DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 11-882
TO 31R2-2URR-161

RADIO RECEIVING SET AN/URR-29 AND RADIO RECEIVER R-220/URR

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

NOVEMBER 1955

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 450-volt plate and power supply circuits, or on the 115-volt ac line connections.

DON'T TAKE CHANCES!

TECHNICAL MANUAL
No. 11–882
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DEPARTMENT OF THE ARMY AND
THE AIR FORCE
WASHINGTON 25, D. C., 7 *November 1955*

RADIO RECEIVING SET AN/URR–29 AND RADIO RECEIVER RX220/URR

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual contains information necessary for the installation, operation, maintenance, and repair of Radio Receiving Set AN/URR–29 (fig. 1), which includes Radio Receiver R–220/URR (fig. 2).

b. Forward comments on this publication directly to the Commanding Officer, The Signal Corps Publications Agency, Fort Monmouth, N. J., ATTN: Standards Division.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army materiel and equipment and when performing preventive maintenance:

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

b. DA 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. DD Form 535, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700–45–5 and AF TO 00–35D–54.

d. DA Form 11–238, Operator First Echelon Maintenance Checklist for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form (fig. 13).

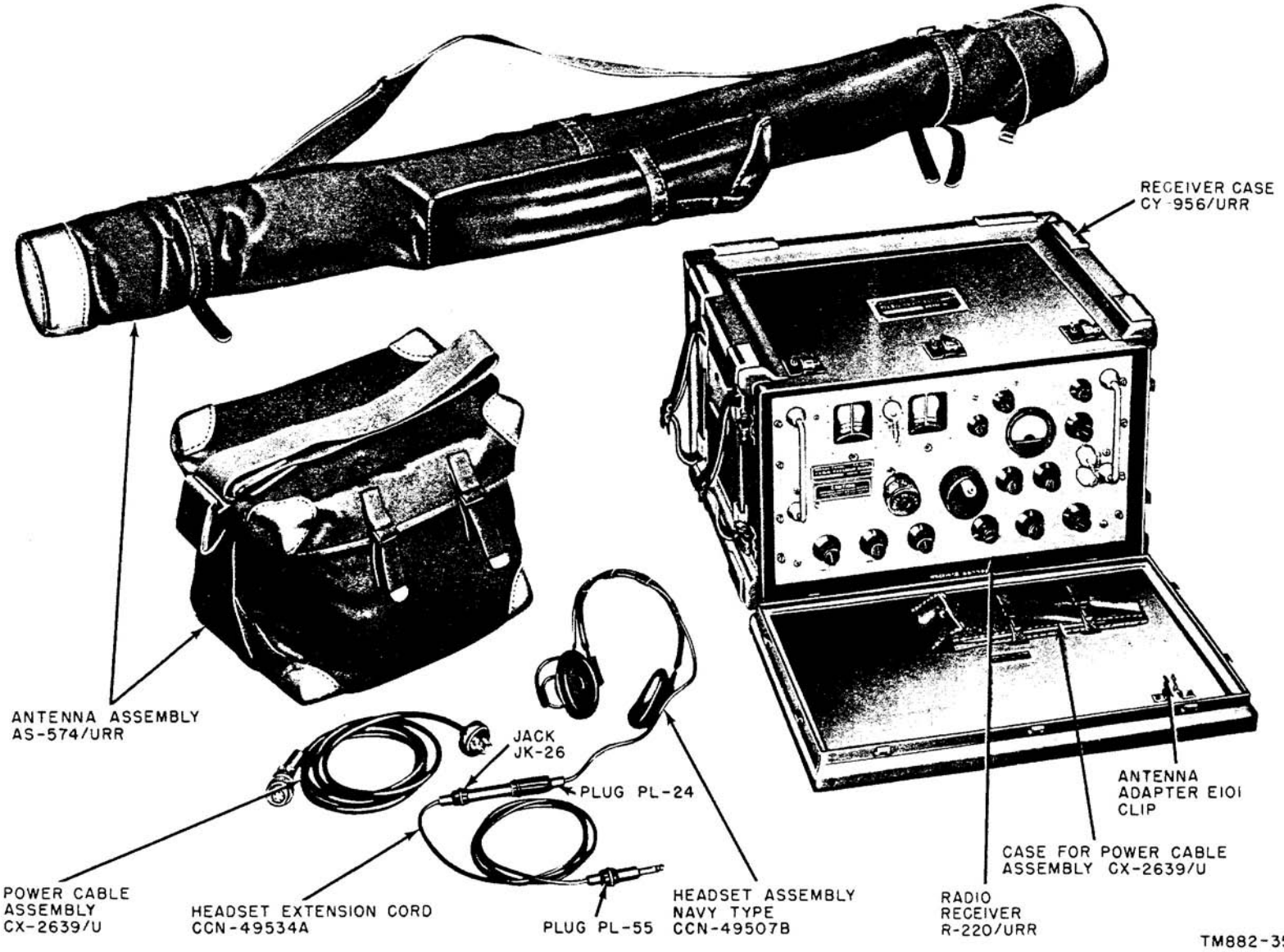
e. DA Form 11–239, Second and Third Echelon Maintenance Checklist for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form (fig. 14).

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

Radio Receiving Set AN/URR–29 is used for the reception and monitoring of amplitude-modulated (am.), frequency-modulated (fm), modulated continuous wave (mcw), and continuous-wave (cw) signals over a frequency range of 20 to 230 megacycles (mc). Radio Receiving Set AN/URR–29 can be used in fixed, semifixed, or portable installations. It is moisture and fungus resistant and may be used under extreme climatic conditions, such as cold, heat, moisture, rain, and in desert areas.



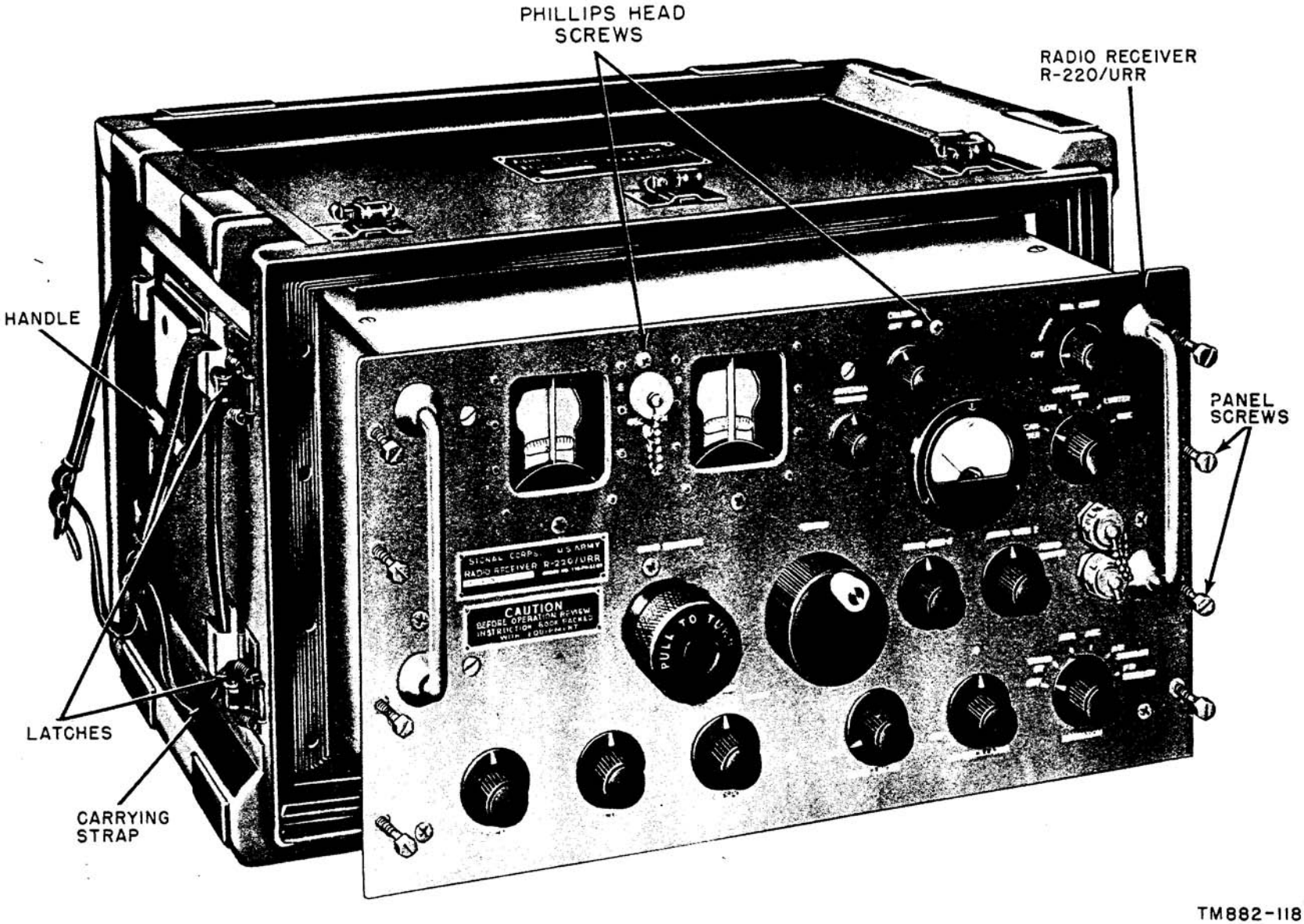


Figure 2. Radio Receiver R-220/URR and Receiver Case CY-596/URR.

4. Technical Characteristics of Radio Receiver R–220/URR

Type of receiver	Triple-conversion superheterodyne.
Type of signal received	Am, fm, cw, and mcw.
Deviation, fm	±75 kc maximum.
Number of tubes:	
Receiver	41 (including ballast tube RT301).
Power supply	1.
Intermediate frequencies:	
First (variable)	Band 1, 6.0942 mc; band 2, 8.6369 mc; band 3, 12.1884 mc; band 4, 17.2738 mc; band 5, 24.3767 mc; band 6, 34.5476 mc; band 7, 48.7535 mc.
Second (fixed)	1.75 mc.
Third (fixed)	455 kc.
If selectivity	10 kc, 50 kc, and 200 kc bandwidths.
Frequency range	19.74 to 237.97 mc in seven bands.
Band 1	19.74 to 28.5 mc.
Band 2	28.5 to 40.5 mc.
Band 3	40.5 to 57 mc.
Band 4	57 to 81 mc.
Band 5	81 to 114 mc.
Band 6	114 to 162 mc.
Band 7	162 to 237.97 mc.
Type of tuning	Continuous on each band, with overlap; frequency is indicated directly on megacycle and kilocycle dials.
Method of calibration	Built-in, crystal-controlled calibration oscillator.
Calibration points	20–230 mc, in 5-mc steps.
Receiver sensitivity to produce an output of 10 mw for 10 db signal-to-noise ratio:	
Am signals	2 microvolts on bands 1 through 5. 4 μv on band 6. 6.5 μv on band 7.
Cw signals	1.2 μv on bands 1 through 5. 1.7 μv on band 6. 2.2 μv on band 7.
Fm signals	6.5 μv on bands 1 through 5. 7.5 μv on band 6. 16 μv on band 7.
Squelch sensitivity	1 μv.
Audio response:	
SHARP, using 800-cps band-pass filter	−6 db at 600 cps and 1,000 cps. −30 db at 400 cps and 1,200 cps.
MEDIUM, using 3,500 cps low-pass filter	200–3,500 cps, flat, ±3 db. −35 db at 4,000 cps.
WIDE, using no filter	300–3,500 cps, flat, ±1 db. 200–4,000 cps, flat, ±3 db.
Outputs:	
J301	Auxiliary diode output, 5 v dc or af across 47,000 ohms.
J302	Auxiliary if output, 455 kc, 1 mw across 50 ohms.
J305	0.5 w across 600-ohm unbalanced audio output.
J306	0.5 w across 600-ohm unbalanced audio output.
TB308:	
Terminals 1 and 2	0.5 w across 600-ohm unbalanced audio output.
Terminals 3 and 6	100 mw across 600-ohm balanced line, audio output.
Antenna input:	
Balanced	95 ohms impedance, for connecting to 95-ohm twinaxial transmission line.
Unbalanced	95 ohms impedance, using adapter, for connecting to 50-ohm coaxial transmission line.

Power Requirements:	
Tube heaters	26 volts ac or dc at 2.1 amp and 6.3 volts ac or dc at 3 amp.
B+ circuits	175 volts dc at 170 ma.
Oscillator heater element	115 volts ac at 0.78 amp, or 26 volts, ac or dc, at 3.5 amp.
Normal operating temperature	−40° F. (=40° C.) to 140° F. (60° C).
Height	10½ in.
Width	19 in.
Depth	14¾ in.
Weight (including power supply, but less case)	96 lb.
Weight of Receiver Case CY–956/URR	38 lb.
Power Supply PP–660/URR:	
Input	115 volts ac at 2.2 amp, 48–62 cps, or 230 volts ac at 1.1 amp, 48–62 cps.
Electron tube	1 full-wave rectifier.
Output at J604	115 volts ac at 0.78 amp, 26 volts ac at 2.1 amp, 6.3 volts ac at 3 amp, and 175 volts dc at 170 ma.
Weight	30 lb.

5. Packing and Packaging Data

a. General. Radio Receiving Set AN/URR–29 may be packed for export or for domestic shipment; the method of packing differs only in the number and type of outer containers. Radio Receiver R–220/URR may be packed separately for export or domestic shipment. A list of the contents of all inner cartons (packages) is stenciled or labeled on each inner box; the contents of each outer container is shown on a packing list (contents) inside the outer box. In addition, a consolidated packing list, itemizing all the components in the shipment, will be found tacked or taped to one of the outer containers. Two orange stripes stenciled at one end of the packing case (fig. 3) indicate an export shipment. An orange spot and a number, such as ⅓, ⅔, or ⅜, means that the box is part of a set (example: ⅔ indicates the second box in a set of three). The method of packing may vary somewhat from that shown, depending on the supply channel.

b. Export Packing. An export shipment of Radio Receiving Set AN/URR–29 is packed in three wooden crates (fig. 3). The first crate contains Radio Receiver R–220/URR, Receiver Case CY–956/URR, Headset Assembly Navy Type CCN–49507B with Headset Extension Cord CCN–49534A, Power Cable Assembly CX–2639/U, the running spare parts, and the manuals. The second and third crates contain Antenna Assembly AS–574/URR, including cable assemblies CG–1079/U and CG–718/U. Radio Receiver R–220/URR is packed for export shipment in a single wooden crate (fig. 4). Besides the receiver, the crate contains Power Cable Assembly CX–2639/U, running spare parts, and the manuals.

c. Domestic Packing. A domestic shipment of Radio Receiving Set AN/URR–29 is packed in four containers (fig. 7) as follows: a cleated fiberboard box containing Radio Receiver R–220/URR and Receiver Case CY–956/URR; a cardboard carton containing Power Cable Assembly CX–2639/U, Headset Assembly Navy Type CCN–49507B with Headset Extension Cord CCN–49534A, running spare parts and the manuals; a cardboard carton containing mast sections and dipoles for Antenna Assembly AS–574/URR; and a wooden crate containing accessories for the antenna assembly. Radio Receiver R–220/URR is packed for domestic shipment in two containers (fig. 8). One of these is a cleated fiberboard box containing Radio Receiver R–220/URR. The other is a carboard carton containing Power Cable Assembly CX–2639/U, running spare parts, and manuals.

d. Packaging. The materials used for the inner cartons, or *packages*, are the same for both export and domestic shipment. Typical packages are shown in figures 5 and 6. Both the cartons and the tape used for packaging are waterproof. Fillers are used to protect the equipment from shock. The contents of each package is stenciled or labeled on the outside of the box.

