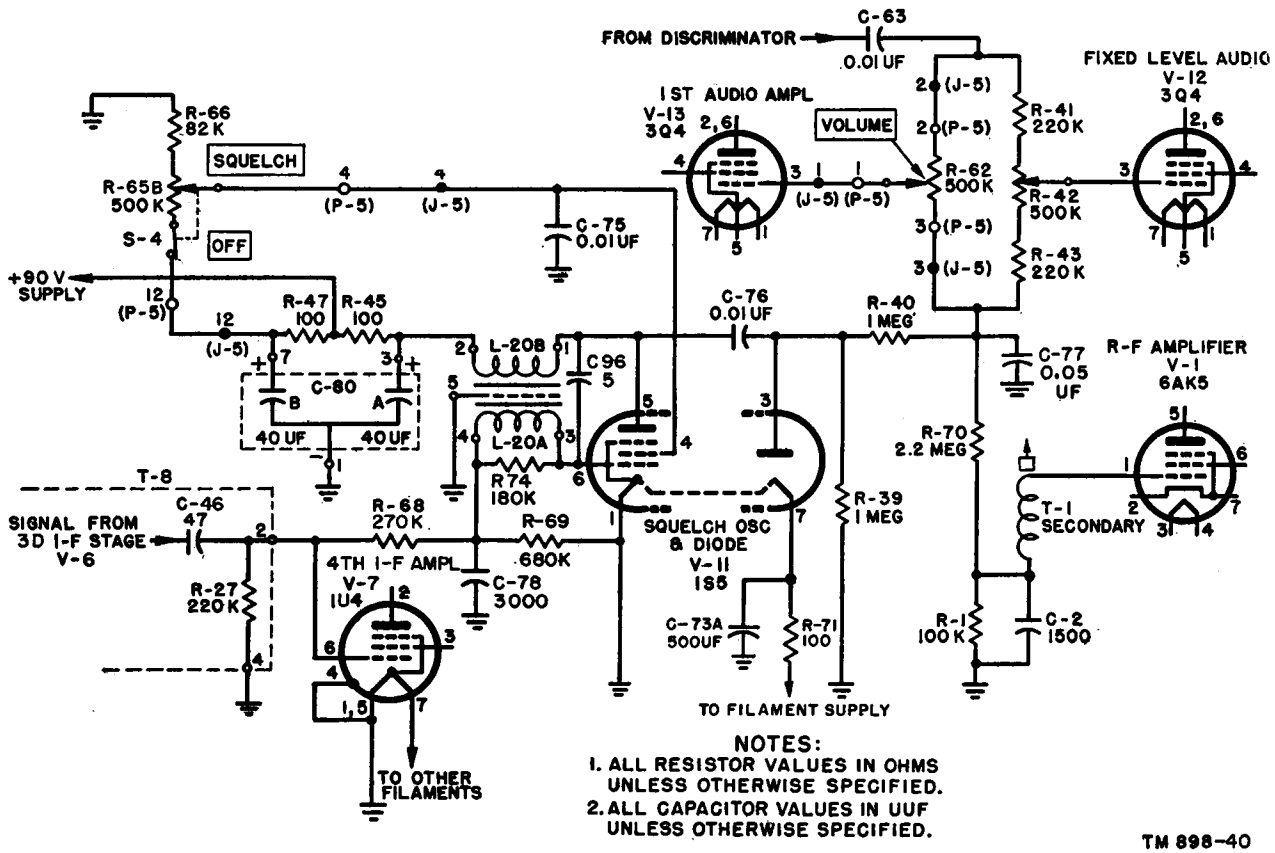


Figure 19. Squelch circuit, functional diagram.

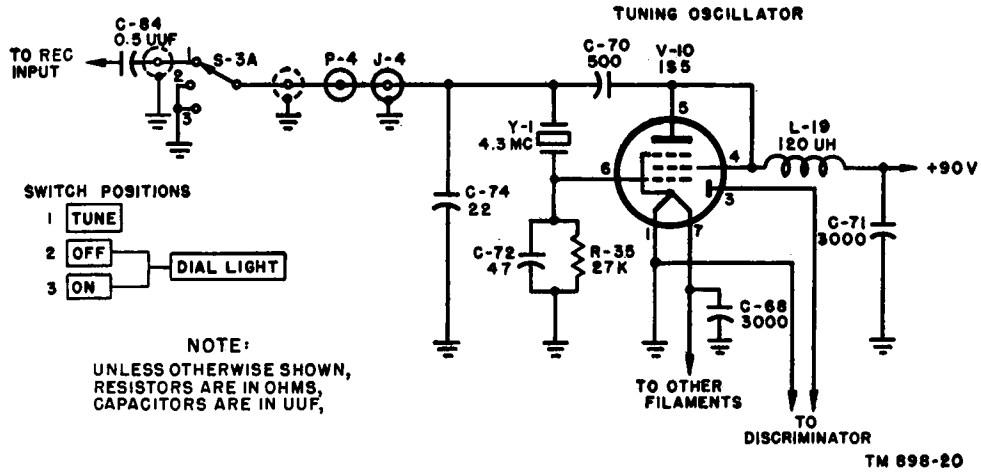


Figure 20. Tuning oscillator circuit, functional diagram.

Radio receiver	Calibrate 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.

c. Plate voltage for the operation of the crystal oscillator is shunt-fed from the 90-volt internal supply circuits through a three-section r-f filter network (fig. 35) consisting of isolating coils L–19, L–18, and L–12 and bypass capacitors C–71, C–69, and C–90.

30. Tests and Adjustments With Tuning Oscillator

a. When switch S–3 is in the TUNE position, the tuning oscillator feeds its signal over two paths. One path is by coupling capacitor C–84 to the input of the receiver; the other path is by capacitive coupling through the electrodes of tube V–10 to the diode portion of that tube. When the receiver circuits are tuned by means of the dial on the front panel to a frequency which is a multiple of 4.3 mc and if the calibration of the tuning dial is correct, the r-f circuits of the receiver pick out the proper harmonic of 4.3 mc generated by the tuning oscillator. For example, if the receiver is tuned to 21.5 mc the fifth harmonic of the output of the tuning oscillator is selected.

(1) This signal is amplified in the first r-f amplifier stage V–1 and is applied together with the output of the variable oscillator, V–3, to the input of the mixer stage, V–2. If, as required, the frequency generated by V–3 is 4.3 mc above the frequency setting of the dial, the frequency at the output of the mixer stage is 4.3 mc. If oscillator V–3 is not 4.3 mc above the dial reading, the output of the mixer stage is not 4.3 mc but some other frequency, depending on the amount by which the variable oscillator is off frequency. In the case exemplified here, the frequency generated by V–3 should be 25.8 mc.

(2) Assuming this to be the case, the 25.8-mc signal from V–3 and the 21.5-mc signal from the tuning oscillator beat in the mixer stage to produce the intermediate frequency of 4.3 mc. The 4.3-mc signal is then amplified in the i-f amplifier and limiter circuits and appears as a voltage across the input to the discriminator rectifier circuits. When this i-f frequency is 4.3 mc it beats with the 4.3 mc applied to the discriminator by internal coupling and the resultant voltage across the discriminator output is close to 0 cps. For the purposes under consideration here, the discriminator rectifier circuit serves as a nonlinear mixing device causing sum and difference frequencies to be produced.

(3) By mixing the incoming r-f signal frequency and the internally coupled frequency, a sum frequency of 8.6 mc is produced. This is rejected by the receiver audio circuits. The difference frequency is in the a-f range and is consequently picked up by the receiver audio amplifier circuits for application to the headset or to a test meter. The presence

of the audio signal in the headset can be taken as an indication that the frequency relationships outlined above exist.

b. The tuning oscillator may be used for checking the calibration of the tuning dial. Calibration check points are provided on the dial. These check points, identified by red dots, are the 4.3-mc harmonic frequencies of the tuning oscillator. Dial calibration check is accomplished by comparing the position of the dial at which the beat note actually occurs with relation to the red dot. Normally, the dial calibration error of one-half a scale division is permissible. If the hairline on the dial is more than one-half division away from the red dot, then the calibration error is excessive and dial calibration correction is necessary. By using an external source of test signal frequencies spaced at 1-mc intervals, the calibration error of the dial may be checked at every mc point on the dial. Again, a calibration error in excess of one-half scale division calls for dial recalibration. The red dot calibration points are useful primarily for spot checking the dial calibration. The dial may be found to have a uniform error, that is, all calibration points readings are equally high or equally low. Adjustment of this type of difficulty is accomplished by means of the screw marked DIAL, accessible by lifting the diamond-shaped cover plate on the panel. Nonuniform dial calibration errors, caused by poor tracking of the variable gang capacitor, can be corrected by adjusting the cam adjusting screws on the face of the dial. The cam adjusting screws are accessible through the hole in the panel, bared when the left-hand mounting post of the diamond-shaped cover is removed and the cover lifted.

31. Plate and Screen Supply Circuits
(figs. 21 and 23)

a. The plate and screen supply circuit extends from pin 8 of J–2, the output terminal of the vibrator power supply unit (fig. 23), and is routed through voltage-dropping resistor R–54 and section B of switch S–1 over several paths to the plates and screens of tubes in the receiver. One path extends directly to the plates of audio output tube V–14. Another path extends through voltage-dropping resistor R–57 and ripple filter circuits R–60 and C–80C to several branch paths as shown in figure 21. Voltage regulator tube V–15 (par. 33), connected between the junction of R–57 and R–60 to ground, serves to insure that a uniform voltage is applied to the plates and screens of the tubes associated with these branch paths in spite of changes in load conditions or battery input voltage.

b. One branch path (fig. 21) includes all the r-f, i-f, and discriminator circuit tubes (V–1 through V–8 and V–10). This branch includes r-f filter networks consisting of choke coils L–6, L–10, L–12, L–13, L–18, and L–19 and the associated bypass capacitors. The purpose of this arrangement is to prevent interaction between the h-f stages through the power supply circuits. Another branch path extends through filter resistor R–45 to the plate and screen of fixed level audio amplifier V–12 and to the plate of squelch oscillator tube V–11. Still another branch extends through filter resistor R–47 and through SQUELCH potentiometer R–65 to the screen of V–11 and through terminals J and H (when strapped) of panel connector J–8 to the plate and screen of first audio amplifier stage V–13. The screen supply circuit for squelch tube V–11 includes SQUELCH potentiometer R–65 and the SQUELCH ON-OFF switch S–4 and voltage-dropping resistor R–66. When the SQUELCH control is in the extreme counterclockwise position, switch S–4, which is mechanically ganged with the shaft of the control potentiometer, is opened and no screen voltage is applied to V–11. If the SQUELCH potentiometer is rotated in a clockwise direction, increasingly larger screen voltage is applied to that tube. A point to be noted is that the plate and screen voltages for V–13 are obtained, not by direct connection to the plate supply circuit, but by external connection between terminals H and J of J–8. The manner in which this external connection is made depends upon the particular system arrangement. In some arrangements, this connection is simply a strap between the two terminals. In arrangements involving the retransmission of signals from the audio output circuits of the receiver to the audio input circuits of a transmitter, a relay coil is connected between these two terminals so that the entrance of a signal into the receiver causes the relay to be energized to complete the retransmission circuits. It should be noted that since under normal operation and with no signal entering the receiver the squelch circuit keeps the audio stages in the cut-off condition, no plate current flows in V–13 and, therefore, the relay is normally unenergized. The moment a signal enters the receiver, the squelch circuit is

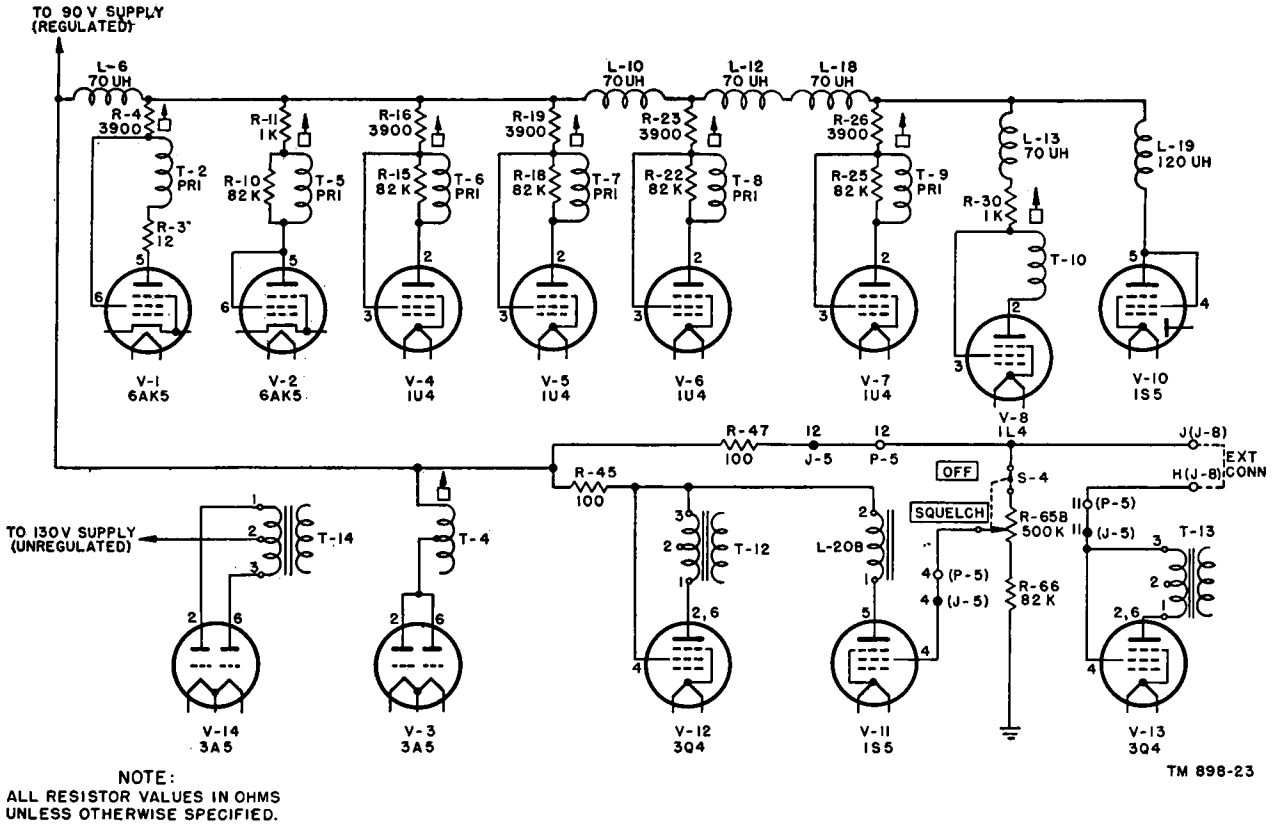


Figure 21. Plate and screen circuits, functional diagram.

opened, V–13 is energized, and current flows through the external relay coil and causes it to become energized.

32. Filament Circuits
(fig. 22)

The filament circuits of all tubes except V–14 extend through the overvoltage relay circuit to terminal 5 of overvoltage relay K–1 (fig. 23). The filament circuit of V–14 extends from terminal 1 of J–2 or pin A of J–6, (when external supply is used) through section A of switch S–1, directly to the filaments of V–14 and through voltage-dropping resistor R–22 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 22. The 6-volt tubes, V–1 and V–2, each represent one string. Isolating chokes and filter capacitors are used throughout to prevent a-c currents in one stage from entering tubes in the same or associated strings by the filament circuits. This is particularly true of h-f circuits. Voltage-dropping resistor R–21, in series with V–6, resistors R–13 and R–14 in series with V–4 and V–5 and resistor R–71 in series with V–11 serve to bring the total voltage rating of the associated string to 6.3 volts. Ripple filters are inserted in series with filaments of tubes requiring a high degree of stability in operation. Thus, the filter composed of voltage-dropping resistor R–71 and filter capacitor C–73A is connected in series with the filament of V–11. Similarly, the parallel arrangement of voltage-dropping resistors R–44 and R–48 and capacitor C–73C constitute a ripple filter for the filament supply of V–12 and V–13. Finally, R–38 and C–73B is a ripple filter for the supply to the receiver oscillator tube V–3. The series arrangement of R–37 and R–38 is shunted across the portions of the filament strings as shown in figure 22 to limit the current flow through these filaments to the required values.

b. The DIAL LIGHT circuit is shunted across the unregulated filament supply lead by section B of switch S–3 in either the TUNE or DIAL LIGHT ON positions. For either one of these two positions, the circuit extends from the filament supply circuit pin 1 of J–2 (or pin A of J–6 when an external supply is used) through contacts

(A1 or C3 and A1, 2, and 3) of S–1, through pins 7 of chassis connectors J–5 and P–5 over the contact of section B of switch S–3 and through voltage-dropping resistor R–63 to lamp E–14. When switch S–3 is in the DIAL LIGHT OFF position, the lamp is disconnected from the circuit. The circuit then extends through the path outlined above except that resistor R–64 is substituted for the series arrangement of R–63 and the dial lamp. Resistor R–64 represents a dummy load on the filament supply circuit equivalent to that represented by the combination of R–63 and the dial lamp, thus insuring constant drain on the filament supply under all conditions of operation. The purpose of the dial light is to illuminate 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 at the point of its connection to the receiver filament circuits proper is continuous. In operation within a system installation, the fact that the dial light goes on when S–3 is turned to either one of the two positions mentioned above may be used as an indication that the filament voltage is reaching the receiver filaments.

33. Power Supply Circuits Arranged for 24-Volt Operation
(fig. 23)

a. Battery Circuit. The 24-volt storage battery is connected between terminals B (+) and C (−) (ground) of POWER IN connector J–6. The battery circuit extends through a 4-ampere fuse, F–1, and through contacts of power switch S–2 to terminals 15 of chassis connectors P–5 and J–5. Switch S–2 is mechanically coupled to VOLUME control R–62, and is turned to the on position when the control is rotated away from its extreme counterclockwise position. The branch circuits which are supplied from this point are described in paragraphs *b* through *d* below. Capacitor C–87 is a battery decoupling filter.

b. H-V Supply Circuit. The vibrator power supply is connected between terminals 3 (+) and 7 (−) of male connector J–2. The power supply unit converts the storage battery voltage to the h-v plate and screen supply. The output voltage, approximately 135 volts, is developed across terminals 8 (+) and 7 (−) of J–2. The operation of the vibrator power supply unit is described in TM 11–5040.

(1) The voltage is applied through R–54 and over section B of switch S–1 (when in the 6, 12, and 24 VOLTS position) to the plates of V–14.

(2) The h-v supply circuit continues through R–57 and R–60 to the plates and screens of tubes V–1 through V–8 and V–10 and through R–45 to the plate and screen of V–12 and to the plate of V–11.

(3) The screen voltage for squelch tube V–11 is taken through the arm of SQUELCH potentiometer R–65, which in series with the contacts of SQUELCH switch S–4 (when closed) and voltage-dropping resistor R–66, is shunted across the h-v supply. Switch S–4 (part of the mechanical assembly of the SQUELCH control R–65 and S–4) is closed when the knob of the SQUELCH control is rotated away from its extreme counterclockwise position. When the control is in the extreme counterclockwise position, the contacts of S–4 are open, and no screen voltage is applied to V–11. The amount of voltage applied to V–11 is adjustable by varying potentiometer R–65.

(4) The h-v supply continues through voltage-dropping resistor R–47, and pins 12 of chassis connectors J–5 and P–5 to terminal J of REC CONTROL connector J–8. The 90-volt potential appearing at this terminal is used to supply the plate and screen of the first audio amplifier, V–13, when a connection is established by external means between terminals J and H of J–8. As shown in figure 21, there is no internal connection between the plate and screen of V–13 and the h-v supply circuit. Instead, these circuits are connected to terminal H of J–8. When a connection is placed between terminals H and J of J–8 the 90-volt supply is brought to the electrodes of V–13 (par. 25).

(5) Voltage regulator tube V–15, a tube type OB2, is connected from the junction of R–57 and R–60 to chassis, across the h-v supply. This tube limits the maximum output voltage of the circuit. Resistors R–57 and R–60, R–47, and R–54 are voltage-dropping and filter resistors. Sections A, B, and C of a triple section, plug-in electrolytic capacitor C–80 serve as

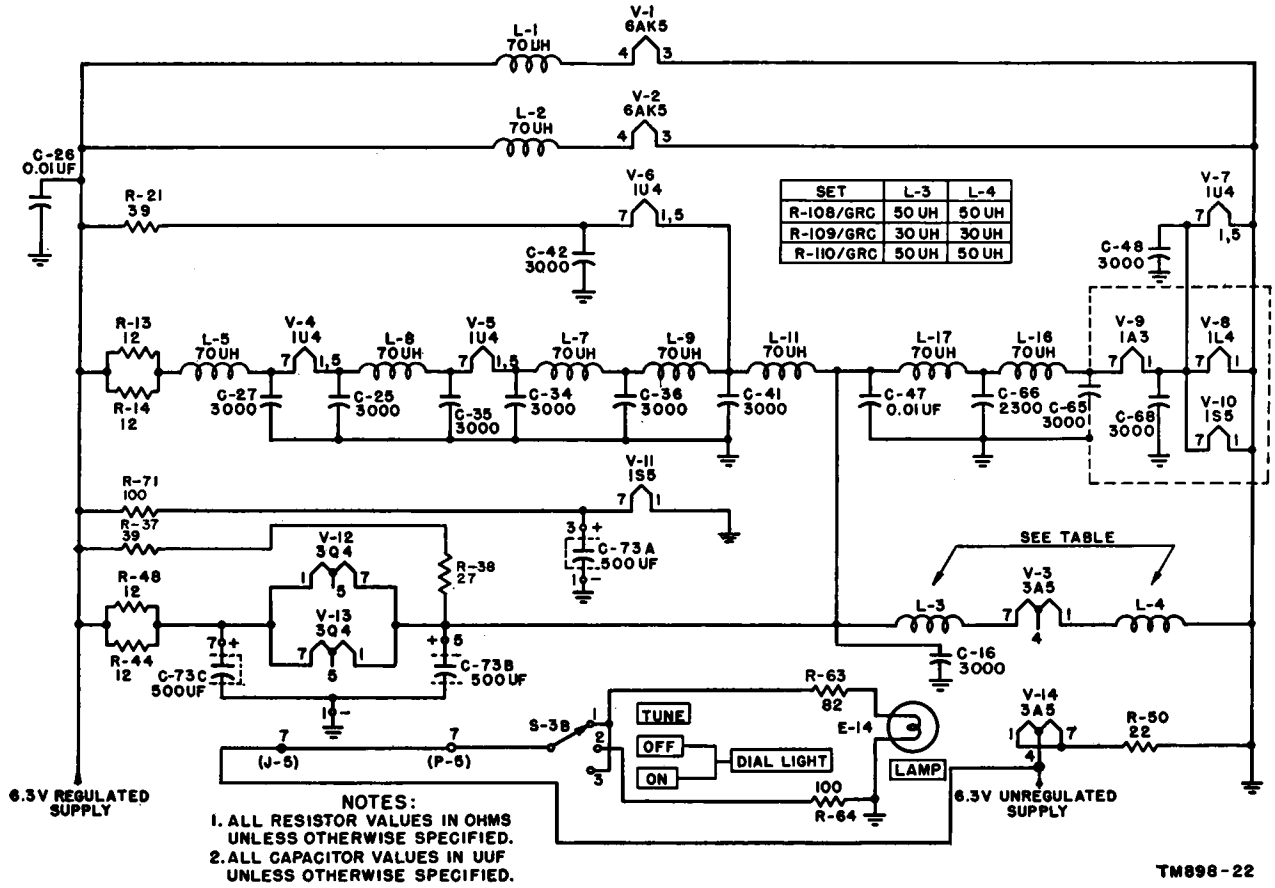


Figure 22. Filament circuits, functional diagram.

power supply ripple filters. Capacitors C–83 and C–92 are r-f filters, serving to prevent interstage coupling of the h-f circuits through the common power supply. Separate capacitors are used for r-f and ripple filtering, since the low Q (at high frequencies) of the paper capacitors makes those capacitors unsuitable for r-f filtering.

c. Filament Supply Circuits. For 24-volt operation, socket connector X–1 of Power Supply PP–282/GRC provides a strap connection between terminals 3 and 6 of J–2 in the power supply compartment of the receiver. (See dotted lines in lower left-hand corner of figure 23.) This connection arranges a group of voltage-dropping resistors (R–53, R–56, R–58, R–61 and R–72 and thermal resistor R–59) to drop the 24 volts from the storage battery to the 6 volts required by the series-parallel arrangement of the receiver filaments and dial lamp E–14.

(1) The strap connection between terminals 3 and 6 of J–2 connects the battery circuit through voltage-dropping resistors R–58, in parallel with R–73 and R–53, in parallel with R–72, section A of switch S–1 in the 6, 12, and 24 VOLTS position, the filament of tube V–14, and voltage-dropping resistor R–50 to ground. Depending on setting S–3 (par. 32) either E–14 in series with R–63 or R–64 is shunted across this unregulated filament supply lead.

(2) The strap connection between terminals 3 and 6 of J–5 also connects the battery circuit through voltage-dropping-resistor R–61, ballast tube (thermal resistor) R–59, over section C of S–1 in the 6, 12, and 24 VOLTS position, and resistor R–52, which is normally shorted by the closed contacts of thermal overvoltage relay K–1 to the series-parallel, 6-volt arrangement of receiver tubes V–1 through V–13 (par. 32). The ballast tube is essentially a variable resistor whose resistance (over its normal operating range)

depends on the voltage supplied to it. If the battery voltage decreases, the voltage applied across R–59 decreases and the resistance of R–59 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, R–59 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 R–55 and R–56 in parallel and the coil (heater element) of thermal relay K–1. The normally closed contacts 5–7 of the relay are connected across resistor R–52, and the combination is in series with the filament supply circuit. This arrangement serves to protect the filament circuit against an overvoltage condition, such as 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 R–61, R–55, and R–56, and the value and placement of R–59 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 K–1) exceeds 7.5 volts, the voltage across the heater element of K–1 increases and causes the relay to operate. Contacts 5 and 7 of K–1 open, placing resistor R–52 in series with the receiver filaments and filament supply circuit. The increased resistance in these circuits drops the filament voltage

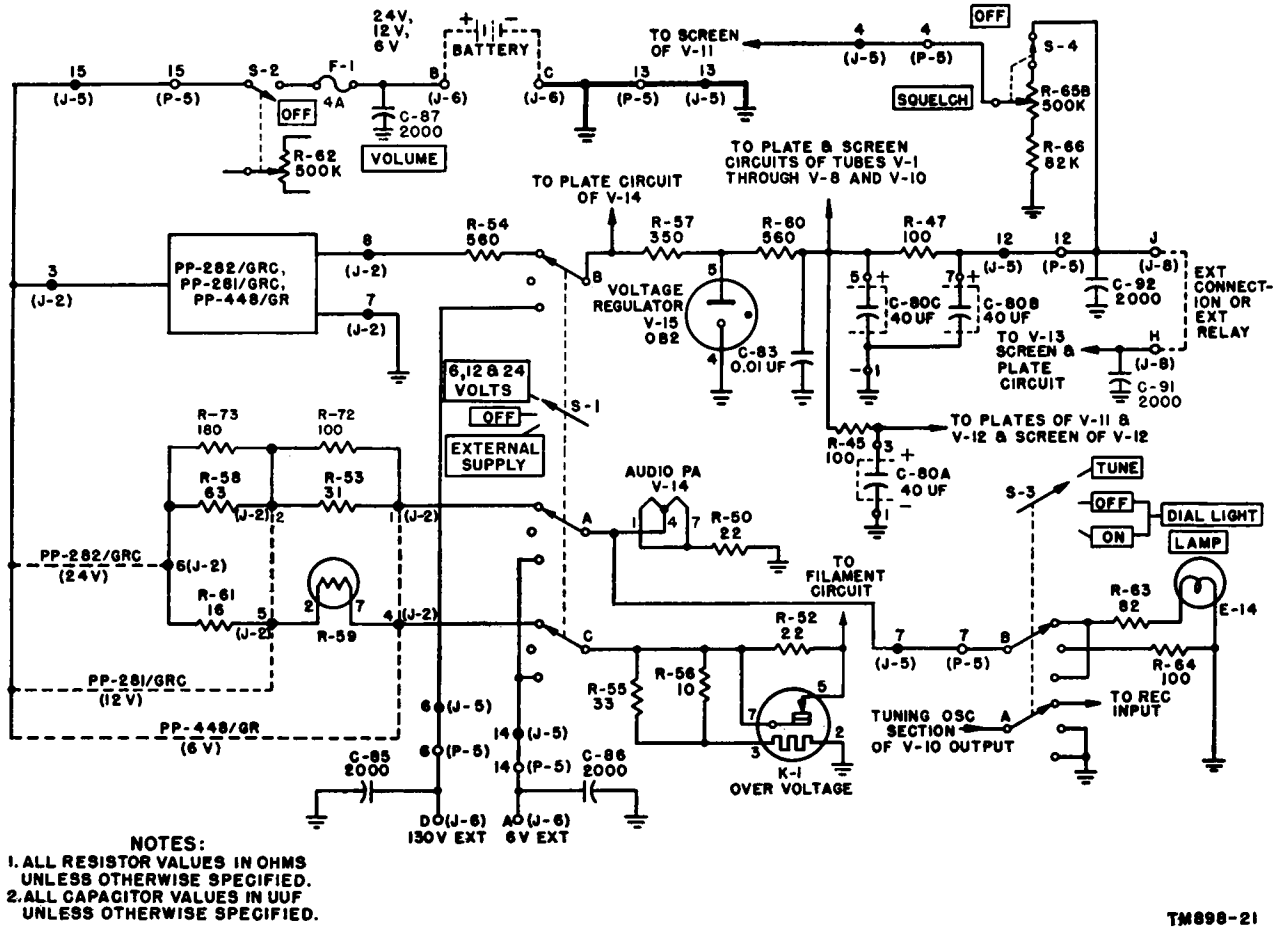


Figure 23. Power supply circuits, functional diagram.

to a safe value, but maintains it high enough to allow circuit checking. When the contacts of K–1 open, a redistribution of voltage drops occurs because of the added resistance. 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 from the filament supply circuit, as shown in figure 23. The filament supply circuit extends from pin 1 of J–2 through contacts of S–1 (par. 32), through terminals 7 of J–5 and P–5 to section B of switch S–3. When this switch is in either the TUNE or the DIAL LIGHT ON positions, dial lamp E–14, in series with voltage-dropping-resistor R–63, is effectively shunted across the filament supply circuit. When S–3 is in the DIAL LIGHT OFF position, the series combination of R–63 and E–14 is disconnected and an equivalent load resistor R–64 is placed across the filament supply. Other contacts of switch S–3 in the TUNE position turn on the tuning oscillator (par. 29).

34. Power Supply Circuits Arranged for 12-Volt Operation

For operation from a 12-volt storage battery, Power Supply PP–281/GRC is used, and the rating of fuse F–1 is 4 amperes. The strap connection provided by connector X–1 of Power Supply PP–281/GRC joins terminals 3, 5, and 2 of J–2, thereby short-circuiting resistors R–58, R–73, and R–61. Since a lower battery voltage is involved, resistor R–53, in parallel with R–72 and thermal resistor R–59, are 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 33.

35. Power Supply Circuits Arranged for 6-Volt Operation

For operation from a 6-volt storage battery, Power Supply PP–448/GR is used, and the rating of the fuse F–1 is 4 amperes. The strap connections provided by socket connector X–1 of Power Supply PP–448/GR joins terminals 3, 4, and 1 of J–2, thereby shorting resistors R–58, R–73, R–53, R–72, R–61 and ballast tube R–59 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 33.

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

(fig. 23)

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 J–6. The 6.3-volt supply is connected between terminals A (+) and C (−) (ground) of J–6. Switch S–1 is set in the EXTERNAL SUPPLY position, arranging the supply circuits, as follows. Note that the fuse is not in the circuit. Fusing, if any, must be provided externally.

b. The 130-volt supply circuit extends from terminal D of J–6, through pins 6 of J–5 and P–5, over section B of S–1 directly to the plate circuit of V–14, and through the voltage regulator and filter circuits (R–57, R–60, R–47, R–45, V–15) to the plate and screen circuits of the other receiver tubes, as described in paragraph 33. Capacitor C–85 is a plate supply decoupling filter.

c. The 6.3-volt supply circuit extends from A of J–6, through pins 14 of J–5 and P–5 over sections A and C of S–1 (in the EXTERNAL SUPPLY position). From this point the filament and dial lamp supply circuits remain as described in paragraph 33. Capacitor C–86 serves as a filament supply decoupling filter.

37. Differences in Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC

Radio Receivers R–109/GRC and R–110/GRC are similar to Radio Receiver R–108/GRC described in paragraphs 18 through 36. They differ from that unit only in operating frequency range (par. 5) and in those circuit components which determine frequency range. The circuit components that differ in each of the receivers are noted with their respective values on the partial schematics (figs. 11 through 22).

CHAPTER 3

FIELD MAINTENANCE INSTRUCTIONS

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available and by the skill of the repairman.

Section I. TROUBLE-SHOOTING AT FIELD MAINTENANCE LEVEL

38. Trouble-Shooting Procedures

The test procedures for sectionalizing and localizing trouble in Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC are outlined in the following steps:

a. Short-Circuit Checks. These checks consist of resistance measurements. They are intended to locate any short circuits which might damage the power supply or cause additional damage to the equipment when power is applied (par. 40). Repair all short circuits before applying power to the unit.

b. Operational Checks. The operational checks, outlined in chart form in paragraph 43, are made to determine whether or not the receiver performs its functions properly. The trouble symptoms thus obtained will point to a faulty condition within the receiver or within the power supply circuit, and in some cases may sectionalize the trouble to a smaller circuit group. In some cases, a specific part or wire may be shown to be causing trouble. It is recommended that the operational checks be made in the order given and that each trouble be cleared as it is found before proceeding with the next operational check. Accordingly, every time a fault condition is encountered, the additional checks recommended in the chart should be made. Detailed instructions for using the operational check chart are given in paragraph 42.

c. Additional Trouble Sectionalization Checks. A trouble sectionalization chart (par. 44) supplements the operational checks. When trouble is encountered as a result of an operational check, refer to the sectionalization chart and perform the additional checks found to be necessary. These checks will narrow the trouble possibilities to a related group of stages and, in some cases, to an individual stage or part. Power supply circuit troubles are sectionalized in paragraph 45 and localized in paragraph 46.

d. Signal Substitution. Once the trouble within the receiver has been sectionalized to a particular circuit, a signal substitution or signal tracing procedure (par. 47) is used to localize the trouble to a particular stage within the group of stages. A stage gain chart is given to assist in making the signal substitution tests.

e. Resistance Measurements. These tests (par. 48) are made to locate faults or defective components and wiring within the circuit or stage shown to be defective by the signal tracing procedure.

f. Voltage Measurements. Voltage measurements (par. 49) are made to determine whether the correct d-c voltages are present at significant points of the circuit. They are made for the purpose of disclosing faults not observable during the preceding tests. The d-c voltage measurements are of two types—those that can be made with a relatively low impedance meter and those which require the use of a vacuum-tube voltmeter of the high-impedance type to yield significant results.

g. Additional Checks. Continuity checks (par. 50) are made to determine faults in wiring and circuit sections which cannot be discovered by any of the means outlined above.

39. Test Equipment and Tools Required for Trouble Shooting

Arbitrary references are assigned to signal generators and meters listed below to facilitate identification with instruments called for in

trouble-shooting procedures. The following test equipment and tools are required for making the trouble-shooting tests described in this section.

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, d-c filament supply and a 130-volt, d-c 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. Test instruments as follows:
- (1) Electronic Multimeter TS–505/U, d-c voltohmmeter (M–1).
- (2) Electronic Multimeter ME–6/U or Multimeter TS–352/U, a-c voltmeter (M–2).
- (3) Output Meter TS–585/U or equal (M–3).
- (4) Frequency Meter Set SCR–211 (M–4).
- (5) Frequency Meter TS–174/U (M–5).

d. Signal generators as follows:
- (1) Signal Generator Set AN/URM–27 (G–1).
- (2) Signal Generator I–208, fm (G–2).
- (3) Audio Oscillator TS–382/U (G–3).
- (4) RF Signal Generator SG–20/U (G–4).
- (5) Signal Generator TS–588/U or RF Signal Generator Set AN/URM–25 (G–5).

e. Tube Tester I–177 or equal.

f. Electrical components, as follows:
- (1) Shunting unit, complete with test clips, consisting of a .0062-uf capacitor, JAN type CM35C622J, in series with a 2.700-ohm, ½-watt resistor.
- (2) Mica dielectric, .0062-uf capacitor.
- (3) Two alligator-type test clips.

g. 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 J–8.
- (4) Connector, a plug to mate with J–7.
- (5) Connector, a receptacle to mate with J–6 and wire.

h. Tools, as follows:
- (1) Tool Equipment TE–113.
- (2) Allen wrenches (supplied).
- (3) Tube puller (supplied).

40. Checking Key Circuits for Shorts

a. The purpose of the checks outlined in this paragraph is to make sure that when power is finally connected to the receiver, the equipment will not be damaged due to short circuits. Also many types of trouble, such as shorted capacitors, faulty connector pins, etc., may be discovered by means of these tests. Check the vibrator power supply for shorts in accordance with TM 11–5040. Use Electronic Multimeter TS–505/U (M–1) 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 removed from its compartment on the receiver panel-and-chassis assembly.

b. If the required readings are not obtained, refer to the schematic diagram (figs. 35 through 37) and to the power supply circuit functional diagram (fig. 23) to determine which part or parts may be responsible for the trouble. Incorrect readings may be due to 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 chassis. 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. Repair as necessary. Do not apply power until the trouble has been cleared and all the readings in the table have been obtained.

Note. The resistance reading between terminal J of J–8 and the chassis should show a capacitor charge (when the SQUELCH control is in any clockwise position) and should reach about 110,000 ohms, since the SQUELCH control potentiometer, R–65, in series with R–66 and the filter capacitors, C–80C and C–80B, of the 90-volt circuit are connected across these two points. A shorted or leaky filter capacitor anywhere in the 90-volt supply lead may bring this reading down to some considerably lower finite value or to zero. The finite resistance reading obtained will then depend on the extent of the leakage and the value of the filter resistor which is in series with the meter and the leaky capacitor. For example, a completely shorted capacitor, C–80C, will cause a reading of 100 ohms or less to be obtained, since that is the value

of the associated resistor, R–47, in series with the capacitor and the meter. On the other hand, a completely shorted capacitor, C–80B, will cause a reading of 0 ohms.

Point of measurement	Switch position and condition of test	Nominal required reading (ohms)
Term. A of J–6	S–1 in 6, 12, and 24 VOLTS or OFF position.	Infinity.
	S–1 in EXTERNAL SUPPLY position.	23.
Term. B of J–6	VOLUME control R–62 in extreme counterclockwise position (OFF).	Infinity.
	VOLUME control in any clockwise position.	Infinity.
Term. C of J–6	----------	0.
Term. D of J–6	S–1 in 6, 12, and 24 VOLTS position.	Infinity.
	S–1 in OFF position	Infinity.
	S–1 in EXTERNAL SUPPLY position and SQUELCH in OFF position.	Infinity.
	S–1 in EXTERNAL SUPPLY position and SQUELCH in any clockwise position.	582 K.
Term. 1 of J–2	S–1 in OFF or EXTERNAL SUPPLY position.	Infinity.
	S–1 in 6, 12, and 24 VOLTS position.	23.
Term. 4 of J–2	S–1 in OFF or EXTERNAL SUPPLY position.	Infinity.
	S–1 in 6, 12, and 24 VOLTS position.	7.5.
Term. 7 of J–2	----------	0.
Term. 8 of J–2	S–1 in 6, 12, and 24 VOLTS position and SQUELCH in OFF position.	Infinity.
	S–1 in 6, 12, and 24 VOLTS position and SQUELCH in any clockwise position.	582 K.
	S–1 in OFF or EXTERNAL SUPPLY position.	Infinity.
Term. J of J–8	SQUELCH in OFF position.	Infinity.
	SQUELCH in any clockwise position.	582 K.
Term. H of J–8	----------	Infinity.

41. Test Bench Set-Up for Operational Checks (fig. 24)

If the receiver is to be tested apart from the components with which it normally is associated in the operating installation, it is necessary to install a vibrator power supply unit and a source of operating power (or some other power supply combination), audio receiving devices (a headset and loudspeaker), measuring instruments, and test signal sources. Test instrument and signal source connections are to be made as called for in the individual test procedures. External connections are to be made as shown in figure 24 and as follows: To connect the audio device, prepare a suitable cable and fit one end with a connector to mate with REC CONTROL connector J–8. The cable is to be made of four 16-gage wires (or heavier wires) connected to terminals E, A, B, and D (ground) of J–8.

a. Audio Connections.

(1) Connect a headphone (or a-f output meter M–3 when called for) between terminals E and D (ground) of J–8.

(2) Connect a loudspeaker (or a-f output meter M–3 when called for) between terminals A and D of J–8.

(3) Connect a headphone (or a-f output meter M–3 when called for) between terminals B and D of J–8.

Note. If desired, a switch arrangement may be provided to connect M–3, headphones, and a loudspeaker to the connector terminals as called for in the test procedures. It is not necessary to duplicate meters, phones, 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 J–8. When power is turned on, terminal J of J–8 carries a 90-volt potential.

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 that a 4-ampere fuse is installed in the holder on the front panel.

(3) Make sure that the VOLUME control is in the OFF position (the extreme counterclockwise position) at this time.

(4) Make sure that the internal power selector switch, S–1, is in the OFF position at this time.

(5) Make sure that all tubes, including the voltage regulator tube, V–15, ballast tube R–59, thermal relay K–1, and electrolytic capacitors C–80 and C–73 are installed and are seated firmly in their sockets. Also, see that the dial lamp is inserted in its holder under the LAMP cap on the front panel.

(6) 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, J–6, on the receiver panel.

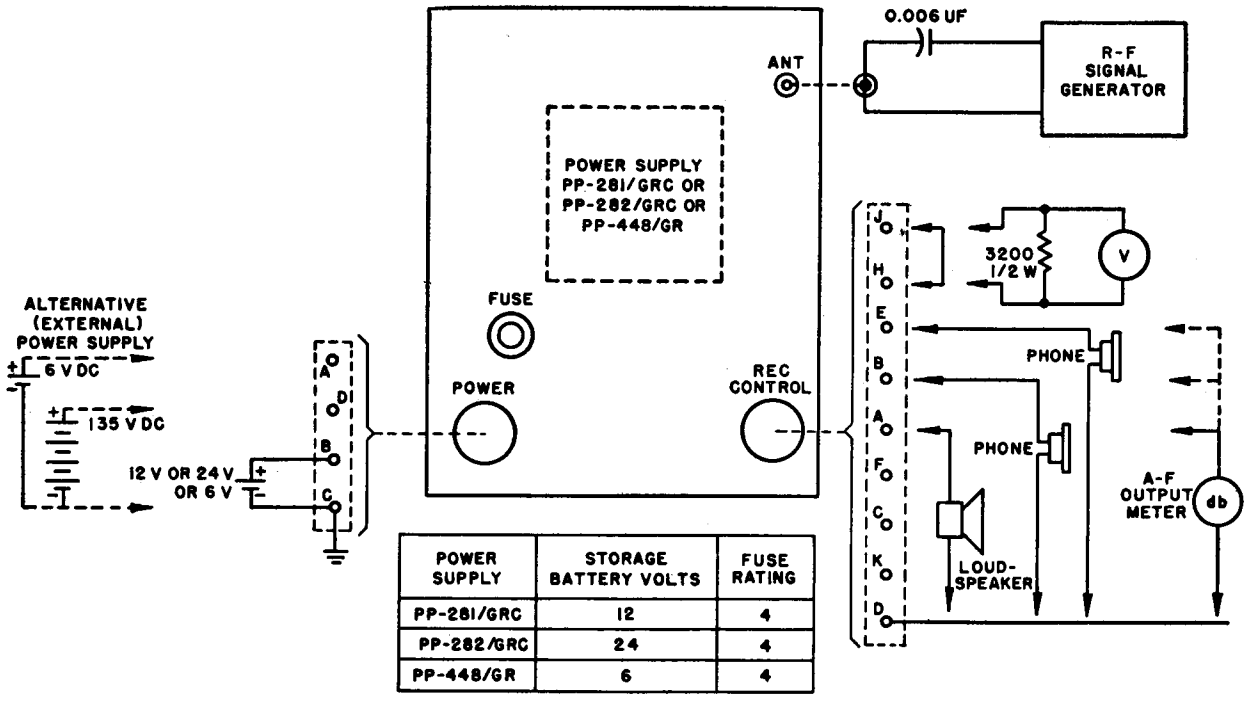
(7) Connect the + terminal on the storage battery to terminal B of J–6. Connect the − terminal of the battery to terminal C (ground) of J–6.

(8) Turn switch S–1 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, S–1, is in the OFF position at this time. The setting of the VOLUME control is immaterial, since the power switch, S–2, is not in the external supply circuit. Also, fuse F–1 is not in the external supply circuit. S–1 provides the only internal means for turning external power on or off. Make sure that tubes, voltage regulator V–15, relay K–1, and dial lamp E–14 are properly installed. Ballast tube R–59 is not in the circuit.

(2) Connect the 6-volt filament supply between terminals A (+) and C (−) (ground) of J–6. Connect the 130-volt plate supply between terminals D (+) and C (−) (ground) of J–6. Use heavy duty leads, one end equipped with connectors suitable for attachment to the particular power supply sources used, and the other end with a 4-prong connector to mate with female connector J–6. Turn internal switch S–1 to the EXTERNAL SUPPLY position to turn on power to the receiver.



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

Figure 24. Test set-up connections, functional diagram.

42. Purpose and Use of Operational Check Chart

a. PURPOSE. The operational checks (par. 43) serve as a first step in sectionalizing trouble in the receiver. The panel-mounted controls and facilities are used to operate the equipment under as close to normal conditions as possible at a test bench. The trouble symptoms yielded by these checks, when properly interpreted, will show specific circuit sections to be defective and will indicate additional checks necessary to further localize the trouble to a particular stage.

b. CIRCUIT SECTIONS FOR OPERATIONAL CHECKS. For the purpose of the operational checks the circuits of the receiver may be grouped functionally into the following:

(1) The high-frequency portion of the receiver, including:
   (*a*) A receiver r-f amplifier and a receiver mixer.
   (*b*) A variable oscillator.
(2) The i-f and a-f portion of the receiver, including:
   (*a*) The first through the fourth i-f amplifiers and a limiter.
   (*b*) A discriminator.
   (*c*) Receiver audio amplifiers.
(3) The power supply circuits.
(4) Miscellaneous circuits, including:
   (*a*) The tuning oscillator.
   (*b*) The squelch circuit.

c. ADDITIONAL TROUBLE SECTIONALIZATION DATA. The operational check chart (par. 43) is supplemented by two trouble sectionalization charts (pars. 44 and 45) which serve to further localize the trouble to a particular stage within the circuit section found to be defective by the operational checks. These charts include:

(1) The receiver circuit trouble sectionalization chart (par. 44).
(2) Power supply trouble sectionalization (par. 45).

d. USE OF OPERATIONAL CHECK CHART. The tests given in the operational check chart follow a certain specific sequence. In each test it is assumed that the preceding tests have been made and that the troubles thus discovered have been eliminated. Accordingly, start with item 1 and proceed in the indicated order. The chart includes several columns as follows:

(1) *Item of check.* This column assigns a numerical sequence to the particular check to facilitate further reference to it and describes briefly the purpose of each check.
(2) *Test condition and operation.* This column lists the switches and controls to be operated and the conditions to be met. The headset, loudspeaker, and power supply unit are not part of the receiver being tested but are needed in making the tests. To facalitate identification, meter (M) and signal generator (G) references corresponding to those given in paragraph 39 are included. It should be noted, however, that the nature of the normal indication in the next column should serve as a guide in the selection of meters, meter ranges, and signal generators.
(3) *Normal indication.* Both aural and visual indications are outlined to show what to expect after the test conditions have been met. If these indications are not met as specified, a trouble condition exists. For best results, the repairman should be acquainted sufficiently well with the circuit theory and the actual operational behavior of the receiver to be able to interpret the normal indications correctly. Thus, for example, in the case of item 2 (which is a qualitative check of receiver operation based on the presence of noise in the r-f and i-f circuits), absence of noise shows that the receiver is defective at some point. Audibility of the noise does not prove conclusively, however, that the entire receiver functions properly. The r-f stage may be defective and yet noise may be heard in the earpiece. Since the volume of noise is a function of the total gain of all stages, a defect in the r-f and mixer stages of the receiver may show up as a reduction in the volume of the noise heard. Proper interpretation of the volume of noise heard will give a more precise meaning to the normal indication for item 2.
(4) *Possible causes of trouble.* This column indicates the circuit section suspected to be defective if the normal indication is not obtained. In cases where several types of trouble symptoms are possible, the circuit checks involved in each type of trouble symptom are listed.

(5) *Further checks and remarks.* This column lists further sectionalization or localization checks to be made if the normal indication is not obtained. Where further operational checks in the operational check chart are called for, perform that operational check, note the resultant indication, and, if abnormal, follow through as indicated in the *further checks* column for that operational check. Where reference is made to the trouble sectionalization chart it will usually not be necessary to perform all checks listed in that chart but only those related to the check called for.

43. Receiver Operation Checks

Item of check	Test conditions and operation	Normal indication	Possible causes of trouble	Further checks and remarks
Preliminary	Set up the receiver as shown in figure 24 and as described in paragraph 41. Turn switch S–1 to 6, 12, and 24 VOLTS if a vibrator power supply is used. Turn to EXTERNAL SUPPLY if an external power source is used. Turn S–3 to DIAL LIGHT OFF. Turn VOLUME control to extreme clockwise position. Turn SQUELCH control to extreme clockwise position.			
(1)				
Dial light	Turn S–3 to DIAL LIGHT ON	Dial light goes on	Defective E–14	Check E–14 for continuity.
			Defective fuse F–1 (only when vibrator supply is used.	Check fuse F–1 for continuity, and replace if defective. Make sure that fuze rating corresponds to ratings of power supply unit and storage battery used.
			Defective filament supply circuit.	Check filament supply circuit for defects as indicated in power supply circuit trouble sectionalization (par. 45).
	Turn S–3 to DIAL LIGHT OFF	Dial light goes out	Defective switch S–3	Check contacts of S–3 for short circuit.
(2)				
Over-all receiver operation (noise check).	Turn SQUELCH control to extreme counterclockwise position (OFF).	Rushing noise (assuming no incoming signal) is heard in earphones and in loudspeaker.	Defective receiver	Make quantitative measurements given in receiver trouble sectionalization chart (par. 44).
			Defective Power Supply circuit.	Check power supply circuit (par. 45).
(3)				
Over-all receiver operation (quantitative check).	Apply an r-f, 1.0-uv signal modulated at 1 kc with ±15-kc deviation to ANT connector (use G–1).		Improper alinement of discriminator.	Check discriminator alinement (par. 67).

	Set VOLUME control to maximum clockwise position. Set SQUELCH control to maximum counterclockwise (OFF) position. Turn test switch to the DIAL LIGHT ON position. Adjust test signal frequency to any suitable frequency (i. e., highest m-c position on dial). Tune signal in with dial. Using a-f power output meter M-3, measure the power output across each pair of audio output terminals. In doing this, set output meter impedance for a 600-ohm load.		Reduce discriminator output. Low output of V-8.	Check stage gains (par. 47). Check V-8 and associate circuit components.
	Between E and D of J-8 (or A and B of J-7).	Meter should read .04 watt approximately.		
	Between A and F of J-8 (or L and B of J-7).	Meter should read 1.04 watts approximately.		
	Between B and D of J-8	Meter should read .04 watt approximately.		
(4) Volume adjustment	Turn VOLUME control in counterclockwise direction.	Volume of rushing noise decreases gradually as control is rotated.	Volume control R-62 or associated circuit components defective.	Check R-62 and associated wiring and circuit components.
(5) Squelch action	Turn SQUELCH control in clockwise direction.	Rushing noise disappears abruptly.	Defective squelch (V-11) circuit.	Check V-11 in a tube checker. Check squelch circuit (par. 44, item (8)).
			Poor receiver sensitivity	Check stage gains (par. 47).
(6) Dial operation	Rotate tuning knob from one end of dial to the other and back.	Dial rotates smoothly without scraping, slippage, or bumps.	Broken or defective dial-drive mechanism.	Examine dial-drive mechanism for obvious signs of damage. If damaged, replace. DO NOT TRY TO TAKE DIAL-DRIVE ASSEMBLY APART (par. 52).

Item of check	Test conditions and operation	Normal indication	Possible causes of trouble	Further checks and remarks
(7) Tuning oscillator operation.	Turn S–3 to TUNE position (with SQUELCH control in clockwise direction) and tune dial until normal indication is obtained.	Dial light goes on. Receiver is quiet (squelched) except at calibration points where a beat note is heard.	Defective S–3. Defective squelch circuit V–11.	Check S–3 for open contacts. Check V–11 in a tube checker. Check squelch circuit (par. 44, item (8)).
	Turn SQUELCH control to OFF position. Tune dial until normal indication is obtained.	Rushing noise is reduced considerably. Beat note is heard at some point of the dial at or near a red dot calibration.	Defective tuning oscillator V–10.	Check V–10 in a tube checker. Check tuning oscillator circuit (par. 44, item (10)).
			Receiver r-f or i-f circuits defective, or low gain.	If signal is heard or measured, tuning oscillator is operative and receiver circuit is probably defective. Check as in par. 44, steps (2) through (7).
			Variable receiver oscillator V–3 not oscillating or badly misalined.	Touch grid of V–3. Noise output, if present, should be reduced. If it is not reduced, V–3 circuit is defective.
(8) Calibration check (rough).	Rotate dial through its entire tuning range starting with the high-frequency end. Listen in headphones for beat notes. For each beat note, adjust tuning dial to obtain a zero beat. Observe position of dial window hairline with respect to red dot on dial (calibration point).	The zero-beat note should be obtained when hairline is within one-half a dial scale division of each red dot. The pitch of the sound in the headphones will be higher as the knob is rotated in either direction away from a *zero-beat* position. This fact should be noted to make sure that what is presumed to be zero beat is not in reality a note too high in pitch to be audible.	Variable oscillator V–3 is off frequency if beat notes occur at points more than one-half a scale division (50 kc) from red dots.	Check variable oscillator alinement (par. 68) and realine oscillator V–3 if necessary (par. 69).

44. Receiver Trouble Sectionalization Checks

Item of check	Text conditions and operation	Normal indication	Possible causes of trouble	Further checks and remarks
(1) Audio amplifier circuits	Set switch S–1 in 6, 12, and 24 VOLTS or EXTERNAL SUPPLY positions depending upon type of power supply used. Set switch S–3 in DIAL LIGHT OFF (or ON) position. Set SQUELCH control in OFF position. Set VOLUME control in extreme clockwise position. Connect audio signal generator G–3 between pin 3 of V–9 and chassis. Adjust frequency to 1,000 cps and level to 3.6 volts. Connect meter M–3 using a 600-ohm output impedance as follows:			
	Between E of J–8 and chassis. Set fixed level VOLUME control at maximum.	A-f meter M–3 reads at least .04 watt.	Defective first a-f amplifier stage V–13.	Check tube V–13 in a tube checker. Check R–62 by rotating VOLUME control and noting changes in output reading. Check circuit components of the V–13 stage by the point-to-point voltage and resistance measurements (pars. 48 and 49).
	Between A of J–8 and chassis	A-f meter M–3 reads at least 1 watt.	Defective audio power amplifier stage V–14.	Check tube V–14. Make point-to-point voltage and resistance measurements on that stage (pars. 48 and 49).
	Between B of J–8 and chassis	A-f meter M–3 reads at least .04 watt.	Defective fixed level audio stage V–12.	Check tube V–12. Make point-to-point voltage and resistance measurements (pars. 48 and 49).

Item of check	Text conditions and operation	Normal indication	Possible causes of trouble	Further checks and remarks
(2) Determine reference A limiter meter reading.	Connect the 4.3-mc test signal generator G–2 through a .01-uf capacitor between grid (pin 6) of V–7 and chassis. Connect meter M–1 between grid (pin 6) of V–8 and chassis. Adjust test signal frequency for zero-beat note in headset with switch S–3 in TUNE position. Adjust test signal level to .1 volt with switch S–3 in DIAL LIGHT position.	Meter M–1 reads .5 volt. Record the reading thus obtained. This reading will be referred to as reference A. In subsequent measurements, the test signal levels will be adjusted to obtain this reference reading. The test signal level required to obtain this reading will be taken as a measure of the gain of the circuit or stage being measured.	Defective fourth i-f amplifier stage V–7, and/or limiter stage V–8.	Check tubes V–7 and V–8. Check alinement of T–9 (par. 66) by adjusting the P and S slugs of T–9 for peak readings on M–1 (limiter meter).
(3) I-f amplifier limiter stages, over-all gain.	Connect limiter meter M–1 between grid (pin 6) V–8 and chassis.	Test signal level should be 170 uv (approximately).	Defective i-f amplifier stages V–4 through V–7.	Check gain of individual i-f amplifier stages V–4 through V–7 (par. 47).
	Connect 4.3-mc test signal generator G–2 (unmodulated) through a .01-uf capacitor between grid (pin 6) of V–4 and chassis.	----------	----------	Check tube of stage with low or no output. Make point-to-point voltage and resistance measurements (pars. 48 and 49) of stage with low or no output.
	Adjust frequency of G–2 for a zero-beat note in headset with S–3 in TUNE position. Adjust level of G–2 S–3 in DIAL LIGHT position to obtain reference A (item (2)).	----------	----------	Check alinement of i-f amplifier circuits if above procedures fail to reveal causes of trouble (par. 66).
	Measure test signal level when reference A reading is obtained.	----------	Excessive gain may be indicative of regeneration in i-f amplifier circuits.	Check for spurious oscillators.
(4) Reference B indication for r-f circuit measurements.	Raise test signal level until limiter meter M–1 reads 6.5 volts dc. Determine test signal level required to obtain that reading.	Test signal level should be approximately 1,500 microvolts. This reading will be referred to as reference B.	Defective i-f amplifier stages V–4 through V–7.	Recheck item 3.

(5)				
Gain of mixer stage V–2	Shift generator G–2 connection to grid (pin 1) of V–2.	Test signal level should be approximately 500 microvolts.	Improper alinement	Check alinement of T–5 (par. 68).
	Adjust signal generator output level to obtain reference B reading on limiter meter M–1.		Defective V–2	Check tube V–2.
	Measure test signal level		Defective circuit components of mixer stage V–2.	Check components by point-to-point resistance and voltage measurements (pars. 48 and 49).
(6)				
Discriminator:				
(*a*) Alinement	Connect 4.3-mc signal generator G–2 between grid (pin 6) of V–7 and chassis. Adjust level for reference A reading on limiter meter at E–3.	Discriminator meter M–1 reads 0 ± .5 volts.	Defective V–9, V–10, or V–8.	Check V–8, V–9, and V–10 in tube checker.
			Defective circuit components of discriminator.	Check resistances and voltages in limiter and discriminator circuit (pars. 48 and 49).
	Connect meter M–1 between E–5 (fig. 30) and chassis. Note reading of this meter.		Misalined discriminator circuit.	Check alinement and adjust slug of T–10 and T–11 if necessary (par. 67).
(*b*) Balance	Change test signal frequency to 4.33 mc.	+13 volts minimum	Defective alinement	The two readings should be of opposite polarity and numerically equal to each other within .2 volt. If these requirements are not met, realine T–10, T–11, and C–67 (par. 67).
	Change frequency to 4.27 mc.	−13 volts minimum.		
			Defective circuit components of discriminator.	Check resistances and voltages in discriminator circuit (pars. 48 and 49). Check tubes V–9 and V–10.

Item of check	Test conditions and operation	Normal indication	Possible causes of trouble	Further checks and remarks
(7) Gain of receiver r-f stage V–1.	Connect r-f signal generator G–1 to the ANT connector.			
	Adjust frequency to highest integral m-c setting on dial.	Approximately 1.5 microvolts.	Improper alinement	Check alinement of V–1 (par. 68).
			Defective tube V–1	Check V–8 in a tube checker.
	Tune in signal with dial. Adjust ANT TUNE control for maximum on limiter meter. Adjust level of signal generator to obtain reference B reading on the limiter meter.		Defective circuit components of antenna or r-f stage.	Make point-to-point voltage and resistance measurements for antenna and r-f stages.
			Output of receiver oscillator too low.	Check grid voltage of V–3 (par. 49). Check alinement of receiver oscillator (par. 68).
	Determine signal generator output level required to obtain reference B.			
	Adjust test frequency to lowest integral m-c setting of dial. Tune in signal with dial.	Approximately 3 microvolts.	Improper alinement	Check alinement of V–1, V–2, and V–3 stages (par. 68). Aline, if necessary, as described in pars. 69 to 71.
	Adjust signal input level to obtain reference B reading on limiter meter.			
	Determine test signal generator output level required to obtain reference B.			
(8) Squelch circuit operation.	Turn VOLUME control in maximum clockwise direction. Turn SQUELCH control OFF.			
	Apply test signal at the highest integral m-c setting of the dial, with 1-kc modulation at ±15-kc deviation (G–1) and at a level of 1 uv to the ANT connector.			
	Tune in signal with dial.			
	Reduce test signal level to zero.			
	Connect a 1,000-ohm, ½-watt resistor between terminals H and J of J–8.	With the receiver squelched, the voltage between H and J of J–8 should be less than .5 volt across 1,000 ohms.	Defective squelch circuit. Poor receiver sensitivity.	Check squelch circuit voltage using M–1 as a high-impedance vacuum-tube voltmeter (par. 49).

	Reduce test signal level to zero			Make over-all receiver sensitivity check (step (9) below).
	Rotate the SQUELCH control until the receiver noise is quieted.			Follow up with receiver-stage-by-stage gain check and receiver alinement if sensitivity is poor (par. 47 and 64 to 71).
Same as above except apply modulated r-f signal of sufficient level to just open the squelch (i.e. until tone is heard) Again measure the voltage across the 1,000-ohm resistor connected between H and J of J–8.	Using M–1, measure the voltage across H and J of J–8. When the receiver opens, the voltage between H and J of J–8 should increase to at least 4 volts.			
(9) Receiver sensitivity	Apply a .5-uv r-f signal modulated at 1 kc within ±15 kc deviation to ANT connector. Tune antenna trimmer C–4 for maximum audio output. Reduce the audio power output level by means of the VOLUME control until power output meter (M–3) connected between A and D of J–8 reads 100 mw. Remove modulation from test signal and measure audio output level as above. Compute the ratio of the audio output level obtained with a modulated signal to that obtained with the unmodulated test signal. This is the signal-plus-noise-to-noise ratio.	The signal-plus-noise-to-noise ratio should be at least 20 db.	Improper alinement Low gain in r-f or i-f amplifier stages.	Realine receiver circuits (pars. 64 to 71). Make stage gain checks (par. 47).
(10) Tuning oscillator V–10	Connect a high-impedance vacuum-tube voltmeter, M–1, between pin 6 (grid) of V–10 and chassis.		Defective Y–1 Defective V–10	Check by substituting another crystal. Check tube V–10.
	With S–3 in either DIAL LIGHT position, read meter. Turn S–3 to TUNE.	Meter reads approximately 0 volt. Meter reads approximately 25 volts.	Defective circuit components.	Check circuit components particularly contacts of S–3. See point-to-point measurements (pars. 48 and 49).

45. Trouble Sectionalization in Power Supply Circuits

To check whether the power supply circuits within the receiver are functioning properly and whether the correct voltages are made available for the receiver, proceed as follows:

a. Install Power Supply PP-281/GRC, PP-282/GRC, or PP-448/GR in the power supply compartment and fasten the clamp. Check the input voltage rating of the unit used against the voltage rating of the storage battery available for these tests.

b. Check that the fuse installed in the holder on the front panel has a rating of 4 amperes. Set the 6, 12, and 24 VOLTS-OFF-EXTERNAL SUPPLY switch S–1 (mounted on the chassis and having a screw driver control) to the 6, 12 and 24 VOLTS position. Connect a strap between pins H and J of REC CONTROL connector J–8.

c. Make sure that all tubes (voltage regulator tube V–15, ballast tube R–59, thermal relay K–1, and electrolytic capacitors C–80 and C–73) are installed and are firmly seated in their sockets. Make sure that the VOLUME control is in the OFF position. The power on-off switch, S–2, mechanically ganged on the shaft of the volume control, keeps the battery circuit open in this position of the VOLUME control.

d. Connect the + terminal of the storage battery to terminal B of connector J–6. Connect the − terminal of the battery to terminal C (ground) of J–6. Turn the VOLUME control in the clockwise direction and measure the voltages with Electronic Multimeter TS–505/U between the chassis and each of the terminals listed in the following table.

e. No voltage is applied to the squelch tube screen unless the SQUELCH switch, S–4, is turned on. Turn the SQUELCH control in the clockwise direction, and measure the voltage between terminal 4 of V–11 and chassis. A 90-volt reading should be obtained. Otherwise, switch S–4 is probably defective.

f. Turn S–1 to the OFF position. If any of the readings indicated in the preceding table or in paragraph *e* above are not obtained, check the circuit components in the particular power supply circuit (par. 46) and repair as needed.

Test point	Nominal reading (volts)	Probable trouble
Term. 5 of K–1 (X–17).	6. 3	Relay K–1 operated or defective; defective filament supply circuit.
Term. 4 of V–14	3	Defective switch S–1, the strapping on plug-in power supply unit, or resistors R–53, R–58, R–61, or ballast tube R–59.
Term. 2 of T–14	130	Defective vibrator power supply unit, switch S–1, or components of receiver plate supply circuits.
Term. 5 of C–80 (X–18).	90	Defective vibrator power supply unit, switch S–1, or 90-volt supply circuit in receiver.
Term. J of J–8	90	Defective 90-volt supply circuit.

46. Trouble Localization in Power Supply Circuits

If incorrect readings are obtained as a result of the checks outlined in paragraph 45, it may be assumed that the power supply circuit associated with the particular measuring point is defective. Refer to the schematic diagram (figs. 35 to 37) and to the power supply functional diagram (fig. 23) to identify the point of measurement with the circuit section involved. Using Electronic Multimeter TS–505/U (M–1), make point-to-point resistance measurements for the defective circuit section as indicated in the table below. These measurements will aid in the location of the trouble in the defective power supply circuit in a particular component or wire. For the purpose of these measurements, disconnect the battery and the plug-in power supply. Use the data given in the table merely as a guide. Other measurements for localizing the trouble to a defective part or wire should suggest themselves. Clear troubles in the power supply circuits before proceeding with the receiver circuit checks.