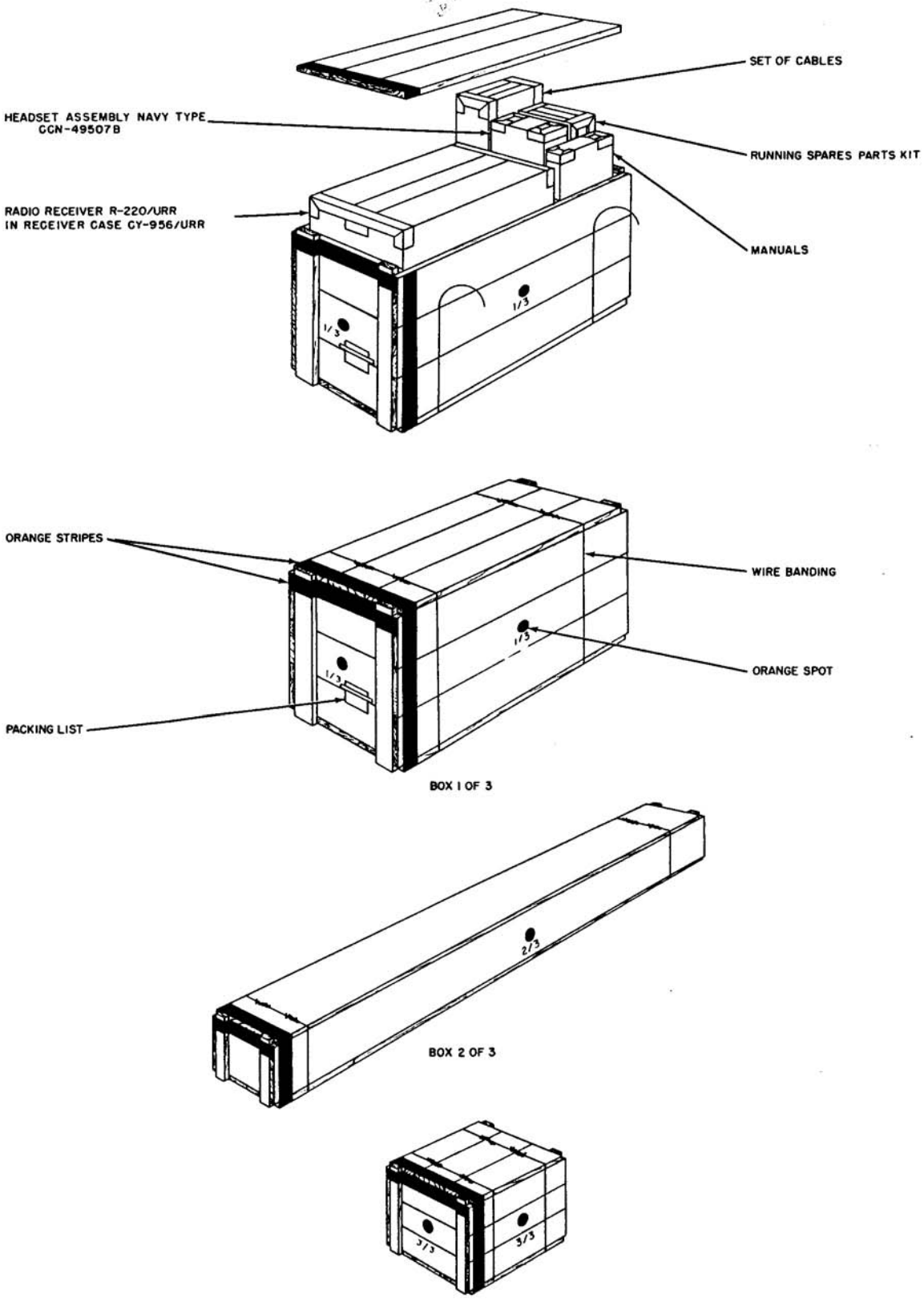


Figure 3. Radio Receiving Set AN/URR-29, packed for export shipment.

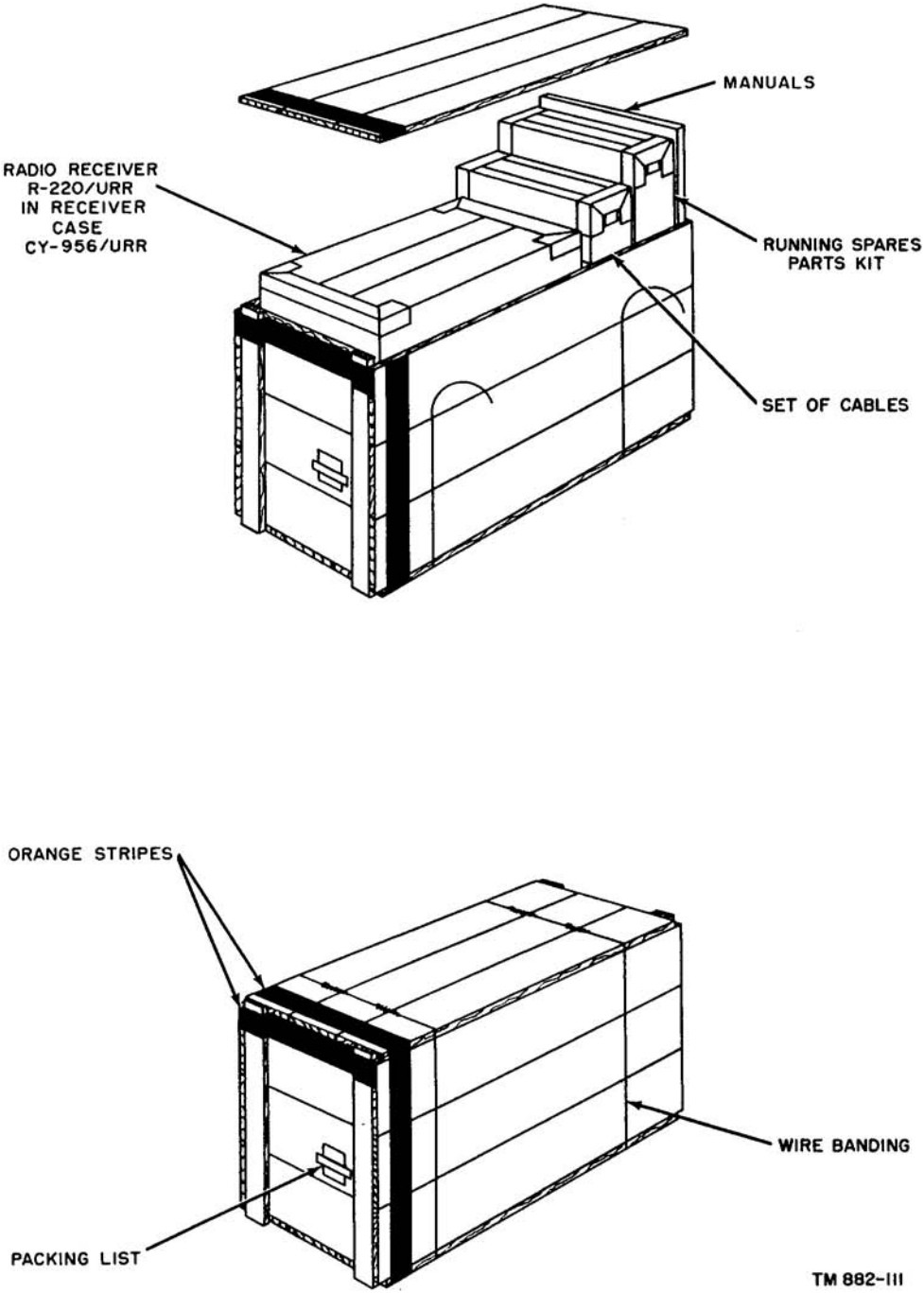


Figure 4. Radio Receiver R-220/URR, packed for export shipment.

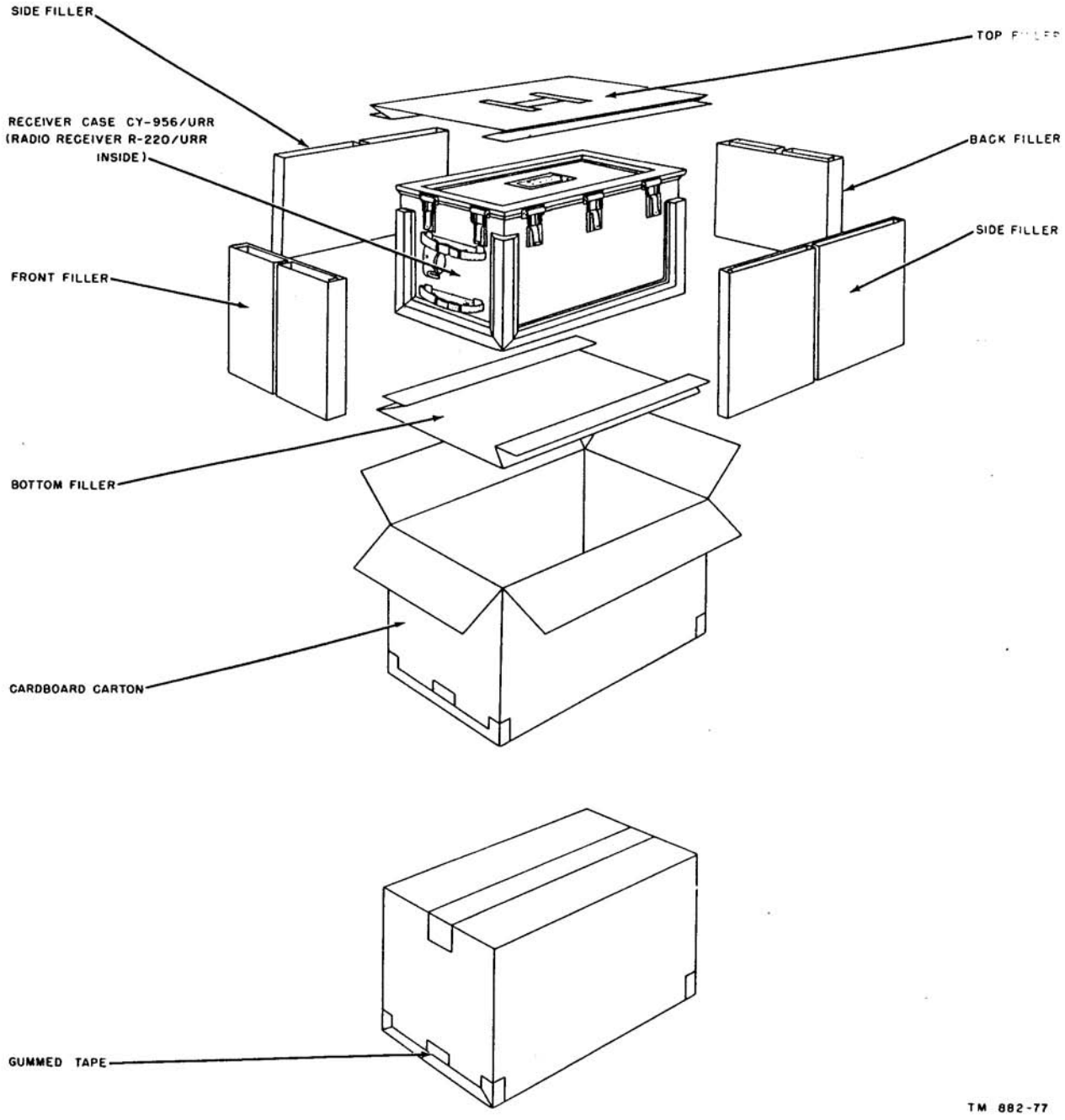


Figure 5. Radio Receiver R-220/URR, inside of Receiver Case CY-956/URR.

a. Case Contents and Dimensions. The following charts list the case contents and dimensions for both export and domestic shipments of Radio Receiving Set AN/URR-29 and Radio Receiver R-220/URR.

Note. Items may be packaged in a manner different from that shown, depending on supply channels.

(1) *Export shipment, Radio Receiving Set AN/URR-29* (fig. 3).

Crate No.	Height (in.)	Width (in.)	Depth (in.)	Volume (cu. ft.)	Unit weight (lb.)	Contents
1 of 3	24	20	20	5. 7	133	Radio Receiver R-220/URR, Receiver Case CY-956/URR, Headset Assembly Navy Type CCN-49507B with Headset Extension Cord CCN-49534A, Power Cable Assembly CX-2639/U, running spares kit, and manuals.
2 of 3	18	70	10	3. 2	85	Antenna Assembly AS-574/URR dipoles and mast sections.
3 of 3	12	18	14	1. 8	52	Antenna Assembly AS-574/URR transmission lines, guy ropes, brackets, tools, hardware.
Total weight (lb)					270	

(2) *Domestic shipment, Radio Receiving Set AN/URR-29* (fig. 7).

Crate No.	Height (in.)	Width (in.)	Depth (in.)	Volume (cu. ft.)	Unit weight (lb.)	Contents
1 of 4	22	28	19	5. 7	175	Radio Receiver R-220/URR and Receiver Case CY-956/URR.
2 of 4	12	15	15	1. 8	22	Headset Assembly Navy Type CCN-49507B with Headset Extension Cord CCN-49534A, Power Cable Assembly CX-2639/U, running spare kit, and manuals.
3 of 4	8	20	10	3. 2	85	Antenna Assembly AS-574/URR dipoles and mast sections.
4 of 4	12	18	14	1. 8	52	Antenna Assembly AS-574/URR transmission lines, guy ropes, brackets, tools, and hardware.
Total weight (lb)					334	

(3) *Export shipment, Radio Receiver R-220 URR* (fig. 4).

Crate No.	Height (in.)	Width (in.)	Depth (in.)	Volume (cu. ft.)	Unit weight (lb.)	Contents
1 of 1	23	38	16	7. 1	165	Radio Receiver R-220/URR, Power Cable Assembly CX-2639/U, running spares kit, and manuals.
Total weight (lb)					165	

(4) *Domestic shipment, Radio Receiver R-220/URR* (fig. 8).

Crate No.	Height (in.)	Width (in.)	Depth (in.)	Volume (cu. ft.)	Unit weight (lb.)	Contents
1 of 2	21	25	19	5. 7	133	Radio Receiver R-220/URR.
2 of 2	12	15	15	1. 8	22	Power Cable Assembly CX-2639/U, running spares kit, and manuals.
Total weight (lb)					155	

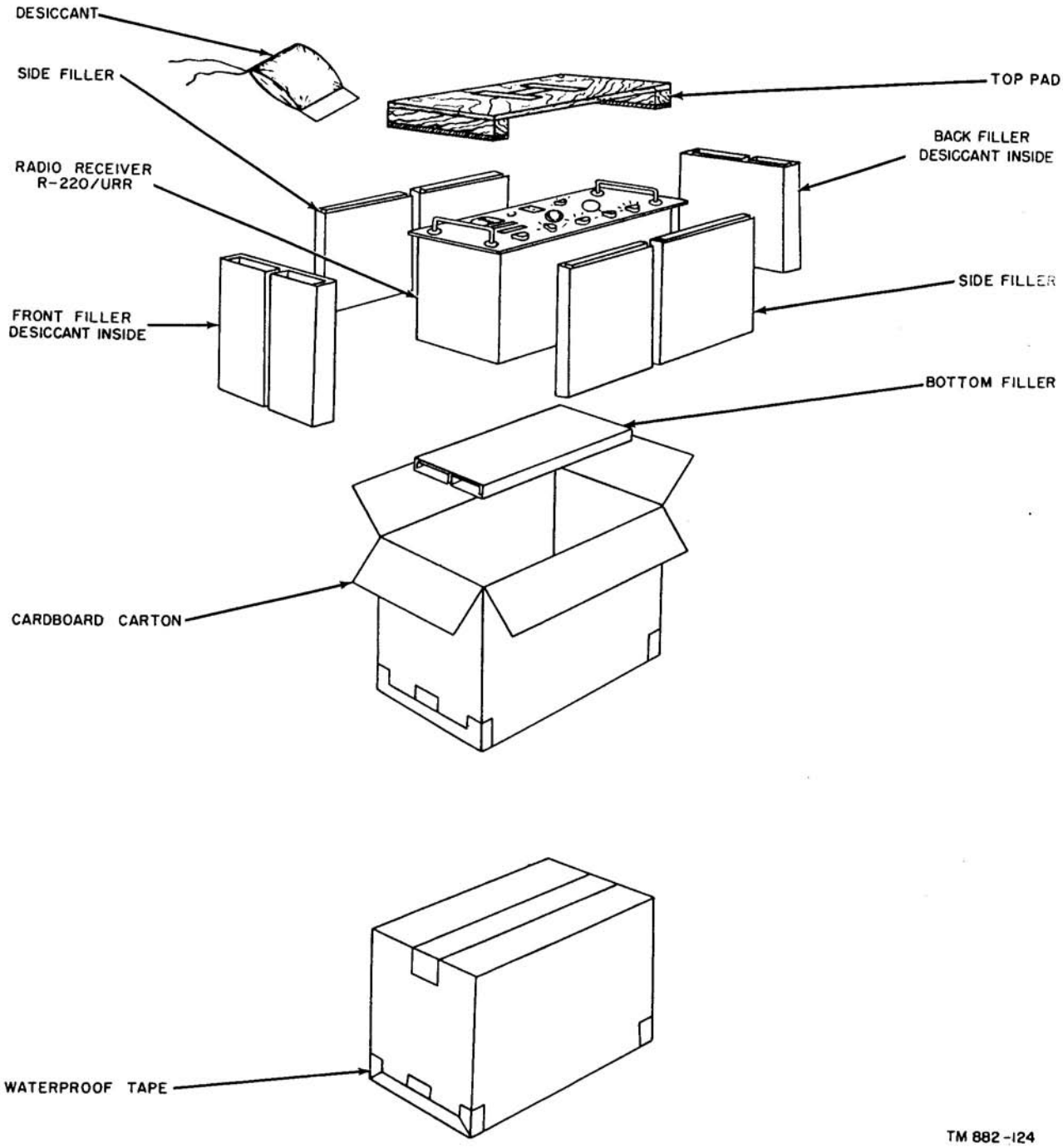


Figure 6. Radio Receiver R-220/URR, packaging.

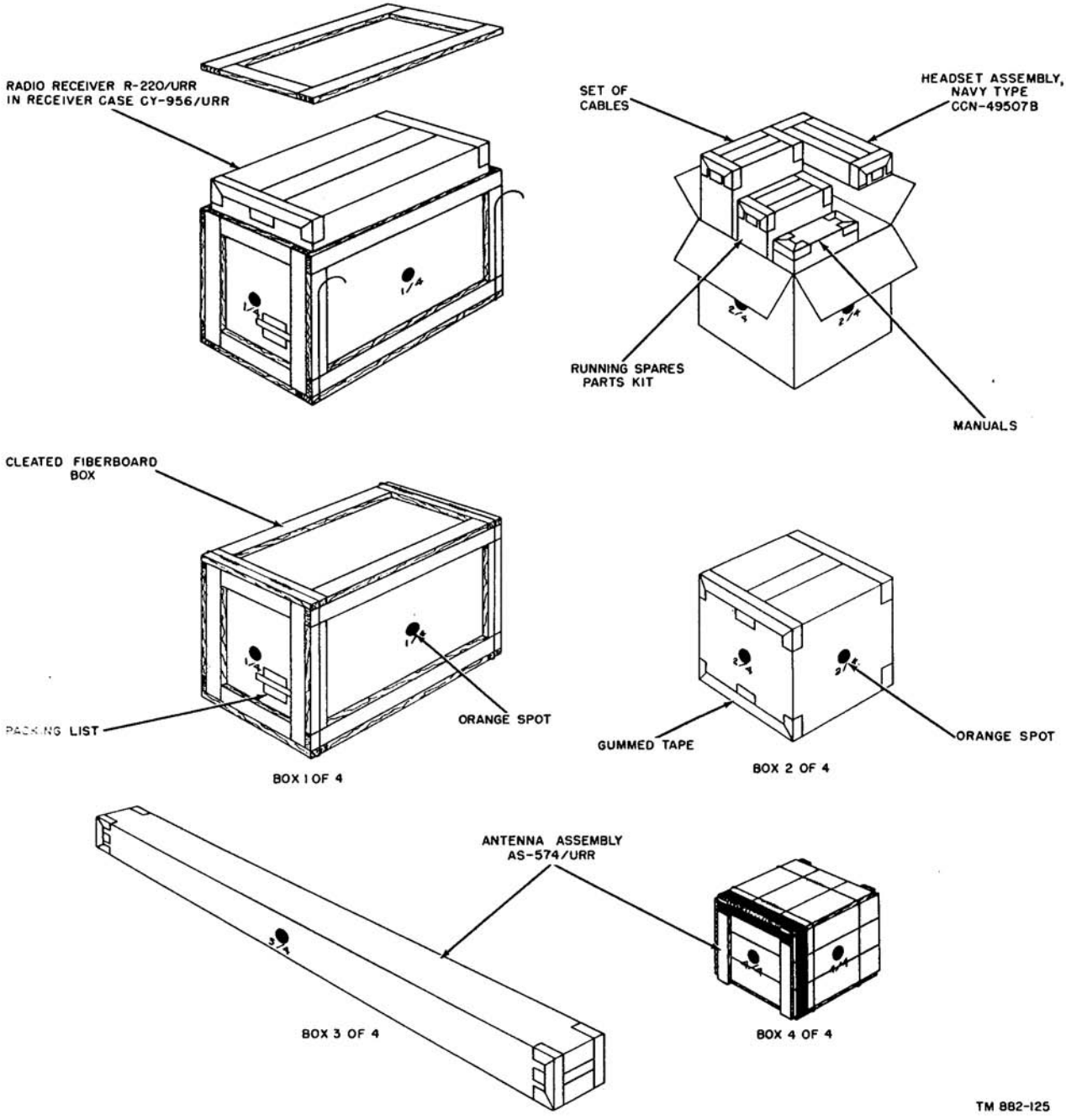


Figure 7. Radio Receiving Set AN/URR-29, packed for domestic shipment.

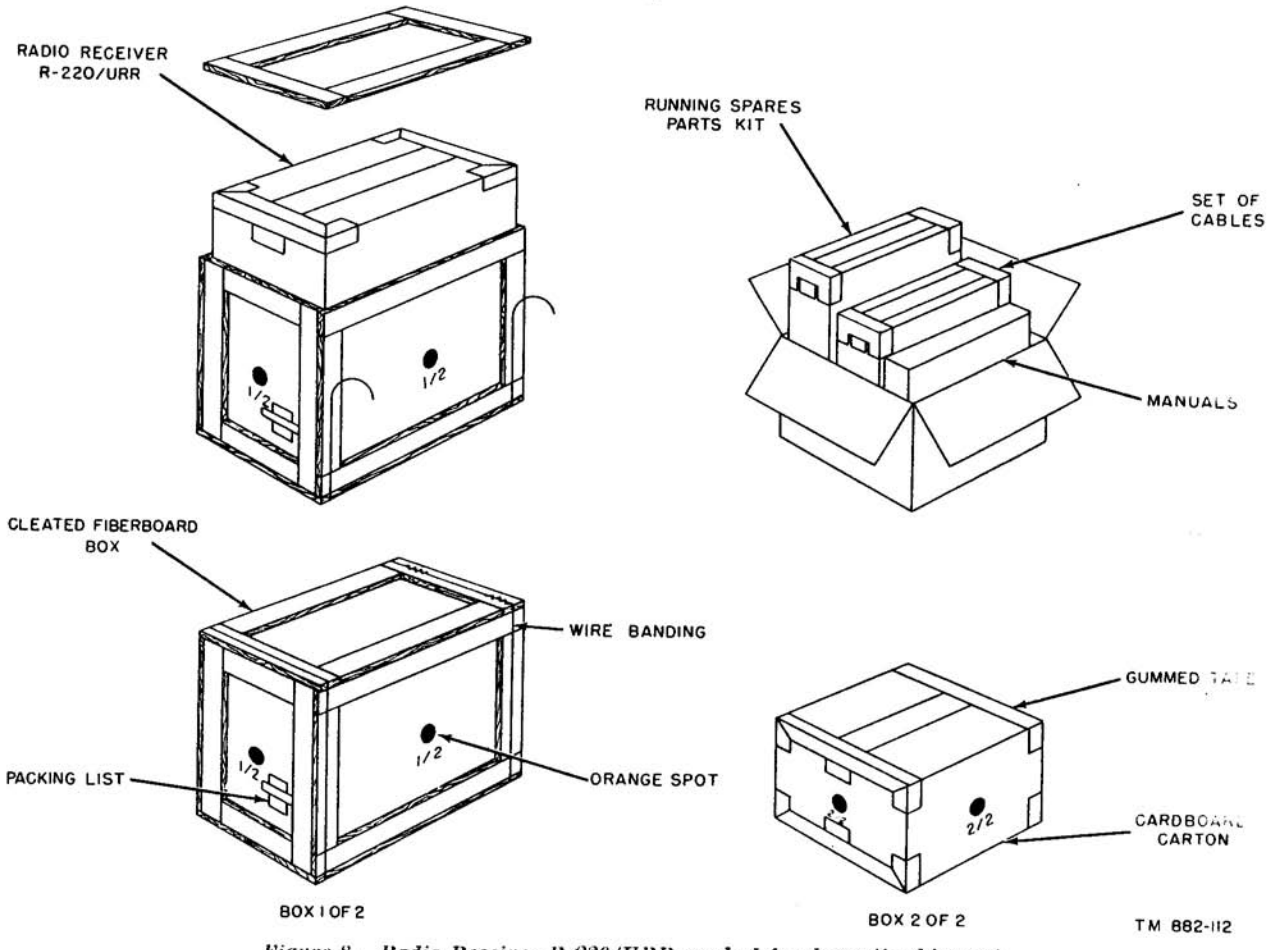


Figure 8. Radio Receiver R-220/URR, packed for domestic shipment.

6. Table of Components

(fig. 1)

a. Quantity and Dimensions.

Component	Quantity	Height (in.)	Depth (in.)	Length (in.)	Unit weight (lb)
Radio Receiver R–220/URR	1	10½	14¾	19	96
With internal Power Supply PP–660/URR	1	6¼	5¾	11½	30
Receiver Case CY–956/URR	1	17⅛	13¼	22	38
Antenna Assembly AS–574/URR dipoles and mast sections	1	9⅜	7	67¾	
Antenna Assembly AS–574/URR transmission lines and connectors, guy ropes, brackets, tools, and hardware	1	10	12⁹⁄₁₆	15¼	
Headset Assembly Navy Type CCN–49507B	1				¾
Kit, running spares	1	9½	4½	13¼	
Headset Extension Cord CCN–49534A	1			67	
Power Cable Assembly CX–2639/U	1			96	
Manuals for Radio Receiving Set AN/URR–29 and Radio Receiver R–220/URR	2	2	11	8½	"
Manuals for Antenna Assembly AS–574/URR	2	½	11	8½	

Note. This list is for general information only. See appropriate supply publications for information pertaining to requisitioning of spare parts.

b. Nomenclature Assignments. A list of the common name assignments for the components of Radio Receiving Set AN/URR–29 is given below.

Nomenclature	Common name
Radio Receiver R–220/URR	Radio receiver
Power Supply PP–660/URR	Power supply
Radio Receiving Set AN/URR–29	Receiving set
Radio Frequency Cable Assembly CG–1079/U.	CG–1079/U
Radio Frequency Cable Assembly CG–718/U.	CG–718/U
Headset Assembly Cord CCN–49534A	Cord
Receiver Case CY–956/URR	Case

7. Description of Radio Receiving Set AN/URR–29

Radio Receiving Set AN/URR–29 consists of Radio Receiver R–220/URR, Receiver Case CY–956/URR, Antenna Assembly AS–574/URR, Headset Extension Cord CCN–49534A, Headset Assembly Navy Type CCN–49507B, Power Cable Assembly CX–2639/U, a spare parts kit, and manuals.

8. Description of Antenna Assembly AS–574/URR

The antenna assembly consists of dipole radiators, mast sections, connectors, guy ropes, brackets, and hardware. Two transmission lines—Radio Frequency Cable Assembly CG–1079/U, consisting of 50 feet of 95-ohm twinaxial cable, and Radio Frequency Cable Assembly CG–718/U, consisting of 25 feet of 50-ohm coaxial cable are included.