Item of Check	Point of measurement	Required reading (ohms)	Probable trouble
Plate supply circuit	From term. 5 of C–80 (X–18) to term. 5 of V–15 (X–15).	560	R–60.
	From term. 1 of C–80 (X–18) to chassis	0	Defective wiring.
	From term. 4 of V–15 (X–15) to chassis	0	Defective wiring.
	From term. 5 of V–15 to term. 8 of J–2 with S–1 in 6, 12, and 24 VOLTS position.	910	Defective R–57, R–54, or S–1.
	Same as above (S–1 in OFF or EXTERNAL SUPPLY position).	Infinity	Shorted S–1 contacts.
	From term. 7 of J–2 to chassis	0	Broken connection.
Filament supply circuit	From term. 5 to term. 7 of K–1 (X–17)	0	Contacts of relay K–1 open.
	From term. 7 of K–1 (X–17) to chassis (S–3 in DIAL LIGHT OFF position).	17. 5	Defective R–55, R–56, K–1, or receiver filament circuit.
	From term. 7 of K–1 (X–17) to term. 4 of J–2 (S–1 in 6, 12, and 24 VOLTS position).	0	Defective wiring or open contacts of S–1.
	Same as above (S–1 on OFF or EXTERNAL SUPPLY position).	Infinity	Shorted contacts of S–1.
	Between terms. 1 and 2 of J–2 (S–1 in OFF or EXTERNAL SUPPLY position).	23	R–53 or R–72.
	Between terms. 2 and 6 of J–2 (S–1 in OFF or EXTERNAL SUPPLY position).	47	R–58 or R–73.
	Between terms. 5 and 6 of J–2 (S–1 in OFF or EXTERNAL SUPPLY position).	16	R–61.
	Between terms. 4 and 5 of J–2 (S–1 in OFF or EXTERNAL SUPPLY position).	1	R–59.
Battery input circuits	From term. B of J–6 to term. 3 of J–2 (VOLUME control in OFF position).	Infinity	Defective power on-off switch S–2.
	Same as above (VOLUME control in clockwise position).	0	Defective S–2 or F–1.
	From term. C of J–6 to chassis	0	Broken connection.
External supply circuits	From term. A of J–6 to term. 5 of K–1 (X–17) (S–1 in EXTERNAL SUPPLY position).	0	Defective wiring or S–1.
	Same as above (S–1 in 6, 12, and 24 VOLTS or OFF position).	Infinity	Defective S–1.
	From term. A of J–6 to term. 4 of V–14 (S–1 in EXTERNAL SUPPLY position).	0	Defective S–1.
	Same as above (S–1 in 6, 12, and 24 VOLTS or OFF position).	Infinity	Defective S–1.
	From term. D of J–6 to term. 5 of V–15 (X–15) (S–1 in EXTERNAL SUPPLY position).	350	Defective S–1 or R–57.
	From term. D of J–6 to term. 5 of V–15 (X–15) (S–1 in 6, 12, and 24 VOLTS or OFF position).	Infinity	Defective S–1.
External relay circuit	From term. J of J–8 to term. 5 of V–15 (X–15)	660	Defective R–60 or R–47.

47. Signal Substitution

a. General. The purpose of the signal substitution or signal tracing checks described in this paragraph is to localize trouble to a particular stage or part within the circuit group of the receiver which has been shown to be defective by the operation checks and trouble sectionalization checks of paragraphs 43 and 44. The data thus obtained serves also to determine whether a particular stage needs alinement.

b. Test Equipment. The test equipment should be connected as described in paragraph 41 and as shown in figure 24. The connections for the test meters and signal source are to be made as indicated in the stage gain chart included in this paragraph 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 i-f and r-f measurements or to the audio output connection for a-f

measurements. It also consists of connecting the signal generator successively 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 reference reading on the meter. By comparing the values thus obtained with the data given in the stage gain chart, it is determined whether or not a particular stage provides the required gain. Failure to provide the required gain may be due to 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, and the reference readings 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 i-f stages including the limiter and the discriminator, and the r-f stages including the oscillator, the mixer, and the r-f amplifier.

(2) For measurements on the audio circuits, the reference reading is the nominal audio power output of the receiver. The reference A reading is the reference level for the measurements on all i-f circuits including the limiter. The reference B reading is the reference level for measurements on all r-f circuits.

(3) The reference A reading is obtained as follows: Connect the meter, M–1, between the grid (pin 6) of V–8 (fig. 30) and the chassis. Connect the test signal generator, G–2, through a .01-uf mica capacitor between terminal 6 of V–7 (the grid of the fourth i-f amplifier) and the chassis. Adjust the frequency of G–2 to 4.3 mc. (Use the built-in tuning oscillator to calibrate the test signal generator frequency as described in (4) below, and adjust the output level to .1 volt) The meter reading thus obtained is the reference A limiter meter reading and its value will be approximately .5 volt dc. The fourth i-f amplifier stage, V–7, and tuning unit T–9 can affect the reading. To check the alinement of T–9, apply the shunting unit between terminal 2 of V–7 and ground. Adjust the secondary winding in T–9 (fig. 4) to obtain a maximum reading on the meter connected to the grid (pin 6) of V–8. (Note that hereafter the meter thus connected will be referred to as the limiter meter.) Next apply the shunting unit across terminal 6 of V–8 and the chassis, and adjust the primary tuning slug of T–9 for maximum reading of the limiter meter. Because of loading by the shunting unit, it may be necessary to increase the signal generator output level to obtain a reading while tuning T–9. Remove the shunting unit and check reference A again.

(4) To calibrate the test signal generator against the tuning oscillator built into the receiver, proceed as follows: Disconnect cable connector J–1 from P–1. Next, turn the TUNE–DIAL LIGHT (ON-OFF) switch to the TUNE position. Adjust the signal generator frequency until a zero-beat note is heard in the headphones. Turn the VOLUME control in the extreme clockwise direction. The position of the SQUELCH control should be OFF. When a beat note is heard, the signal generator is tuned to 4.3 mc with an accuracy of .005 percent.

(5) The reference B limiter meter reading is used as a reference reading for measurements of the r-f circuits. The reference B reading is obtained by performing the following steps: Connect metter M–1 between the grid (pin 6) of V–8 and the chassis as before. Connect signal generator G–2 through a .006-uf mica capacitor terminal 1 of V–2 and the chassis. Make sure that P–1 and J–1 are reattached to each other. Adjust the signal generator frequency to 4.3 mc. Adjust the signal generator frequency for zero beat with the tuning oscillator by turning switch S–3 to the TUNE position and by adjusting the signal generator frequency until a beat note is heard in the headphone. Turn off the tuning oscillator by setting switch S–3 to one of the DIAL LIGHT positions, and adjust the output level of the test signal generator to obtain an increase above the reference A reading

by a factor of 3. This should be approximately 1.5 volts dc. Use this reference limiter meter reading for all measurements on the receiver r-f and mixer circuits.

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

Switch or control	Setting
SQUELCH	OFF.
TUNE-DIAL LIGHT (ON-OFF) switch (S–3).	DIAL LIGHT 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.	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 below.

d. Stage Gain Chart.

(1) *R-f and i-f circuits.* Connect the test signal generator (G–1 for i-f measurements or G–2 (without modulation) for r-f measurements) between the grid of the indicated stage and the chassis. Connect meter M–1 between the grid (pin 6) of V–8 and the chassis. The table of stage-by-stage gain readings follows:

Signal generator at grid of	Approx input (uv)	Signal generator frequency (mc)	Limiter meter M–1 reading (volts dc)
V–7	87, 000	4. 3 (G–2)	0. 5
V–6	8, 700 ±20%	4. 3 (G–2)	. 5
V–5	870 ±45%	4. 3 (G–2)	. 5
V–4	1, 500 ±75%	4. 3 (G–2)	6. 5
V–2	500 +100%−50%	4. 3 (G–2)	6. 5
R–108/GRC (V–1)	30	20. 0	6. 5
	10	28. 0	6. 5
R–109/GRC (V–1)	30	28. 0	6. 5
	10	39. 0	6. 5
R–110/GRC (V–1)	30	39. 0	6. 5
	10	55. 0	6. 5
ANT jack of R–108/GRC	3	20. 0	6. 5
	1. 5	28. 0	6. 5
ANT jack of R–109/GRC	3	28. 0	6. 5
	1. 5	39. 0	6. 5
ANT jack of R–110/GRC	3	39. 0	6. 5
	1. 5	55. 0	6. 5

(2) *Audio circuits.* Apply an r-f signal (G–2) 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 mv. 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 M–3 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 J–8.

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

e. Analysis. Compare the signal generator output levels required to give the reference readings with the levels given in the chart. The tabulated data 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. 35 through 37) 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 due to 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 the power off 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) Attempt to realine the stage or stages which show low gain if a tube (particularly in the oscillator and h-f circuits) has been replaced (pars. 66 to 71) or after many repairs have been made on a tuned stage. Realine the discriminator circuit (par. 67) 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, investigate the need for mechanical realinement of the dial (par. 68). 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 (pars. 57 and 58).

(4) If realinement fails to clear the trouble, measure the resistances at the tube socket of the defective stage. Refer to paragraph 48 and to figure 32 for the points of measurement and the required reading. 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 (par. 49 and fig. 32).

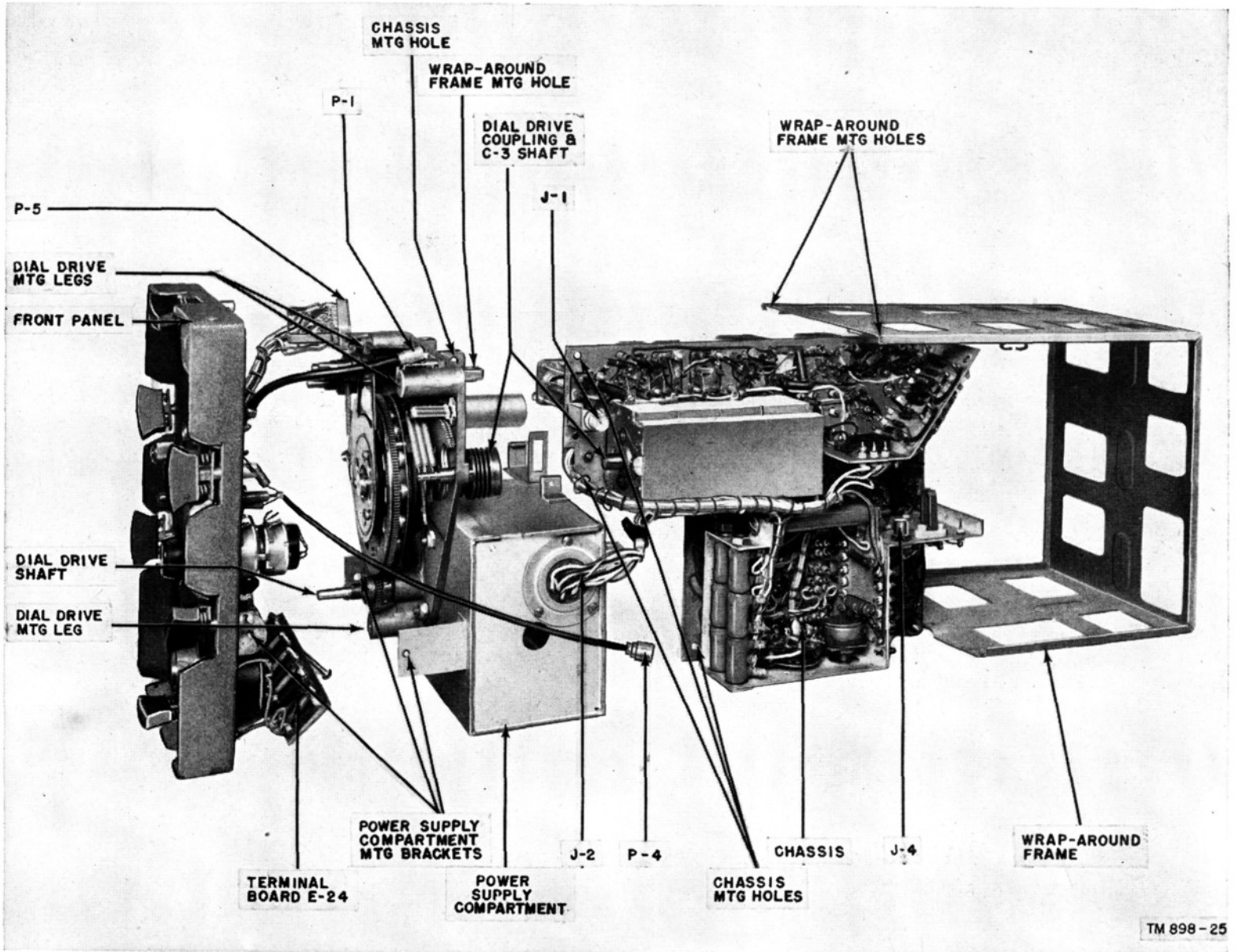


Figure 25. Typical receiver, disassembled view.

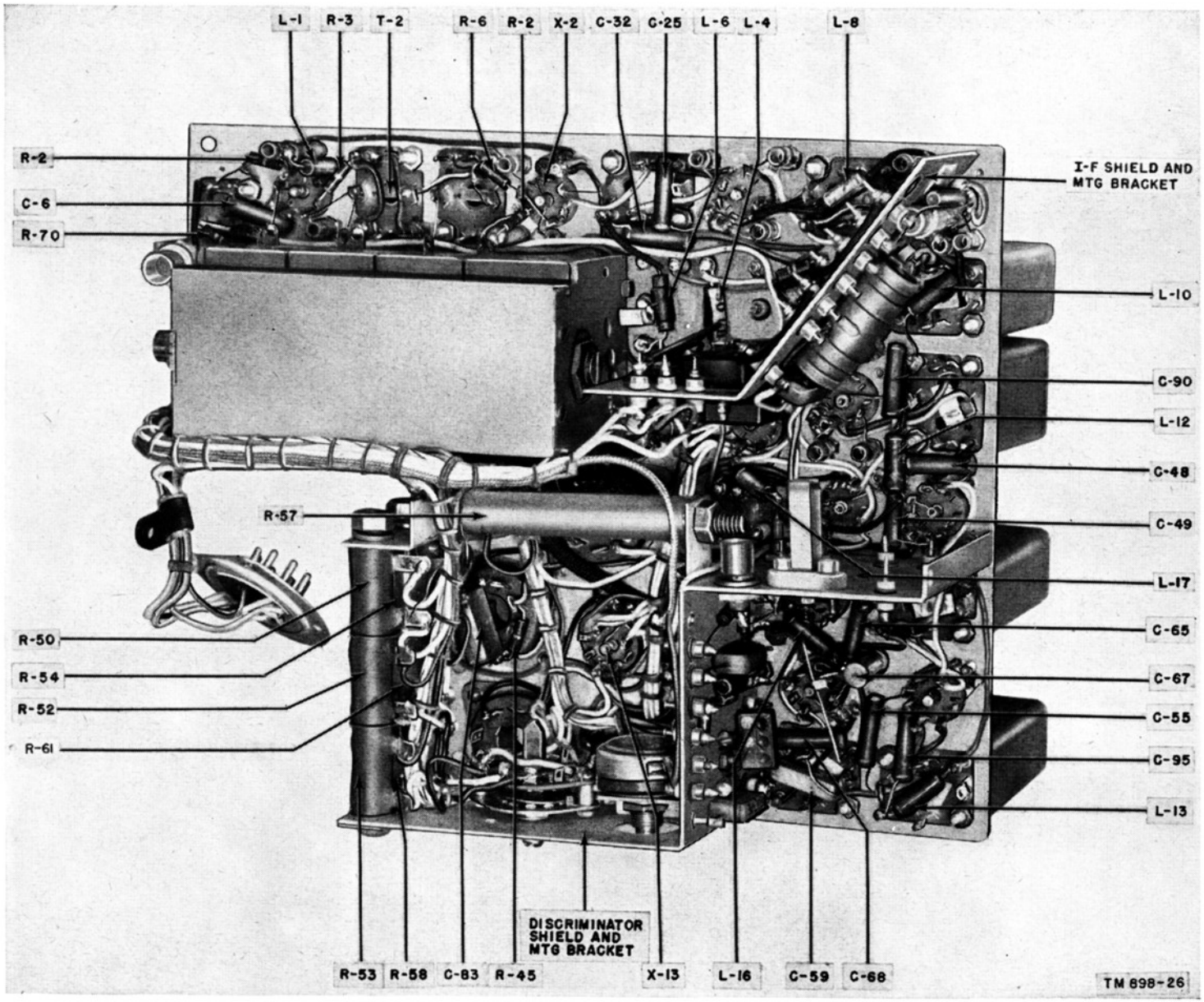


Figure 26. Typical receiver, bottom of chassis (oblique view of top and rear edges).

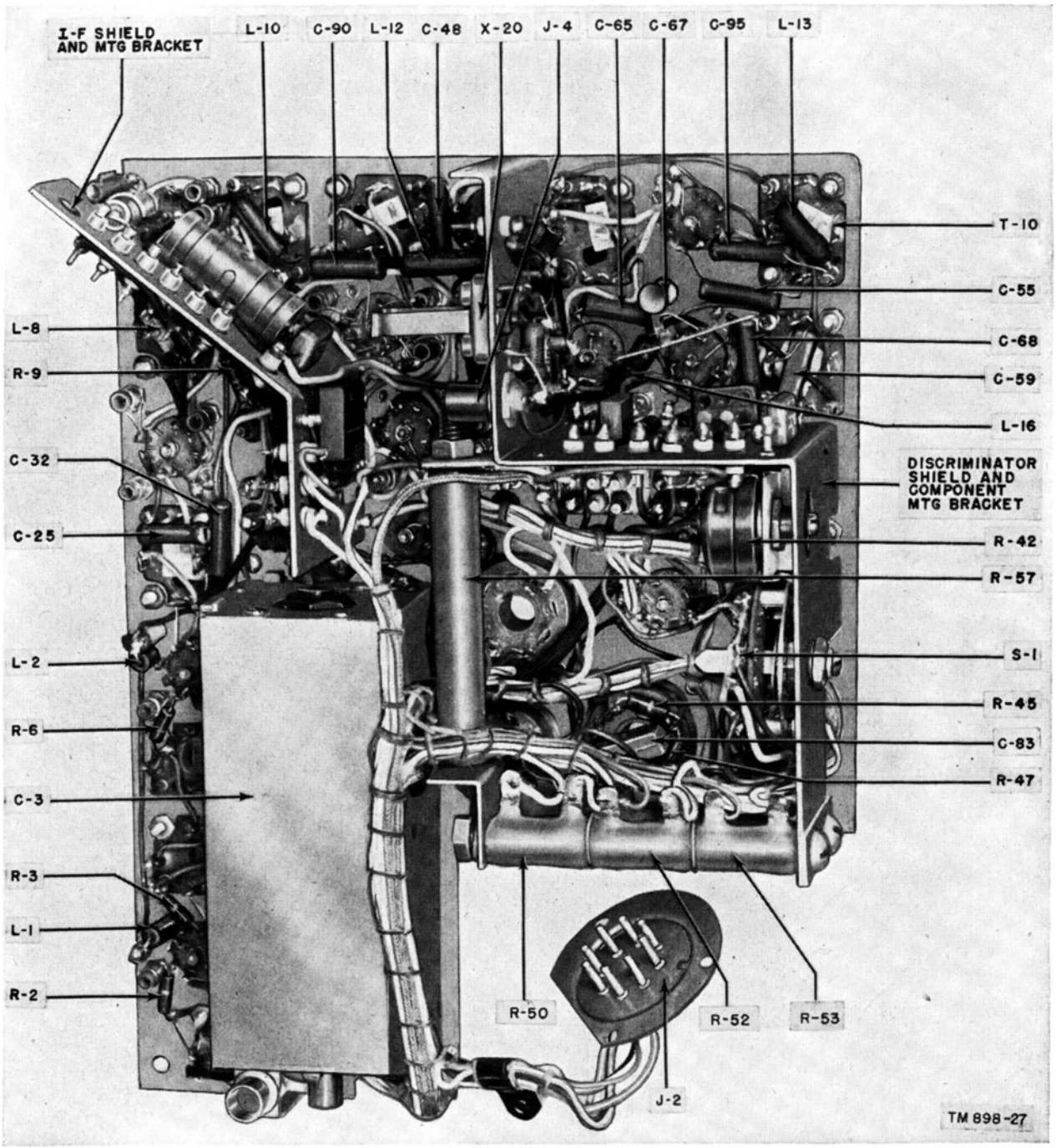


Figure 27. Typical receiver, bottom view of chassis (oblique view of bottom and side edges).

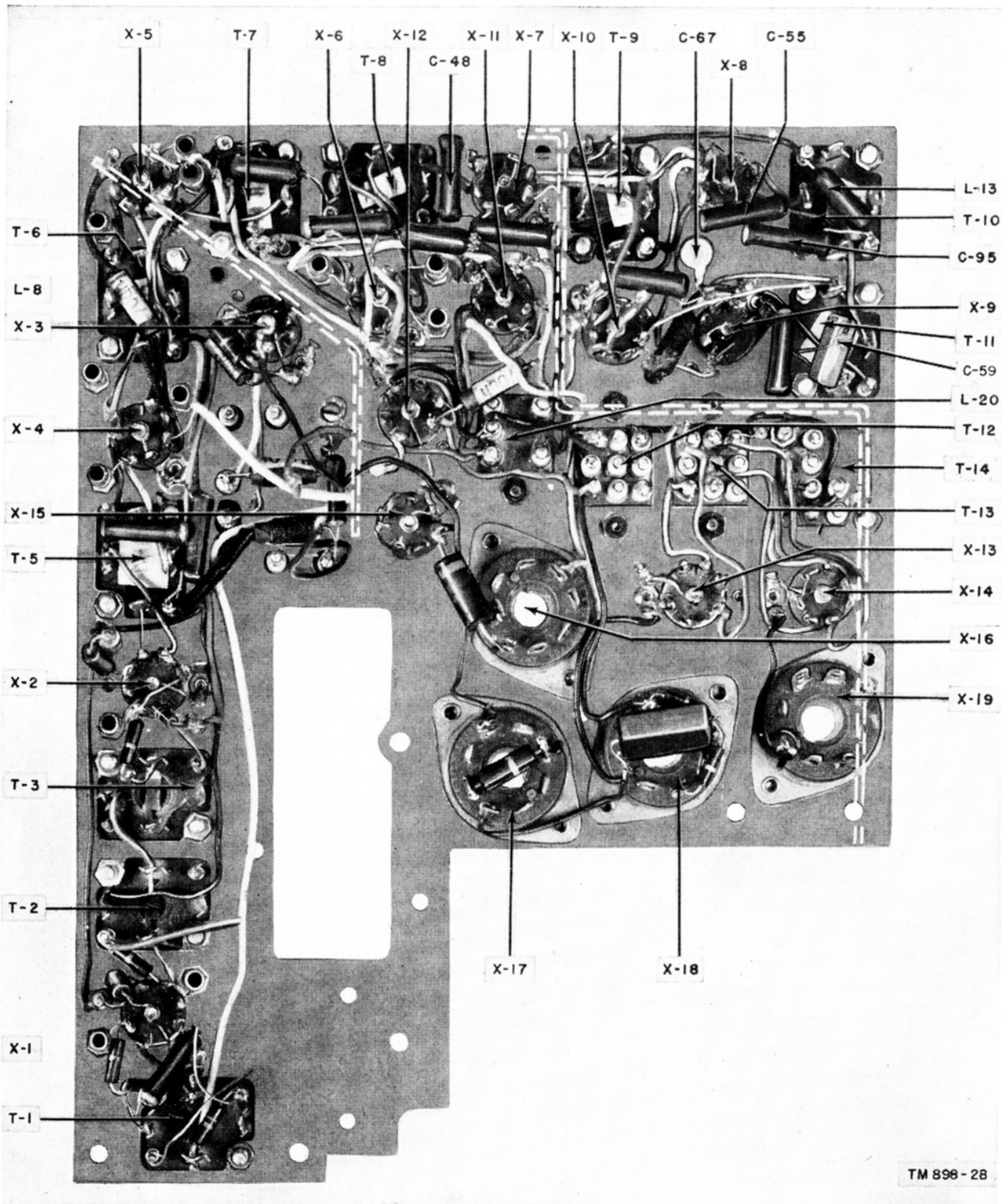


Figure 28. Typical receiver, bottom view of chassis, tube socket layout (i-f and discriminator shields and gang capacitor C-3 removed).

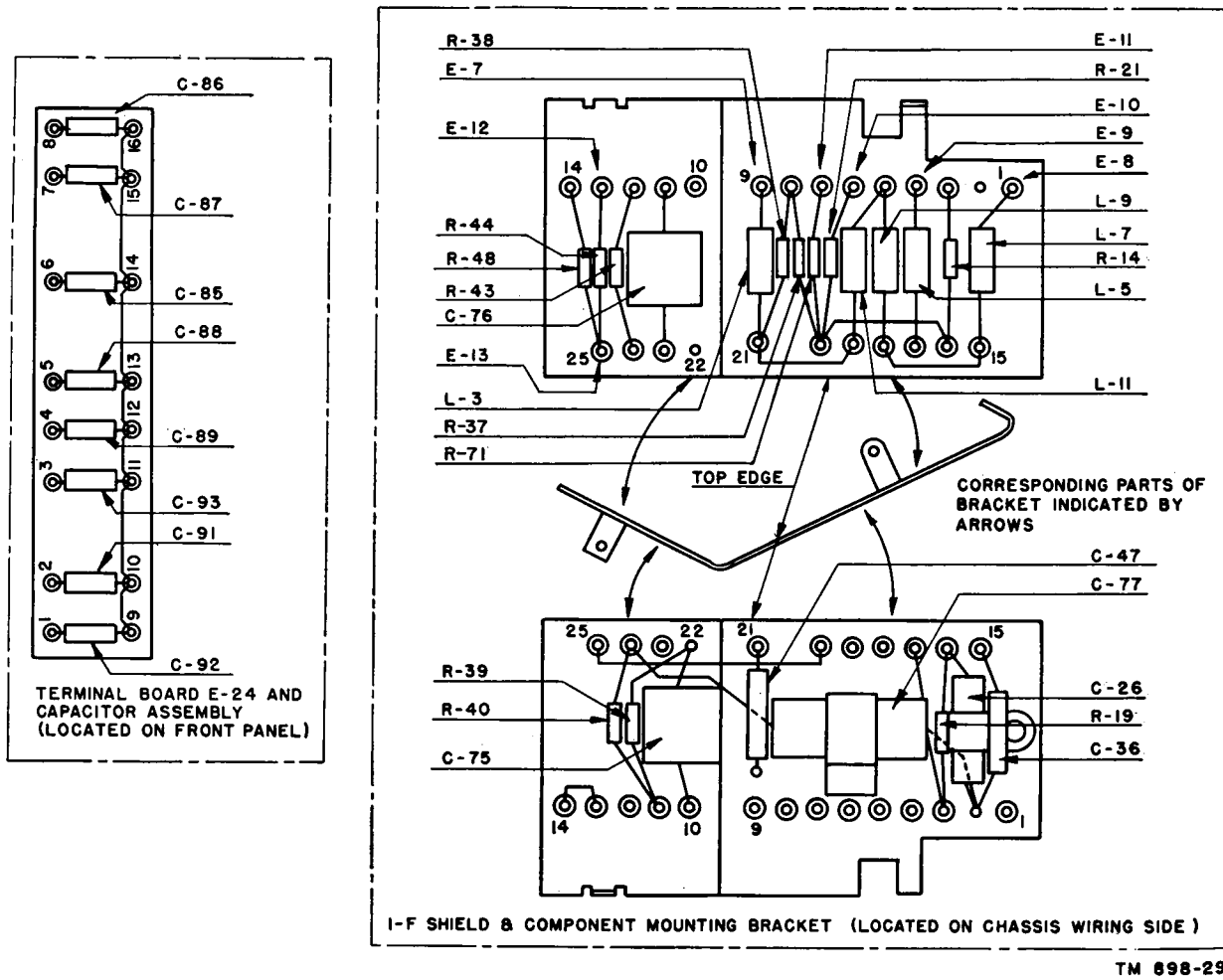


Figure 29. Terminal board E-24 and i-f shield and component mounting bracket, component location diagram.

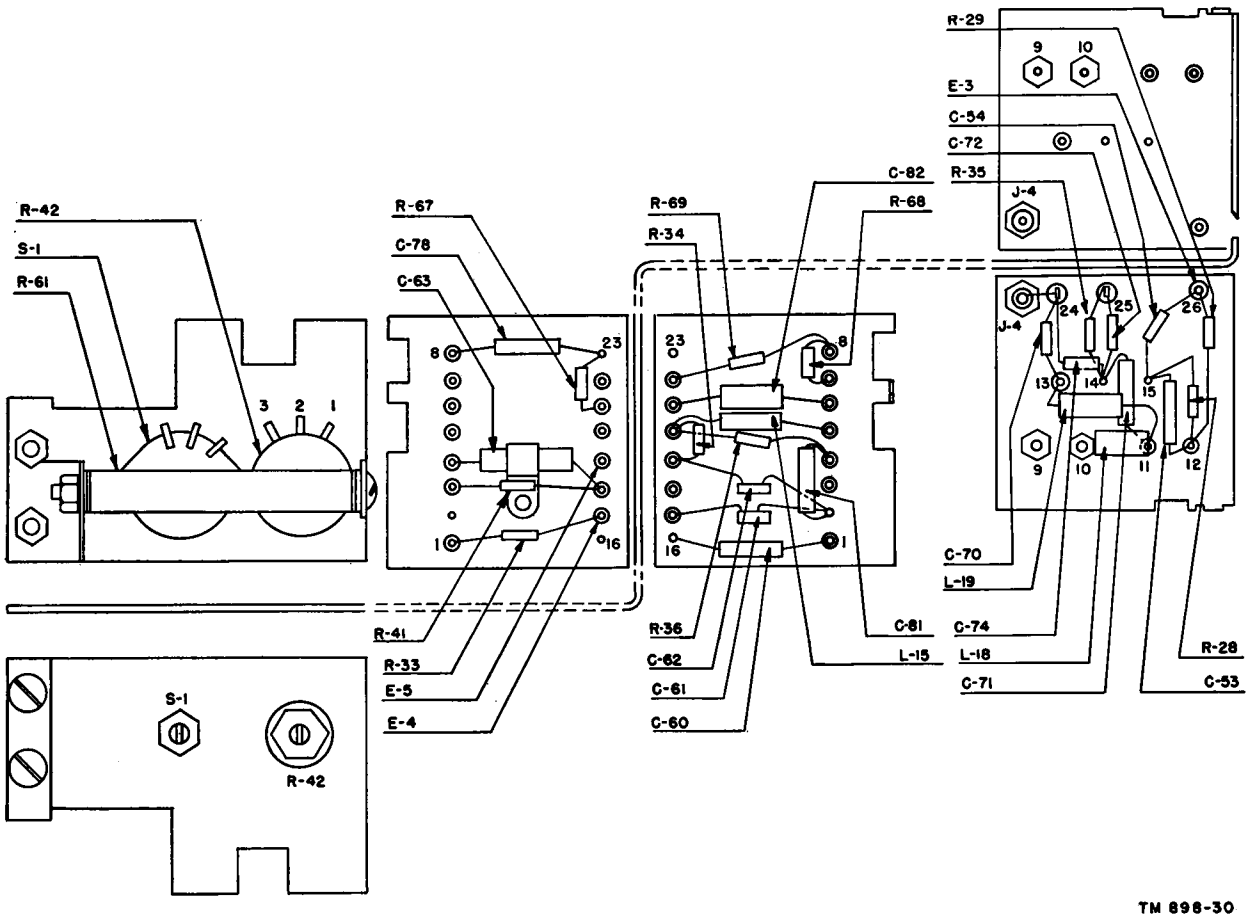


Figure 30. Discriminator shield and component mounting bracket, component location diagram.

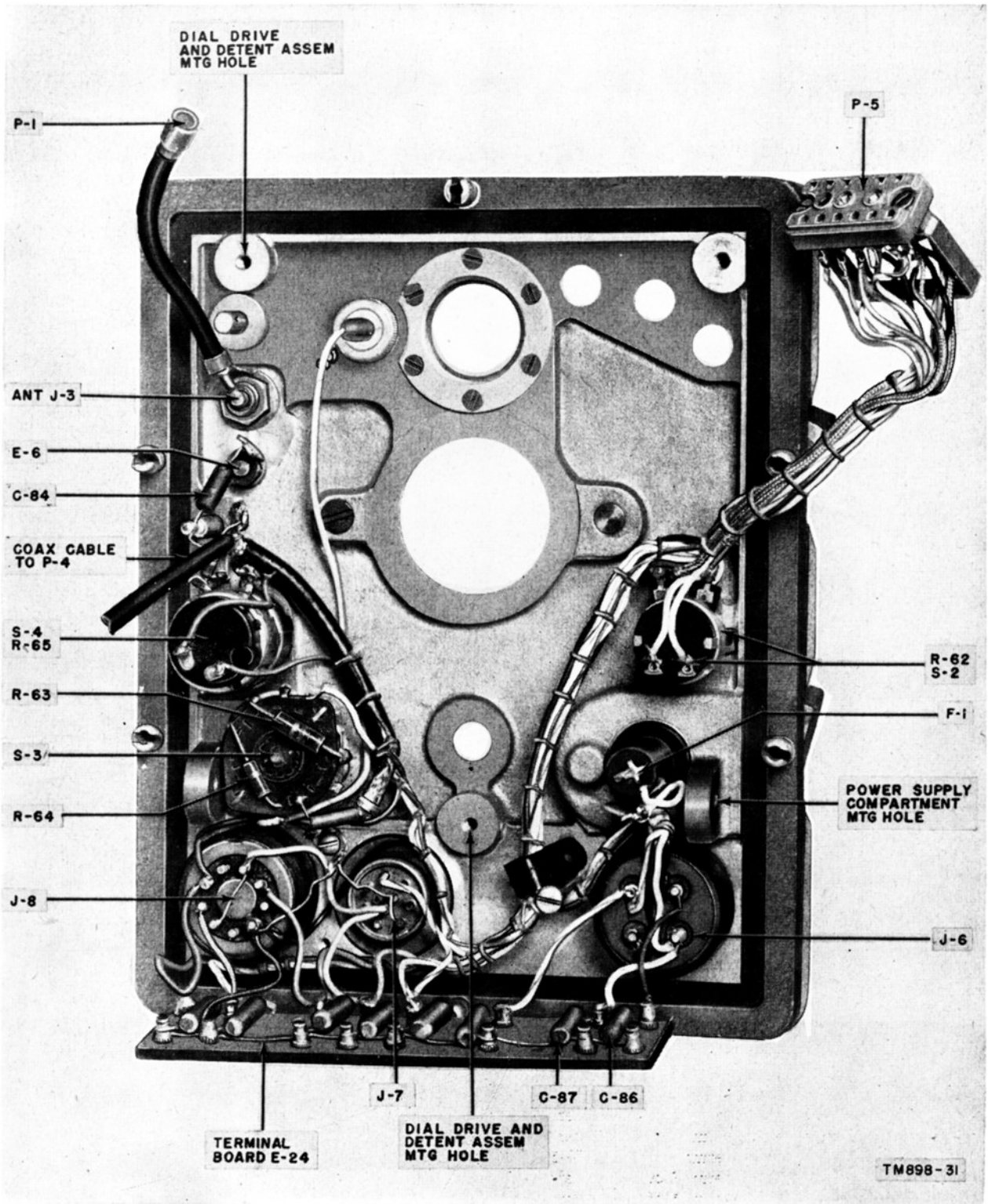


Figure 31. Typical receiver, rear view of front panel.