9. Receiver Case CY–956/URR

(fig. 1)

Caution: Be careful when releasing the latches. They snap back quickly and may injure the fingers.

a. The case is designed to inclose Radio Receiver R–220/URR. The front cover is held in place by 10 latches (fig. 2) and is equipped with a rubber gasket that fits the body edges, making a waterproof seal. The case can be lifted by two handles on the sides. Two straps fastened to each side hold the case rigidly in place when the receiver is used in a moving vehicle. The receiver rests on shock mounts inside the case and is held in place by eight panel screws on the front panel (fig. 2).

b. To reach the controls and jacks at the rear of the receiver while the receiver is in the case, loosen the eight Dzus fasteners and remove the cover from the back of the case (fig. 9). A chain fastened to the cover and the case secures the cover.

10. Description of Radio Receiver R–220/URR

(fig. 2)

a. Radio Receiver R–220/URR is a triple-conversion superheterodyne receiver designed to receive am, cw, mcw, and fm signals in the frequency range of 20 mc to 230 mc, and can be used with various types of antenna systems used for communications, intercept, and direction-finding purposes. Provision is made for output connections to standard loudspeakers, headphones, and wire lines. Provision is made for output connections to standard equipments as required for diversity reception, direction finding, carrier-shift radioteletype, facsimile, signal analysis, and single side band reception.

b. The receiver is a panel and chassis assembly that may be either rack mounted, in which case it is protected by a dust cover, or mounted in Receiver Case CY–956/URR.

c. The receiver may be used with either a 100-ohm balanced transmission line or a 50-ohm unbalanced (single-ended) transmission line. An antenna adapter is provided for use with the unbalanced line, and an antenna trimmer is used with either input circuit. When Radio Receiver R–220/URR is shipped in Receiver Case CY–956/URR, antenna adapter E101 is fastened to the rear of the front cover. When the case is not supplied with the receiver, the antenna adapter is fastened to the rear apron of the receiver.

d. Two audio-output channels are provided, one for local monitoring and one for remote monitoring. Adjustment of the level or loading of the local channel will not affect the remote channel; however, adjustment of the level or loading of the remote channel will affect the local channel.

e. The receiver contains a push-pull radio-frequency (rf) amplifier, three oscillators, three mixers, automatic gain control (agc), manual gain control (mgc) circuits, an audio response filter, a selectivity filter, one variable if. stage, eight fixed intermediate-frequency (if.) stages, two limiters, a squelch circuit, a beat-frequency oscillator (bfo) circuit, a noise limiter, two audio amplifiers, a power amplifier (pa) circuit, an auxiliary diode circuit, a built-in crystal calibrator and buffer, five multiplier-buffer circuits, and a metering circuit.

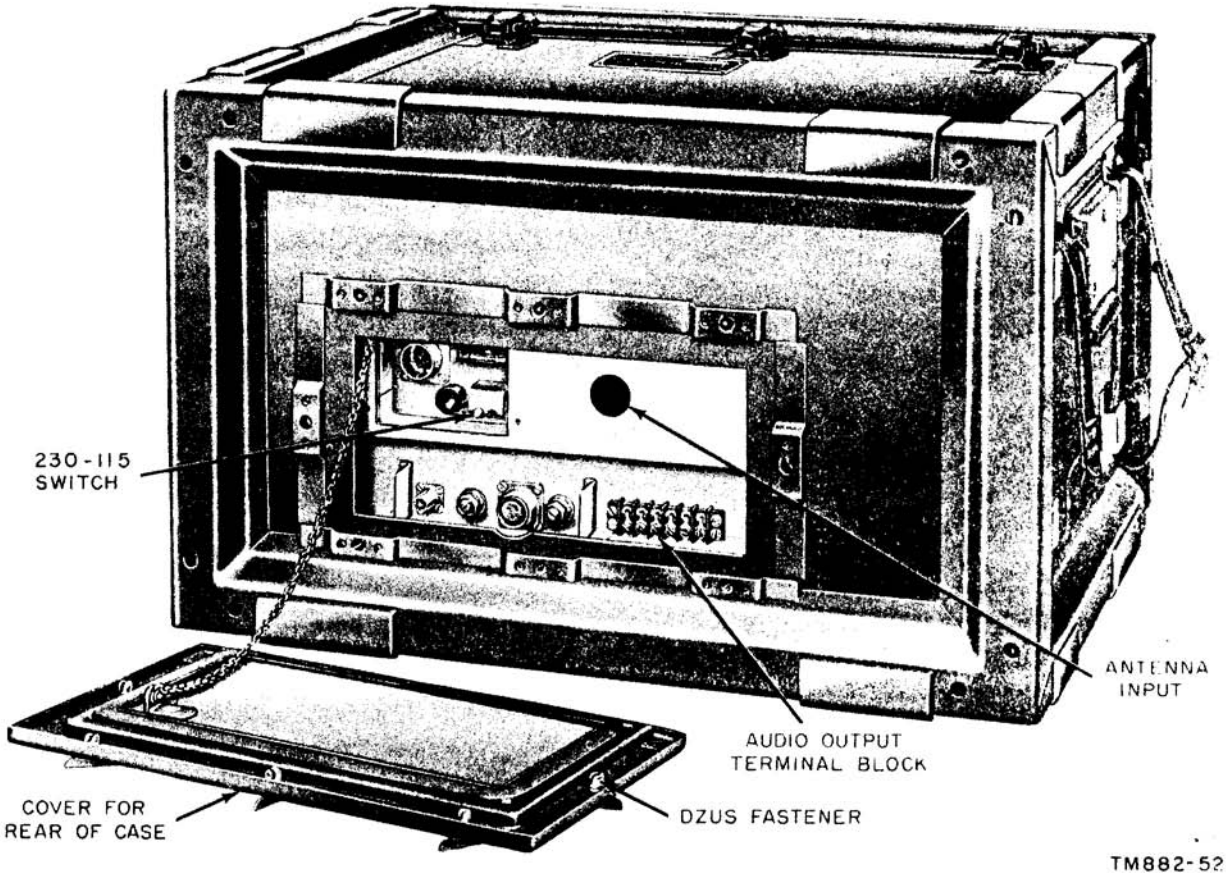


Figure 9. Receiver Case CY-956/URR, showing access to rear of Radio Receiver R-220/URR.

f. Special features include a squelch circuit that disables the audio amplifier when no incoming carrier signal is present and energizes the audio amplifier when a carrier signal is present.

11. Power Supply PP-660/URR

(fig. 64)

The power supply provides the required operating voltages for the receiver when the proper input voltages are used. Either 115 volts or 230 volts ac may be used; a toggle switch located at the rear of the power supply changes the internal connections to permit operation from either source. The switch arm is held in place by a spring metal bracket, with slots located in the two switch-arm postions. The input voltage selector switch, power input jack, line fuse, and spare fuse are all accessible through an opening in the receiver dust cover. To reach the rectifier tube the dust cover must be removed.

12. Cables

(fig. 10)

a. General. A set of cables is supplied with Radio Receiving Set AN/URR-29 for connecting the units to the external power source and to the antenna system, and for interconnecting the units.

b. Power Cables.

(1) An 8-foot power cable, CX-2639/U, is used to bring ac power from an outlet receptacle to the radio receiver. The cable is made up of two heavy-duty, rubber-covered wires. It has a two-prong plug at one end; the other end is fitted with a five-contact plug and a threaded cable clamp for connection to power supply input jack J603.

(2) Two power cables, W302 and W304, are used to interconnect the main unit, rf unit, and power supply. These cables are similar in appearance, each having identi

cal polarized plug connectors at both ends and identical shielding and plastic covering, but they differ in length and number of conductors. Power cable W304 is an 18-inch cable used to connect the power supply to the main unit. It consists of nine stranded copper wires (seven #18 AWG and two #22 AWG). Power cable W302, the 22-inch cable, interconnects the main unit and the rf unit. It consists of 11 stranded copper wires (five #18 AWG and six #22 AWG).

c. Rf Cables. Three radio-frequency cables are supplied with Radio Receiving Set AN/URR–29. One is an if. signal cable, W301; the other two cables are the transmission lines, CG–1079/U and CG–718/U.

(1) Power cable W301 is a 7-inch length of Coaxial Cable RG–62A/U which has a characteristic impedance of 93 ohms and consists of a single solid #22 AWG copper-covered steel wire with plain copper shielding. This cable is fitted with a Plug UG–260/U (P307) at one end, and a Plug UG–692/U (P306) at the other end.

(2) Two transmission lines, CG–1079/U and CG–718/U, are supplied with the receiving set. The CG–1079/U is a 50-foot cable consisting of a 95-ohm Twinaxial Cable RC–22B/U with polarized male plug connectors P703 and P704, at each end. The CG–718/U is a 25-foot cable consisting of a 50-ohm Coaxial Cable RG–8A/U, with polarized male plug connectors P701 and P702, at each end.

d. Headset Extension Cord CCN–49534A. This cord is a general-purpose headset cord consisting of two color-coded conductors. It is fitted with Plug PL–55 on one end; the other end is fitted with a Jack JK–26. The cord, which is packaged with Headset Assembly Navy Type CCN–49507B, is 5 feet, 7 inches long.

13. Headset Assembly Navy Type CCN–49507B

(fig. 1)

Note. Headset Extension Cord CCN–49534A is not a part of Headset Assembly Navy Type CCN–49507B.

This headset is designed especially for use under the standard infantry metal helmet or the standard armored vehicle crash helmet. For this reason, the headband is a covered flat spring steel band equipped with the necessary cording and connecting plug.

14. Running Spare Parts

A kit of running spares is supplied with Radio Receiver R–220/URR and also with Radio Receiving Set AN/URR–29. The items included in both kits are the same, differing only in quantity. Spares for both receiver and power supply are packed in the same case with Radio Receiver R–220/URR in export shipment. When packed for domestic shipment, the spare parts kit is included in a separate carton with the cables and manuals. Spares are provided for expendable items, such as tubes, pilot lamps, and fuses. Following is a list of running spare parts.

Note. Spares for Antenna Assembly AS–574/URR are packed with the antenna assembly.

Item	Radio Receiving Set AN/URR–29	Radio Receiver R–220/URR
Fuse, 3-ampere, 250-volt, type 3AG	5	4
Lamp, min bay., 14.4 v, .1 amp, G. E. No. 1813	1	2
Tube, ballast regulator, type 1HTF10	2	1
Tube OB2	1	1
Tube 5R4WGY	1	1
Tube 5718	2	2
Tube 5840	3	3
Tube 6AK6	1	1
Tube 5726/6AL5W	3	2
Tube 6AU6	3	4
Tube 5749/6BA6W	3	3
Tube 12AT7	1	1
Crystal Unit CR–18/U, 5.000 mc	1	1
Crystal Unit CR–18/U, 2.205 mc	1	1
Crystal Unit CR–18/U, 7.8442 mc	1	1
Crystal Unit CR–18/U, 6.8869 mc	1	1
Crystal Unit CR–18/U, 10.4384 mc	1	1
Crystal Unit CR–23/U, 15.5238 mc	1	1
Crystal Unit CR–23/U, 22.6267 mc	1	1
Crystal Unit CR–23/U, 32.7976 mc	1	1
Crystal Unit CR–23/U, 47.0035 mc	1	1

15. Additional Equipment Required

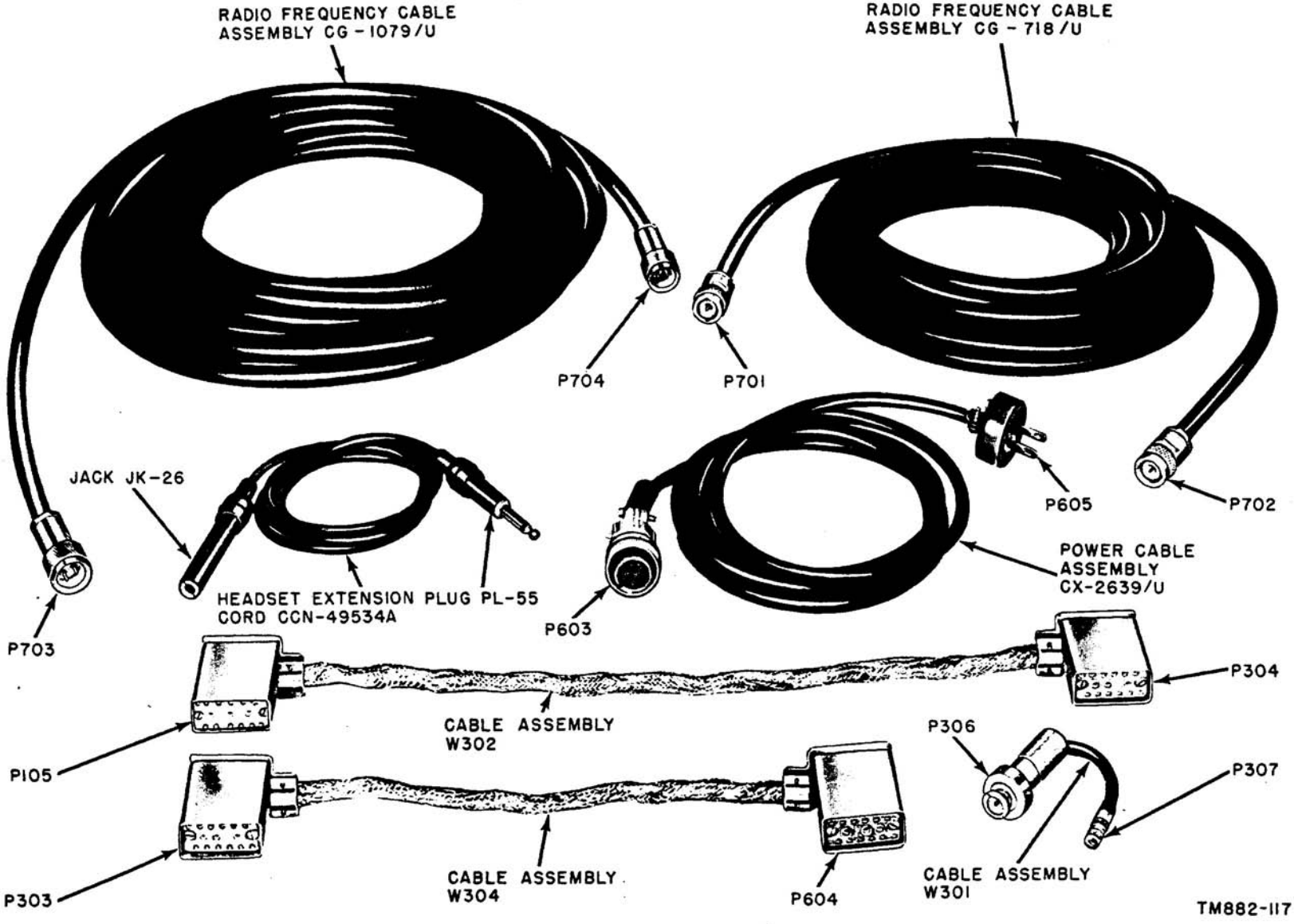
a. The following item is *not* supplied as a part of Radio Receiving Set AN/URR–29 but is required for its installation and operation: Speaker or extra headsets (optional).

b. The following items are *not* supplied as a part of Radio Receiver R–220/URR, but are required for its installation and operation:

(1) Suitable antenna or antenna system.