48. Resistance Measurements
(fig. 32)

These checks are intended to serve as a guide for locating defective components or wiring in the stage or stages found to be defective by the signal substitution checks of paragraph 47. For these checks, disconnect power from the receiver. Disconnect all external connections. Use Electronic Multimeter TS–505/U (M–1). Repair any component or wire found to be defective.

a. Make the pertinent measurements indicated in figure 32. These measurements are made from the socket terminal to ground. The required resistance readings from the socket terminal are shown below the guide line. Note that the infinity and zero readings are just as significant as the readings that show numerical resistance value. 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 32 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 pertinent point-to-point resistance measurements listed in the following table. The table supplements the data given in figure 32. It covers measurements which 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 found to be defective by the trouble sectionalization checks of the preceding paragraphs.

Circuit or stage	Point of measurement	Nominal reading (ohms)	Probable trouble
R-f amplifier V–1	E–6 to chassis	0. 05	Primary coil in T–1 defective.
	Between terms. 4 and 5 of T–1	0	Defective secondary coil in T–1.
	Between terms. 5 and 6 of V–1	0	Defective R–3 or coil in T–2.
	Between term. 3 of T–1 and chassis	0	Broken ground connection.
	Between term. 5 of T–2 and chassis	0	Broken ground connection.
	Between term. 4 of V–1 and term. 7 of P–5	0	Defective L–1.
	Between term. 6 of V–1 and term. 5 of V–15	4, 500	Defective L–6, R–60, or R–4.
Mixer stage V–2	Between term. 1 of V–2 and term. 1 of T–3	0	Defective coil in T–3.
	Between term. 1 of T–3 and term. 4 of T–2	0	Defective coil in T–3 or connection.
	Between terms. 5 and 6 of V–2	0	Defective wire.
	Between term. 5 of V–2 and term. 5 of V–15	1, 600	Defective primary coil in T–5, R–10, R–11, L–6, or R–60.
	Between terms. 2 and 7 of V–2	220	Broken wire.
	Between term. 4 of V–2 and term. 7 of P–5	0	Defective L–2.
Oscillator V–3	Between terms. 2 and 6 of V–3	0	Defective wire.
	Between term. 2 of V–3 and term. 1 of T–4	0	Defective coil in T–4.
	Between term. 6 of T–4 and term. 5 of V–15	560	Defective coil in T–4 or R–60.
	Between terms. 3 and 5 of V–3	0	Defective wire.
	Between term. 3 of V–3 and term. 1 of V–2	100K	Defective R–7.
	Between term. 1 of V–3 and term. 4 of T–4	0	Defective wire.
	Between term. 7 of V–3 and term. 1 of V–6	0	Defective L–3 or L–11.
First i-f amplifier V–4	Between terms. 6 and 1 of V–4	220K	Defective R–12.
	Between terms. 2 and 3 of V–4	0	Defective primary coil in T–6.
	Between term. 3 of V–4 and term. 5 of V–15	4, 460	Defective R–16, L–6, or R–60.
	From term. 7 of V–4 to term. 5 of K–1 (X–17).	6	Defective L–5, R–13, or R–14.
	From term. 5 of V–4 to term. 7 of V–5	0	Defective L–8.
Second i-f amplifier V–5.	From term. 6 of V–5 to term. 1 of V–5	220K	Defective R–17.
	From terms. 2 and 3 of V–5	0	Defective primary coil in T–7.
	From term. 3 of V–5 to term. 5 of V–15	4, 460	Defective R–19, L–6, or R–60.
	From term. 5 of V–5 to term. 5 of V–6	0	Defective L–7 or L–9.

Circuit or stage	Point of measurement	Nominal reading (ohms)	Probable trouble
Third i-f amplifier V–6	From term. 2 to term. 1 of V–6	220K	Defective R–20.
	Between terms. 2 and 3 of V–6	0	Defective primary coil in T–8.
	From term. 3 of V–6 to term. 5 of V–15	4, 500	Defective R–23, L–10, L–6, or R–60.
	From term. 7 of V–6 to term. 5 of K–1 (X–17).	39	Defective R–21.
Fourth i-f amplifier V–7.	From term. 2 to term. 1 of V–7	220K	Defective R–24.
	From term. 2 to term. 3 of V–7	0	Defective primary coil in T–9.
	From term. 3 of V–7 to term. 5 of V–15	4, 500	Defective R–26, L–18, L–12, L–10, L–6, or R–60.
	From term. 7 of V–7 to term. 7 of V–8	0	Defective wire.
Limiter stage V–8	From term. 6 of V–8 to test point E–3	225, 600	Defective R–27 or R–29.
	From term. 2 to term. 3 of V–8	0	Defective coil in T–10.
	From term. 2 of V–8 to term. 1 of T–11	0	Defective wire.
	From term. 3 of V–8 to term. 5 of V–15	1, 600	Defective R–30, L–13, L–18, L–12, L–10, L–6, or R–60.
Discriminators V–19 and V–10.	From term. 2 of V–9 to term. 3 of V–10	0	Defective discriminator coil in T–11
	From term. 6 to term. 3 of T–11	1	Defective discriminator coil or L–14 in T–11.
	From term. 5 of T–11 to term. 3	1	Defective discriminator coil on L–14 in T–11.
	From term. 3 of V–9 to term. 7 of V–10	360K	Defective R–33 or R–32.
	From term. 3 of V–9 to test point E–4	1. 18 meg	Defective R–31 or R–33.
	From term. 2 or 4 of T–11 to term. 3 of T–11.	180K	Unbalanced R–31 or R–32.
	From term. 3 of V–9 to test point E–5	1 meg	Defective L–15 or R–34.
	From term. 1 of V–9 to term. 2 of T–11	0	Defective wiring.
	From term. 7 of V–9 to term. 7 of V–12	0	Defective L–16 or L–17.
First audio amplifier V–13.	From term. 3 of V–13 to term. 3 of J–5 (with VOLUME control R–62 in OFF position).	0	Defective arm, R–62, or wiring.
	From term. 3 of V–13 to term. 2 of J–5 (with R–62 in extreme clockwise position).	0	Defective R–62 or wiring.
	From term. 3 of V–13 to term. 3 of V–11 (R–62 in extreme counterclockwise position).	1 meg	Defective R–40.
	From term. 2 to term. 3 of J–5	500K	Defective R–62.
	From term. 2 to term. 4 of V–13	1, 000	Defective primary (winding 1–2–3) of T–13.
	From term. 4 of V–13 to term. H of J–8	0	Defective wiring.
	From term. A of J–7 to chassis	25	Defective winding 7–8–9 of T–14.
	From term. 7 of V–13 to term. 1 of V–12	0	Defective wiring.
	From term. 1 of X–19 to chassis	0	Defective wiring.
	From term. 1 of V–13 to term. 7 of V–12	0	Defective wiring.
	From term. 1 of V–13 to term. 5 of C–73 (X–19).	0	Defective wiring.
	From term. 7 of V–13 to term. 7 of C–73 (X–19).	0	Defective wiring.
Audio power amplifier V–14.	From term. 3 to term. 5 of V–14	600	Defective winding 4–5–6 of T–13.
	From term. 3 or term. 5 of V–14 to chassis	300	Defective T–13.
	From term. 2 to term. 6 of V–14	700	Defective winding 1–2–3 or T–14.
	From term. 2 of V–14 to term. 5 of X–15	350	Defective R–57.
	From term. 4 of V–14 to term. 1 of J–2 (S–1 in 6, 12, and 24 VOLTS position).	0	Defective wiring or S–1.
	Same as above (S–1 in OFF or EXTERNAL SUPPLY position).	Infinity	Defective S–1.

Circuit or stage	Point of measurement	Nominal reading (ohms)	Probable trouble
Fixed level audio amplifier V–12.	From term. 3 of V–12 to term. 2 of P–5 (R–42 in extreme clockwise position).	200K	Defective R–41, R–42, R–43, or R–62.
	From term. 3 of V–12 to term. 3 of P–5 (R–42 in extreme clockwise position).	380K	Defective R–41, R–42, R–43, or R–62.
	From term. 2 or term. 6 of V–12 to term. 4 of V–12.	1, 700	Defective winding 1–2–3 of T–12.
	From term. 4 of V–12 to term. J of J–8	200	Defective R–45 or R–47.
	From term. 4 of V–12 to term. 5 of V–15	660	Defective R–45 or R–60.
	From term B of J–8 to chassis	25	Defective winding 7–8–9 of T–12.
Tuning oscillator V–10	From term. 4 to term. 5 of V–10	0	Defective wiring.
	From term. 6 of V–10 to chassis (S–3 in TUNE position).	27K	Defective R–35.
	From term. 6 of V–10 to switch S–3 side of C–84 (S–3 in TUNE position).	Infinity	Defective Y–1, J–4, P–4 coax cable, or S–3.
	From term. 6 of V–10 to switch S–3 side of C–84 (S–3 in either DIAL LIGH position).	Infinity	Defective S–3.
Squelch circuit V–11	From term. 6 to term. 1 of V–11	210K	Defective L–20A or R–69.
	From term. 6 of V–11 to term. 6 of V–7	270K	Defective L–20A or R–68.
	From term. 5 of V–11 to term. 4 of V–12	300	Defective L–20B.
	From term. 4 of V–11 to term. J of J–8 (SQUELCH control in extreme clockwise position).	0	Defective R–65 or S–4.
	Same as above (SQUELCH control in OFF position).	Infinity	Defective S–4.
	From term. 3 of V–11 to term. 3 of V–13 (VOLUME control in OFF position).	1 meg	Defective R–40 or R–62.
	From term. 3 of V–11 to term. 3 of V–12 (R–32 in extreme clockwise position).	1.4 meg	Defective R–40, R–43, R–42, R–41, or R–62.
	From term. 3 of V–11 to term. 1 of V–1	750K	

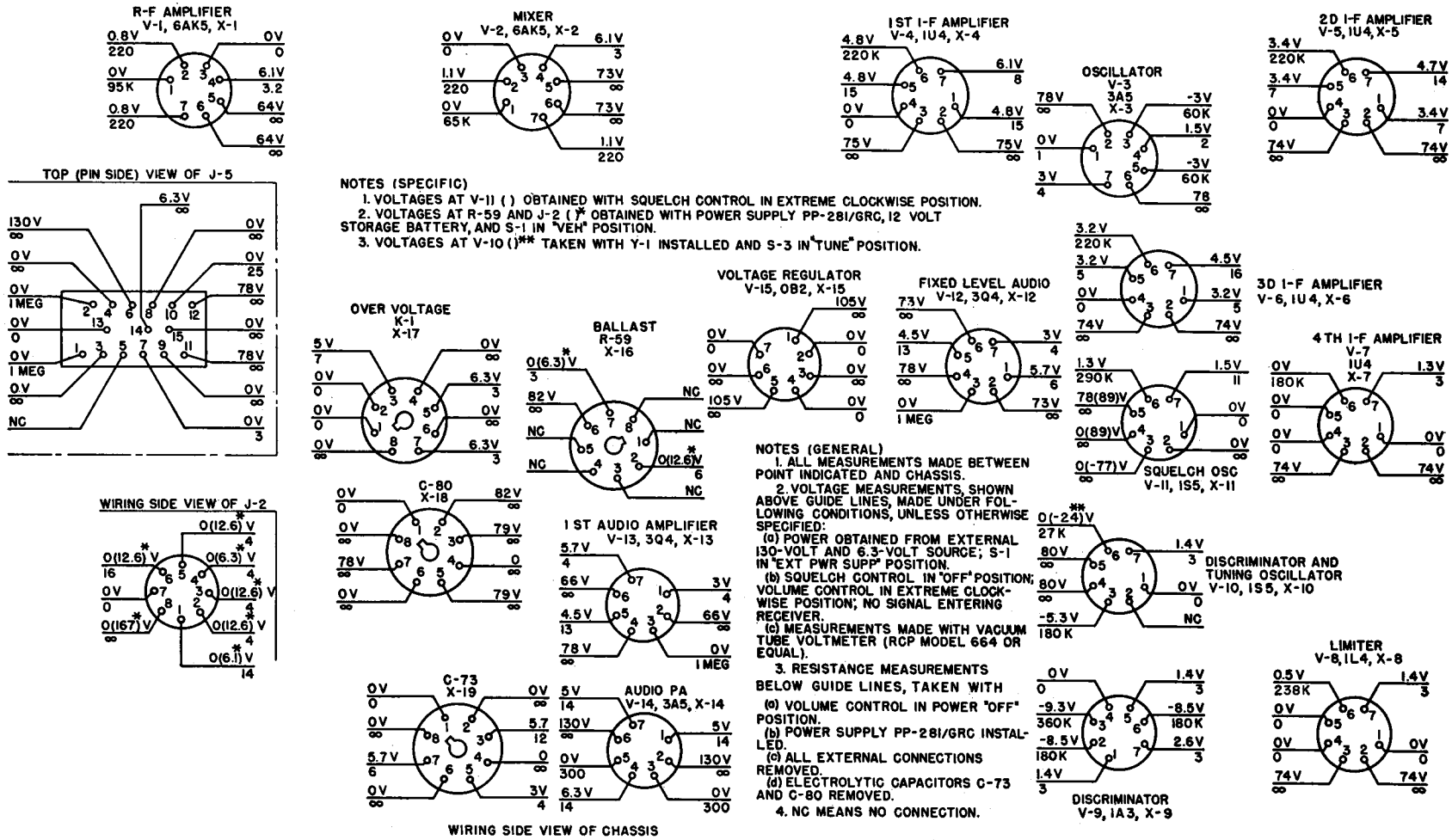


Figure 32. Resistance and voltage chart.

49. D-C Voltage Measurements
(fig. 32)

a. Make the pertinent d-c voltage measurements indicated in figure 32. These measurements serve to locate faults which 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 by rotating the VOLUME control in the clockwise direction. As before, turn switch S–1 to either the 6, 12, and 24 VOLTS or to 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 41. All voltage measurements shown in figure 32, 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 (fig. 35, 36, or 37) to identify the circuit components involved in a particular measurement. Note especially those circuits which are changed by the setting of the switches. Note, for example, that screen voltage is not applied to squelch tube V–11 until the SQUELCH control is turned in the clockwise direction. Note also that no power is applied to the first audio amplifier stage, V–13, unless the jumper strap is connected between terminals H and J of J–8. The required readings are shown above the guide lines from the socket terminals. Use Electronic Multimetetr TS–505/U (M–1) as a voltmeter. Repair any part found to be defective as a result of the voltage measurement.

b. The data given in (1) through (4) below supplement the measurements indicated in figure 32. They also supplement (and in some cases repeat) the data given in the trouble sectionalization chart. Readings are obtained with a high-impedance vacuum-tube voltmeter, Electronic Multimeter TS–505/U (M–1). The points listed are those at which readings obtained with a low-impedance voltmeter lose significance because of the shunting effect of the meter. Except where otherwise stated, all measurements are made between the test point indicated in the table and the chassis.

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

Point of Measurement	Circuit or stage involved	Nominal voltage reading (volts dc)
E–3	Limiter grid (V–8)	0 to 0.4
E–4	Discriminator circuit	0
E–5	Discriminator circuit	0
E–] (S–2 in TUNE).	Tuning oscillator output (V–10).	0

(2) For measurements at oscillator grids, measure between test 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)
V–3, pin 3	Receiver oscillator	−3 to −7
V–10, pin 6	Tuning oscillator:	
	S–3 in TUNE position	25
	S–3 in DIAL LIGHT OFF position.	0
	S–3 in DIAL LIGHT ON position.	0
V–11, pin 6	Squelch oscillator:	
	SQUELCH control ON	−2.5
	SQUELCH control OFF	−1.0

(3) The following measurements are a summary of the measurements made in paragraph 44 of discriminator output voltages.

(*a*) Connect M–1 between test point E–4 (fig. 30) and chassis or test point E–5 (fig. 30) and the chassis as indicated.

(*b*) Connect a 4.3-mc generator, G–2 through a .003-uf capacitor between pin 6 of V–7 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)	Noraml reading (volts dc)	
	At test point E–4	At test point E–5
4370	8	+10
4330	15	+10
4300	22	0
4230	27	−10
4270	27	−10

(4) The following measurements of squelch bias voltages supplement the checks of paragraph 44, and the measurement at pin 6 of V–11 ((2) above). Use meter M–1 to make the indicated voltage measurements. Turn the SQUELCH control to the extreme clockwise position. Measurements are made between indicated test points and chassis.

Point of measurements	Nominal reading (volts dc)
Pin 3 of V–13	−55
Pin 3 of V–12	−55
Pin 1 of V–1	−2

50. Check of Inter-Unit Strapping Connections

a. The continuity checks outlined below should be made to determine whether the strapping connections between the multiconnectors in the receiver are properly made. The strapping connections serve to tie in the receiver with other units of the system in which it is used. The trouble in a system may have been traced to a receiver simply because one of these strap connections is broken.

b. Using an ohmmeter (Electronic Multimeter TS–505/U or equivalent), check for continuity between the points listed below. In each case a reading of 0 ohm should be obtained. Otherwise, the wire connnecting the two terminals in question is broken or the connector pin is defective. Repair as necessary.

From term. A to term. F of J–8.
From term. A of J–8 to term. L of J–7.
From term. E of J–8 to term. A of J–7.
From term. D of J–8 to the chassis.
From term. B of J–7 to the chassis.
From term. E of J–8 to the chassis.
From term. H of J–7 to the chassis.
From term. C of J–6 to the chassis.
From ANT connector J–3 to ANT binding post E–6.

Section II. REPAIRS

51. Repair Procedures

This section describes the procedure for disassembling the major subassemblies of Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC, and the removal and replacement of components and subassemblies found to be defective by the trouble-shooting procedures of the preceding section and by the inspection procedure described below.

52. Disassembly

(figs. 4 through 6 and 25 through 31)

Caution: Be careful in going through the disassembly procedure. The assembly is rather 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. Save all screws, nuts, and washers removed during the disassembly. They will be needed to reassemble the unit.

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 proceed as follows:

(1) Loosen the six spring preloaded Dzus fasteners which are distributed around the edges of the front panel.

(2) Slide the panel-and-chassis assembly out of the case. Take care not to damage any wiring or components while removing the cover, or at any time while the panel-and-chassis assembly is being handled without the cover.

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

(1) Loosen the three screws which hold the latch to the power supply compartment. Turn the screws about one half 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 which 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. 3). The other two screws, accessible from the bottom of the assembly (fig. 6), attach the frame to brackets on the power supply compartment.

(2) Remove the three screws which hold the wrap-around frame to each of the two shields (i-f shield (fig. 3) and discriminator shield (fig. 6)) and to the heat reflector shield around the electrolytic capacitors C–80 and C–73 (fig. 6).

(3) Spread the end of the frame in order to disengage the projections on the chassis from the slits in the wrap-around frame.

(4) 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 P–1 and J–1. Coaxial connector P–1 is attached to the short piece of coaxial cable, which in turn is connected to the ANT connector on the front panel (fig. 31). Connector J–1, which is mounted on a bracket at the edge of the chassis adjacent to the back of the dial-drive assembly, is connected to antenna input circuit T–1 on the chassis (fig. 25).

(2) Disengage connectors P–4 and J–4. Coaxial connector P–4 is attached to the end of the long coaxial cable, which in turn is connected to the TUNE-DIAL LIGHT (ON-OFF) switch on the panel. Mating connector J–4 (fig. 25) is mounted near the tuning oscillator crystal on the large resistor and capacitor bracket.

(3) Disengage multiconnectors P–5 and J–5. These 15-pin connectors are located on the component side of the chassis (figs. 25 and 31) in the angle formed by the power supply compartment and the dial-drive assembly. To disengage these connectors, pull at the handle on P–5. 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 (fig. 1), and pull the knob off the shaft.

(2) Remove the screws (fig. 1) on the faces of each of the three detent adjusting knobs (upper left-hand corner of panel), and pull the knobs off the shafts.

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

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

(5) Remove the two screws which hold the dial-drive assembly to the front panel

(figs. 4 and 5). These screws are located on each of the two corner legs at the top of the assembly.

(6) Remove the two screws (figs. 4 and 5) which hold the power supply compartment to the front panel. These screws are located on the mounting brackets at each end of the compartment.

(7) 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 accurately calibrated signal generators. The procedure for removing the assembly from the chassis is as follows:

(1) Using a hex wrench, remove the large nut which holds the bracket on the right side of the power supply compartment to the large resistor assembly.

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

(3) Remove the screw which holds the chassis to the power supply compartment, near the corner of the power supply compartment, which fits into the L cut-out of the chassis.

(4) Turn the unit wiring (right) side up, and remove the three screws on the bottom of the power supply compartment which hold the retaining ring for J–2 to the power supply compartment.

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

(6) Slip the retaining ring for J–2 over the cable and withdraw the cable and J–2 from the power supply compartment.

(7) Loosen the two #6 Allen setscrews which hold the dial-drive assembly bellows coupling to the variable capacitor shaft. To gain access to these screws, rotate the dial until the cut-out 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 which hold the chassis assembly to the projection from the back of the dial drive and detent assembly casting.

(9) Unsolder the lead from the variable capacitor C–3 which is connected to antenna trimmer capacitor C–4.

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

53. General Inspection of Chassis and Panel

If the unit has been disassembled as described in the preceding paragraph, it is possible to inspect all parts and wiring. Inspect the unit thoroughly for abnormal conditions. The cause of such conditions should be determined and the defects remedied. Repair instructions for defective components (located by the inspection procedure described below, or by the trouble-shooting procedure described in the preceding paragraphs) are given in paragraphs 55 and 56.

a. Inspect all parts for rust, corrosion, breakage, or other mechanical damage. Inspect wiring for loose connections, frayed or burned insulation, and inspect mounting hardware for mechanical defects. Examine the chassis for dirt or corrosion.

b. Examine wiring for charred, defective, or broken insulation. Examine lugs on capacitors, transformers, chokes, switches, connectors, and tube sockets for bad connections. Examine hardware for looseness. Loose mounting hardware may cause intermittent noises in the receiver which are very difficult to locate except by visual inspection. Inspect sockets for broken, excessively spread, or corroded and dirty contacts. Make sure that mounting hardware and rivets hold components firmly to the chassis. Be sure the tube shields

are held firmly in their bases when installed, and that springs are properly seated within the tube shield.

c. Where applicable, adjust and try the action of a connector after adjustment. Make sure that solder connection and wiring to connectors is not broken, frayed, or loose.

d. Examine fixed capacitors for signs of discoloration, leaks, bulging, dirt, loose mounting hardware, and loose connections. Melted or oozing wax or other dielectric is a sure sign of damage to the part. Such capacitors should be removed for electrical check, and should be replaced with good ones.

e. Examine resistors for blistering, discoloration, or other signs of overheating. Inspect connecting leads for corrosion, dirt, dust, looseness, or broken or trailing strands of wire. Discoloration of a resistor usually indicates that the component has been operating under overload and overheating and is to be taken as a sign of a defect in another part. Note, however, that power resistors may show discoloration because they have been tropicalized. Such discoloration is not a sign of a defect.

f. Examine the variable capacitor plates for signs of damage or misalinement or binding that may cause them to touch other plates during turning. Check for loose terminals, mounting hardware, and connections.

Note. Unless trouble with the variable capacitor is definitely suspected, it is not advisable to remove the capacitor cover. If necessary to remove the cover, be careful not to damage or bend the plates.

g. Remove covers of tuning assemblies by removing the retaining screws at the top of the can. Examine the components inside the can to make sure they are not damaged, and that the wiring between the component and terminal lugs is not broken, frayed, or loose. Check tuning slugs to make sure they are not loose or broken and that the spring clips are installed. These clips insure that the tuning slugs remain firm after adjustment.

Caution: Do not turn adjusting slugs, since that will throw the set out of alinment.

h. Examine crystal, crystal socket, and spring clips on socket to make sure that the crystal is held firmly in place.

i. Operate panel-mounted switches and the internal switch to each one of their operating positions to determine that they work easily with no searching for contacts. Where switch contacts are accessible, examine for evidences of corrosion, improper contacts, or dirt. Proper contacts may best be determined by continuity measurements. Refer to the schematic diagram for continuity details (figs. 35 through 37).

j. Make sure that all metal sealed cans are firmly mounted to the assembly posts. Loose cans may contribute to noise and poor operation of the equipment.

k. Screw on the knob on the dial-drive assembly and rotate the dial through its entire operating range, noting evidences of scraping, binding, or other evidences of poor operation. Examine dial-drive assembly to make sure that all springs are attached and are not defective. Eight springs are mounted on the dial-drive assembly as indicated in figures 8 and 9. One spring is attached between the index plate and the post on which the detent adjusting shafts are located. Three long springs are attached between a post on the right side of the assembly and each one of the three detent levers. Three small springs are attached between a post at the top right of the assembly and each one of the detent flags. One spring is attached to the sector gear which drives the coupling. This spring holds the two parts of the sector gear together to prevent backlash. Make sure the spring is in place. Check to see that the teeth on the two halves of the sector gear line up with each other.

54. Cleaning

Dirt or corrosion will interfere with electrical continuity and mechanical efficiency of the parts and of the unit by causing switches to be jammed or circuits to be shorted or insulated. For these reasons, it is important to clean all parts of the chassis and panel carefully and thoroughly. No set method can be given for removal of dirt because of the many ways and places it can collect. Cleaning should be done with a lintless cloth, #000 sandpaper, crocus cloth, soft brush, sharp edge of a screw driver or penknife. Normally, dust and grease can be removed with a cloth or brush moistened with solvent (SD). Never use gasoline. Extra care must be exercised in cleaning delicate parts or parts which are difficult to reach in order to avoid damage to wiring or components. When necessary to remove portions of the moisture-fungus-proofing in order to clean a part properly, refinishing is essential (par. 62). If available, use

an airhose to blow out dust and lint from the chassis. Make sure, however, that no oil or water is carried along with the air stream and that the stream is controlled so that damage to small parts, such as resistors and capacitors, does not result. To determine that the air stream does not carry air or water place a clean white sheet of paper in its path and observe any evidences of streaking or moisture. When handling the chassis, be careful not to break wiring or small parts. Lift the chassis by the metal sides and keep fingers clear of the insides where small wires and components subject to breakage are located.

55. 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 (refer to schematic diagrams, figs. 35 through 37).

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 crosstalk, 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 solder until all traces of rust, corrosion, and paint or varnish are removed. Dust the sprayed parts with a small clean brush. 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 tinned surfaces. 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.

f. Retropicalization. If the parts being replaced require a special treatment, such as retropicalization, follow the instructions given in paragraph 61.

56. 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. 52) 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. It is a matter of judgment to decide when and to what extent it is necessary to disassemble the unit, and when it is possible to do the replacement without disassembly.

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

(1) Disassemble the chassis (par. 52) 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 (fig. 35, 36, or 37).

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

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

(1) Disengage the panel from the rest of the assembly to gain access to the rear of the panel (fig. 31).
(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 (fig. 35, 36, or 37).
(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, S–3, may be removed as follows:

(1) Disconnect the panel from the rest of the assembly (par. 52).
(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 conections 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-nose 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 contracts to make sure that they are properly made and that the switch turns freely to its operating positions. The TUNE position of test switch S–3 is a spring-return position. Check whether the switch is returned from this position to the adjacent DIAL LIGHT 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. 35 through 37). Clean away all solder drops.
(8) Reattach the panel to the rest of the assembly.

e. Other Panel-Mounted Components.

(1) Terminal board E–24 mounted on the rear of the front panel mounts a number of small capacitors (fig. 29). To gain access to the capacitors for replacement, remove mounting screws near 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 holding the part to the panel, unsolder the panel wiring, and replace as described in (1) above.

f. I-F 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 29 and 30. 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. In some cases, particularly to gain access to parts mounted on the side facing the interior of the chassis or to tube socket X–5, it may be necessary to detach the shield. Note that tube socket X–5 is mounted under the i-f shield (fig. 28). To detach the shield, simply remove the two mounting screws which 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 wiring during this procedure.

g. TUBES. A tube puller is provided to permit removal of tubes from their sockets. This tube puller is mounted in a bracket on the power supply compartment (component side). To remove a tube, remove the tube shield by pressing down lightly on the shield, rotating one half-turn in the counterclockwise direction and releasing the downward pressure. The shield will then come off easily. Using the tube puller, remove the tube from its socket by placing the puller well over the tube and pulling in a direction perpendicular to the chassis. Avoid jiggling or rocking the tube in its socket to prevent damage to the prongs. Label any tube as soon as it is removed so that it can be replaced in its proper socket. Whenever the condition of the tube permits, it is desirable to restore the original tube. This will minimize the necessity for realining tuned circuits because of differences in interelectrode capacitances. Tube reference symbols are stamped on the chassis alongside the tube socket (figs. 4 and 28).

h. CIRCUIT LABEL. A circuit label rolled up in a compartment toward the rear of the chassis (component side) is provided to permit identification of electrical parts and circuit components which are to be repaired or replaced. Be sure to replace the circuit label in its compartment after the repair of the equipment has been completed. When the circuit label is properly folded it will fit snugly in the compartment.

57. Inspection, Repair, and Replacement of Dial-Drive and Detent Mechanism

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 involving very close fit tolerances of small parts. For this reason, it 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. 52). In the following paragraphs, assume that the front panel has been removed.

b. REMOVAL OF INDEX WINDOW. 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 holding 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. Replacement of Index Tension Spring.

(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.

d. 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.

e. Removal of Drive Gear.

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

(2) Rotate the tuning dial until the cut-out 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) Using a #6 Allen setscrew wrench, loosen the two setscrews which 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 under side 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.

f. Removal of Dial and Detent Disk Assembly.

(1) Turn the drive mechanism into any undetented dial position.

(2) Remove the retaining C ring washer from the shaft on which the detent assembly turns, using a pair of pointed long-nose pliers. Note the small pinhole 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 loosening the other.

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

(5) Lift off the dial and detent assembly.

g. 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 #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 brake shoes is exposed and may be removed if necessary.

h. Removal of Detent Supporting Frame.—As a rule, it should not be necessary to remove the detent supporting casting from the chassis for accessibility to 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 a $\frac{1}{16}$-inch x $\frac{5}{8}$-inch groove pin. The flexible coupling is attached to the variable gang capacitor shaft with #4 Allen setscrews.

i. 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. 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 hex wrench and a right-angle screw driver. The nuts are easily accessible when the dial and detent disk assembly has been removed as described in *f* above.

j. Reassembly. To reassemble the dial-drive mechanism, reverse the procedure outlined above.

58. 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 #6 Allen setscrews. Normally, it is inadvisable to detach this coupling from the capacitor shaft, since 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 precedure will aid in properly resetting the capacitor to its correct angular location.

a. Using a #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 ½-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 68. 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 holding the cover in place.

59. Reassembling the Equipment

In general, the procedure for reassembling the equipment follows the reverse of the procedure for disassembling the unit (par. 52). 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 58.

a. Power Supply Compartment and Dial Drive and Detent Assembly. To reattach the dial-drive and detent assembly with power 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 cut-out in the receiver chassis.

(3) Restore the two machine screws, lockwashers, and nuts which 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 X–14. The other hole is located near trimmer capacitor C–3C (figs. 4 and 25).

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

(6) Restore the two lockwashers and screws which 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 set screws in the coupling collar (par. 58).

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 which 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 the top of the casting.

(4) Restore the two mounting screws which 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 P–1 and J–1 and P–4 and J–4. Restore the connection between multiconnectors P–5 and J–5.

e. PLUG-IN COMPONENTS. Make sure that all tubes, ballast lamp, thermal relay, voltage regulator, and plug-in electrolytic capacitors C–73 and C–80 are properly installed in their sockets. Make sure that tube shields are installed over all tubes.

Section III. LUBRICATION AND WEATHERPROOFING

60. Lubrication

Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC do not require lubrication in the field. Certain parts are self-lubricated. Included in this category are the dial-drive mechanism and the O-ring seals on shafts of panel-mounted components. Do not attempt to oil or grease any of these parts since doing so would require disassembly. Normally, the dial-drive mechanism must not be disassembled in the field.