(2) Speaker or headset.

(3) Carrying case or rack.



CHAPTER 2

INSTALLATION

16. Siting

a. Exterior Requirements. The best location for radio equipment depends on the tactical situation and local conditions, such as the following: the need to house the equipment where its shelter cannot be seen; the type of housing available; possible installation in a vehicle; the terrain; and the need of easy access for messengers. Signals will be received from a greater distance by Radio Receiver R–220/URR if the antenna is high and clear of hills, buildings, cliffs, densely wooded areas, and other obstructions. Depressions, valleys, and other low places are poor locations for radio reception because the surrounding high terrain absorbs rf energy. Weak or otherwise undesirable signals may be expected if the set is operated under or close to steel bridges, underpasses, power lines, hospitals, or power units. Normally, reception over water is better than over land. See that drainage is adequate to prevent flooding the interior of the shelter. If the equipment is part of a communication center but is not installed within the center, locate the equipment nearby. When locating the antenna, avoid obstructions which are more than 2° above the horizontal plane of the antenna in the direction of desired reception; this is a height of approximately 200 feet at a distance of 1 mile from the antenna.

b. Shelter Requirements. The shelter for the equipment must meet the following requirements:

(1) Sufficient space must be available for possible repair work, for connections to the audio output terminals, and for input voltage selector switch operation. Except for these limitations, the receiver may be located anywhere that is convenient to the transmission lines and the power source.

(2) Adequate lighting for day and night operation must be provided. Place the receiver so that the panel designations may be read easily by the operating personnel. Artificial lighting other than that supplied by the dial lights of the receiver should be provided by light bulbs placed so that the light falls directly on the panel. A portable drop lamp and extension cord are convenient assets for both operating and maintenance personnel.

17. Uncrating and Unpacking New Equipment

Note. For used or reconditioned equipment, refer to paragraph 19.

a. General. Equipment may be shipped in export packing cases or in domestic packing cases and, sometimes, in its own carrying case. When new equipment is received, select a location where the equipment may be unpacked without exposure to the elements and which is convenient to the permanent or semipermanent installation of the equipment. The instructions in *b* below apply to equipment shipped in export packing cases, and the instructions in *c* below, to equipment in domestic packing cases.

Caution: Be careful when uncrating, unpacking, and handling the equipment; it is easily damaged. If it becomes damaged, a complete overhaul might be required, or the equipment might become useless.

b. Step-by-Step Instructions for Uncrating and Unpacking Export Shipments (figs. 3 and 4).

(1) Place the packing case as near the operating position as convenient.

(2) Cut and fold back the steel banding wire.

(3) Remove the nails with a nail puller. Remove the top and one side of the packing case. Do not attempt to pry off the sides and top; the equipment may become damaged.

(4) Remove the waterproof container or moistureproof barrier and any excelsior or corrugated paper.
(5) Remove the equipment from its inner case and place it on the work bench or near its final location.
(6) Inspect the equipment for possible damage incurred during shipment.
(7) Check the contents of the packing case against the master packing slip.

c. Unpacking Domestic Packing Cases (figs. 7 and 8). The instructions given in *b* above apply also to radio equipment received in domestic packing cases. Open the cartons that protect the equipment; if heavy wrapping paper has been used, remove it carefully and take out the components. Check the contents of the packing case against the master packing slip.

Note. Save the original packing cases and containers from both export and domestic shipments. They can be used again when the equipment is repacked for storage or shipment.

18. Checking New Equipment

Note. Instructions for checking Antenna Assembly AS–574/URR are given in TM 11–5016. Check the equipment for possible damage incurred during shipment.

a. Remove all the packing material from the crates or cartons containing Radio Receiving Set AN/URR–29 (par. 17). If the equipment is damaged, perform the procedures outlined in paragraph 98.

b. Release the latches from Receiver Case CY–956/URR and remove the cover from the case (fig. 2). Inspect the antenna adapted mounted on the cover of the case.

c. Loosen the panel screws (fig. 2) and remove the receiver from the case. Inspect the two cable connectors and their plugs and connector receptacles for contact, looseness, cracks or other damage (fig. 96).

d. Inspect all front panel and rear apron controls and jacks for looseness, binding, and damage (fig. 12). Check the fuses at the rear of the power supply (fig. 64).

e. Check and inspect the wrenches and alinement tool fastened to the outside of the main unit (fig. 96).

f. Remove the rf unit (par. 92*e*) and power supply unit (par. 92*d*) from the main unit base (fig. 101). Remove dust covers from the rf unit (par. 93*b*) and check rf and power cables between the units and the sections for contact, looseness, cracks, or other damage.

g. Inspect the units for damaged resistors, broken leads, bent parts, etc.

h. Be sure that all crystals are firmly seated in their sockets. Nine crystals are used in the receiver; the frequency of each crystal is marked on the crystal holder and also on the chassis. (Refer to fig. 88 for location of Y101; fig. 90 for locations of Y102 through Y108; and fig. 15 for location of Y301.)

i. Be sure that all tubes are firmly seated in their sockets (figs. 67–69).

j. Check the fuse for proper seating and correct value (3-ampere, 250-volt, type 3AG).

k. Replace the rf unit dust covers and put the rf unit and power supply back into the main unit.

19. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions given in paragraph 17 for uncrating and unpacking the equipment; follow the instructions in paragraph 17 for disassembling and checking the equipment.

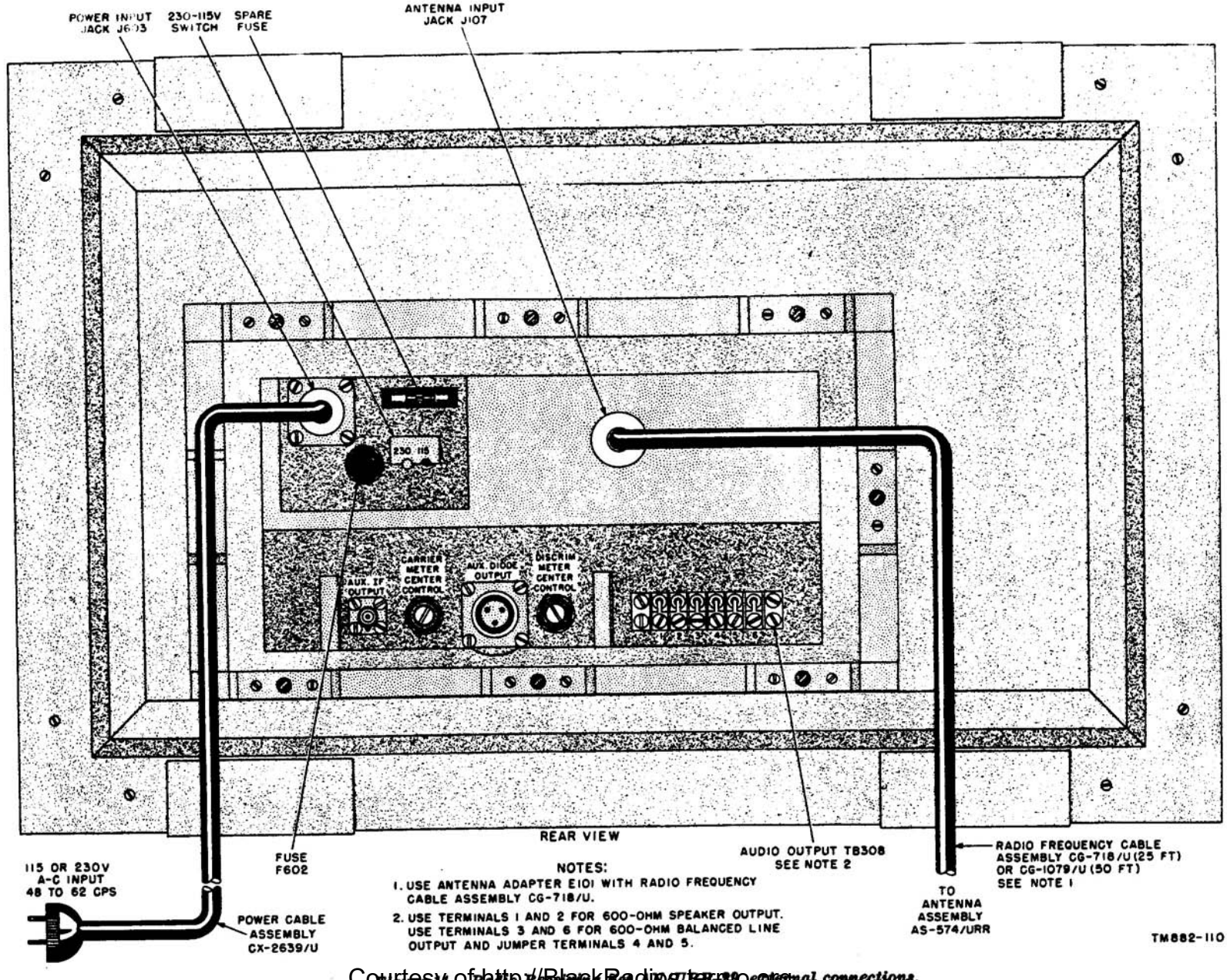
b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in the wiring of the equipment. If any changes in wiring have been made, note the changes in this manual, preferably on the schematic diagram.

c. Check the operating controls for ease of rotation. If lubrication is required, refer to the lubrication instructions in paragraph 99.

20. Connections
(fig. 11)

a. Connect Power Cable Assembly CX–2639/U to a suitable source of power and set the 230/115-volt switch to the proper position. Set the switch to the left for 230-volt operation and to the right for 115-volt operation (fig. 64).

b. Connect Cable Asembly CG–718/U or CG–1079/U to Antenna Assembly AS–574/URR.
(1) If Radio-Frequency Cable Assembly CG–718/U is used, make connection to the antenna input jack (fig. 9) through antenna adapter E101 (fig. 12).
(2) If Radio Frequency Cable Asesmbly CG–1079/U is used, make connection directly to the antenna input jack.



NOTES:

1. USE ANTENNA ADAPTER E101 WITH RADIO FREQUENCY CABLE ASSEMBLY CG-718/U.
2. USE TERMINALS 1 AND 2 FOR 600-OHM SPEAKER OUTPUT. USE TERMINALS 3 AND 6 FOR 600-OHM BALANCED LINE OUTPUT AND JUMPER TERMINALS 4 AND 5.

Figure 3. Radio Receiver R-390/URR, rear view, original connections.

c. Connect the low-impedance speaker or the headphones to terminals 1 and 2 of terminal board TB308 at the rear of the receiver (fig. 11).

d. Connect Power Assembly CX–2639/U to the power input jack J603 (fig. 64).

e. Make connections to AUX. IF. OUTPUT J302 and to AUX. DIODE OUTPUT J301 if used (fig. 11).

21. Presetting Radio Receiver R–220/URR

a. General. It is necessary to preset the receiver by adjusting the OSC. TRIM slotted shafts on the front panel to calibrate the dial. Alinement of one spot in any section of the band being used is sufficient. Original tracking of the first high frequency oscillator was performed with both OSC. TRIM shaft slots in a vertical position. For greatest overall accuracy, make sure that these slots remain in a vertical position. However, for correction at one frequency, a slight adjustment may be necessary. In this case, follow the dial calibration procedure given in *b* below.

b. Dial Calibration Procedure.

(1) Adjust the receiver controls for cw reception (par. 26*c*).

(2) Rotate the BAND SELECTOR to the desired band.

(3) Rotate the TUNING control so that the dial reads the multiple of 5 mc nearest the desired frequency. (For example, if the desired frequency is 100.3 mc, tune the receiver to 100 mc.)

(4) Turn the CALIBRATE switch to ON.

(5) Rotate the B. F. OSCILLATOR control to the 0 position (dial pointer straight up).

(6) Unscrew the cap (fig. 12) that covers the OSC. TRIM shafts. Turn the proper shaft until the calibrator signal is at zero beat with the bfo signal. Use the shaft on the left, marked E, to trim the even bands (2, 4, and 6). Use the shaft on the right, marked O, for the odd bands (1, 3, 5, and 7).

22. Initial Adustment

a. General. Initial adjustment of the receiver is performed with the DISCRIM METER CENTER CONTROL (fig. 12). This adjustment must be made so that when the METER switch is rotated to the DISC position, the meter needle will be properly centered on the DISC. CENTER scale. Use a screwdriver in making this adjustment.

b. Discriminator Meter Balance Adjustment.

(1) Adjust the receiver controls for fm reception (par. 27*a*).

(2) Rotate the METER switch to the DISC position.

(3) Rotate the TUNING control to a point where no signal is being received.

(4) Adjust the DISCRIM METER CENTER CONTROL at the rear of the chassis until the meter needle points to the 25 position on the DISC. CENTER scale. This position is indicated by a long vertical line on the meter scale.

CHAPTER 3

OPERATION

Section I. CONTROLS AND INSTRUMENTS

23. General

Haphazard operation or improper setting of the controls can cause damage to electrical equipment. For this reason, it is important to know the function of every control. The actual operation of the equipment is discussed in paragraphs 25 through 29.

24. Controls and Their Uses
(fig. 12)

The controls for Radio Receiver R-220/URR are located on the front panel and the rear apron of the main unit. The controls for Power Supply PP-660/URR are located at the rear of the power supply chassis (fig. 64). The following charts list the controls for the radio receiver and power supply and indicate their functions.