61. Weatherproofing and Rustproofing

a. GENERAL. Signal Corps equipment, when operated under severe climatic conditions, such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. TROPICAL MAINTENANCE. A special moisture-proofing and fungiproofing treatment has been

devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained fully in TB SIG 13 and TB SIG 72.

c. WINTER MAINTENANCE. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained fully in TB SIG 66.

d. DESERT MAINTENANCE. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained fully in TB SIG 75.

e. RUSTPROOFING. Rust and corrosion can be prevented by touching up bared surfaces. Clean where necessary with fine sandpaper. Never use steel wool.

Note. For further information on general preventive maintenance techniques, refer to TB SIG 178.

62. Refinishing

a. When the finish on the case or panel has been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces. Use #00 or #000 sandpaper to clean the surface down to the bare metal; obtain a bright smooth finish. Instructions for refinishing badly marred panels and cases are given in TM 9–2851.

Caution: Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touch-up job is necessary, apply paint with a small brush. Remove rust from the case by cleaning corroded material with solvent (SD). In severe cases it may be necessary to use solvent (SD) to soften the rust and to use sandpaper to complete the preparation for painting. Paint used will be authorized and consistent with existing regulations.

Section IV. ALINEMENT PROCEDURES

63. Test Equipment Required for Alinement

The test equipment required for alinement of the receiver units is the same as that listed in paragraph 39.

64. Initial Procedures

a. INITIAL SWITCH AND CONTROL SETTINGS. Unless otherwise specified, the controls should be set as follows:

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

b. TEST CONNECTIONS. Unless otherwise called for under the alinement procedures, the test connections are the same as described in paragraph 41.

c. CHECK OF BUILT-IN TUNING OSCILLATOR OPERATION.

(1) Connect a vacuum-tube voltmeter, M–1, between the grid (pin 6) of tuning oscillator V–10 and chassis.

(2) Turn test switch S–3 to the TUNE position, and observe whether the following requirement is met.

Requirement: The meter should read approximately 21 volts.

(3) Turn the test switch to either of the DIAL LIGHT positions.

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

(4) If the above requirement is not met, and trouble with the tuning oscillator is indicated, refer to paragraphs 44, 48, and 49 to clear the trouble before proceeding.

65. Calibration of Test Signal Generator Frequency

Since a 4.3-mc crystal oscillator is contained in the receiver for calibrating the tuning dial, this crystal oscillator will be used as a frequency standard for adjusting the test oscillator frequency. This adjustment is made as follows:

a. ADJUSTMENT OF TEST SIGNAL GENERATOR FREQUENCY FOR I–F ALINEMENT OR TESTS.

(1) Connect the signal generator to the test points specified in the alinement or test procedure through a .003-uf capacitor.

(2) Operate test switch S–3 on the receiver panel to the TUNE position.

(3) Tune the signal generator until a beat note is heard in a headphone connected to either of the phone connections on the panel connector.

(4) Set switch S–3 to either of the DIAL LIGHT positions to turn off the crystal oscillator.

b. Adjustment of Test Signal Generator Frequency for R-F Alinement or Tests. The red-dot calibration points on the dial may be used as a guide in adjusting the test signal generator at frequencies which are multiples of 4.3 mc. The red dots represent frequencies which are harmonics of 4.3 mc. The procedure is similar to that described in *a* above, except that since the alinement of the receiver oscillator and the calibration of the dial are unknown factors at this point, it is necessary first to find the true *red-dot* position on the dial. Proceed as follows:

(1) Connect the signal generator to the test point specified in the test or alinement procedure. Be sure to include a blocking capacitor as required.

(2) Set the signal generator output level to zero and operate switch S–3 to the TUNE position.

(3) Starting with the lowest end of the dial, turn the dial until a zero beat note is heard in the headphones. Note the point on the dial for which the zero beat is obtained. This is a true *red-dot* position on the dial. (If the dial calibration is correct, the beat note will be obtained at or near a red dot on the dial.)

(4) Leave the dial set in the position determined above. Set switch S–3 in either of the DIAL LIGHT positions and raise the level of the signal generator output to some convenient level, and tune its frequency until an audio note and finally a zero beat note are heard again in the headphones.

66. Alinement of Receiver I-f Amplifier and Limiter Stages

a. Determination of I–F Reference Level (Reference A). The proper value for alinement of the i-f amplifier and limiter stages of the receiver is 20 ua or .5 volt. This reference level hereafter will be referred to as *reference A*.

(1) Connect the 4.3-mc test signal generator G–1, in series with a .01-uf capacitor between the grid (pin 6) of fourth i-f amplifier stage V–7 and chassis.

(2) Connect meter M–1 between the grid (pin 6) of tube V–8 and chassis. Hereafter, the meter thus connected will be referred to as the *limiter meter.*

(3) Adjust the test signal frequency for zero beat with the tuning oscillator. To do this:

(*a*) Operate the test switch on the front panel (S–3) to the TUNE position.

(*b*) Adjust the test signal frequency to approximately 4.3 mc, and then make a fine adjustment of frequency until a beat note is heard in the headset, connected to any pair of audio output terminals.

(*c*) Return the test switch to either of the DIAL LIGHT positions.

(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, the fourth i-f amplifier stage, V–7, is probably defective. The tube then should be checked and replaced if found defective. If necessary, make point-to-point resistance measurements to locate a defective component. After repairing the fault and obtaining the required reading, proceed with the tests and adjustments described in *b* below. If the requirement still is not met, check the possibility of misalinement of stage V–7. Leave the test equipment connected as before and proceed as follows:

(*a*) Connect the shunting unit (the series arrangement of a .0062-uf capacitor and a 2,700-ohm ½-watt resistor) between the plate (pin 2) of V–7 and chassis.

(*b*) Adjust the tuning slug of T–9 marked S (secondary) until the limiter meter shows a peak reading.

(*c*) Shift the connection of the shunting unit to the grid (pin 6) of limiter stage V–8 and adjust the slug of T–9 marked P (primary) until the limiter meter again shows a peak reading.

(*d*) Repeat (*a*) through (*c*) 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. Due to the shunting effect of the shunting unit, the test signal generator will have to be increased for the tuning adjustments of T-9.

b. Alinement Procedure.

(1) Connect generator G–1 and meter M–1 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-uf capacitor in series with a 2,700-ohm ½-watt resistor) between the plate (pin 2) of V–7 and chassis.

(3) Adjust the tuning slug of T–9 marked S until the limiter meter shows a peak reading.

(4) Shift the connection of the shunting unit to the grid (pin 6) of limiter stage V–8 and adjust the slug marked P of T–9 until the limiter meter shows a peak reading.

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

(6) Adjust the frequency for zero beat with the tuning oscillator and 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 V–6, and adjust the slug marked S of T–8 to obtain a peak reading on the limiter meter.

(8) Shift the shunting unit connection to pin 6 of V–7, and adjust the slug marked P on T–8 until limiter meter shows a peak reading.

(9) Shift the test signal generator connection to pin 6 of V–5.

(10) Adjust the frequency for zero beat with the tuning oscillator and the test signal level to obtain reference A reading on the limiter meter.

(11) Shift the shunting unit connection to the plate (pin 2) of V–5.

(12) Adjust tuning slug marked S at T–7 to obtain peak reading on limiter meter.

(13) Shift shunting unit connection to pin 6 of V–6 and adjust the P slug on T–7 to obtain a peak reading on the limiter meter.

(14) Shift the signal generator connection to pin 6 of V–4.

(15) Adjust the frequency and the level as before.

(16) Shift the shunting unit connection to pin 2 of V–4 and adjust slug S on T–6 for a peak reading on the limiter meter.

(17) Shift the shunting unit connection to pin 6 of V–5 and adjust slug P on T–6 for a peak reading on the limiter meter.

(18) Shift the signal generator connection to pin 1 of V–2 and adjust the frequency and the level as before.

(19) Shift the shunting unit connection to pin 5 of V–2 and adjust slug S or T–5 to obtain a peak reading on the limiter meter.

(20) Shift the shunting unit connection to pin 6 of V–4 and adjust slug P on T–5 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 on the limiter meter. Note the level required to obtain that reading.

Requirement: For a properly alined i-f amplifier limiter circuit, the test signal level should be approximately 150 uv when reference B limiter meter reading is obtained.

67. Discriminator Alinement

a. Connect signal generator G–2 through a .06-uf blocking capacitor between pin 6 of V–7 and chassis.

b. Connect the limiter meter between the grid (pin 6) of V–8 and chassis.

c. Connect meter M–1 (hereafter called the *discriminator meter*) between test point E–5 and chassis.

d. Adjust the frequency of the signal generator for zero beat with the tuning oscillator, and adjust the level to obtain the reference A level, as described in paragraph 66*a*.

e. Adjust the tuning slug in tuning assembly T–11 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 ±5 kc from the setting of the signal generator for which the zero discriminator meter reading (*e* above) is obtained. The difference between the numerical values (disregarding signs) of the two peak readings should not be greater than 2 volts dc. The two peak readings should be of opposite polarity (one should be + and the other −). Each of the two peak readings should be approximately 17 volts dc.

h. If the meter readings at the peaks are not equal to 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 T–10 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 steps (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, zero beat with the tuning oscillator, and observe whether the discriminator meter still reads zero as in *e* above.

j. If the meter reading is not zero, readjust the tuning slug of T–11 for zero deflection of the discriminator meter, and repeat the steps in *f* through *i* above, and if necessary, *j*, until the requirements following *g* and the requirement following *i* are met.

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 M–1 between test point E–4 and chassis. (The meter thus connected will be referred to as the *alinement meter*, since if desired, all alinement of the r-f and i-f circuits may be made for a peak deflection on this meter.)

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

(3) Adjust the tuning slug of T–10 for a peak reading on the alinement meter.

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

(5) Proceed with the tests and adjustments of *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 C–67, and 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 C–67 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 has been completed, check the discriminator alinement as follows:

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

(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.

68. Alinement Checks of Receiver Oscillator and R-f Amplifier Circuits

a. Determination of R-F Reference Level (Reference B). For alinement of the r-f ampli-

fier 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 r-f and oscillator circuits.

(1) Connect test signal generator G–2 to the grid (pin 1) of the mixer stage V–2 through a .0062-uf capacitor.

(2) Connect limiter meter M–1 as before, between grid (pin 6) of V–8 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.

Requirement: The test signal level required to obtain reference B reading of the limiter meter should be approximately 100 uv but will vary widely between sets.

b. Check of Receiver Oscillator Alinement.

(1) Connect a pair of headphones between terminals E and D of J–8.

(2) Operate test switch S–3 on the receiver panel to the TUNE position.

(3) Turn the receiver dial to the calibrate point (red dot) nearest the h-f end of the dial. The calibration point frequencies for the three receivers are tabulated 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 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 channel division (one channel division is the space between any two dial markings) of the red dot.

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

(6) Rotate the dial in the vicinity of the red dot to obtain a beat note in the headphones. Note whether the requirement following *c* (4) below is met.

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

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

c. Precise Check of Oscillator Alinement and Dial Tracking, Using Crystal Calibrator. The following checks are based on the assumption that a crystal calibrator is available. The crystal calibrator should be capable of providing accurate check frequencies at each integral mc setting of the receiver dial. Crystal calibrator Ferris type 33A, or equivalent, may be used. If available, Receiver-Transmitter RT–70/GRC may be used to provide such check frequencies, since the calibration oscillator built into that unit uses a 1-mc crystal to provide harmonic frequencies of 1 mc through the tuning range of each of the three receivers. Refer to the instruction book for that unit for the method of use of the built-in 1-mc harmonic generator (calibrate oscillator).

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

(2) Operate test switch S–3 on the receiver panel to 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) Rotate the dial, in the vicinity of that integral mc setting, to obtain a zero beat note in the headphones.

Requirement: The zero beat note should be obtained when the hairline on the dial index window is within ½-scale division of the mc mark on the dial.

(5) Repeat the above procedure 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 hairline on the dial window is within ½-scale division of the integral mc mark on the dial.

(6) 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 69, and dial calibration corrected as described in paragraph 70.

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

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

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

(3) Operate test switch S–3 to the TUNE position.

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

(5) Return the test switch to either of the DIAL LIGHT positions.

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

(7) Connect the discriminator meter M–1 between test point E–4 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 i-f amplifier limiter and discriminator circuits still are not in proper alinement. It is necessary then to repeat the alinement of the limiter circuit and the discriminator circuit as described in paragraph 67 before proceeding with the alinement of the r-f 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 i-f amplifier limiter and discriminator circuits (pars. 66 and 67) before proceeding with the checks and adjustments of r-f 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. It is a useful guide when no signal generator is available.

(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) Adjust the signal generator level to obtain reference B reading on the limiter meter, and note the signal generator output level required to obtain that reading.

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

Requirement: Discriminator meter should read 0±3 volts.

(17) 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.

(18) 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.

(19) 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 tabulated in table II.

Table II. Reference B Signal Generator Output Levels

Radio Receiver	Test frequency	Signal generator output level (uv)
R-108/GRC	20	0.5
	28	.5
R-109/GRC	27	.7
	39	.7
R-110/GRC	38	1.0
	55	1.0

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

(21) 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 screw driver, adjust the setting of trimmer capacitor C–4 to obtain a peak reading on the limiter meter at this frequency.

(*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 signal generator output levels required at each of these frequencies to obtain the reference B reading still are not approximately equal to those listed in table II, proceed with the alinement of the r-f amplifier circuits as described in paragraph 69. If, however, the signal generator output levels required to obtain reference B reading, as shown in the table, are obtained, alinement of r-f amplifier circuit is not necessary.

69. Receiver R-f Amplifier and Oscillator Alinement

Three procedures for adjusting the receiver oscillator are described below; *a* describes the preliminary alinement procedure based on the assumption that the oscillator is considerably out of alinement; *b* describes the procedure for alinement of the oscillator if the oscillator is only slightly out of adjustment; *c* describes a more precise adjustment of the oscillator by means of the crystal calibrated signal generator.

a. Preliminary Alinement of R–F Amplifier and Oscillator Circuits.

(1) Rotate each of the three r-f trimmer capacitors (fig. 4), which are located above the variable gang capacitor and are accessible through the component side of the chassis, until the plates of the trimmer capacitor are one-half way enmeshed.

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

(3) Remove the cap on top of the oscillator coil assembly T–4 (fig. 4). This cap should be removed only in a dry location, since the unit is sealed to keep out moisture.

(4) Connect the signal generator G–1 to the ANT connector on the front panel.

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

(6) Operate the test switch S–3 to the TUNE position.

(7) Using a screw driver, adjust the tuning slug of T–4 to obtain a zero beat note in the headphone.

(8) Return the test switch to either of the DIAL LIGHT positions.

(9) Adjust tuning slugs of T–3, T–2, and T–1, 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) Operate test switch S–3 to the TUNE position.

(13) Adjust trimmer capacitor C–3C (fig. 4) to obtain a zero beat note in the headphone.

(14) Operate the test switch to either of the DIAL LIGHT positions.

(15) Adjust trimmer capacitors C–3E and C–3C (fig. 4) for maximum deflections of the limiter meter.

(16) Adjust the antenna trimmer capacitor C–4 for a peak reading of the limiter meter.

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

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

b. Precise Alinement of Receiver Oscillator, Using Calibrate Markings on the Dial.

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

(2) Operate test switch S–3 to the TUNE position.

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

(4) Adjust trimmer capacitor C–3G (fig. 4) 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 T–4 to obtain a zero beat note in the headphone.

(7) Repeat the adjustment of C–3G with the dial at the highest calibration point and the adjustment of T–4 with the dial at the lowest calibration point until a zero beat note is obtained at both calibrate points.

c. Precise Adjustment of Receiver Oscillator and Dial Tuning Range, Calibrated Signal Generator. The following adjustment involves the use of a crystal calibrator (Ferris type 33A, or equal) and insures a more precise adjustment of the receiver oscillator than that obtainable with the procedures outlined in *a* and *b* above.

(1) Connect the crystal calibrator to the ANT connector.

(2) Check the dial calibration as follows:

(*a*) Operate test switch S–3 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 not more than one-half of a division away from the mc marker on the dial when a zero beat note is heard (check that the dial tracking error does not exceed one-half the dial division).

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

(*e*) Repeat the above procedure at each integral mc setting of the dial.

(3) If the requirements of the dial calibration check are not met (namely, 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 out of place the front panel detent cover plate (fig. 1). 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 in figure 8) and note the range of adjustment of the dial reading. Set the screw at the point which sets the dial at the center of these limits.

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

(*d*) Operate a test switch S–3 to the TUNE position.

(*e*) Adjust trimmer capacitor C–3G (fig. 4) to obtain a zero beat note in the headphone.

(*f*) Turn the dial to its lowest mc setting and adjust the slug of T–4 (fig. 4) 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 T–4 at the low end of the dial until no further improvement is noted.

(4) Recheck the dial error at each mc setting as described in (2) above, and note whether the maximum dial calibration error at any of the mc settings exceeds the required limits of one-half the dial division.

(5) 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 70.

70. Correction of Dial Calibration Cam

Adjustment of the dial calibration cam should not be attempted unless an accurately calibrated signal generator (Ferris type 33A, or equal) crystal calibrator is available. This signal generator must be able to supply check 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 unless it is certain that the dial error exceeds the specified limits (one-half the dial division) and that adjustment of the dial screw under the detent cover plate was not able to remedy the error (par. 69). To insure that the correct frequency is selected for the checks described below, perform the dial calibration described in paragraph 69*c*. After this has been done, proceed as follows:

a. Radio Receiver R–109/GRC. At each integral mc point on the dial, adjust the variable cam adjusting screw, which appears in the hole in the index window frame to the left of the dial shaft. This hole is located near the pin which actuates the index window (fig. 8). 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.

b. 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 *a above*. At 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 this 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 integral 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.

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 at 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 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.

71. Final R-f Circuit Alinement

After the receiver oscillator and the dial calibration have been checked and adjusted as described in the preceding paragraphs, aline the r-f circuits as follows:

a. Disconnect the crystal calibrator and connect signal generator G–1 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. Fine-adjust the signal generator to obtain a zero-reading on the discriminator meter, M–1 (connected between test point E–5 and chassis).

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

f. Adjust trimmer capacitors C–3E and C–3C (fig. 4) and antenna trimmer capacitor C–4 (fig. 1) 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 0.1 volt above the noise level.

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

i. Adjust the tuning slugs of T–1, T–2, and T–3 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 C–3G while making these adjustments.

Section V. FINAL TESTING

72. General

After the receiver-transmitter has been repaired and alined as described in the preceding sections of this chapter, the unit should be fit for return to service. To make sure that this is the case, repeat the operational checks outlined in paragraph 43. Other faults may thus come to light. Make the necessary repairs. If the unit operates as required in paragraph 43, perform the tests outlined in the following paragraphs. These tests are *double checks* to make sure that the most important functional requirements of the unit are met and that it is safe to return the unit to service.

73. Over-All Receiver Sensitivity

Connect the test equipment as indicated in paragraph 41 with the following exceptions:

a. Connect signal generator G–1 to the ANT connector on the front panel.

b. Connect an a-c voltmeter (M–2) shunted by a 600-ohm ½-watt resistor to audio output terminals A and D of panel connector J–8.

c. Set the controls on the front panel as follows:

(1) SQUELCH switch to the OFF position.

(2) TUNE - DIAL LIGHT (ON - OFF) switch to either DIAL LIGHT position.

(3) 6, 12, and 24 VOLTS-OFF-EXTERNAL SUPPLY switch to either 6, 12 and 24 VOLTS or EXTERNAL SUPPLY position, depending on whether the vibrator power supply or external batteries are used to supply power.

(4) VOLUME control to extreme clockwise position.

d. Adjust the frequency of the dial to the lowest frequency shown in table III.

e. Adjust the signal generator output to 1.0 uv.

f. Apply frequency modulation to the signal generator. The modulation frequency should be 1,000 cycles ± 15 kc deviation.

g. Adjust the VOLUME control on the front panel until the voltmeter (M–2) reads 7.75 volts rms (root mean square). (This voltage reading is equivalent to 100 mw.) Remove the modulation from the signal generator frequency. Note the voltmeter reading.

Requirement: The voltmeter reading should be not greater than .775 volt (or 20 db below 7.75 volts).

h. Repeat *d* through *g* above for each of the remaining r-f frequencies in table III. The same requirement should be met at each frequency.

Table III. Sensitivity Calibrating Frequencies

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

74. Over-All Selectivity

a. MEASUREMENTS.

(1) Connect r-f signal generator G–1 to the ANT connector.

(2) Connect limiter meter M–1 between the grid (pin 6) of tube V–8 and chassis.

(3) Adjust the r-f signal generator to the highest mc frequency shown on the dial.

(4) Tune in with receiver dial. This is done by varying the dial setting at or near the highest mc setting until the limiter meter shows a peak reading.

(5) Adjust the signal generator output level to produce the reference B (par. 68) reading on the limiter meter. Note the signal generator output level at the reference B reading.

(6) Increase the signal generator output level by 6 db (double the output).

(7) Tune the receiver to a frequency above the highest mc setting until the reading obtained in (5) above is obtained again. Note the change in frequency for which this occurs. For example, if the original reading occurred at 28 mc and the new reading occurred at 28.05 mc, the change in frequency is .05 mc.

(8) Tune the receiver to a frequency below the integral mc reading until the reading obtained in (5) above (reference B) is obtained again. Note the change in frequency from center frequency (see example in (7) above) for which this reading occurs.

(9) Compute the sum of the two changes in frequency obtained in (7) and (8) above. This is the over-all receiver bandwidth at points which are 6 db below the center frequency. The bandwidth should be about 85 kc.

(10) Compute the difference between the two changes in frequency noted in (7) and (8) above. This difference in measure of symmetry should be not greater than 15 kc.

b. Analysis. Incorrect bandwidth (requirement of *a* (9) above) is indicative of improper alinement of the receiver. An unsymmetrical selectivity curve (requirement of *a* (10) above) indicates a defective component in the tuning circuit or improper alinement of the double-tuned stages of the i-f amplifier, or regeneration of any of the i-f circuits. Accordingly, if the measurements made in *a* above show that either of these defects exist, recheck the alinement of the receiver stages as described in paragraphs 63 to 71. If alinement fails to clear the trouble, look for a defective resistor, bypass capacitor, or tuning coil. The bandwidth check in *c* below need not be performed if the requirements of *a* above are met. If these requirements are not met, this check will help to sectionalize the difficulty to the i-f stage or the r-f stage.

c. I-F Selectivity (4.3 MC).

(1) Connect signal generator G–1 through a .0062-uf capacitor between the grid (pin 1) of the receiver mixer V–2 and chassis.

(2) Adjust the signal generator frequency to 4.3 mc and the signal generator level to obtain reference B reading on the limiter meter. Note the level of the signal generator output required to do so.

(3) Raise the signal generator output level by 6 db (double the level of (2) above).

(4) Raise the frequency of the signal generator above 4.3 mc until the reference B reading on the limiter meter is obtained again. Note the change in signal generator frequency for which reference B reading is again obtained.

(5) Lower the frequency below 4.3 mc. and note the change in frequency for which the reference B reading is again obtained.

(6) Compute the sum of the two changes in frequencies obtained in (4) and (5) above. The sum (a measure of bandwidth) should be 85 ± 15 kc.

(7) Compute the difference between the two changes in frequency of (4) and (5) above. This difference (a measure of symmetry) should not exceed 10 kc.

(8) If the above requirements ((6) and (7) above) are not met, check as indicated in *b* above.

(9) Check the calibration of the dial at each of the mc positions as described in paragraph 68 and note whether the following requirement is met:

Requirement: A beat note should be heard at each of the calibration points of the dial. When the beat note is heard, the hairline in the dial window should not be more than one-half of a division away from the calibration marker (dot) on the dial.

75. Limiting Action

a. Connect signal generator G–1 to the ANT connector of the receiver.

b. Adjust the r-f 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 1.0 uv and apply modulation (1,000 cycles at 15-kc deviation).

d. Adjust the VOLUME control until a-f output meter M–4 connected between A and D of J–8 reads 100 mw.

e. Raise the signal generator output level to 1,000 uv and observe the change in meter reading.

Requirement: The meter reading should not change by more than 10 percent.

76. Over-All Receiver Frequency Response

a. Connect signal generator G–1 to the ANT connector.

b. Tune the receiver and the signal generator to the frequency listed in the preceding paragraph.

c. Adjust the signal generator output level to 10 uv.

d. Modulate the test signal with a 1,000-cycle audio at ±15-kc deviation.

e. Connect a-f output meter M–3 to the AUDIO output connection on the front panel (terminals A and D of J–8).

f. Connect discriminator meter M–1 between test point E–5 and chassis.

g. Adjust the frequency of the signal generator to obtain a zero reading on discriminator meter M–1.

h. Adjust the VOLUME control to obtain a 100-mw reading on the output meter. This reading of meter M–3 is taken as the reference reading on 0 db.

i. 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 uv. For each modulation frequency, observe the reading of the output meter.

Requirement: The approximate readings at the audio frequencies applied as modulation to the r-f signal should be as tabulated below.

Audio modulation frequency (cps)	A-f output meter reading (*m*-4) (db)
400	±2
1,000	0
2,000	between 0 and −7
3,500	−12
5,000	−20

j. Apply 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 output meter M–3.

Requirement: The output meter should read at least 850 mw.

k. Shift the output meter connection to terminals E and D of J–8 leaving the test signal generator connections as before.

Requirement: The output meter should read at least 40 mw.

l. Shift meter M–3 connection between terminals B and D of J–8, leaving the test connection and adjustments as before.

Requirement: The meter should read at least 30 mw. If the above requirement is not met, adjust internal potentiometer R–42 to obtain the required output level.

77. Squelch Sensitivity

a. Minimum Squelch Sensitivity.

(1) Disconnect the strap between terminals H and J of J–8 and in its place connect a 1,000-ohm resistor. Place meter M–1 across the resistor.

(2) Apply the unmodulated output of the signal generator (G–1) 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 in with the receiver dial until the DISCRIMINATOR METER (test point E–5 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 M–1. The meter should read 0 volt.

(6) Raise the signal generator output level until the meter reads at least 4 volts. Determine the signal generator output level when this meter reading is obtained.

Requirement: The signal input level should be between 3 and 20 uv to obtain the 4-volt reading on the meter.

b. MAXIMUM SQUELCH SENSITIVITY.

(1) Reduce the test signal generator output level to 0.

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

(3) Raise the r-f signal input level until the meter reads at least 4 volts, and determine the lowest signal generator output level required to produce that reading.

Requirement: The signal generator output level should be not more than .5 uv.

78. 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 J–8.

b. Connect another pair of headphones between terminals B and D of J–8.

c. Connect a loudspeaker between terminals A and D of J–8.

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. Turn on the test transmitter and talk into the microphone associated with it.

g. Listen in the headphones and to the loudspeaker for quality of speech.

Requirement: Clear, good quality speech should be heard. The volume of background noise should be low.

CHAPTER 4

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

79. Repacking for Shipment or Limited Storage

Wrap and pack equipment securely according to directions given in Packaging Specifications JAN–P–100 or Signal Corps Instructions No. 712–478, revised 15 October 1948, or as directed by the Officer-in-Charge.

80. Demolition of Matériel to Prevent Enemy Use

The demolition procedures outlined below will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander. DESTROY EVERYTHING.

a. SMASH. Smash capacitors, transformers, resistors, sockets, plugs, and other components, using sledges, axes, handaxes, pickaxes, hammers, crowbars, or heavy tools.

b. CUT. Cut wiring, using axes, handaxes, or machetes.

c. BURN. Burn technical manual, records and forms, resistors, capacitors, and transformers, using gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. BEND. Bend chassis, panels, and covers.

e. EXPLOSIVES If explosives are necessary, use firearms, grenades, or TNT.

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

APPENDIX I
REFERENCES

Note. For availability of items listed, check SR 310–20–3 and SR 310–20–4. Check Department of the Army Supply Catalog SIG 1 for Signal Corps supply catalog pamphlets.

1. Army Regulations

AR 380–5	Safeguarding Military Information.

2. Supply Publications

SIG 1	Introduction and Index.
SIG 3	List of Items for Troop Issue.
SB 11–6	Dry Battery Supply Data.
SB 11–47	Preparation and Submission of Requisitions for Signal Corps Supplies.
SB 11–76	Signal Corps Kit and Materials for Moisture- and Fungi-Resistant Treatment.

3. Technical Manual on Test Equipment

TM 11–2627	Tube Tester I–177

4. Painting and Preserving

TB SIG 13	Moistureproofing and Fungiproofing Signal Corps Equipment.
TM 9–2851	Painting Instructions for Field Use.

5. Demolition

FM 5–25	Explosives and Demolitions.

6. Other Publications

FM 24–18	Field Radio Techniques.
SR 310–20–3	Index of Training Publications (Field Manuals, Training Circulars, Firing Tables and Charts, Army Training Programs, Mobilization Training Programs, Graphic Training Aids, Joint Army-Navy-Air Force Publications, and Combined Communications Board Publications).
SR 310–20–4	Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, Modification Work Orders, Tables of Organization and Equipment, Reduction Tables, Tables of Allowances, Tables of Organization, and Tables of Equipment.
SR 700–45–5	Unsatisfactory Equipment Report (Reports Control Symbol CS GLD–247).
SR 745–45–5	Report of Damaged or Improper Shipment (Reports Control Symbols CS GLD–66 (Army).
TB SIG 66	Winter Maintenance of Signal Equipment.
TB SIG 72	Tropical Maintenance of Ground Signal Equipment.
TB SIG 75	Desert Maintenance of Ground Signal Equipment.
TB SIG 123	Preventive Maintenance Practices for Ground Signal Equipment.
TB SIG 178	Preventive Maintenance Guide for Radio Communication Equipment.
TM 9–2857	Storage Batteries Lead-Acid Type.
TM 11–430	Batteries for Signal Communication. Except those pertaining to Aircraft.
TM 11–453	Shop Work.
TM 11–455	Radio Fundamentals.

TM 11–483	Suppression of Radio Noises.
TM 11–486	Electrical Communication Systems Engineering.
TM 11–660	Introduction to Electronics.
TM 11–4000	Trouble Shooting and Repair of Radio Equipment.
TM 38–650	Basic Maintenance Manual.

7. Abbreviations

ac	alternating current.
af	audio frequency.
afc	automatic frequency control.
amp	ampere(s).
C	centigrade.
db	decibel(s).
dc	direct current.
F	Fahrenheit.
f-m	frequency-modulation.
hf	high frequency.
hv	high voltage.
i.f	intermediate frequency.
kc	kilocycle.
lf	low frequency.
lv	low voltage.
ma	milliampere.
mc	megacycle.
mw	milliwatt.
rf	radio frequency.
rms	root mean square.
ua	microampere.
uf, uuf	microfarad, micromicrofarad.
uv	microvolt.

8. Glossary

For explanation of terms used in this manual, refer to TM 11–455.

APPENDIX II

IDENTIFICATION TABLE OF PARTS

1. Requisitioning Parts

The fact that a part is listed in this table is not sufficient basis for requisitioning the item. Requisitions must cite an authorized basis, such as T/O & E, T/A, SIG 7–8–10, SIG 10, list of allowances of expendable material, or other authorized supply basis. The Department of the Army Supply Catalogs applicable to the equipment covered in this manual are SIG 7 & 8–R–108/GRC, SIG 7 & 8–R–109/GRC, and SIG 7 & 8–R–110/GRC. For an index of available supply catalogs in the Signal portion of the Department of the Army Supply Catalog, see the latest issue of SIG 1, Introduction and Index.

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2. Identification Table of Parts for Radio Receivers R–108/GRC, R–109/GRC, and R–110/GRC

Ref symbol			Function of part	Name of part and description	Signal Corps stock No.
R–108/GRC	R–109/GRC	R–110/GRC			
*				ARMY-NAVY RADIO RECEIVER R–108/GRC: FM; 20 to 28 mc in 1 band; nom input 6.3, 12.6, or 25.2 v DC w/internal power supply, or 6.3 and 125 v DC external supply; mtd in metal case; 7 5/16″ wd x 9¼″ h x 12⅞″ d o/a; 14 tube superheterodyne ckt; integral coils; incl tube puller, set of wrenches, 2 instruction books, and spare tubes, crystal, and fuse; squelch ckt, moisture- and fungus-resistant, rigidized case, self-luminous dial and control markings, compartment to accept plug in vibrator power supply; p/o Army-Navy Radio Set AN/GRC–3; Fed Tele & Rad part/dwg #GA–2512–14–GR I; U. S. Army spec #71–3321.	2C4180–108
	*			ARMY-NAVY RADIO RECEIVER R–109/GRC: FM; 27 to 39 mc in 1 band; nom input 6.3, 12.6, or 25.2 v DC w/internal power supply, or 6.3 and 125 v DC external supply; mtd in metal case; 7 5/16″ wd x 9¼″ h x 12⅞″ d o/a; 14 tube superheterodyne ckt; integral coils; incl tube puller, set of wrenches, 2 instruction books, and spare tubes, crystal, and fuse; squelch ckt, moisture- and fungus-resistant, rigidized case, self-luminous dial and control markings; compartment to accept plug in vibrator power supply; p/o Army-Navy Radio Set AN/GRC–5; Fed Tele & Rad part/dwg #GA–2512–14–GR II; U. S. Army spec #71–3321.	2C4180–109
		*		ARMY-NAVY RADIO RECEIVER R–110/GRC: FM; 38 to 55 mc in 1 band; nom input 6.3, 12.6, or 25.2 v DC w/internal power supply, 6.3 and 125 v DC external supply; mtd in metal case; 7 5/16″ wd x 9¼″ h x 12⅞″ d o/a; 14 tube superheterodyne ckt; integral coils; incl tube puller, set of wrenches, 2 instruction books, and spare tubes, crystal, and fuse; squelch ckt moisture- and fungus-resistant, rigidized case, self-luminous dial and control markings, compartment to accept plug in vibrator power supply; p/o Army-Navy Radio Set AN/GRC–7; Fed Tele & Rad part/dwg #GA–2512–14–GR III; U. S. Army spec #71–3321.	2C4180–110
O–1	O–1	O–1	Tuning control shaft bearing.	BEARING, sleeve: bearing for dial-drive shaft; brass; ⅝″ OD x .251″ ID x ½″ lg o/a; shoulder on front end ⅝″ diam x .171″ lg, rear end thd ⅜″–32 NEF–2 x 1 7/64″ lg, rear edge slotted 1/16″ wd x 1/16″ d for screwdriver; p/o Fed Tele and Rad #GA–2309–14 front panel assem and #GA–1223–14 detents drive assem; Fed Tele & Rad part/dwg #GB–1256–2.	2Z581–28

E-24	E-24	E-24	Capacitor mounting board	BOARD, terminal; 16 solder type stud term; term spaced ¾" between ctr; laminated phenolic board; 5½" lg x 1⅛" wd x 2³⁄₆₄" thk o/a; two .154" diam mtg holes spaced diagonally on ¾" x 2¾" mtg/c; p/o Fed Tele & Rad #GA-2309-14 front panel assem; Fed Tele & Rad part/dwg #GA-3098-2.	3Z770-16.40
O-21	O-21	O-21	Capacitor clamp mounting spacer.	BLOCK, spacing: steel, cad pl; 1" lg x ¾" wd x 7⁄32" thk; two .169" diam holes on ⅜" mtg/c; Fed Tele & Rad part/dwg #GB-2614-2.	2Z736-73
C-84	C-84	C-84	Tuning oscillator V-10 to antenna coupling.	CAPACITOR, fixed: ceramic dielectric; JAN type CC21CKOR5C; .5 uuf ±.25 uuf; 500 vdcw; spec JAN-C-20A.	3D9000.5-6
C-96	----------	----------	Squelch oscillator V-11 coupling.	CAPACITOR, fixed: ceramic dielectric; JAN type CC21LH050D 5 uuf; 500 vdcw; spec JAN-C-20.	3D9005 117
	C-18	C-18	R-f oscillator V-3 shunt padders, part of T-4.	CAPACITOR, fixed: ceramic dielectric; JAN type CC30RH100C; 10 uuf ±.25 uuf; 500 vdcw; spec JAN-C-20A.	3D9010 178
	C-1,	C-1,	Antenna coil tuning, part of T-1.	CAPACITOR, fixed: ceramic dielectric; JAN type CC20LH100G; 10 uuf ±1 uuf; 500 vdcw; spec JAN-C-20A.	3D9010-179
	C-8,	C-8,	R-f amplifier, V-1 plate coil tuning, part of T-2.		
	C-11	C-11	Mixer V-2 grid coil tuning, part of T-3.		
C-18	----------	----------	R-f oscillator V-3 shunt padder, part of T-4.	CAPACITOR, fixed: ceramic dielectric; JAN type CC30LH150J; 15 uuf ±5%; 500 vdcw; spec JAN-C-20A.	3D9015-131
C-91,	C-91,	C-91,	REC control receptor J-8, relay return, r-f bypass.		
C-92,	C-92,	C-92,	REC control receptor J-8, relay B+ r-f bypass.		
C-93	C-93	C-93	REC control receptor J-8, fixed level r-f bypass.		
C-66,	C-66,	C-66,	Filament V-9, feedthrough r-f bypass.	CAPACITOR, fixed: ceramic dielectric; 2300 uuf −20% +50%; var temp coef; 500 vdcw; ⅝" lg x 5⁄16" across flats of mtg flange; 2 axial wire leads; single hole mtg, #12-28 NF-2 thd; ceramic insulation; feedthrough type w/metal mtg stud; Centralab style #DA 817 or Erie type #321; Fed Tele & Rad part/dwg #GH-2051-2-2.	3DA2.300-1
C-69	C-69	C-69	V-10, B+ feedthrough r-f bypass.		
C-6,	C-6,	C-6,	R-f amplifier V-1, cathode bypass.	CAPACITOR, fixed: ceramic dielectric; 3000 uuf ±20%; var temp coef; 500 vdcw; .937" lg x .312" diam; radial wire leads; dipped phenolic insulation; Erie type #337 H1-K Ceramicon; Fed Tele & Rad part/dwg #GH-2094-2-5.	3DA3-142
C-14,	C-14,	C-14,	Mixer V-2 screen bypass.		
C-16,	C-16,	C-16,	R-f oscillator V-3, filament decoupling.		
C-32,	C-32,	C-32,	B+ r-f filter bypass, V-3.		
C-33,	C-33,	C-33,	B+ r-f filter bypass, V-3.		
C-36,	C-36,	C-36,	Second i-f amplifier V-5, filament bypass.		
C-48,	C-48,	C-48,	Fourth i-f amplifier V-7, filament bypass.		
C-49,	C-49,	C-49,	Fourth i-f amplifier V-7, screen bypass.		

Ref symbol			Function of part	Name of part and description	Signal Corps stock No.
R-108/GRC	R-109/GRC	R-110/GRC			
C-53,	C-53,	C-53,	Limiter V-8, measurement circuit bypass.		
C-55,	C-55,	C-55,	Limiter V-8, screen bypass.		
C-65,	C-65,	C-65,	Discriminator V-9, filament bypass.		
C-68,	C-68,	C-68,	Discriminator V-10, filament bypass.		
C-71,	C-71,	C-71,	V-10, B+ r-f filter bypass.		
C-78,	C-78,	C-78,	Squelch oscillator bias bypass.		
C-90,	C-90,	C-90,	V-6 B+ r-f filter bypass.		
C-95	C-95	C-95	B+ r-f filter bypass.		
C-5,	C-5,	C-5,	R-f amplifier V-1, cathode bypass.	CAPACITOR, fixed: ceramic dielectric; 3000 uuf; guaranteed min value 3000 uuf at 25°C; 500 vdcw; ⅝" lg x 3/16" diam; radial wire leads; one #2-56 thd mtg hole in mtg base; uninsulated; standoff type; Centralab type #DA090; Fed Tele & Rad part/dwg #GH-2050-2.	3DA3-144
C-7,	C-7,	C-7,	R-f amplifier V-1, screen bypass.		
C-13,	C-13,	C-13,	Mixer V-2, cathode bypass.		
C-25,	C-25,	C-25,	First i-f amplifier V-4, filament bypass.		
C-27,	C-27,	C-27,	First i-f amplifier V-4, filament bypass.		
C-28,	C-28,	C-28,	First i-f amplifier V-4, screen bypass.		
C-34,	C-34,	C-34,	Second i-f amplifier V-5, filament bypass.		
C-35,	C-35,	C-35,	Second i-f amplifier V-5, filament bypass.		
C-37,	C-37,	C-37,	Second i-f amplifier V-5, screen bypass.		
C-41,	C-41,	C-41,	Third i-f amplifier V-6, filament bypass.		
C-42,	C-42,	C-42,	Third i-f amplifier V-6, filament bypass.		
C-43	C-43	C-43	Third i-f amplifier V-6, screen bypass.		
C-1,	----------	----------	Antenna coil tuning (fixed) part of T-1.	CAPACITOR, fixed: ceramic dielectric; JAN type CC20LH-150K; 15 uuf ± 10%; 500 vdcw; spec JAN-C-20A.	3D9015-132
C-8	----------	----------	R-f amplifier, V-1, plate coil tuning (fixed), part of T-2.		
C-74,	C-74	C-74	Crystal oscillator V-10, plate tuning.	CAPACITOR, fixed: ceramic dielectric; JAN CC21UK220K; 22uuf ± 10%; 500 vdcw; spec JAN-C-20A.	3D9022-45
C-15,	----------	----------	Oscillator mixer coupling.		

	C-19	----------	R-f oscillator V-3, shunt padder, part of T-4.	CAPACITOR, fixed: ceramic dielectric; JAN type CC30RH240J; 24 uuf ±5%; 500 vdcw; spec JAN-C-20A.	3D9024-53
C-22,	C-22,	C-22,	Mixer V-2, plate coil tuning, part of T-5.	CAPACITOR,fixed: ceramic dielectric; JAN type CC25RH300J; 30 uuf ±5%; 500 vdcw; spec JAN-C-20A.	3D9030-68
C-23,	C-23,	C-23,	First i-f amplifier V-4, grid coil tuning, part of T-5.		
C-29,	C-29,	C-29,	First i-f amplifier V-4, plate coil tuning, part of T-6.		
C-30,	C-30	C-30,	Second i-f amplifier V-5, grid coil tuning, part of T-6.		
C-38,	C-38,	C-38,	Second i-f amplifier V-5, plate coil tuning, part of T-7.		
C-39,	C-39,	C-39,	Third i-f amplifier V-6, grid coil tuning, part of T-7.		
C-44,	C-44,	C-44,	Third i-f amplifier V-6, plate coil tuning, part of T-8.		
C-45,	C-45,	C-45,	Fourth i-f amplifier V-7, grid coil tuning, part of T-8.		
C-50,	C-50,	C-50,	Fourth i-f amplifier V-7, plate coil tuning, part of T-9.		
C-51,	C-51,	C-51,	Limiter V-8, grid coil tuning, part of T-9.		
C-58,	C-58,	C-58,	Discriminator V-9, secondary coil tuning, part of T-11.		
C-57,	C-57	C-57	Discriminator V-9, secondary coil tuning, part of T-11.		
C-19	----------	----------	R-f oscillator V-3, padder, part of T-4.	CAPACITOR, fixed: ceramic dielectric; JAN type CC30LH390J; 39 uuf ±5%; 500 vdcw; spec JAN-C-20A.	3D9039-41
C-24,	C-24,	C-24,	First i-f amplifier V-4, grid bias, part of T-5.	CAPACITOR, fixed: ceramic dielectric; JAN type CC30LH470K; 47 uuf ±10%; 500 vdcw; spec JAN-C-20A.	3D9047-56
C-31,	C-31,	C-31,	Second i-f amplifier V-5, grid bias, part of T-6.		
C-40,	C-40,	C-40,	Third i-f amplifier V-6, grid bias, part of T-7.		
C-46,	C-46,	C-46,	Fourth i-f amplifier V-7, grid bias, part of T-8,		
C-52,	C-52,	C-52,	Limiter V-8, grid bias, part of T-9.		
C-56	C-56	C-56	Limiter V-8, plate coil tuning, part of T-10.		
C-17,	C-17,	C-17,	R-f oscillator V-3, grid bias	CAPACITOR, fixed: ceramic dielectric; JAN type CC21UK470K; 47 uuf ±10%; 500 vdcw; spec JAN-C-20A.	
C-72	C-72	C-72	Crystal oscillator V-10 grid bias.		
C-21	----------	----------	R-f oscillator V-3, series padder, part of T-4.	CAPACITOR, fixed: ceramic dielectric; 250 uuf ±20%; neg temp coef 220 (tol ±15%) uuf/uf/°C; 500 vdcw; 1.165" lg x .36" diam max; 2 radial wire leads; uninsulated; Fed Tele & Rad part/dwg #GN-2531-12-1.	3D9250-116

Ref symbol			Function of part	Name of part and description	Signal Corps stock No.
R-108/GRC	R-109/GRC	R-110/GRC			
		C-21, C-94	R-f oscillator V-3, series padders, part of T-4.	CAPACITOR, fixed: ceramic dielectric; 350 uuf ± 20%; neg temp coef 220 (tol ± 15%) uuf/uf/°C; 500 vdcw; 1.165″ lg x .36″ diam max; 2 radial wire lead; uninsulated; Fed Tele & Rad part/dwg #GN-2531-12-2.	3D9350-31
	C-21	----------	R-f oscillator V-3, series padder, part of T-4.	CAPACITOR, fixed: ceramic dielectric; 450 uuf ± 10%; neg temp coef 220 (tol ± 30 PPM) uuf/uf/°C; 500 vdcw; 1.56″ lg x .36″ diam; 2 radial wire leads; uninsulated; Fed Tele & Rad part/dwg #GN-2531-12-3.	3D9450-7
C-54,	C-54,	C-54,	Limiter V-8, grid test point bypass.	CAPACITOR, fixed: ceramic dielectric; 500 uuf ± 20%; var temp coef; 500 vdcw; .460″ lg x .240″ diam; radial wire leads; dipped phenolic insulation; Erie type #331 Hi-K Ceramicon; Fed Tele & Rad part/dwg #GH-2094-2-2.	3D9500-237
C-61,	C-61,	C-61,	Discriminator V-9, primary test point bypass.		
C-62,	C-62,	C-62,	Discriminator V-9, secondary test point bypass.		
C-70	C-70	C-70	Tuning oscillator V-10, plate-grid coupling.		
C-10	C-10	C-10	R-f amplifier V-1, plate-mixer V-2, grid coupling, part of T-2.	CAPACITOR, fixed: ceramic dielectric; 1000 uuf ± 20%; 500 vdcw; 1 1/16″ lg x 3/16″ diam; radial wire leads; dipped phenolic insulation; Muter type #BBK-1200.	3DA1-298
C-2,	C-2,	C-2,	R-f amplifier V-1, grid bias, part of T-1.	CAPACITOR, fixed: ceramic dielectric; 1500 uuf ± 20%; 500 vdcw; 1 1/16″ lg x 3/16″ diam; radial wire leads; dipped phenolic insulation; Muter type #BBK-1200.	3DA1.500-55
C-9,	C-9,	C-9,	B+ to r-f amplifier V-1, plate bypass, part of T-2.		
C-12	C-12	C-12	Mixer grid bias, part of T-3		
C-85,	C-85,	C-85,	Power receptor J-6, B+r-f bypass.	CAPACITOR, fixed: ceramic dielectric; 2000 uuf ± 20%; var temp coef; 500 vdcw; .937″ lg x .312″ diam; radial wire leads; dipped phenolic insulation; Erie type #337 Hi-K Ceramicon; Fed Tele & Rad part/dwg #GH-2094-2-4.	3DA2-213
C-86,	C-86,	C-86,	Power receptor J-6, 6.3-volt external supply r-f bypass.		
C-87,	C-87,	C-87,	Power receptor battery, r-f bypass.		
C-88,	C-88,	C-88,	Audio receptor J-7, first audio r-f bypass.		
C-89,	C-89,	C-89,	Audio receptor J-7, power amplifier, r-f bypass.		
C-80	C-80	C-80	C-80A and C-80B: V-12 B+ filter, low-frequency bypasses. C-80C: V-15 B+ filter, low-frequency bypass.	CAPACITOR, fixed: electrolytic; JAN type CE53C400J; 3 sect; ea sect 40 uf; 150 vdcw; spec JAN-C-62.	3DB40-80

C–73	C–73	C–73	C–73A: Squelch oscillator V–11, low-frequency bypass. C–73B and C–73C: Audio amplifier V–13, low-frequency bypasses.	CAPACITOR, fixed: electrolytic; 3 sect; ea sect 500 uf; 10 vdcw; oper temp range −40° C to +85° C; 2½″ lg x 1½″ diam; HS metal can; 4 round pin type term; all term ins from can; mts in std octal socket; Aerovox type #E2C41; Fed Tele & Rad part/dwg #GH–2038–2.	3DB500–39
C–81	C–81	C–81	Second audio amplifier V–14, grid r-f bypass.	CAPACITOR, fixed: mica; JAN type CM20A221M; 220 uuf ±20%; 500 vdcw; spec JAN–C–5.	3K2022114
C–59, C–60	C–59, C–60	C–59, C–60	Discriminator output V–9, r-f filter bypasses.	CAPACITOR, fixed: mica; JAN type CM20B471M; 470 uuf ±20%; 500 vdcw; spec JAN–C–5.	3K2047124
C–20	C–20	C–20	V–3, B+ filter, part of T–4	CAPACITOR, fixed: mica; 3000 uuf ±10%; 500 vdcw; temp coef letter E; .651″ diam x .125″ max thk; 1 solder lug on top side, 3 mtg and grounding lugs other side; mts by 3 lugs on bottom 120 deg apart on ¼″ rad; button type capacitor; Erie style #4700–CA or Sangamo type #M–10; Fed Tele & Rad part/dwg #GN–2566–12.	3DA3–145
C–75,	C–75,	C–75,	Squelch oscillator V–11, screen bypass.	CAPACITOR, fixed: paper dielectric; JAN type CN35A103M; 10,000 uuf ±20%; 600 vdcw; spec JAN–C–91.	3DA10–367
C–76	C–76	C–76	Squelch oscillator V–11, diode coupling.		
C–26, C–63	C–26, C–63	C–26, C–63	V–4, filament r-f bypass Discriminator-audio coupling	CAPACTIOR, fixed: paper dielectric; JAN type CP21A1EC103-M; 10,000 uuf ±20%; 200 vdcw; spec JAN–C–25.	3DA10–541
C–82, C–83	C–82, C–83	C–82, C–83	B+ r-f bypass Audio shaping.	CAPACITOR, fixed: paper dielectric; JAN type CN22A103M; 10,000 uuf ±20%; 300 vdcw; spec JAN–C–91.	3DA10–447
C–47	C–47	C–47	V–6, filament r-f bypass	CAPACITOR, fixed: paper dielectric; JAN type CN20E103M; 10,000 uuf ±20%; 120 vdcw; spec JAN–C–91.	3DA10 380
C–77	C–77	C–77	Audio grid-squelch decoupling	CAPACITOR, fixed: paper dielectric; JAN type CP29A1EF503-M; 50,000 uuf ±20%; 600 vdcw; spec JAN–C–25.	3DA50–259
C–67	C–67	C–67	V–10 discriminator bandwidth adjustor.	CAPACITOR, variable: air dielectric; adj core type; .3 to 3.0 uuf; 1$\frac{1}{32}$″ diam x 1″ lg excluding adj screw; 1 radial wire lead, 1 mtg stud gnd lead; single mtg stud w/#12–24 thd $\frac{7}{32}$″ lg; adj screw w/screwdriver slot; glass body standoff type capacitor; Corning Glass code #690082; Fed Tele & Rad part/dwg #GH–1989–2–2.	3D9003V–19
C–3	C–3	C–3	C–3: Antenna coil tuning C–3B: R-f amplifier V–1, plate coil tuning. C–3C: R-f amplifier V–1, plate 6 coil trimmer. C–3D: Mixer grid V–2, coil tuning. C–3E: Mixer grid V–2, coil trimmer. C–3F: R-f oscillator V–3, tuning. C–3G: R-f oscillator V–3, trimmer.	CAPACITOR, variable: air dielectric; plate meshing type, 4 ganged sect w/3 trimmer sect; 11 to 54.4 uuf ea sect; SLF characteristic; 1000 v RMS test; 5″ lg x 2.112″ wd x 3.338″ h excluding shaft, shaft $\frac{3}{8}$″ diam x $\frac{7}{16}$″ lg; screwdriver adj; sect A, B, D ea 11 cad pl steel plates, sect F 17 cad pl steel plates; 180 deg counterclockwise rotation; ceramic ins stator, phenolic ins rotor; solder lug term; three #6–32 x 1$\frac{1}{32}$″ lg mtg studs on 2$\frac{27}{32}$″ x 1$\frac{3}{8}$″ mtg/c; trimmer G for sect F, E for sect D, and C for sect B, drawing number marked on rear end; RCC part #CN–800232; Fed Tele & Rad part/dwg #GH–1055–14.	3D9054VE4

L–5,	L–5,	L–5,	First i-f amplifier V–4, filament filters.	5/8" lg x 5/16" diam; powdered iron core; two 1½" lg axial wire leads; marked 70 uh; phenolic coated wax impr and phenolic covered; Muter part #C–7307; Fed Tele & Rad part/dwg #GN–1312–12.	
L–6,	L–6,	L–6,	B+ r-f filter.		
L–7,	L–7,	L–7,	Second i-f amplifier V–5, filament filter.		
L–8,	L–8,	L–8,	Second i-f amplifier V–5, filament filter.		
L–9,	L–9,	L–9,	V–5 filament r-f filter.		
L–10,	L–10,	L–10,	B+ r-f filter.		
L–11,	L–11,	L–11,	V–6 filament r-f filter.		
L–12,	L–12,	L–12,	B+ r-f filter.		
L–13,	L–13,	L–13,	V–8 limiter B+ and r-f filter.		
L–15,	L–15,	L–15,	V–9 discriminator output r-f filter.		
L–16,	L–16,	L–16,	V–9 discriminator filament filter.		
L–17,	L–17,	L–17,	V–9 discriminator filament r-f filter.		
L–18	L–18	L–18	V–10 B+ r-f filter.		
L–19	L–19	L–19	Tuning oscillator V–10, shunt feed.	COIL, RF: choke; single layer, close wound; unshielded; 110 uh at 1000 cyc, 5.0 ohms DC resistance; 127 turns #38 AWG wire; 5/8" lg x 5/16" diam; powdered iron core; two 1½" lg axial wire leads; marked 120 uh; phenolic coated, wax impr; Muter part #C–7303; Fed Tele & Rad part/dwg #GN–2401–12.	3C345–10
L–14	L–14	L–14	Discriminator d-c return, part of T–11.	COIL, RF: choke; single winding, 2 pie universal wound; unshielded; 2 mh ±10%; 3/8" diam x 5/8" lg; powdered iron core; two 1½" lg axial wire leads; wax impr; Muter part #C–7338.	3C345–11
T–1	----------	----------	Antenna coil	COIL, RF: 2 windings, single layer wound; rectangular aluminum shield can; 3" lg x 1 7/32" wd x 3 1/32" thk; phenolic form; adj powdered iron core; scdr adj thru top of can; two #6–32 NC–2 x 5/16" lg mtg studs on diagonally opposite corners of base on .608" x .858" mtg/c; 6 solder term on bottom; marked "GH–2347–2–1" on side of can; tropicalized; Muter part #C–7311–1; Fed Tele & Rad part/dwg #GH–2347–12–1.	2Z9629–270
	T–1	----------	Antenna coil	COIL, RF: 2 windings, single layer wound; rectangular aluminum shield can; 3" lg x 1 7/32" wd x 3 1/32" thk; phenolic form; adj powdered iron core; scdr adj thru top of can; two #6–32 NC–2 x 5/16" lg mtg studs on diagonally opposite corners of base on .608" x .858" mtg/c; 6 solder term on bottom; marked "GH–2347–2–2" on side of can; tropicalized; Muter part #C–7311–2; Fed Tele & Rad part/dwg #GH–2347–12–2.	2Z9629–271
		T–1	Antenna coil	COIL, RF: 2 windings, single layer wound; rectangular aluminum shield can; 3" lg x 1 7/32" wd x 3 1/32" thk; phenolic form; adj powdered iron core; scdr adj thru top of can; two #6–32 NC–2 x 5/16" lg mtg studs on diagonally opposite corners of base on .608" x .858" mtg/c; 6 solder term on bottom; marked "GH–2347–2–3" on side of can; tropicalized; Muter part #C–7311–3; Fed Tele & Rad part/dwg #GH–2347–12–3.	2Z9629–272

Ref symbol			Function of part	Name of part and description	Signal Corps stock No.
R-108/GRC	R-109/GRC	R-110/GRC			
T-2	----------	----------	R-f amplifier V-1, plate coil	COIL, RF: RF transformer; single tapped winding; single layer wound; rectangular aluminum shield can; 3" lg x 1 7/32" wd x 3 1/32" thk; phenolic form; adj powdered iron core; scdr adj thru top of can; two #6-32 NC-2 x 5/16" mtg studs on diagonally opposite corners of base on .608" x .858" mtg/c; 6 solder term on bottom; marked "GH-2348-2-1" on side of can; tropicalized; Muter part #C-7312-1; Fed Tele & Rad part/dwg #GH-2348-2-1.	3C1084Z81-1
	T-2	----------	R-f amplifier V-1, plate coil	COIL, RF: RF transformer; single tapped winding, single layer wound; rectangular aluminum shield can; 3" lg x 1 7/32" wd x 3 1/32" thk; phenolic form; adj powdered iron core; scdr adj thru top of can; two #6-32 NC-2 x 5/16" lg mtg studs on diagonally opposite corners of base on .608" x .858" mtg/c; 6 solder term on bottom; marked "GH-2348-12-2" on side of can; tropicalized; Muter part #C-7312-2; Fed Tele & Rad part/dwg #GH-2348-2-2.	3C1084Z81-2
		T-2	R-f amplifier V-1, plate coil	COIL, RF: RF transformer; single tapped winding, single layer wound; rectangular aluminum shield can; 3" lg x 1 7/32" wd x 3 1/32" thk; phenolic form; adj powdered iron core; scdr adj thru top of can; two #6-32 NC-2 x 5/16" lg mtg studs on diagonally opposite corners of base on .608" x .858" mtg/c; 6 solder term on bottom; marked "GH-2348-2-3" on side of can; tropicalized; Muter part #C-7312-2; Fed Tele & Rad part/dwg #GH-2348-12-3.	3C1084Z81-3
T-3	----------	----------	Mixer V-2, grid coil	COIL, RF: RF transformer; single tapped winding, single layer wound; rectangular aluminum shield can; 3" lg x 1 7/32" wd 3 1/32" thk; phenolic form; adj powdered iron core; scdr adj thru top of can; two #6-32 NC-2 x 5/16" lg mtg studs on diagonally opposite corners of base on .608" x .858" mtg/c; 6 solder term on bottom; marked "GH-2349-2-1" on side of can; tropicalized; Muter part #C-7313-1; Fed Tele & Rad part/dwg #GH-2349-12-1.	3C1084Z81-4
	T-3	----------	Mixer V-2, grid coil	COIL, RF: RF transformer; single tapped winding, single layer wound; rectangular aluminum shield can; 3" lg x 1 7/32" wd x 3 1/32" thk; phenolic form; adj powdered iron core; scdr adj thru top of can; two #6-32 NC-2 x 5/16" lg mtg studs on diagonally opposite corners of base on .608" x .858" mtg/c; 6 solder term on bottom; marked "GH-2349-2-2" on side of can; tropicalized; Muter part #C-7313-2; Fed Tele & Rad part/dwg #GH-2349-12-2.	3C1084Z81-5

		T–3	Mixer V–2, grid coil	COIL, RF: RF transformer; single tapped winding, single layer wound; rectangular aluminum shield can; 3″ lg x 1 7/32″ wd x 3 1/32″ thk; phenolic form; adj powdered iron core; scdr adj thru top of can; two #6–32 NC–2 x 5/16″ lg mtg studs on diagonally opposite corners of base on .608″ x .858″ mtg/c; 6 solder term on bottom; marked "GH–2349–2–3" on side of can; tropicalized; Muter part #C–7313–3; Fed Tele & Rad part/dwg #GH–2349–12–3.	3C1084Z81–6
T–4			R-f oscillator V–3, coil	COIL, RF: oscillator; single tapped winding, single layer wound; rectangular aluminum shield can; 3 1/8″ lg x 1 7/8″ wd x 1 7/16″ thk; ceramic form; adj powdered iron core; scdr adj thru top of can; two #6–32 tapped mtg holes on diagonally opposite corners of base on 1.344″ x .906″ mtg/c; 6 stud type solder term on bottom; marked "GA–2144–12" on side of can; moisture-proofed; removable cap over adj hole; Fed Tele & Rad part/dwg #GA–2144–12.	3C1081–11J
	T–4		R-f oscillator V–3, coil	COIL, RF: oscillator; single tapped winding, single layer wound; rectangular aluminum shield can; 3 1/8″ lg x 1 7/8″ wd x 1 7/16″ thk; ceramic form; adj powdered iron core; scdr adj thru top of can; two #6–32 tapped mtg holes on diagonally opposite corners of base on 1.344″ x .906″ mtg/c; 6 stud type solder term on bottom; marked "GA–2145–12" on side of can; moisture-proofed; removable cap over adj hole; Fed Tele & Rad part/dwg #GA–2145–12.	3C1081–11K
		T–4	R-f oscillator V–3, coil	COIL, RF: oscillator; single tapped winding, single layer wound; rectangular aluminum shield can; 3 1/8″ lg x 1 7/8″ wd x 1 7/16″ thk; ceramic form; adj powdered iron core; scdr adj thru top of can; two #6–32 tapped mtg holes on diagonally opposite corners of base on 1.344″ x .906″ mtg/c; 6 stud type solder term on bottom; marked "GA–2146–12" on side of can; moisture-proof; removable cap over adj hole; Fed Tele & Rad part/dwg #GA–2146–12.	3C1081–11L
P–4	P–4	P–4	Front panel to tuning oscillator connector.	CONNECTOR, plug: single round male cont; straight; 21/64″ diam x 15 3/4″ lg o/a incl cable; cylindrical silver pl brass body 39/64″ lg; teflon insert; push on friction mtg, mts w/mating receptacle; supplied w/length of Radio Frequency Cable RG–58/U attached to connector; Amphenol dwg #82–830; Fed Tele & Rad part/dwg #GH–2116–2–3.	2Z3021–221
P–1	P–1	P–1	Front panel to antenna coil connector.	CONNECTOR, plug: single round male cont; straight; 21/64″ diam x 5″ lg o/a incl cable; cylindrical silver pl brass body 39/64″ lg; teflon insert; push on friction mtg, mts w/mating receptacle; supplied w/length of Radio Frequency Cable RG–58/U attached to connector; Fed Tele & Rad part/dwg #GA–2588–2.	2Z3021–226

Ref symbol			Function of part	Name of part and description	Signal Corps stock No.
R-108/GRC	R-109/GRC	R-110/GRC			
P-5	P-5	P-5	Front panel cable connector (front panel side).	CONNECTOR, plug: 15 round female cont; straight; 1½" lg x ¾" wd x .415" deep excluding term; rectangular molded phenolic body; two .150" diam mtg holes on 1.188" mtg/c; cont marked from 1 to 15; Amphenol dwg #26–150; Fed Tele & Rad part/dwg #GH–2126–12.	2Z3076–31
J–3	J–3	J–3	Front panel ANT connector	CONNECTOR, receptacle: single round female cont; straight; 1 3/32" lg x 5/16" diam o/a; cylindrical silver pl brass body; locking; polyethylene insert; single hole mtg, bushing 3/8"–32 NEF–2 x 3/8" lg; wp seal in mtg bushing flange, wp insert, supplied w/lockwasher and mtg nut; Amphenol dwg #31–102; Fed Tele & Rad part/dwg #GH–2118–2.	2Z3062–233
J–1, J–4	J–1, J–4	J–1, J–4	Front panel to antenna coil connector. Front panel to tuning oscillator connector.	CONNECTOR, receptacle: single round female cont; straight; 15/16" lg x ½" diam o/a; cylindrical silver pl brass body; teflon insert; single hole mtg, bushing 3/8" –32 NF–2 x 5/16" lg; supplied w/lockwasher and mtg nut; Amphenol dwg #82–831; Fed Tele & Rad part/dwg #GH–2117–2.	2Z3062–232
J–6	J–6	J–6	Front panel POWER IN connector.	CONNECTOR, receptacle: 4 round female cont; straight; 1 15/32" diam x 1⅛" max lg o/a; cont rated 20 amp at 800 v AC; cylindrical brass body, electro tin pl finish; locking; molded phenolic insert; single hole mtg. 1¼"–18 NEF–2 x ⅜" lg mtg bushing; "O" ring seal in mtg flange, supplied w/spanner type mtg nut and lockwasher immersion and RSW; 2 index flats on mtg bushing ¼"–20 double thd tapped metal insert in ctr of phenolic insert provides locking action w/mating plug, locating key in outer shell and groove in insert; Amphenol dwg #164–1; Fed Tele & Rad part/dwg #GH–2081–12.	2Z3065–96
J–2	J–2	J–2	Vibrator power supply connector.	CONNECTOR, receptacle: 8 round male cont; straight; 1¼" diam x ⅞" lg o/a; round phenolic body w/brass locating pin; mts by means of ctr locating pin and cont; mts on chassis by means of retainer plate not supplied as part of connector; cont silver pl, notch on outside edge of body to prevent rotation when mtd; Fed Tele & Rad part/dwg #GA–1611–2.	2Z3028–55
J–8	J–8	J–8	Front panel REC control connector.	CONNECTOR, receptacle: 9 round female cont; straight; 1 15/32" diam x 1⅛" max lg o/a; cont rated 10 amp at 800 v AC; cylindrical brass body, electro tin pl finish; locking; molded phenolic insert; single hole mtg, 1¼"–18 NEF–2 x ⅜" lg mtg bushing; "O" ring wp seal on mtg flange supplied w/spanner type mtg nut and lockwasher immersion and RSW; 2 index flats on mtg bushing; ¼"–20 double thd tapped metal insert in ctr of phenolic insert provides locking action w/mating plug, locating key in outer shell and groove in insert; Amphenol dwg # 164–3; Fed Tele & Rad part/dwg #GH–2082–12.	2Z3070–49