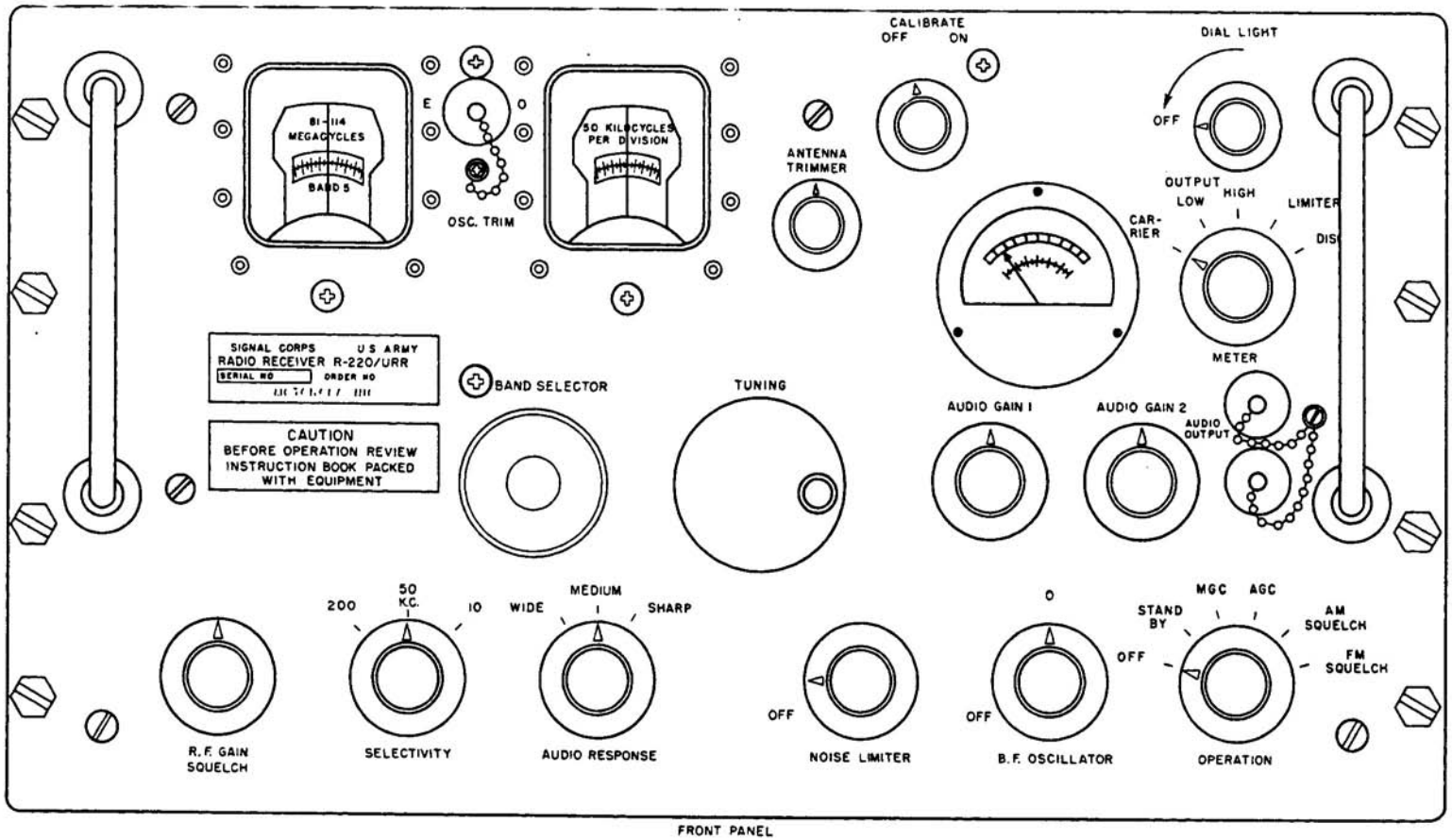
a. Radio Receiver R-220/URR, Front Panel Controls (fig. 12).

Control	Function
TUNING	Tunes the receiver to the desired frequency within the operating band. The vernier dial is calibrated in kc and the main dial is calibrated in mc.
BAND SELECTOR	Selects one of the seven operating bands which include BAND 1, 20–28.5 MEGACYCLES; BAND 2, 28.5–40.5 MEGACYCLES; BAND 3, 40.5–57 MEGACYCLES; BAND 4, 57–81 MEGACYCLES; BAND 5, 81–114 MEGACYCLES; BAND 6, 114–162 MEGACYCLES; BAND 7, 162–230 MEGACYCLES.
OSC. TRIM	Removing the dust cap exposes two slotted shafts: Left shaft marked E controls a trimmer capacitor that is used to adjust the dial calibration of the even-numbered bands. Right shaft marked O controls a trimmer capacitor that is used to adjust the dial calibration of the odd-numbered bands.
CALIBRATE switch	In the ON position, permits dial calibration for any of the seven bands.
DIAL LIGHT control	Clockwise rotation turns on the dial lamps over the two dials. Further clockwise rotation increases the degree of illumination.
ANTENNA TRIMMER	Used to tune the antenna system for best reception.
Panel meter	Used when tuning and testing the receiver.
METER switch	Used to switch the meter to any one of five positions, as follows: CARRIER. Measures strength of carrier signal. OUTPUT LOW. Measures strength of audio signal. Used for weak signals. OUTPUT HIGH. Measures strength of audio signal. Used for strong signals. LIMITER. Measures first limiter grid current. DISC. Indicates balance of discriminator.
AUDIO GAIN 1	Controls level of audio signal output at TB308 and AUDIO OUTPUT jacks.
AUDIO GAIN 2	Controls level of audio signal at the speaker output (pins 1 and 2) on TB308 and at the AUDIO output jacks without disturbing the audio output at pins 3 and 6.

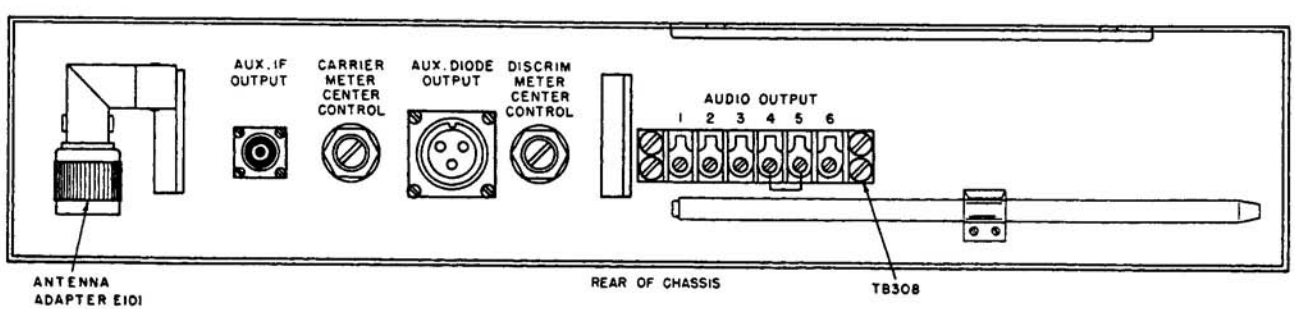
Control	Function
AUDIO OUTPUT	Remove the two dust caps to expose the two AUDIO OUTPUT jacks. Plug the speaker or headset into either of these jacks. Two speakers or headsets may be used at the same time.
SELECTIVITY switch	Three-position switch, used to select a bandpass of 200 kc, 50 kc or 10 kc in the 455-kc if. amplifier.
AUDIO RESPONSE	Three-position switch, used to change the frequency response of the audio output. WIDE. Direct, or normal, response. MEDIUM. Restricts audio response to no higher than 3,500 cps. SHARP. Restricts audio response to between 400 and 1,200 cps. Used for reception of cw or mcw.
NOISE LIMITER	Clockwise rotation, limits the amount of noise present in the audio output.
B. F. OSCILLATOR	Switches bfo on and off and varies the audio output pitch during reception of cw signals. OFF. With the pointer set at this position, the bfo is inoperative. 0. With the pointer set at this position, the audio output is zero. This position is used for calibration purposes.
OPERATION	Used to select type of operation. Consists of a six-position switch. Positions are as follows: OFF. All circuits in the receiver are inoperative. STANDBY. Applies ac to the power supply and to the oscillator heater element. All filament power is applied. Equipment is inoperative. MGC. Permits am reception in conjunction with mgc. AGC. Permits am reception in conjunction with agc. AM SQUELCH. Permits am reception in conjunction with agc and squelch. FM SQUELCH. Permits fm reception in conjunction with squelch.
R. F. GAIN SQUELCH	R. F. GAIN. Controls the amount of mgc when the OPERATION switch is in MGC position. SQUELCH. Controls the squelch threshold when the OPERATION switch is in the AM SQUELCH or FM SQUELCH position.

b. Power Supply PP-660/URR Controls (fig. 64).

Control	Function
230/115-volt switch	Line voltage selector switch used to select either 115-v or 230-v primary circuit.
Fuse, 3 amp	Power line fuse. Provides protection from overloads.
Spare fuse holder	Fuse holder used to hold spare 3-amp fuse.
Power input connector	Provides connection to 230-v or 115-v power source.



FRONT PANEL



TM 882-109

Figure 2. Front panel and rear chassis controls.

25. Starting Procedure

(fig. 12)

Perform the starting procedure given below for operating the receiver.

a. Rotate the OPERATION switch to the STANDBY position. In this position the tubes are kept hot and ready for use.

b. Rotate the DIAL LIGHT control clockwise for sufficient illumination.

c. Rotate the BAND SELECTOR switch to the desired band, as indicated on the MEGACYCLES dial mask.

d. Rotate the TUNING control to the desired frequency, as indicated on the MEGACYCLES and KILOCYCLES dials.

e. Rotate the SELECTIVITY switch to the desired position.

f. Turn the AUDIO RESPONSE switch to the WIDE position.

g. Turn the CALIBRATE switch to the OFF position.

h. Turn the METER switch to the CARRIER position.

i. Turn the following controls to the OFF position.

(1) NOISE LIMITER.

(2) B. F. OSCILLATOR.

j. Turn the R. F. GAIN SQUELCH control to the extreme counterclockwise position.

k. Rotate the OPERATION switch for the desired type of operation (par. 26).

26. Types of Operation

Operating procedure for receiving various types of signals on Radio Receiving Set AN/URR–29 are listed below.

a. Fm Reception. To receive fm signals, perform the following operations in the order given:

(1) Rotate the BAND SELECTOR control to the band desired.

(2) Rotate the SELECTIVITY switch to the desired position.

(3) Set the METER switch to the CARRIER position.

(4) Rotate the OPERATION switch to the FM SQUELCH position.

(5) Turn the R. F. GAIN SQUELCH control to the extreme clockwise position.

(6) Advance AUDIO GAIN 1 and AUDIO GAIN 2 controls clockwise to the approximate midpoint of rotation.

(7) Rotate the TUNING control to the desired frequency. Adjust the TUNING control until the meter indicates a maximum reading.

(8) Rotate the ANTENNA TRIMMER until the meter indicates a maximum reading.

(9) Readjust the TUNING control for maximum deflection on the meter.

(10) Rotate the AUDIO RESPONSE switch to the MEDIUM position. If the signal is not clear or becomes unintelligible as a result of this operation, rotate this switch to the WIDE position.

(11) Rotate the R. F. GAIN SQUELCH control counterclockwise until the noise in the speaker or headphones disappears.

(12) Carefully rotate the R. F. GAIN SQUELCH control clockwise to the point where the noise reappears. Rotate the R. F. GAIN SQUELCH control counterclockwise just beyond the point where the noise disappears. When this adjustment is completed, the receiver will remain quiet during periods when no signal is being received.

b. Am. or Mcw Reception.

(1) Rotate the BAND SELECTOR switch to the desired band.

(2) Rotate the SELECTIVITY switch to the 50 K. C. position.

(3) Rotate the AUDIO RESPONSE switch to MEDIUM.

(4) Rotate the METER switch to the CARRIER position.

(5) Rotate the OPERATION switch to one of the following positions, according to the character of the received signal:

(*a*) *MGC.* For weak or distant signals. In this position, the R. F. GAIN SQUELCH control operates the rf gain only.

(*b*) *AGC.* For strong signals. In this position, the R. F. GAIN SQUELCH control is completely inoperative.

(*c*) *AM SQUELCH.* For strong signals, where tuning between signals is neces-

sary, and when receiver noise and atmospherics are present.

(6) Rotate the TUNING control to the desired frequency.

(7) Rotate the ANTENNA TRIMMER for maximum deflection on the meter.

(8) Readjust the TUNING control for maximum deflection on the meter.

(9) For am. reception, proceed to (10) below. For mcw reception, make the following adjustments:

(*a*) Rotate the SELECTIVITY switch to the 10 position.

(*b*) Rotate the AUDIO RESPONSE switch to the SHARP position.

(10) Adjust the R. F. GAIN SQUELCH control according to the type of operation, as follows:

(*a*) If the OPERATION switch is in the AM SQUELCH position, adjust the squelch threshold as described in *a*(12) above; proceed to (11) below.

(*b*) If the OPERATION switch is in the MGC position, rotate the R. F. GAIN SQUELCH control until the signal is at the desired level.

(*c*) If the OPERATION switch is in the AGC position, rotate the R. F. GAIN SQUELCH control to the off position (extreme counterclockwise).

(11) Rotate the NOISE LIMITER control clockwise until the signal is clearest.

c. Cw Reception.

(1) Rotate the BAND SELECTOR control to the desired band.

(2) Rotate the SELECTIVITY switch to the 50 K. C. position.

(3) Rotate the AUDIO RESPONSE switch to the MEDIUM position.

(4) Rotate the METER switch to the CARRIER position.

(5) Rotate the OPERATION switch to the MGC position.

(6) Rotate the TUNING control to the desired frequency.

(7) Adjust the ANTENNA TRIMMER to obtain maximum deflection on the meter.

(8) Readjust the TUNING control for maximum deflection on the meter.

(9) Rotate the SELECTIVITY switch to the 10 position to eliminate background noise and adjacent-signal interference. If this action tends to cut out the signal, readjust the TUNING control to again obtain the signal; watch for a maximum deflection of the meter rather than depend on the audio level.

(10) Rotate the AUDIO RESPONSE switch to the SHARP position.

(11) Rotate the R. F. GAIN SQUELCH control until the desired signal level is obtained.

(12) Rotate the B. F. OSCILLATOR control clockwise until an audio-frequency (af) beat note is obtained.

(13) Rotate the NOISE LIMITER control clockwise until the signal is noise-free:

27. Standby Procedure

a. Rotate the OPERATION switch to the STANDBY position.

b. Leave all other controls in the positions they were in during reception. This will help quick starting and operation the next time the receiver is used.

28. Stopping Procedure

a. Rotate the OPERATION switch to OFF.

b. Replace the front cover and secure the latches.

29. Antijamming Operation

When an operator recognizes that his receiver is being jammed, he will promptly inform his immediate superior officer. Under no conditions will he cease operating. To provide maximum intelligibility of jammed signals, adhere to the operational procedures as indicated below for each type of operation.

a. When the operator is receiving am and the jamming signal is cw, pulse, or some other type of sharp noise signal, he will follow the procedure indicated below, if possible, until some degree of read-through is established.

(1) Turn the TUNING control very slightly through a degree or two on either side of the desired frequency. It may be possible to read through the interfering signal.

(2) Turn on the NOISE LIMITER. Noise peaks may be sufficiently reduced to afford some read-through. Turn the NOISE LIMITER to OFF if no improvement results.

(3) Adjust the ANTENNA TRIMMER for best reception.

(4) Set the SELECTIVITY control to the position providing the best receiving conditions. Slight tuning as described in (1) above may be necessary.

(5) Turn the OPERATION switch to MGC and turn down the R. F. GAIN SQUELCH control until signals clear up. Use the R. F. GAIN SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls while tuning slightly as described in (1) above.

(6) Change the direction, length, and height of the antenna.

(7) Request a change in frequency and call sign if the foregoing steps do not provide necessary communication.