J–7	J–7	J–7	Front panel AUDIO connector	CONNECTOR, receptacle: 10 round button type cont; straight; 1.286″ max diam x 1.197″ max d o/a; cylindrical, SS body, sand blast finish, locking; molded phenolic insert; single hole mtg, 1″–32 NS–2 x 5/16″ lg thd; "O" ring wp seal on mtg collar, supplied w/spanner type mtg nut, immersion and RSW; index flat on mtg portion; Amphenol dwg # 164–7, or Cannon Elec dwg # 17651–1; Fed Tele & Rad part/dwg #GH–2079–12.	2Z3030–27
J–5	J–5	J–5	Chassis to front panel connector	CONNECTOR, receptacle: 15 round male cont; straight; 1½″ lg x ¾″ wd x 13/64″ d excluding term and cont; rectangular molded phenolic body; two .150″ diam mtg holes on 1.188″ mtg/c; cont marked from 1 to 15; Amphenol dwg # 26–151; Fed Tele & Rad part/dwg #GH–2127–12.	2Z3035–31
A–1	A–1	A–1	Detent and dial adjustment access hole cover.	COVER: detent and drive adj access hole cover; p/o Fed Tele & Rad # GA–2309–14 front panel assem; aluminum; diamond shape w/rounded corners; 3¾″ lg x 2 1/32″ wd x 7/16″ thk o/a; 1 mtg slot approx .296″ wd x 7/16″ lg, 1 mtg hole .221″ diam, slot and hole on 3″ mtg/c; circular shoulder on back side w/groove in circumference for "O" ring gasket; marked "rotate this plate to set detents or cal dial," and has channel marking chart; Fed Tele & Rad part/dwg #GA–2663–2.	2Z3351–221
Y–1	Y–1	Y–1	Tuning oscillator crystal	CRYSTAL UNIT, quartz: Army-Navy Crystal Unit CR–18/U; single quartz plate in Army-Navy Crystal Holder HC–6/U; nom freq 4300 kc; Army-Navy spec #71–3314.	2X209–4300
O–7	----------	----------	Detent and dial drive assembly, receiver.	DRIVE, dial: p/o Army-Navy Radio Receiver R–108/GRC; c/o Fed Tele & Rad #GA–1297–14 support casting assem, 1 #GA–1300–14–1 dial and hub assem, 1 #GA–1250–14 cam shaft assem, 1 #GA–1208–2 guide assem, 1 #GA–1196–12 flag assem, 1 #GA–1667–12 shaft assem, and miscellaneous small parts and hardware; roughly flat iron shape; approx 7¾″ lg x 6¼″ wd x 6⅜″ d o/a; three .209″ diam mtg hole ctb 7/16″ diam x ¼″ d on 5.312″ x 5.978″ mtg/c; dial scale marked from 200 to 280 by tens; Fed Tele & Rad part/dwg #GA–1223–14–GR I.	2Z3876. 128
	O–7	----------	Detent and dial drive assembly, receiver.	DRIVE, dial: p/o Army-Navy Radio Receiver R–109/GRC; c/o 1 Fed Tele & Rad #GA–1297–14 support casting assem, 1 #GA–1300–14–2 dial and hub assem, 1 #GA–1250–14 cam shaft assem, 1 #GA–1208–2 guide assem, 1 #GA–1196–12 flag assem, 1 #GA–1667–12 shaft assem, and miscellaneous small parts and hardware; roughly flat iron shape; approx 7¾″ lg x 6¼″ wd x 6⅜″ d o/a; three .209″ diam mtg holes ctb 7/16″ diam x ¼″ d on 5.312″ x 5.978″ mtg/c; dial scale marked from 270 to 390 by tens; Fed Tele & Rad part/dwg #GA–1223–14–GR II.	2Z3876. 129

Ref symbol			Function of part	Name of part and description	Signal Corps stock No.
R-108/GRC	R-109/GRC	R-110/GRC			
		O-7	Detent and dial drive assembly, receiver.	DRIVE, dial: p/o Army-Navy Radio Receiver R-110/GRC; c/o 1 Fed Tele and Rad #GA-1297-14 support casting assem, 1 #GA-1300-14-3 dial and hub assem, 1 #GA-1250-14 cam shaft assem, 1 #GA-1208-2 guide assem, 1 #GA-1196-12 flag assem, 1 #GA-1667-12 shaft assem, and miscellaneous small parts and hardware; roughly flat iron shape; 7¾'' lg x 6¼'' wd x 6⅝'' d, o/a; three .209'' diam mtg holes ctb 7/16'' diam x ¼'' d on 5.312'' x 5.978'' mtg/c; dial marked from 380 to 550 by tens; Fed Tele & Rad part/dwg #GA-1223-14-GR III.	2Z3876. 130
H-1 through H-6	H-1 through H-6	H-1 through H-6	Panel to case fasteners	FASTENER, Dzus: die cast zinc and steel, olive drab finish; 1⅝'' lg x 1 5/16'' wd x 5/16'' thk o/a; mts by shaft thru ¼'' diam clearance hole; preloaded spring pressure, unlocked approx 32 lb, locked 45 lb; Dzus dwg #X-486; Fed Tele & Rad part/dwg #GA-2178-2.	2Z4308-22
F-1	F-1	F-1	Vehicular protection	FUSE, cartridge: 4 amp, opens in 1 hr at 135% load, in 2 minutes at 200% load, rated continuous at 110% load; 250 v max; 1 time; glass body; ferrule term; 1½'' lg x 13/32'' diam; term 13/32'' diam x ⅜'' lg; anti-vibration construction; Buss catalog #AGU-4.	3Z2632
O-23	O-23	O-23	Panel to case waterproof gasket	GASKET: Buna N or neoprene; single hole; rectangular, 8.35'' lg x 6.6'' wd x .187'' thk, hole 7.87'' lg x 6.12'' wd; 35-40 durometer hardness; Fed Tele & Rad part/dwg #GR-1443-12-1.	3H2154.12-27
O-24	O-24	O-24	Dial window gasket	GASKET: rubber or rubber substitute; single hole; circular, 1¼'' OD x 1⅛'' ID x .093'' thk o/a; 35-40 durometer hardness; p/o Fed Tele & Rad #GA-2309-14 front panel assem; Fed Tele & Rad part/dwg #GR-1073-2.	2Z4868.795
O-25	O-25	O-25	Antenna tuning adjusting mounting gasket.	GASKET: single hole; circular w/circular cross section; ⅜'' OD x ¼'' ID x 1/16'' thk; Linear Inc. part #1820-5; Fed Tele & Rad part/dwg #GS-1948-1-4.	2Z4868.767
O-26	O-26	O-26	Binding post mounting gasket	GASKET: Buna N; single hole; circular w/circular cross section, 7/16'' OD x 5/16'' ID x 1/16'' thk; Linear Inc part #1820-6; Fed Tele & Rad part/dwg #GS-1948-1-5.	2Z4868.768
O-27	O-27	O-27	Dial light screw gasket	GASKET: Buna N; single hole; circular w/circular cross section; 9/16'' OD x ⅜'' ID x 3/32'' thk; Linear Inc #1820-8; Fed Tele & Rad part/dwg #GS-1948-1-7.	6L54006-19
O-28	O-28	O-28	Channel designation plate waterproof gasket.	GASKET: Buna N; single hole; circular w/circular cross section; 1 1/16'' OD x 1 7/16'' ID x ⅛'' thk; Linear Inc #1820-26; Fed Tele & Rad part /dwg #GS-1948-1-11.	2A1173.2-34
O-29	O-29	O-29	Binding post mounting gasket	GASKET: Buna N; single hole; circular w/circular cross section, 3/32'' OD x 5/32'' ID x 1/16'' thk; Linear Inc #1820-2; Fed Tele & Rad part/dwg #GS-1948-1-15.	6L34005

E–8	E–8	E–8	Fuse holder	HOLDER, fuse: extractor post type; single AGU cartridge fuse; phenolic w/metal cont and term; 50 v, 22 amp; 2¼″ lg x 1.775″ wd x 1.2″ h o/a; two .173″ diam mtg holes on 1.312″ mtg/c; 2 solder lug term; wp seal between cap and body and wp mtg seal; Buss type #HPC–D; Fed Tele & Rad part/dwg #GH–2365–2.	3Z3282–42.3
H–39	H–39	H–39	Pilot lamp cap screw insulating insert.	INSERT, insulator: polystyrene; circular w/tapered sides; .428″ max OD x .378″ max ID x .109″ thk; sides taper at 30 deg angle from top to bottom; mts in tapered hole in lamp cap screw; Fed Tele & Rad part/dwg #GP–2696–2.	2Z5401–4
E–105	E–105	E–105	Pilot lamp insulating bushing	INSULATOR, bushing: flanged circular shape; polystyrene; .187″ lg; .5″ OD for ⅛″ of length, .438″ diam balance of length, .312″ ID for ⅛″ of length, .255″ balance of length; Fed Tele & Rad part/dwg #GP–2921–2.	3G100–160
E–53 through E–89	E–53 through E–89	E–53 through E–89	Wiring terminal posts	INSULATOR, feed thru: cylindrical shape; white grade L–4 steatite, unglazed; 1$^{9}/_{32}$″ lg o/a; .187″ o/a diam; mts in .168″ diam hole; c/o 1 Fed Tele & Rad #GB–1587–2–1 term, 2 #GG–1589–2 ceramic bushings, 1 #GR–1588–2 silicone rubber grommet, and 1 #GB–1590–2–1 eyelet supplied unassembled; p/o Fed Tele & Rad #GA–2159–12 and #GA–2160–14 term board assem; Fed Tele & Rad part/dwg #GA–1584–2.	3G290–19
E–25, E–114	E–25, E–114	E–25, E–114	Wiring terminal posts	INSULATOR, standoff: round post shape; natural or black grade LTS–E–4 phenolic, w/electro tin pl brass term lug and cad pl and clear iridited hex brass mtg base and stud; 1$^{3}/_{16}$″ lg o/a; 600 v RMS breakdown; $^{5}/_{16}$″ diam o/a; single #6–32 NC–2 x ¼″ lg mtg stud; p/o Fed Tele & Rad #GA–2309–14 front panel assem; Fed Tele & Rad part/dwg #GN–2198–2.	3G350-119
E–26, E–27, E–28	E–26, E–27, E–28	E–26, E–27, E–28	Wiring terminal posts	INSULATOR, standoff: round post shape; white unglazed ceramic w/metal end caps; 1.0375″ lg o/a; .209″ diam; ceramic silicone treated, rivet type mtg stud on 1 end cap .094″ diam x .1″ lg, solder type stud term on other end cap; p/o Fed Tele & Rad #GA–2459–14 chassis assem; Fed Tele & Rad part/dwg #GG–1743–2–3.	3G350–120
E–106, E–107, E–108, E–111	E–106, E–107, E–108, E–111	E–106, E–107, E–108, E–111	"A" detent knob "B" detent knob. "C" detent knob. TUNE-OPERATE switch knob.	KNOB: round; olive drab zinc alloy; for ¼″ diam double flatted shaft; single #6–32 screw thru hole in face of knob; screws into axially tapped hole in end of shaft; 1 white luminous line; 2$^{3}/_{32}$″ max diam at bottom tapers to 2$^{1}/_{32}$″ max diam at top, 1$^{5}/_{32}$″ h o/a; shaft hole .359″ d from bottom surface; luminous markings; Fed Tele & Rad part/dwg #GC–1245–2.	2Z5822–403
E–109, E–110	E–109, E–110	E–109, E–110	VOLUME control knob SQUELCH control knob.	KNOB: round; w/bar; olive drab zinc alloy; for ¼″ diam double flatted shaft; single #6–32 screw thru hole in face of knob; screws into axially tapped hole in end of shaft; 1 white luminous line on bar portion; 1$^{3}/_{16}$″ lg x ⅞″ wd x 1$^{5}/_{32}$″ h o/a; shaft hole .359″ d from bottom surface; luminous markings; Fed Tele & Rad part/dwg #GC–1246–2.	2Z5822–402

Ref symbol			Function of part	Name of part and description	Signal Corps stock No.
R-108/GRC	R-109/GRC	R-110/GRC			
E-112	E-112	E-112	Turning knob	KNOB: round; olive drab zinc alloy; for ¼" diam double flatted shaft; single #6-32 screw thru hole in face of knob; screws into axially tapped hole in end of shaft; luminous white circle on face of knob; 1 25/32" diam x 5/8" h o/a; shaft hole .406" deep from bottom surface; luminous markings, fine straight knurl; Fed Tele & Rad part/dwg #GC-1695-2.	2Z5822-475
N-1	N-1	N-1	Voltage designation plate	LABEL: aluminum; 1 15/16" lg x 15/16" wd x 1/32" thk; inscribed 4A, 12V INTERNAL VIBR. SUPPLY on 1 side, 4A, 24V INTERNAL VIBR. SUPPLY other side; white print on olive drab background; mtg slot on edge .152" wd x 3/8" d; hole in ctr 1 1/32" diam; individually packed; p/o Fed Tele & Rad #GA-2309-14 front panel assem; Fed Tele & Rad part/dwg #GT-2121-2.	2Z5872. 10
N-2	N-2	N-2	Voltage designation plate	LABEL: aluminum; 1 15/16" lg x 15/16" wd x 1/32" thk; inscribed 4A, 6V INTERNAL VIBR. SUPPLY on 1 side, 6.3V, 130V EXTERNAL POWER SUPPLY other side; white print on olive drab background; mtg slot in edge .152" wd x 3/8" d; hole in ctr 1 1/32" diam; indivdually packed; p/o Fed Tele & Rad #GA-2309-14 front panel assem; Fed Tele & Rad part/dwg #GT-2122-2.	2Z5872.11
N-3			Circuit label	LABEL: white nylon tafetta, 120 x 88 mesh; 10½" wd x 15 13/16" lg x .004" thk w/¼" wd nylon tape stitched to 1 end extending 13½" beyond label; black printing on white background; edges heat-treated to prevent fraying; individually packed; Fed Tele & Rad part/dwg #GD-1019-26; Sig C dwg #SC-D-40610-A.	2Z5872.12
	N-3		Circuit label	LABEL: white nylon tafetta, 120 x 88 mesh; 10½" wd x 15 13/16" lg x .004" thk, w/¼" wd nylon tape stitched to 1 end extending 13½" beyond label; black printing on white background; edges heat-treated to prevent fraying; individually packed; Fed Tele & Rad part/dwg #GD-3042-26; Sig C dwg #SC-D-40611-A.	2Z5872.13
		N-3	Circuit label	LABEL: white nylon tafetta, 120 x 88 mesh; 10½" wd x 15 13/16" lg x .004" thk, w/¼" wd nylon tape stitched to 1 end extending 13½" beyond label; black printing on white background; edges heat-treated to prevent fraying; individually packed; Fed Tele & Rad part/dwg #GD-3043-26; Sig C dwg #SC-D-40612-A.	2Z5872.14
E-14	E-14	E-14	Dial light	LAMP, incandescent: 1.35 v, .06 amp; bulb T-1¾ clear; 5/8" lg; single cont, midget flanged base; C-6 tungsten filament; burn any position; GE type #331; Fed Tele & Rad part/dwg #GH-1992-2.	2Z5877-21

H–7,	H–7,	H–7,	"A" detent mounting nut	NUT, castellated: steel, cad pl and olive drab iridite; finished per dwg; 3/8"–32 NS–2; 1/8" thk; 9/16" OD; 4 slots 3/32" wd x 3/64" displaced 90 deg apart; p/o Fed Tele & Rad #GA–2390–14 front panel assem; Fed Tele & Rad part/dwg #GB–1106–2.	6L3006–32S
H–8,	H–8,	H–8,	"B" detent mounting nut.		
H–9,	H–9,	H–9,	"C" detent mounting nut.		
H–10,	H–10,	H–10,	VOLUME control mounting nut.		
H–11,	H–11,	H–11,	SQUELCH control mounting nut.		
H–12,	H–12,	H–12,	Switch control mounting nut.		
H–13,	H–13,	H–13,	ANT trimmer mounting nut.		
H–14	H–14	H–14	TUNING control mounting nut.		
H–15, H–16	H–15, H–16	H–15, H–16	CHANNEL designation plate mounting nuts.	NUT, thumb: steel, cad pl and olive drab iridite; chamfered edge on bearing surface; #10–32 NC–2; 1/2" thk; 1/2" OD; knurled around OD; tapped for 5/32" of length, clearance hole balance of length .281" diam; p/o Fed Tele & Rad #GA–2390–14 front panel assem; Fed Tele & Rad part/dwg #GB–1760–2.	6L3890–32S
O–8	O–8	O–8	Dial window retaining plate	PLATE, retainer: p/o Fed Tele & Rad #GA–2309–14 front panel assem; aluminum; circular; 1 3/4" OD x 1 1/16" ID x 1/16" thk; six 1/8" diam csk mtg holes on 3/4" rad, 60 deg apart; Fed Tele & Rad part/dwg #GB–1704–2.	2Z7091–350
O–9	O–9	O–9	Power pack receptacle retaining ring.	PLATE, retainer: p/o Fed Tele & Rad #GA–2459–14 chassis assem; steel, tin pl; D–shaped plate w/hole in ctr; 2" OD x 1" ID x .108" thk o/a; three .152" diam mtg holes on 7/8" rad, two 90 deg apart, third hole 135 deg from other 2; flat edge on side 3/8" from ctr; Fed Tele & Rad part/dwg #GB–1609–2.	2Z7091–342
E–6	E–6	E–6	Antenna connection	POST, binding: push type; 33/64" diam x 49/64" lg above mtg surface; 3/4" lg x #6–32 NC–2 thd mtg stud; phenolic cap; nickel pl brass body; 1/8" diam wire hole; D-shaped wire grip hole in cap; Eby cat #8330; Fed Tele & Rad part/dwg #GM–2253–2.	3Z737–57
L–20	L–20	L–20	Terminal 3–4 (section A) squelch oscillator V–11, grid reactor. Terminal 1–2 (section B) squelch oscillator V–11, plate reactor.	REACTOR, audio: dual; term 1 and 2, 225 to 250 mh, term 3 and 4, 275 to 310 mh; term 1–2, 270 ohms, term 3–4, 280 ohms DC resistance; 500 v RMS test; HS metal case, 1 3/8" lg x 7/8" wd x 2 1/2" h o/a; two .128" diam mtg holes on 1 1/8" mtg/c; 5 solder type stud term on bottom of case; electrostatic shield between sect; Fed Tele & Rad part/dwg #GH–1226–2.	3C315–153
K–1	K–1	K–1	Filament overvoltage protection.	RELAY, thermal: SPST normally closed; cont rating 2 amp max; silver cont; single wnd heat coil; operates at 6.9 v DC w/1 amp cont load, releases at 2 to 3.5 v, heater current 250 ma w/6.9 v applied, ins; coil and cont leads terminate in octal base; 1.275" diam x 2 7/8" lg excluding base cont and locating pin; mts by means of octal base; operates within 10 sec; enclosed in type T–9 bulb w/std octal base; Fed Tele & Rad part/dwg #GH–2392–12.	2Z7598–129
R–56	R–56	R–56	Overvoltage relay heater, voltage dropping.	RESISTOR, fixed: comp; JAN type RC30BF100K; 10 ohms ±10%; 1 w; spec JAN–R–11.	3RC30BF100K
R–3,	R–3,	R–3,	R-f amplifier V–1 plate parasitic suppressor.	RESISTOR, fixed: comp; JAN type RC20BF120K; 12 ohms ±10%; 1/2 w; spec JAN–R–11.	3RC20BF120K

Ref symbol			Function of part	Name of part and description	Signal Corps stock No.
R-108/GRC	R-109/GRC	R-110/GRC			
R-13,	R-13,	R-13,	First and second i-f amplifiers V-4 and V-5, filament voltage dropping.		
R-14,	R-14,	R-14,	First and second i-f amplifiers V-4 and V-5 filament dropping.		
R-44,	R-44,	R-44,	Fixed level audio amplifier V-12, filament dropping.		
R-48	R-48	R-48	First audio amplifier V-13, filament dropping.		
R-38	R-38	R-38	Squelch oscillator V-11, filament dropping resistor.	RESISTOR, fixed: comp; JAN type RC20 BF270K; 27 ohms ±10%; ½ w; spec. JAN-R-11.	3RC20BF270K
R-55	R-55	R-55	Overvoltage relay heater dropping.	RESISTOR, fixed; comp: JAN type RC20BF330K; 33 ohms ±10%; ½ w; spec. JAN-R-11.	3RC20BF330K
R-21,	R-21,	R-21,	Third i-f amplifier V-6, filament dropping.	RESISTOR, fixed: comp; JAN type RC20BF390K; 39 ohms ±10%; ½ w; spec. JAN-R-11.	3RC20BF390K
R-37	R-37	R-37	Filament dropping.		
R-63	R-63	R-63	Dial light dropping	RESISTOR, fixed: comp; JAN type RC30BF820J; 82 ohms ±5%; 1 w; spec. JAN-R-11.	3RC30BF820J
R-45,	R-45,	R-45,	B+ to fixed level audio amplifier V-12, decoupling.	RESISTOR, fixed: comp; JAN type RC20BF101K; 100 ohms ±10%; ½ w; spec JAN-R-11.	3RC20BF101K
R-47	R-47	R-47	B+ to front panel decoupling.		
R-64,	R-64,	R-64,	Ballast bleeder	RESISTOR, fixed: comp; JAN type of RC30BF101K; 100 ohms ±10%; 1 w; spec JAN-R-11.	3RC30BF101K
R-71,	R-71,	R-71,	Filament dropping.		
R-72	R-72	R-72	Filament dropping.		
R-2,	R-2,	R-2,	R-f amplifier V-1, cathode bias	RESISTOR, fixed: comp; JAN type RC20BF222K; 220 ohms ±10%; ½ w; spec JAN-R-11.	3RC20BF221K
R-6	R-6	R-6	Mixer V-2, cathode bias.		
R-60	R-60	R-60	Voltage regulator V-15, B+ dropping resistor.	RESISTOR, fixed: comp; JAN type RC40BF561J; 560 ohms ±5%; 2 w; spec JAN-R-11.	3RC40BF561J
R-11,	R-11,	R-11,	Mixer V-2, plate B+ decoupling, part of T-5.	RESISTOR, fixed: comp; JAN type RC20BF101K; 1000 ohms ±10%; ½ w; spec JAN-R-11.	3RC20BF102K
R-30	R-30	R-30	Limiter V-8, plate B+ decoupling, part of T-10.		
R-4,	R-4,	R-4,	R-f amplifier plate B+ decoupling, part of T-2.	RESISTOR, fixed: comp; JAN type RC20BF392K; 3900 ohms ±10%; ½ w; spec JAN-R-11.	3RC20BF392K
R-16,	R-16,	R-16,	First i-f amplifier V-4, plate B+ decoupling, part of T-6.		
R-19,	R-19,	R-19,	Second i-f amplifier V-5, plate B+ decoupling, part of T-7.		
R-23,	R-23,	R-23,	Third i-f amplifier, V-6 plate B+ decoupling, part of T-8.		
R-26	R-26	R-26	Fourth i-f amplifier V-7, plate B+ decoupling, part of T-9.		

R–73	R–73	R–73	Filament dropping	RESISTOR, fixed: comp; JAN type RC30BF181K; 180 ohms ±10%; 1 w; spec JAN–R–11.	3RC30BF181K
R–29	R–29	R–29	Limiter V–8 grid, test point decoupling.	RESISTOR, fixed: comp; JAN type RC20BF562K; 5600 ohms ±10%; ½ w; spec JAN–R–11.	3RC20BF562K
R–67	R–67	R–67	First audio amplifier V–13, plate load.	RESISTOR, fixed: comp; JAN type RC20BF103K; 10,000 ohms ±10%; ½ w; spec JAN–R–11.	3RC20BF103K
R–28	R–28	R–28	Limiter V–8, grid measuring circuit filter.	RESISTOR, fixed: comp; JAN type RC20BF183K; 18,000 ohms ±10%; ½ w; spec JAN–R–11.	3RC20BF183K
R–35	R–35	R–35	Tuning oscillator V–10, grid bias.	RESISTOR, fixed: comp; JAN type RC20BF273K; 27,000 ohms ±10%; ½ w; spec JAN–R–11.	3RC20BF273K
R–9,	R–9,	R–9,	R-f oscillator V–3, grid bias	RESISTOR, fixed: comp; JAN type RC20BF823K; 82,000 ohms ±10%; ½ w; spec JAN–R–11.	3RC20BF823K
R–66,	R–66,	R–66,	Squelch oscillator V–11, screen limiting.		
R–10,	R–10,	R–10,	Mixer V–2, plate loading, part of T–5.		
R–15,	R–15,	R–15,	First i-f amplifier V–4, plate loading, part of T–6.		
R–18,	R–18,	R–18,	Second i-f amplifier V–5, plate loading, part of T–7.		
R–22,	R–22,	R–22,	Third i-f amplifier V–6, plate loading, part of T–8.		
R–25	R–25	R–25	Fourth i-f amplifier V–7, plate loading, part of T–9.		
R–7,	R–7,	R–7,	Mixer V–2, injection coupling	RESISTOR, fixed: comp; JAN type RC20BF104K; 100,000 ohms ±10%; ½ w; spec JAN–R–11.	3RC20BF104K
R–1,	R–1,	R–1,	R-f amplifier V–1, grid bias, part of T–1.		
R–5	R–5	R–5	Mixer V–2, grid bias, part of T–3.		
R–31,	R–31,	R–31,	Discriminator V–9, diode load, part of T–11.	RESISTOR, fixed: comp; JAN type RC20BF184J; 180,000 ohms ±5%; ½ w; spec JAN–R–11.	3RC20BF184J
R–32	R–32	R–32	Discriminator V–9, diode load, part of T–11.		
R–74	R–74	R–74	Squelch oscillator grid resistor	RESISTOR, fixed: comp; JAN type RC20BF184K; 180,000 ohms ±10%; ½ w; spec JAN–R–11.	3RC20BF184K
R–12,	R–12,	R–12,	First i-f amplifier V–4, grid loading, part of T–5.	RESISTOR, fixed: comp; JAN type RC20BF224K; 220,000 ohms ±10%; ½ w; spec JAN–R–11.	3RC20BF224K
R–17,	R–17,	R–17,	Second i-f amplifier V–5, grid loading, part of T–6.		
R–20,	R–20,	R–20,	Third i-f amplifier V–6, grid loading, part of T–7.		
R–24,	R–24,	R–24,	Fourth i-f amplifier V–7, grid loading, part of T–8.		
R–27,	R–27,	R–27,	Limiter V–8, grid loading, part of T–9.		
R–36,	R–36,	R–36,	Audio de-emphasis.		
R–41,	R–41,	R–41,	Fixed level control limiting.		
R–43,	R–43,	R–43,	Fixed level control limiting.		

Ref symbol			Function of part	Name of part and description	Signal Corps stock No.
R-108/GRC	R-109/GRC	R-110/GRC			
R-68	R-68	R-68	Squelch oscillator V-11, input.		
R-33,	R-33,	R-33,	Squelch oscillator V-11, input. Coil L-4 test point decoupling.	RESISTOR, fixed: comp; JAN type RC20BF105K; 1 meg ±10%; ½ w; spec JAN-R-11.	3RC20BF105K
R-34,	R-34,	R-34,	Discriminator V-9, output test point decoupling.		
R-39,	R-39,	R-39,	Squelch oscillator V-11, load resistor.		
R-40	R-40	R-40	Squelch oscillator V-11, decoupling.		
R-69	R-69	R-69	Squelch oscillator V-11, bias	RESISTOR, fixed: comp; JAN type RC20BF684K; 680,000 ohms ±10%; ½ w; spec JAN-R-11.	3RC20BF684K
R-70	R-70	R-70	Squelch r-f return	RESISTOR, fixed: comp; JAN type RC20BF225K; 2.2 meg ±10%; ½ w; spec JAN-R-11.	3RC20BF225K
R-50,	R-50,	R-50,	Power amplifier filament V-14, dropping.	RESISTOR, fixed: WW; JAN type RW30G220; 22 ohms ±5%; 8 w; spec JAN-R-26A.	3RW14408
R-52	R-52	R-52	Filament overvoltage dropping.		
R-53	R-53	R-53	Vehicular filament dropping	RESISTOR, fixed: WW; JAN type RW30G310; 31 ohms ±5%; 8 w; spec JAN-R-26A.	3RW15307
R-58	R-58	R-58	Vehicular filament dropping	RESISTOR, fixed: WW; JAN type RW30G630; 63 ohms ±5%; 8 w; spec JAN-R-26A.	3RW17103
R-57	R-57	R-57	Vehicular B+ dropping	RESISTOR, fixed: WW; JAN type RW30G351; 350 ohms ±5%; 8 w; spec JAN-R-26A.	3RW21617
R-54	R-54	R-54	Vehicular B+ dropping	RESISTOR, fixed: WW; JAN type RW30G561; 560 ohms ±5%; 8 w; spec JAN-R-26A.	3RW22808
R-61	R-61	R-61	Vehicular filament	RESISTOR, fixed: WW; JAN type RW33G160; 16 ohms ±5%; 18 w; spec JAN-R-26A.	3RW13526
R-59	R-59	R-59	Constant current filament regulation.	RESISTOR, thermal: current thru lamp greater than .76 amp w/4 v measured across lamp, less than .825 amp w/9.5 v measured across lamp; designed for DC; T-9 bulb, 2⅞″ lg o/a; intermediate octal base; Amperite type #7H4B; Fed Tele & Rad part/dwg #GH-1101-2.	3Z6925-3.20
R-42	R-42	R-42	Fixed level audio amplifier V-12, volume control.	RESISTOR, variable: comp 500,000 ohms ±20%; 2 w; 70° C max continuous operating temp; 3 solder lugs; metal case 1 1/16″ diam x 9/16″ d, enclosed; round metal shaft w/scdr slot, ¼″ diam x ⅝″ lg; AB type A taper, 1% resistance at 30% rotation, 5% at 40%, 10% at 50%, 20% at 60%, 40% at 70%, 65% at 80%, 92% at 90%; ins cont arm w/o off position; normal torque w/shaft locking device; ½″ lg x ⅜″-32 bushing; nonturn device on 17/32″ rad at 9 o'clock; tropicalized and RSW; AB type #SD-40406; Fed Tele & Rad part/dwg #GH-1565-2.	3Z7498-50.121

R–62	R–62	R–62	First audio amplifier V–13, volume control.	RESISTOR, variable: comp; 500,000 ohms ±20%; 2 w; 70° C max continuous operating temp; 3 solder lugs; metal case 1 1/16" diam x 15/16" d, enclosed; round metal shaft w/double flats on end, shaft 1/4" diam x 23/32" lg w/axially tapped #6–32 hole 1/4" d in end; AB type A taper, 1% resistance at 30% rotation, 5% at 40%, 10% at 50%, 20% at 60%, 40% at 70%, 65% at 80%, 92% at 90%; ins cont arm w/o off position; normal torque; bushing 9/32" lg x 3/8"–32, nonturn device on 1 7/32" rad at 3 o'clock; SPST, normally open, operates at start of rotation, 2.5 amp, 25 v DC; 2 term; tropicalized and RSW, wp seal in bushing and mtg collar; AB type #JSW modified; Fed Tele & Rad part/dwg #GH–2037–2.	3Z7498–50.147
R–65	R–65	R–65	Squelch oscillator V–11, control	RESISTOR, variable: comp; 2 sect, ea sect 500,000 ohms ±20%; ea sect 2 w; 70 deg max continuous operating temp; 3 solder lugs ea sect; metal case 1 1/16" diam x 1 3/8" lg enclosed; round metal shaft w/double flats on end, shaft 1/4" diam x 23/32" lg, w/axially tapped #6–32 hole 1/4" d in end; front sect AB type S taper, 4% resistance at 20% rotation; 15% at 30%, 33% at 40%, 50% at 50%, 70% at 60%, 90% at 70%, 98% at 90%; rear sect extreme counterclockwise position 1% of total resistance, 455,000 ohms ±20% at 50% rotation, 10,000 ohms at extreme clockwise position; ins cont arms w/o off position; normal torque; 9/32" lg x 3/8"–32 bushing, nonturn device on 1 7/32" rad at 9 o'clock; SPST switch, normally open, operates at start of rotation; 2 amp 125 v; 2 solder lug term; tropicalized and RSW has wp seal in bushing and on mtg collar; AB type #JJSW modified; Fed Tele & Rad part/dwg #GH–1649–2.	3Z7498–50.143
H–17	H–17	H–17	Channel designation plate mounting screw.	SCREW, machine: slot drive; FH finished per dwg; steel, cad plate and olive drab iridited; #10–32 NC–2; 1 1/32" lg; thd portion 7/8" lg; 3/8" diam head, 3/32" thk; hollow half dog point; p/o Fed Tele & Rad #GA–2309–14 front panel assem; Fed Tele & Rad part/dwg #GB–1759–2.	6L7032–16.59S
H–40	H–40	H–40	Pilot lamp retaining screw	SCREW, thumb: knurled head; brass; head top and knurl painted olive drab; 9/16"–24 NEF–2; .25" lg; thd 1/4" lg; recessed end; head 1 1/16" diam x 1/16" thk; shoulder .39" diam x 1/8" lg; coined slot in head .062" wd on 3/8" rad; marked "lamp" on head; Fed Tele & Rad part/dwg #GA–2695–2.	6L17509–4.8K
E–90,	E–90,	E–90,	Tube shield for V–1	SHIELD, tube: JAN type SOS–3; cad pl brass; round w/hole in top; .81" ID x 1 3/8" lg; pressure coil spring inside; spec JAN–S–28A.	2Z8304.57
E–91	E–91	E–91	Tube shield for V–2.		
E–92,	E–92,	E–92,	Tube shield for V–3	SHIELD, tube: JAN type SOS–6; cad pl brass; round w/hole in top; .81" ID x 1 3/4" lg; pressure coil spring inside; spec JAN–S–28A.	2Z8304.154
E–93,	E–93,	E–93,	Tube shield for V–4.		
E–94,	E–94,	E–94,	Tube shield for V–5.		
E–95,	E–95,	E–95,	Tube shield for V–6.		
E–96,	E–96,	E–96,	Tube shield for V–7.		
E–97,	E–97,	E–97,	Tube shield for V–8.		
E–98,	E–98,	E–98,	Tube shield for V–9.		