(8) If jamming action is so thorough and complete that communication is impossible, report this fact to your immediate superior and use some alternate means of getting the message through. Continue to operate unless specifically instructed to do otherwise. The enemy may not realize his jamming success and may move to another frequency.

b. When the operator is receiving am. and the jamming signal is fm, bagpipes, or am., he will follow the procedure indicated below, if possible, until read-through is established.

(1) Turn the TUNING control very slightly through a degree or two on each side of the desired frequency. It may be possible to read through the interfering signal.

(2) Adjust ANTENNA TRIMMER for best reception.

(3) Set the SELECTIVITY control to the position providing the best receiving conditions. Slight tuning as described in (1) above may be necessary.

(4) Turn the OPERATION switch to MGC and turn down the R. F. GAIN SQUELCH control until signals clear up. Use the R. F. GAIN SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2, controls while slightly tuning as described in (1) above.

(5) Change the direction, length, and height of the antenna.

(6) Request a change in frequency and call sign if the foregoing steps do not provide necessary communication.

(7) If jamming action is so thorough and complete that communication is impossible, report this fact to your immediate superior and use some alternate means of getting the message through. Continue to operate unless specifically instructed to do otherwise. The enemy may not realize his jamming success and may move to another frequency.

c. When the operator is receiving cw signals and the jamming signal is cw or any other type of interference, he will follow the procedure in the order indicated below, if possible, until a degree of read-through is established.

(1) Turn the TUNING control very slightly through a degree or two on each side of the desired signal frequency. It may be possible to read through the interfering signal.

(2) Turn on the B. F. OSCILLATOR and vary it until a separate audio pitch for the interfering and desired signal results, if possible.

(3) Adjust the ANTENNA TRIMMER for best reception.

(4) Set the SELECTIVITY control to the position providing the best receiving conditions. Slight tuning as described in (1) above may be necessary.

(5) Turn the OPERATION switch to MGC and turn down the R. F. GAIN SQUELCH control until the signals clear up. Use the R. F. GAIN SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls while slightly tuning as described in (1) above.

(6) Change the direction, length, and height of the antenna.

(7) Request a change in frequency and call sign if the foregoing steps do not provide necessary communication.

(8) If jamming action is so thorough and complete that communication is impossible, report this fact to your immediate superior and use some alternate means of getting the message through. Continue to operate unless specifically instructed to do otherwise. The enemy may not

realize his jamming success and may move to another frequency.

d. When the operator is receiving fm and any type of jamming interference occurs, he will follow the procedure indicated below, if possible, until some degree of read-through is established.

(1) Turn the OPERATION switch to FM SQUELCH.
(2) Set the SELECTIVITY control to 200.
(3) Turn the TUNING control very slightly through a degree or two on each side of the desired signal frequency. It may be possible to read through the interfering signal.
(4) Adjust the ANTENNA TRIMMER for best reception; the desired signal may come through satisfactorily.
(5) If interference consists of noise, pulses, cw, etc., turn on the NOISE LIMITER. If this action does not aid in read-through, turn it to OFF.
(6) Change the direction, length, and height of the antenna.
(7) Request a change in frequency and call sign if the foregoing steps do not provide necessary communication.
(8) If jamming action is so thorough and complete that communication is impossible, report this fact to your immediate superior and use some alternate means of getting the message through. Continue to operate unless specifically instructed to do otherwise. The enemy may not realize his jamming success and may move to another frequency.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

30. General

The operation of Radio Receiving Set AN/URR–29 may be difficult in regions where extreme cold, heat, humidity and moisture, or sand conditions prevail. Instructions are given in paragraphs 31 through 33 on procedures for minimizing the effect of these unusual operating conditions.

31. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of the equipment. Instructions and precautions for operation under such adverse conditions follow:

a. Handle the equipment carefully.

b. Keep the equipment warm and dry. If the set is not in a heated inclosure, construct an insulated box for it. Keep the electron tube filaments lighted constantly, unless this overtaxes the power source.

c. When operating in the open air, wear a knitted woolen cap over the earphones if headsets without rubber earpieces are worn. The edges of the ears may freeze without the operator being conscious of this condition. Never bend rubber earcaps; this action may render them useless. If water gets into the receivers, or if moisture condenses within them, it may freeze and impede the action of the diaphragm. When this happens, unscrew the bakelite cap and remove the ice and moisture.

d. When equipment that has been exposed to the cold is brought into a warm room, it will sweat until it reaches room temperature. When the equipment has reached room temperature dry it thoroughly.

32. Operation in Tropical Climates

When operated in tropical climates, radio equipment may be installed in tents, huts, or, when necessary, in underground dugouts. When equipment is installed below ground or when it is set up in swampy areas, moisture conditions are more acute than is normal in the tropics. Ventilation is usually very poor, and the high relative humidity causes condensation of moisture on the equipment whenever the temperature of the equipment becomes lower than the surrounding air. To minimize these conditions, place lighted electric lamps under the equipment.

33. Operation in Desert Climates

a. Conditions similar to those encountered in tropical climates often prevail in desert areas. Use the same measures to insure proper operation of the equipment.

b. The main problem that arises with equipment operation in desert areas is the large amount of sand or dust and dirt that enters the moving parts of the radio set, such as the dial assembly and gear

train. The ideal preventive precaution is to house the unit in a dustproof shelter. Such a building is seldom available and would require air conditioning; therefore, the next best precaution is to make the building in which the equipment is located as dustproof as possible with available materials. Hang wet sacking over the windows and doors, cover the inside walls with heavy paper, and secure the side walls of tents with sand to prevent them from flapping in the wind.

c. Never tie power cords, signal cords, or other wiring connections to the inside or outside of tents. Desert areas are subject to sudden wind squalls that may jerk the connections loose or break the lines.

d. Be careful to keep the equipment as free from dust as possible. Excessive amounts of dust, sand, or dirt that come into contact with oil and grease result in grit, which will damage the equipment.

CHAPTER 4

ORGANIZATIONAL MAINTENANCE

Section I. TOOLS AND EQUIPMENT

34. General

The tools, parts, supplies, and test equipment necessary to perform organizational maintenance are authorized by appropriate publications. Additional tools supplied with Radio Receiving Set AN/URR–29 are listed in paragraph 84.

35. Tools, Test Equipment, and Materials

The following tools, test equipment, and materials are required for organizational maintenance:

Tool Equipment TE–41
Electron Tube Test Set TV–7/U
Multimeter TS–352
Cheesecloth, bleached, lint-free*
Paper, sand, flint #000*
Cleaning Compound (Federal stock No. 7930–395–9542).

*Part of Tool Equipment TE–41.

Section II. PREVENTIVE MAINTENANCE SERVICES

36. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment to keep it in good working condition so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from troubleshooting and repair in that its object is to prevent certain troubles from occurring.

37. General Preventive Maintenance Techniques

a. Use #000 sandpaper to remove corrosion. Never use steel wool.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning. If necessary, moisten the cloth or brush with cleaning compound; then wipe the parts dry with a cloth.

Warning: Prolonged breathing of cleaning compound is dangerous. Make sure adequate ventilation is provided. Cleaning compound is flammable; do not use near a flame.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 pounds per square inch to remove dust from inaccessible places; be careful however, or mechanical damage from the air blast may result.

Caution: When using compressed air, always direct the first blast of the air line toward the floor. This procedure is necessary to clear condensed moisture from the line.

d. For further information on preventive maintenance techniques, refer to TB SIG 178, Preventive Maintenance Guide for Radio Communication Equipment.

38. Use of Preventive Maintenance Forms (figs. 13 and 14)

a. The information in paragraph 39 is presented as a guide to the individual making an inspection of equipment in accordance with instructions on DA Forms 11–238 and 11–239. The decision concerning the items on the forms that are applicable to this equipment is a decision to be made by the communication officer/chief or his designated representative in the case of first echelon maintenance, and, in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

b. Circled items in figures 13 and 14 are partially or totally applicable to Radio Receiving Set AN/URR–29. References in the ITEM block refer to paragraphs in the text which contain additional maintenance information.

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.
RADIO RECEIVING SET AN/URR-29	

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

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (*receiver, ~~transmitter~~, carrying cases, wire and cable, ~~microphones, tubes,~~ spare parts, ~~technical~~ manuals and accessories*). PAR. 39 a (1)							
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 39 a (2)							
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, ~~MICROPHONE~~, HEADSETS, ~~CHESTSETS, KEYS~~, JACKS, PLUGS, ~~TELEPHONES~~, CARRYING BAGS, COMPONENT PANELS. PAR 39 a (3)							
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS. ~~VIBRATORS, PLUG-IN COILS AND RELAYS.~~ PAR. 39 a (4)							
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 39 a (5)							
6	CHECK FOR NORMAL OPERATION. PAR. 39 a (6)							

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, ~~SHOCK MOUNTS~~, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, ~~WAVE GUIDES~~, AND CABLE CONNECTIONS. PAR. 39 a (7)		13	~~INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.~~	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, ~~TOWERS~~, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 39 a (8)		14	CLEAN ~~AIR FILTERS~~, BRASS NAME PLATES, DIAL AND METER WINDOWS. ~~JEWEL ASSEMBLIES.~~ PAR. 39 a (12)	
9	INSPECT CORD, CABLE, AND WIRE, ~~AND SHOCK MOUNTS~~ FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 39 a (9)		15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 39 a (13)	
10	INSPECT ANTENNA FOR ~~ECCENTRICITIES~~, CORROSION, LOOSE FIT, DAMAGED INSULATORS. ~~AND REFLECTORS~~. PAR. 39 a (10)		16	INSPECT ~~SHELTERS AND~~ COVERS FOR ADEQUACY OF WEATHERPROOFING. PAR. 39 a (14)	
11	~~INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.~~		17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION. PAR. 39 a (15)	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ~~ELECTRICAL TRANSFORMERS, POWER STATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS~~, AND PILOT LIGHT ASSEMBLIES. PAR. 39 a (11)		18	~~CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.~~	
19	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION. PAR. 39 b (12)				

DA FORM 1 MAY 51 11-238 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM 882-78

Figure 13. DA Form 11-238.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE: RADIO RECEIVING SET AN/URR-29

EQUIPMENT SERIAL NO.

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

NO	ITEM	CONDITION
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (receiver, ~~transmitter~~, carrying cases, wire and cable, ~~microphones~~, tubes, spare parts, ~~technical~~ manuals and accessories). PAR. 39 a (1)	
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 39 a (2)	
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, ~~MICROPHONE~~, HEADSETS, ~~CHESTSETS~~, ~~MIKE~~, JACKS, PLUGS, ~~TELEPHONES~~, CARRYING BAGS, COMPONENT PANELS. PAR. 39 a (3)	
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS. ~~VIBRATORS, PLUG-IN COILS AND RESISTORS~~. PAR. 39 a (4)	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 39 a (5)	
6	CHECK FOR NORMAL OPERATION. PAR. 39 a (6)	
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, ~~SHOCK MOUNTS~~, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, ~~WAVE GUIDES~~, AND CABLE CONNECTIONS. PAR. 39 a (7)	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, ~~TOWERS~~, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 39 a (8)	
9	INSPECT CORD, CABLE, AND WIRE, ~~AND SHOCK MOUNTS~~ FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 39 a (9)	
10	INSPECT ANTENNA FOR ~~ECCENTRICITIES~~, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS. PAR. 39 a (10)	
11	~~INSPECT CANVAS ITEMS, LEATHER, AND BADGING FOR MILDEW, TEARS, AND FRAYING.~~	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, ~~POWERSTATS, RELAYS, SOCKETS, MOTORS, BLOWERS~~, CAPACITORS, ~~GENERATORS~~, AND PILOT LIGHT ASSEMBLIES. PAR. 39 a (11)	
13	~~INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.~~	
14	CLEAN ~~AIR FILTERS~~, BRASS NAME PLATES, DIAL AND METER WINDOWS. ~~GOGGLE ASSEMBLIES.~~ PAR. 39 a (12)	
15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 39 a (13)	
16	INSPECT ~~SHELTERS AND~~ COVERS FOR ADEQUACY OF WEATHERPROOFING. PAR. 39 a (14)	
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION. PAR. 39 a (15)	
18	~~CHECK TERMINAL BOX COVERS FOR GROMMETS, LEAKS, DAMAGED GASKETS, DIRT AND CRACKS.~~	
19	ELECTRON TUBES - INSPECT FOR LOOSE ~~SHIELDS~~, CAP CONNECTORS, ~~CRACKED SOCKETS, INSUFFICIENT SOCKET SPRING TENSION~~; CLEAN DUST AND DIRT CAREFULLY. ~~CHECK SUBSTITUTION OF INCORRECT TYPE TUBES~~. PAR. 39 b (1)	
20	~~INSPECT FILM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.~~	
21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR. 39 b (2)	
22	~~INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS, BURNED, PITTED, CORRODED CONTACTS, MISALIGNMENT OF CONTACTS AND STRIKES, INSUFFICIENT SPRING TENSION, BINDING OF PLUNGERS AND MINOR PARTS.~~	
23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS. PAR. 39 b (3)	
24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 39 b (4)	
25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS. PAR. 39 b (5)	
26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, ~~BLOWERS, RELAY CASES~~, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR. 39 b (6)	
27	~~INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS.~~	
28	~~CHECK SETTINGS OF ADJUSTABLE RELAYS.~~	
29	LUBRICATE EQUIPMENT. ~~IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER~~. PAR. 39 b (7)	
30	~~INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND PITTING OF COMMUTATOR.~~	
31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, AND POTENTIOMETERS. ~~AND RHEOSTATS~~. PAR. 39 b (8)	
32	INSPECT TRANSFORMERS, CHOKES, AND POTENTIOMETERS, ~~AND RHEOSTATS~~ FOR OVERHEATING AND OIL-LEAKAGE. PAR 39 b (9)	
33	~~BEFORE SHIPPING OR STORING - REMOVE BATTERIES.~~	
34	~~INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.~~	
35	~~INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.~~	
36	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS. PAR. 39 b (10)	
37	MOISTURE AND FUNGIPROOF. PAR. 39 b (11)	
38	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION. PAR. 39 b (12)	

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

Figure 14. DA Form 11-239.

39. Performing Preventive Maintenance

a. Performing Exterior Preventive Maintenance.