Ref symbol			Function of part	Name of part and description	Signal Corps stock No.
R-108/GRC	R-109/GRC	R-110/GRC			
E-99,	E-99,	E-99,	Tube shield for V-10.		
E-100,	E-100,	E-100,	Tube shield for V-11.		
E-101,	E-101,	E-101,	Tube shield for V-12.		
E-102,	E-102,	E-102,	Tube shield for V-13.		
E-103	E-103	E-103	Tube shield for V-14.		
E-104	E-104	E-104	Tube shield for V-15	SHIELD, tube: JAN type TSFOT103; copper or brass, nickel pl; round w/hole in top; .81" ID x 2¼" lg; pressure coil spring inside; spec JAN-S-28A.	2Z8304.172
O-10, O-11	O-10, O-11	O-10, O-11	Connector mounting spacers	SLEEVE, spacer: p/o Fed Tele & Rad #GA-2459-14 chassis assem; brass; tubular; 3/16" OD x .142" ID x ¾" lg; mts by means of ctr hole; Fed Tele & Rad part/dwg #GB-2417-2-1.	2Z8552-75
O-12, O-13	O-12, O-13	O-12, O-13	Terminal board mounting spacers	SLEEVE spacer: p/o Fed Tele & Rad #GA-2309-14 front panel assem; brass; tubular; 3/16" OD x .142" ID x 1¼" lg; mts by means of ctr hole; Fed Tele & Rad part/dwg #GB-2417-2-2.	2Z8552-76
X-20	X-20	X-20	Tuning oscillator V-10, crystal socket.	SOCKET, crystal: ceramic body, tropicalized; 2 round female silver pl phosphor bronze cont; rectangular w/round ends; 55/64" lg x ⅜" wd x 43/64" h o/a; cont on .486" ctr; one ⅛" diam mtg hole ctr between cont; Fed Tele & Rad part/dwg #GH-1991-2.	2Z8672.80
X-1,	X-1,	X-1,	R-f amplifier V-1, tube socket.	SOCKET, tube: 7 cont miniature; JAN type S010M; 1 piece saddle mtg; two ⅛" diam mtg holes on ⅞" mtg/c; round plastic body w/metal shell; 1⅛" lg x .8" wd x 25/32" d excluding term; beryllium copper silver pl cont; marked S010M; w/metal shock shield and ctr shield .18" OD; spec JAN-5-28.	2Z8677.94
X-2,	X-2,	X-2,	Mixer V-2, tube socket.		
X-3,	X-3,	X-3,	R-f oscillator V-3, tube socket.		
X-4,	X-4,	X-4,	First i-f amplifier V-4, tube socket.		
X-5,	X-5,	X-5,	Second i-f amplifier V-5, tube socket.		
X-6,	X-6,	X-6,	Third i-f amplifier V-6, tube socket.		
X-7,	X-7,	X-7,	Fourth i-f amplifier V-7, tube socket.		
X-8,	X-8,	X-8,	Limiter V-8, tube socket.		
X-9,	X-9,	X-9,	Discriminator V-9, tube socket.		
X-10,	X-10,	X-10,	Discriminator tuning oscillator V-10, tube socket.		
X-11,	X-11,	X-11,	Squelch oscillator V-11, tube socket.		
X-12,	X-12,	X-12,	Fixed level audio amplifier V-12, tube socket.		
X-13,	X-13,	X-13,	First audio amplifier V-13, tube socket.		

X–14, X–15	X–14, X–15	X–14, X–15	Audio power amplifier V–14, tube socket. B+ voltage regulator V–15, tube socket.		
X–16, X–17, X–18, X–19	X–16, X–17, X–18, X–19	X–16, X–17, X–18, X–19	Ballast tube R–59, socket. Overvoltage relay K–1, tube socket. Filament bypass socket. B+ bypass socket.	SOCKET, tube: octal; 1 piece molded in mtg plate; two 5/32" diam mtg holes on 1½" mtg/c; round plastic body 1.11" diam x .49" h excluding term; beryllium copper silver pl cont; Amphenol #59–103; Fed Tele & Rad part/dwg #GH–2039–2.	2Z8678.337
O–14 through O–19	O–14 through O–19	O–14 through O–19	Fastener strikes	SPRING: loop type; strike for Dzus fastener; .08" diam olive drab iridited music wire; 1⅜" lg x 5/32" wd x .08" thk o/a; 2 ends turned perpendicular at 90 deg angle to straight portion on 1/16" rad; Dzus dwg #X–487; Fed Tele & Rad part/dwg #GB–2414–2.	6Z8377–10
O–30	0–30	0–30	Pilot lamp contact spring	SPRING: helical compression type; pilot lamp base cont; .02" diam silver pl spring temper phosphor bronze wire; 1⅝" lg x .291" OD o/a; 7 turns; 1 end squared, other end straight wire extending 1" beyond coil portion; Fed Tele & Rad part/dwg #GB–1658–2.	2Z8877.404
H–19	H–19	H–19	Voltage designation plate mounting stud.	STUD ASSEMBLY: p/o Fed Tele & Rad #GA–2309–14 front panel assem; c/o 1 Fed Tele & Rad #GB–2147–2 stud, 1 #GB–2156–2 nut, and 1 #GB–2151–2 washer; steel, cad pl and olive drab iridited; 27/32" lg x 9/32" diam o/a; single #8–32 NC–2 x 7/16" mtd stud, thd for ¼" of lg; stud has hex mtg shoulder ¼" across flats in approx ctr, knurled nonremovable nut on exposed end; Fed Tele & Rad part/dwg #GA–2157–2.	2Z8634–16
H–18	H–18	H–18	Detent cover locking stud	STUD ASSEMBLY: p/o Fed Tele & Rad #GA–2309–14 front panel assem; c/o 1 Fed Tele & Rad #GB–1758–2 screw, 1 #GB–1760–2 nut, 1 #GS–1948–1–5, and 1 screw and lockwasher; steel, cad pl and olive drab iridited; approx 1" lg x ½" diam o/a; mts in single hole, ⅜"–24 NC–2 x 5/32" lg thd on screw portion; knurled nut on exposed end; Fed Tele & Rad part/dwg #GA–2556–2.	2Z8634A–17
S–3	S–3	S–3	TUNE-DIAL LIGHT ON-OFF switch.	SWITCH, rotary: 2 pole, 3 position; single wafer; silver cont; phenolic wafer; 1 9/16" lg x 1¼" wd x 5/8" d o/a; positions 2 and 3 locking, spring return from position 1 to position 2; solder lug term; single hole mtg; bushing 5/16" lg x ⅜"–32, shaft ¼" diam x 1 1/16" lg w/double flat on end and axially tapped #6–32 hole ¼" d in end, flush mtg; wp seal in bushing and on mtg collar; Fed Tele & Rad part/dwg #GH–1629–2.	3Z9825–92.6
S–1	S–1	S–1	Input power selector	SWITCH, rotary: 4 pole, 3 position; 2 wafers; silver pl spring brass cont; phenolic wafers; 1 9/16" lg x 1¼" wd x 1⅛" d o/a; locking detented action; solder lug term; single hole mtg, bushing ¼" lg x ⅜"–32, shaft ¼" diam x ⅜" lg, scdr slot, flush mtg; tropicalized; Fed Tele & Rad part/dwg #GH–1628–2.	3Z9825–92.7

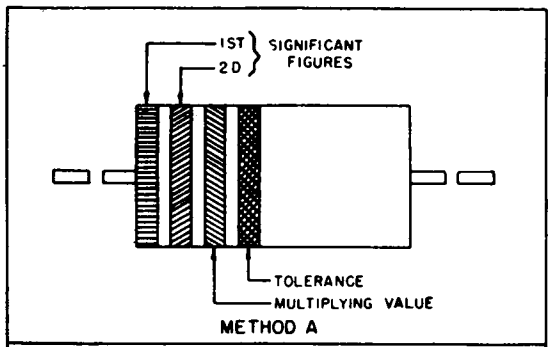
Ref symbol			Function of part	Name of part and description	Signal Corps stock No.
R-108/GRC	R-109/GRC	R-110/GRC			
E-29 through E-33, E-35 through E-43	E-29 through E-33, E-35 through E-43	E-29 through E-33, E-35 through E-43	Wiring grounding lugs	TERMINAL, lug: straight type w/2 bent wp soldering ears; brass, hot tin dipped; 27/64" lg x 7/32" wd x 3/32" h o/a; .12" diam mtg hole between ears; ears bent up at 45 deg angle; solder connects to wire, wrap-around type w/1/32" rad slots in either side of ear; p/o Fed Tele & Rad #GA-2459-14 chassis assem; similar to Shakeproof #2558-04-00; Fed Tele & Rad part/dwg #GR-2248-2-1.	3Z12073-57
E-44 through E-52	E-44 through E-52	E-44 through E-52	Wiring grounding terminals	TERMINAL, stud: p/o Fed Tele & Rad #GA-2159-12 and #GA-2160-14 term board assem; brass, electro tin pl; headed post shape; 13/32" lg x 3/16" diam o/a; mts by means of rivet type base stud 11/64" lg x .114" diam; straight knurl on shoulder raised over edge to provide positive cont w/material on which mtd; Fed Tele & Rad part/dwg #GB-2434-2.	3Z12101-17
T-14	T-14	T-14	Audio power amplifier V-14, output.	TRANSFORMER, AF: plate coupling type; pri 19,000 ohms impedance CT, .005 amp DC, secd 600 ohms impedance CT; 500 v RMS test; HS steel case, silicon steel core; 1 3/16" sq x 2 1/2" h o/a; turns ratio of pri to secd 5.54:1; freq response 250 to 2500 cyc, +2 db to −2 db; 6 solder type stud term on bottom of case; two #6-32 x 15/64" lg mtg studs on diagonally opposite corners of base on 13/16" x 13/16" mtg/c; Fed Tele & Rad part/dwg #GH-1202-2; spec JAN-T-27.	2Z9632.585
T-12, T-13	T-12, T-13	T-12, T-13	Fixed level audio amplifier V-12, output. Interstage coupling, V-13 and V-14.	TRANSFORMER, AF: plate coupling type; pri 22,000 ohms impedance CT, .006 amp DC; secd #1, 600 ohms impedance CT, 160 mw, secd #2, 5200 ohms impedance CT, 140 mw; 500 v RMS test; HS steel case, silicon steel core; 1.38" lg x 7/8" wd x 2 1/16" h o/a; 160 mw output; turns ratio pri to secd #1, 6.28:1, to secd #2, 2.03:1; freq response +2 db to −2 db between 250 and 2500 cyc; 9 solder type stud term on bottom of case; two .128" diam mtg holes on 1 1/8" mtg/c; Fed Tele & Rad part/dwg #GH-1203-2; spec JAN-T-27.	2Z9632.562
T-10	T-10	T-10	Limiter plate coil and discriminator primary.	TRANSFORMER, discriminator: 4.3 mc; shielded; 1 7/32" wd x 3 1/32" d x 3 9/16" lg o/a; phenolic form w/adj powdered iron core; single tuned; adj powdered iron core; two #6-32 NC-2 x 5/16" mtg studs on diagonally opposite corners of base on .608" x .858" mtg/c; 6 solder term on bottom; tropicalized; Muter #7315; Fed Tele & Rad part/dwg #GH-2351-12.	2Z9643.366
T-11	T-11	T-11	Discriminator secondary	TRANSFORMER, discriminator: 4.3 mc; shielded; 1 7/32" wd x 3 1/32" d x 3 9/16" lg o/a; phenolic form w/adj powdered iron core; single tuned; adj powdered iron core; two #6-32 NC-2 x 5/16" mtg studs on diagonally opposite corners of base on .608" x .858" mtg/c; 6 solder term on bottom; tropicalized; Muter #C-7316; Fed Tele & Rad part/dwg #GH-2352-12.	2Z9643.367

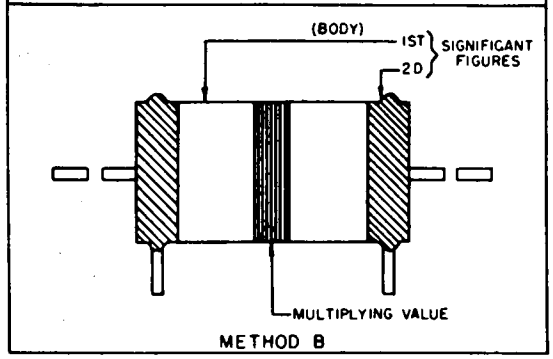
T–5	T–5	T–5	Mixer to first i-f coupling	TRANSFORMER, IF: 4.3 mc; input; shielded; 1 7/32" wd x 3 1/32" d x 3 9/16" lg o/a; phenolic forms w/adj powdered iron core; tuned pri and secd; adj powdered iron core tuning; two #6–32 NC–2 x 5/16" mtg stud on diagonally opposite corners of base on .608" x .858" mtg/c; 6 solder term on bottom; tropicalized; Muter #C–7314–1; Fed Tele & Rad part/dwg #GH–2350–12–1.	2Z9643.368
T–6, T–7, T–8, T–9	T–6, T–7, T–8, T–9	T–6, T–7, T–8, T–9	First i-f to second i-f coupling. Second i-f to third i-f coupling. Third i-f to fourth i-f coupling. Fourth i-f to mixer coupling.	TRANSFORMER, IF: 4.3 mc; interstage; shielded; 1 7/32" wd x 3 1/32" d x 3 9/16" lg o/a; phenolic forms w/adj powdered iron core; tuned pri and secd; adj powdered iron core tuning; two #6–32 NC–2 x 5/16" mtg studs on diagonally opposite corners of base on .608" x .858" mtg/c; 6 solder term on bottom; tropicalized; Muter #C–7314–2; Fed Tele & Rad part/dwg #GH–2350–12–2.	2Z9643.369
V–15	V–15	V–15	B+ voltage regulator	TUBE, electron: JAN–OB2	2J0B2
V–9	V–9	V–9	Discriminator diode	TUBE, electron: JAN–1A3; diode	2J1A3
V–8	V–8	V–8	Limiter	TUBE, electron: JAN–1L4; pentode	2J1L4
V–10,	V–10,	V–10,	Discriminator diode, tuning oscillator.	TUBE, electron: JAN–1S5; diode-pentode	2J1S5
V–11	V–11	V–11	Squelch oscillator.		
V–4, V–5, V–6, V–7	V–4, V–5, V–6, V–7	V–4, V–5, V–6, V–7	First i-f amplifier Second i-f amplifier. Third i-f amplifier. Fourth i-f amplifier.	TUBE, electron: JAN–1U4; pentode	2J1U4
V–3, V–14	V–3, V–14	V–3, V–14	R-f oscillator Audio power amplifier.	TUBE, electron: JAN–3A5; dual triode	2J3A5
V–12, V–13	V–12, V–13	V–12, V–13	Fixed level audio amplifier First audio amplifier.	TUBE, electron: JAN–3Q4; pentode	2J3Q4
V–1, V–2	V–1, V–2	V–1, V–2	R-f amplifier Mixer.	TUBE, electron: JAN–6AK5; pentode	2J6AK5
H–20	H–20	H–20	Binding post mounting insulator	WASHER, extruded: molded phenolic; round, 5/8" OD x .1405" ID x 13/64" thk; extrusion .312" OD x .078" h; face ctb .329" diam x .046" d; p/o Fed Tele & Rad #GA–2309–14 front panel assem; Fed Tele & Rad part/dwg #GG–1514–2.	6L52630
H–22 through H–33	H–22 through H–33	H–22 through H–33	Resistor mounting insulating washers.	WASHER, flat: mica; roung, 1/2" OD x 3/32" ID x 1/32" thk; p/o Fed Tele & Rad #GA–2160–14 term board assem; Fed Tele & Rad part/dwg #GG–2482–2.	6L52404
H–41	H–41	H–41	Binding post mounting washer	WASHER, flat: LTS–E–4, 5, or 6 natural phenolic; 5/8" OD x .154" ID x 1/16" thk; p/o Fed Tele & Rad #GA–2309–14 front panel assem; Fed Tele & Rad part/dwg #GG–2542–2.	3G80–1
H–21	H–21	H–21	Antenna tuning adjustment mounting gasket.	WASHER, flat: Buna N; .56" OD x .428" ID x .066" thk; p/o Fed Tele & Rad #GA–2309–14 front panel assem; Fed Tele & Rad part/dwg #GR–2119–2.	6L54007–9
H–34	H–34	H–34	Dial scale window	WINDOW: p/o Fed Tele & Rad #GA–2309–14 front panel assem; plexiglas; round; 1.245" diam x 3/16" thk o/a; mts in round hole in panel; polished faces; 2 shoulders on outside edge, one .995" diam x 1/16" d, second 1 1/8" diam x 5/64" d; Fed Tele & Rad part/dwg #GG–1705–2.	2ZA1352–184

Ref symbol			Function of part	Name of part and description	Signal Corps stock No.
R-108/GRC	R-109/GRC	R-110/GRC			
				MISCELLANEOUS PARTS	
H-38	H-38	H-38	Tube puller for miniature tubes	PULLER, tube: basket type; steel wire w/flattened copper tubing finger grip; galv; approx 2½'' lg; basket portion approx ⅝'' OD; finger grip portion 1'' wd x ¼'' thk; Kellems type #11–16; Fed Tele & Rad part/dwg #GB–3037–2.	6R7443–4
H-35	H-35	H-35	Setscrew wrench	WRENCH: .05'' across flats; short arm $^{21}/_{32}$'' lg, long arm $1\,^{27}/_{32}$'' lg; steel, parkerized; L-shaped hex bar; for Allen #4 set screw and #1 flat head cap screw; Allen Mfg code #050.	6R55499
H-36	H-36	H-36	Setscrew wrench	WRENCH: set screw key; ⅛'' across flats; short arm $^{27}/_{32}$'' lg, long arm $2\,^{11}/_{32}$'' lg; steel, parkerized; L-shaped hex bar; for Allen ¼'' set screw, #8 socket head cap screw, #10 flat head cap screw, and ¼'' shoulder screw; Allen Mfg code #18.	6R57400–3
H-37	H-37	H-37	Setscrew wrench	WRENCH: set screw key; $^{5}/_{32}$'' across flats; short arm $^{15}/_{16}$'' lg, long arm $2\,^{19}/_{32}$'' lg; steel, parkerized; L-shaped hex bar; for Allen $^{5}/_{16}$'' set screw, #10 socket head cap screw, ¼'' flat head cap screw, $^{5}/_{16}$'' shoulder screw; Allen Mfg code #532.	6R57400–10
E-115	E-115	E-115	Connector contact shorting bar	BAR, shorting: female connector cont shorting bar; 14 ga music wire; U shaped; approx $^{11}/_{16}$'' lg x ¼'' wd x .064'' thk o/a; mts in female connector cont by means of leg portions; top finger grip portion coated w/black polyannide resin; flat in ea. leg ¼'' down from base portion; Fed Tele & Rad part/dwg #GA–3106–2.	2Z558–46

RESISTOR COLOR CODES

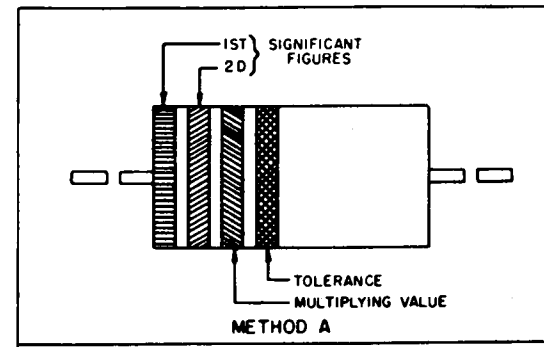
RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS*

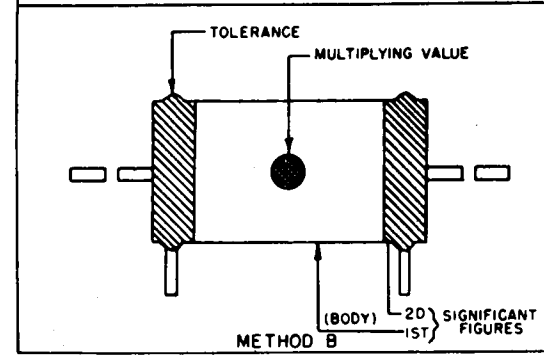




A

JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS*





B

COLOR	SIGNIFICANT FIGURE	MULTIPLYING VALUE	TOLERANCE (%)
BLACK	0	1	± -
BROWN	1	10	± 1
RED	2	100	± 2
ORANGE	3	1,000	± 3
YELLOW	4	10,000	± 4
GREEN	5	100,000	± 5
BLUE	6	1,000,000	± 6
VIOLET	7	10,000,000	± 7
GRAY	8	100,000,000	± 8
WHITE	9	1,000,000,000	± 9
GOLD	-	0.1	± 5
SILVER	-	0.01	± 10
NO COLOR	-	-	± 20

NOTES

* INSULATED FIXED COMPOSITION RESISTORS WITH AXIAL LEADS ARE DESIGNATED BY A NATURAL TAN BACKGROUND COLOR. NON-INSULATED FIXED COMPOSITION RESISTORS WITH AXIAL LEADS ARE DESIGNATED BY A BLACK BACKGROUND.

/ RESISTORS WITH AXIAL LEADS ARE INSULATED. RESISTORS WITH RADIAL LEADS ARE NON-INSULATED.

RMA: RADIO MANUFACTURERS ASSOCIATION

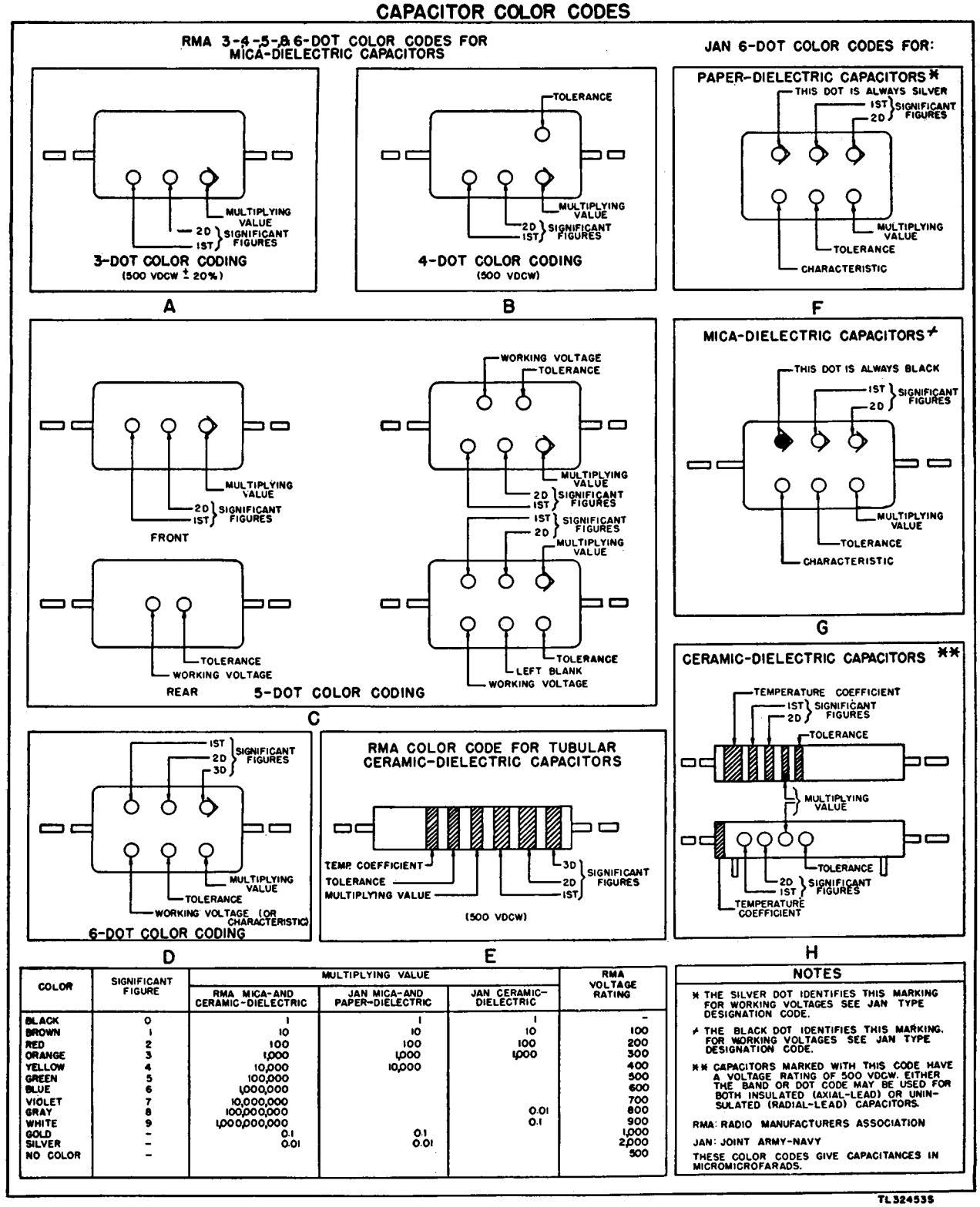
JAN: JOINT ARMY-NAVY

THESE COLOR CODES GIVE ALL RESISTANCE VALUES IN OHMS.

TL 32454S

Figure 33. Resistor color code.

CAPACITOR COLOR CODES



COLOR	SIGNIFICANT FIGURE	MULTIPLYING VALUE			RMA VOLTAGE RATING
		RMA MICA- AND CERAMIC-DIELECTRIC	JAN MICA- AND PAPER-DIELECTRIC	JAN CERAMIC-DIELECTRIC	
BLACK	0	1	1	1	-
BROWN	1	10	10	10	100
RED	2	100	100	100	200
ORANGE	3	1,000	1,000	1,000	300
YELLOW	4	10,000	10,000		400
GREEN	5	100,000			500
BLUE	6	1,000,000			600
VIOLET	7	10,000,000			700
GRAY	8	100,000,000		0.01	800
WHITE	9	1,000,000,000		0.1	900
GOLD	-	0.1	0.1		1,000
SILVER	-	0.01	0.01		2,000
NO COLOR	-				500

NOTES

* THE SILVER DOT IDENTIFIES THIS MARKING FOR WORKING VOLTAGES SEE JAN TYPE DESIGNATION CODE.

≠ THE BLACK DOT IDENTIFIES THIS MARKING. FOR WORKING VOLTAGES SEE JAN TYPE DESIGNATION CODE.

** CAPACITORS MARKED WITH THIS CODE HAVE A VOLTAGE RATING OF 500 VDCW. EITHER THE BAND OR DOT CODE MAY BE USED FOR BOTH INSULATED (AXIAL-LEAD) OR UNINSULATED (RADIAL-LEAD) CAPACITORS.

RMA: RADIO MANUFACTURERS ASSOCIATION

JAN: JOINT ARMY-NAVY

THESE COLOR CODES GIVE CAPACITANCES IN MICROMICROFARADS.

TL32453S

Figure 34. Capacitor color code.

INDEX

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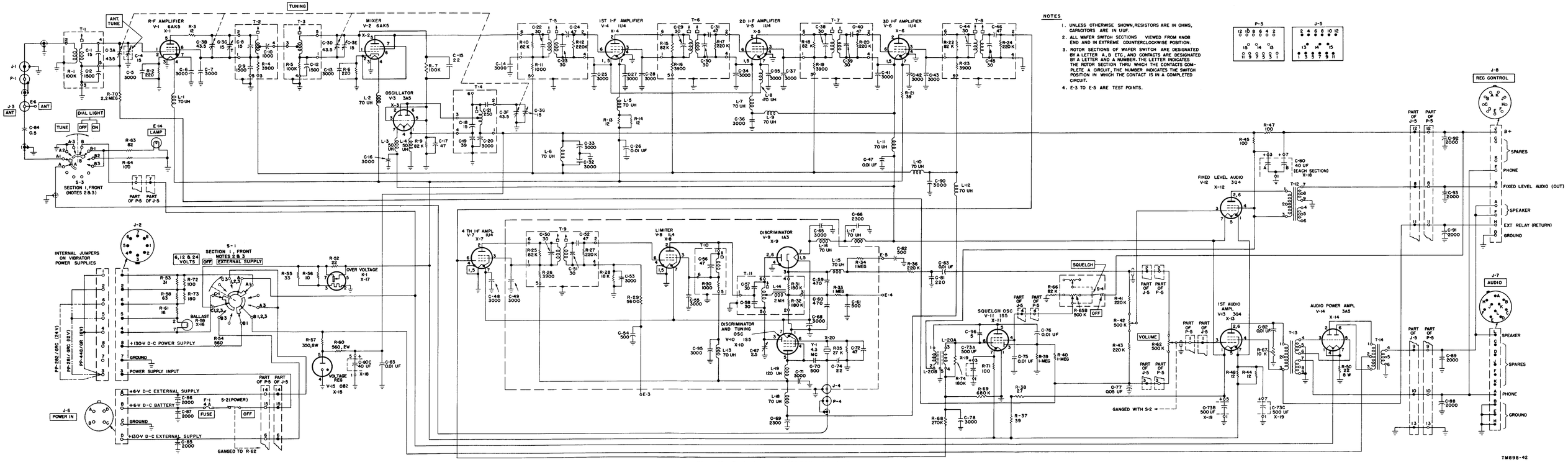

Figure 35. Radio Receiver R-108/GRC, schematic diagram.

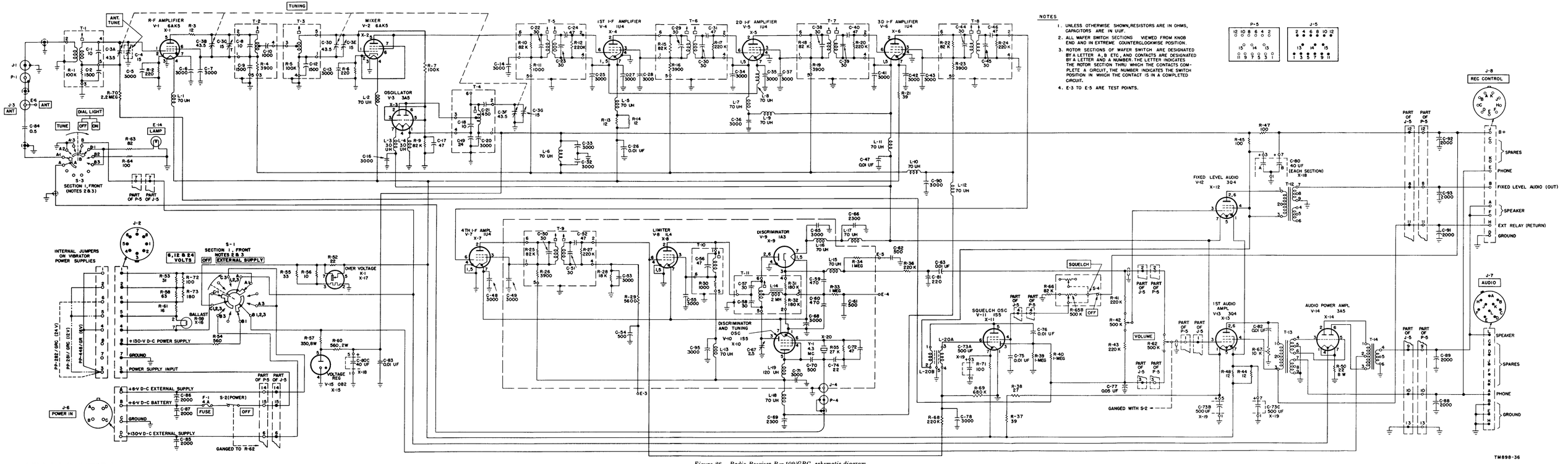

Figure 36. Radio Receiver R-109/GRC, schematic diagram.

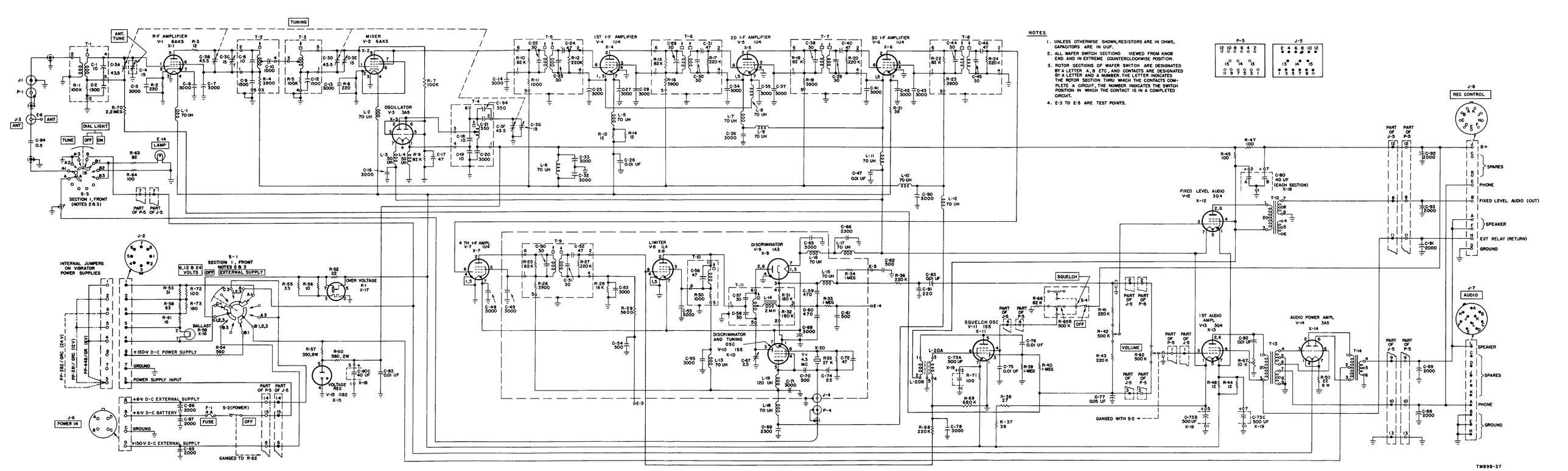

Figure 87. Radio Receiver R-110/GRC, schematic diagram.