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

(1) Check for completeness and satisfactory condition of the radio set. The components of the radio set are listed in paragraph 6 and are illustrated in figure 1.
(2) Check suitability of location and installation for normal operation (par. 16).
(3) Remove dirt and moisture from antenna, headsets, jacks, plugs, and panels of the components.
(4) Inspect the seating of readily accessible plug-in items, such as fuses, and connectors (figs. 67, 68, 69, and par. 19).
(5) Inspect all controls for binding, scraping, excessive looseness, worn or chipped gears, misalinement, and positive action.
(6) Check for normal operation (ch 3).
(7) Clean and tighten the panel mountings of the receiver and the exterior of components, cases, racks, mounts, antenna mounts, and coaxial transmission lines.
(8) Inspect cases, mounting, antenna, and exposed metal surfaces for rust, corrosion, and moisture.
(9) Inspect cords, cables, and wires; for cuts, breaks, fraying, deterioration, kinks, and strain (fig. 11).
(10) Inspect the antenna for corrosion, loose fit, and damaged insulators (par. 19).
(11) Inspect for looseness of accessible items such as switches, knobs, jacks, and connectors.
(12) Clean the name plate, dials, and meter window.
(13) Inspect the meter for damaged glass.
(14) Inspect covers for adequacy of weatherproofing.
(15) Check antenna guy ropes for proper tension.

b. Performing Interior Preventive Maintenance.

Caution: Disconnect all power before performing the following operations. Upon completion, reconnect the power plug and check for satisfactory operation.

(1) Inspect electron tubes for loose envelopes, and cracked sockets; remove all dust and dirt carefully.
(2) Inspect fixed capacitors for leaks, bulges, and discoloration.
(3) Inspect variable capacitors for dirt, moisture, misalinement of plates, and loose mountings.
(4) Inspect resistors, bushings, and insulators for cracks, chipping, blistering, discoloration, and moisture.
(5) Inspect terminals of large fixed capacitors and resistors for corrosion, dirt, and loose contacts.
(6) Clean and tighten switches, and interior of chassis and cabinet.
(7) Lubricate equipment in accordance with applicable Department of the Army lubrication order (par. 99).
(8) Clean and tighten connections and mountings of transformers, chokes, and potentiometers.
(9) Inspect transformers, chokes, and potentiometers for overheating.
(10) Check adequacy of moistureproofing and fungiproofing treatment (par. 40).
(11) If deficiencies noted are not corrected during inspection, indicate the action taken to correct the deficiencies.

Section III. LUBRICATION AND WEATHERPROOFING

Note. No lubrication is required in organizational maintenance.

40. Weatherproofing

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. Some of the troubles encountered are:

(1) Fungus growth and excessive moisture on resistors, capacitors, coils, chokes, transformer windings, etc.
(2) Electrolytic action, often visible in the form of corrosion, takes place in capaci-

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tors, resistors, coils, chokes, transformer windings, etc., causing eventual breakdown.

(3) Breakdown of insulation on hookup wires and cables.

(4) Moisture forms on terminal boards and insulation strips, causing flashovers.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and excessive moisture. This treatment is explained in TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, and TB SIG 72, Tropical Maintenance of Ground Signal Equipment.

c. Arctic Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66, Winter Maintenance of Signal Equipment, and TB SIG 219, Operation of Signal Equipment at Low Temperatures.

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 in TB SIG 75, Desert Maintenance of Ground Signal Equipment.

41. Rustproofing and Painting

a. When the finish on the case has been badly scarred or damaged, rust and corrosion can be prevented by touching up the bared surfaces. Use No. 000 sandpaper to clean the surface down to the bare metal; obtain a bright smooth finish.

Caution: Do not use steel wool. Very small particles may 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 before cleaning corroded metal 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. Refer to TM 9-2851, Painting Instructions for Field Use.

Section IV. TROUBLESHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

42. General

a. The troubleshooting and repair that can be performed at the organizational maintenance level (operators and repairmen) is necessarily limited in scope by the tools, test equipment, and replaceable parts issued, and by the existing tactical situation. Accordingly, troubleshooting is based on the performance of the equipment and the use of the senses in determining such troubles as burned-out tubes, cracked insulators, etc. Refer to paragraph 48 for access to tubes.

b. The material is presented in the order that the repairman would normally employ in servicing a defective radio set. When the procedures indicated are not sufficient to determine the source of the trouble, troubleshooting at a field maintenance level will be required.

43. Visual Inspection

a. Failure of the equipment to operate properly will usually be caused by one or more of the following faults:

(1) Improper setting of controls.

(2) Worn, broken, or disconnected cords or plugs.

(3) Burned-out fuses.

b. When failure is encountered and the cause is not immediately apparent, check as many of the above items as is practicable before starting a systematic operational check of the system. If possible, obtain information from the operator of the equipment.

c. Antenna troubles in Radio Receiving Set AN/URR-29 occur less frequently than troubles in other parts of the set. However, the antenna cannot be overlooked as a possible source of trouble. Inspect the antenna for rust, corrosion, damaged insulators or elements, and inspect the input cable for breaks or other defects.

44. Electron Tube Replacement Procedure

a. Recent studies of maintenance practices have disclosed that more than one-third of all electron tubes are needlessly discarded as faulty. This waste of material must be reduced through effective supply economy measures and training of repair personnel.

(1) Inspect cabling and power connections before removing electron tubes.

(2) Isolate the trouble, if possible, to a section of the unit.

(3) If a tube tester is available, test the tubes one at a time, and replace only those that are defective.

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

(*a*) Replace the suspected tubes one at a time and note any change in performance. If the new tube improves the operation, leave it in the set and discard the tube that was removed.

Note. Do not discard a tube that does not perform satisfactorily in oscillator circuits. That same tube may operate properly in another circuit.

(*b*) DO NOT LEAVE A NEW TUBE IN A SOCKET IF THE EQUIPMENT OPERATES PROPERLY WITH THE ORIGINAL TUBE.

(*c*) If there is an insufficient number of spare tubes available, substitute a new tube for one original tube. If there is a difference in operation, leave the new tube in the socket. If there is no difference, or if the performance is worse, remove the new tube and put the original one back in the socket.

(*d*) It is often possible to remove a tube from a socket without seriously affecting the performance of the set. If this is the case, use the removed tube as a substitute spare.

b. If tube substitution does not correct the trouble, put the original tubes back into their sockets before forwarding the set for higher echelon repair.

c. As a general rule, follow procedures given in (1) through (4) below.

(1) Discard tubes under the following conditions:

(*a*) When a test in a tube tester shows that the tube is defective.

(*b*) When the glass envelope is broken, the filament is burned out, or a base pin is broken.

(2) Do not discard a tube because it has been in use for a long time. Satisfactory operation of the tube in the set is the proof of its condition.

(3) Do not discard a tube because the reading on the tester falls on or near the minimum reading stated. A certain percentage of new tubes barely pass the lower limits of the allowable tolerance.

(4) Be very careful when removing tubes from their sockets. Do not rock a tube in its socket; this may cause the base pins to become broken or badly bent out of shape. When removing a tube, pull it straight up.

45. Interchangeable Tubes

Refer to the chart below. The older type tube listed in the first column can be used interchangeably with the corresponding preferred type tube listed in the third column. The second column lists the stage or stages in which the tube can be used interchangeably in Radio Receiver R–220/URR. The older type tube should be used until stocks are exhausted.

Older type tube	Application		Preferred tube
6AU6	V111	Second high-frequency oscillator.	6AU6WA
6AU6	V112	Second mixer	6AU6WA
6AU6	V114	Calibrator buffer	6AU6WA
6AU6	V115	Calibrator oscillator	6AU6WA
6AU6	V301	Third mixer	6AU6WA
6AU6	V302	2,205-kc oscillator (third high-frequency oscillator).	6AU6WA
6AU6	V308	Fm if amplifier	6AU6WA
6AU6	V309	1st limiter	6AU6WA
6AU6	V310	2d limiter	6AU6WA
6AU6	V312	Noise amplifier	6AU6WA
6AU6	V321	Beat-frequency oscillator	6AU6WA
12AT7	V317A	Squelch	12AT7WA
	V317B	First audio amplifier	
5R4WGY	V601	High-voltage rectifier	5RWGA

46. Troubleshooting by Using Equipment Performance Checklist

a. General. The equipment performance checklist (par. 47) will help the operator to locate trouble in the equipment. The list gives the item to be checked, the conditions under which the item is checked, the normal indications and tolerances of correct operation, and the corrective

measures the operator can take. To use this list, follow the items in numerical sequence.

b. Action or Condition. For some items, the information given in the action or condition column consists of various switch and control settings under which the item is to be checked. For other items, it represents an action that must be taken to check the normal indication given in the normal indications column.

c. Normal Indications. The normal indications listed include the things that the operator should see and hear as the items are checked. If the indications are not normal, the operator should apply the recommended corrective measures.

d. Corrective Measures. In most cases, the corrective measures listed are those the operator can make without turning in the equipment for repairs. A reference in the table to paragraph 87 indicates that the trouble cannot be corrected during operation and that troubleshooting at a field maintenance depot is necessary. However, if the tactical situation requires that communication be maintained and if the set is not completely inoperative, the operator must maintain the set in operation as long as it is possible to do so.

47. Equipment Performance Checklist

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	Antenna	Connect the antenna to the antenna input jack. For use of antenna cable adapter E101, refer to paragraph 20.		
	2	OPERATION switch	Rotate to OFF		
	3	230/115 volt switch. (At rear of power supply unit.)	Set to proper position		
	4	Power Cable Assembly CX-2639/U.	Connects to power source		
	5	AUDIO OUTPUT jacks	Connects headset or speaker to audio output.		
	6	BAND SELECTOR switch.	Rotate to band 1		
	7	CALIBRATE switch	Rotate to OFF		
	8	DIAL LIGHT control	Rotate to OFF		
	9	METER switch	Set to CARRIER position.		
	10	R. F. GAIN SQUELCH control.	Rotate fully clockwise		
	11	SELECTIVITY switch.	Set to 200 position		
	12	AUDIO RESPONSE switch.	Set to WIDE position		
	13	NOISE LIMITER control.	Rotate to OFF		
	14	B. F. OSCILLATOR control.	Rotate to OFF		
	15	AUDIO GAIN 1 control	Rotate to midposition		
	16	AUDIO GAIN 2 control	Rotate to midposition		
	17	ANTENNA TRIMMER control.	This control is adjusted in the step given in item 31.		

47. Equipment Performance Checklist—Continued

	Item No.	Item	Action or condition	Normal indications	Corrective measures
START	18	OPERATION switch	Set to STANDBY position.	Filament voltage applied to Radio Receiver R-220/URR.	
	19	DIAL LIGHT control	Rotate clockwise to obtain desired illumination.	Dial lamps light	Check power source. Check fuse F602 and interconnecting cables. Check dial lamps.
	20	OPERATION switch	Allow a 30-second warm-up period before continuing with item 21.		
	21	OPERATION switch	Set to AGC position	A signal or rushing noise heard in headset or speaker.	Power supply rectifier V601 defective. Replace headset or headset connectors. Refer to troubleshooting chart in paragraph 87.
EQUIPMENT PERFORMANCE	22	CALIBRATE switch and TUNING control.	Set CALIBRATE switch to ON. Tune to 25 mc.	Meter reads at least −20 db.*	Rock TUNING control to insure proper setting. Replace V103 through V116, V301, V302, V304 through V307, V316, V318, or V319; V101, Y102, or V301; RT301.
	23	BAND SELECTOR switch and TUNING control.	Rotate to band 2. Tune to 35 mc.	Meter reads at least −20 db.*	Replace Y103.
			Rotate to band 3. Tune to 50 mc.	Meter reads at least −20 db.*	Replace Y104.
			Rotate to band 4. Tune to 65 mc.	Meter reads at least −20 db.*	Replace Y105.
			Rotate to band 5. Tune to 95 mc.	Meter reads at least −20 db.*	Replace Y106.
			Rotate to band 6. Tune to 130 mc.	Meter reads at least −20 db.*	Replace Y107.
			Rotate to band 7. Tune to 200 mc.	Meter reads at least −20 db.*	Replace Y108.
	24	METER switch	Set to LIMITER position.	Meter reads at least 20 db.*	Replace V308 and V309.
	25	CALIBRATE switch	Turn to OFF		
	26	METER switch, BAND SELECTOR switch, and TUNING control.	Set METER switch to OUTPUT HIGH and tune for incoming signal.	Signal heard in headset or speaker. Meter reads at least −20 db.*	Replace V101, V102, V314, V315, V317, V322, or V324.
	27		OUTPUT SIGNAL drifts	Voltage regulator V323 inoperative.	Replace V323.
				Defective heater ballast IHTF10.	Replace IHTF10.
	28		VOLUME fluctuates	No age action because of defective tubes.	Replace V101, V102, V113, V307, V314, V316, or V319.
	29	METER switch	Rotate to the OUTPUT LOW position.	Panel meter at least −20 db.*	Replace V317 and V322.
	30	NOISE LIMITER control.	Rotate clockwise	Background noise decreases.	Replace V315.
	31	ANTENNA TRIMMER control.	Adjust for maximum volume in headset or speaker.	Volume rises to a maximum at one setting.	Tighten mechanical coupling to trimmer. Replace V101 and V102.

47. Equipment Performance Checklist—Continued

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE	32	SELECTIVITY switch and TUNING control.	Set switch to 50. Set TUNING control to tune in a signal.	When set is tuned above and below signal frequency, the signal is lost at a certain point at both sides of the dial setting.	Refer to paragraph 87.
	33	SELECTIVITY switch and TUNING control.	Set switch to 10. Set TUNING control to tune in a signal.	When set is tuned above and below signal frequency, the signal is lost within a smaller range than above.	Refer to paragraph 87.
	34	AUDIO RESPONSE switch.	Rotate to MEDIUM	Tone gets lower and noise decreases.	Refer to paragraph 87.
	35	AUDIO RESPONSE switch.	Rotate to SHARP	Tone gets still lower and noise decreases more.	Refer to paragraph 87.
	36	OPERATION switch and R. F. GAIN SQUELCH control.	Set switch to MGC position; rotate control counterclockwise.	Volume decreases	Replace V303.
	37	OPERATION switch and R. F. GAIN SQUELCH control.	Set to AM SQUELCH position. When no signal is being received, rotate SQUELCH control clockwise until rushing noise is heard in headset. Back off control until receiver squelches.	Rushing noise ceases	Replace V312, V313, or V317.
	38	OPERATION, SELECTIVITY, and METER switches.	Set OPERATION switch to FM SQUELCH; set SELECTIVITY switch to 200 and METER switch to DISC.	Meter reads 25 ua	Replace V310 and V311.
	39	CALIBRATE switch	Turn to ON.		
	40	B. F. OSCILLATOR control.	Rotate to 0 position.		
	41	BAND SELECTOR switch and TUNING control.	Rotate switch to band 1; set control to 25 mc.	Slight adjustment of B. F. OSCILLATOR control produces a zero beat in headset or speaker.	Replace V321. Refer to paragraph 59.
STOP	42	OPERATION switch	Rotate to OFF.		

*Normal readings depend on the individual receiver. Record these for future reference.

48. Removing Tubes

To gain access to the tubes (fig. 15), remove the bottom dust cover (fig. 101). Te remove the dust cover, remove the 18 screws that hold it in place. To gain access to the tubes in the rf unit, refer to paragraphs 92 and 93.

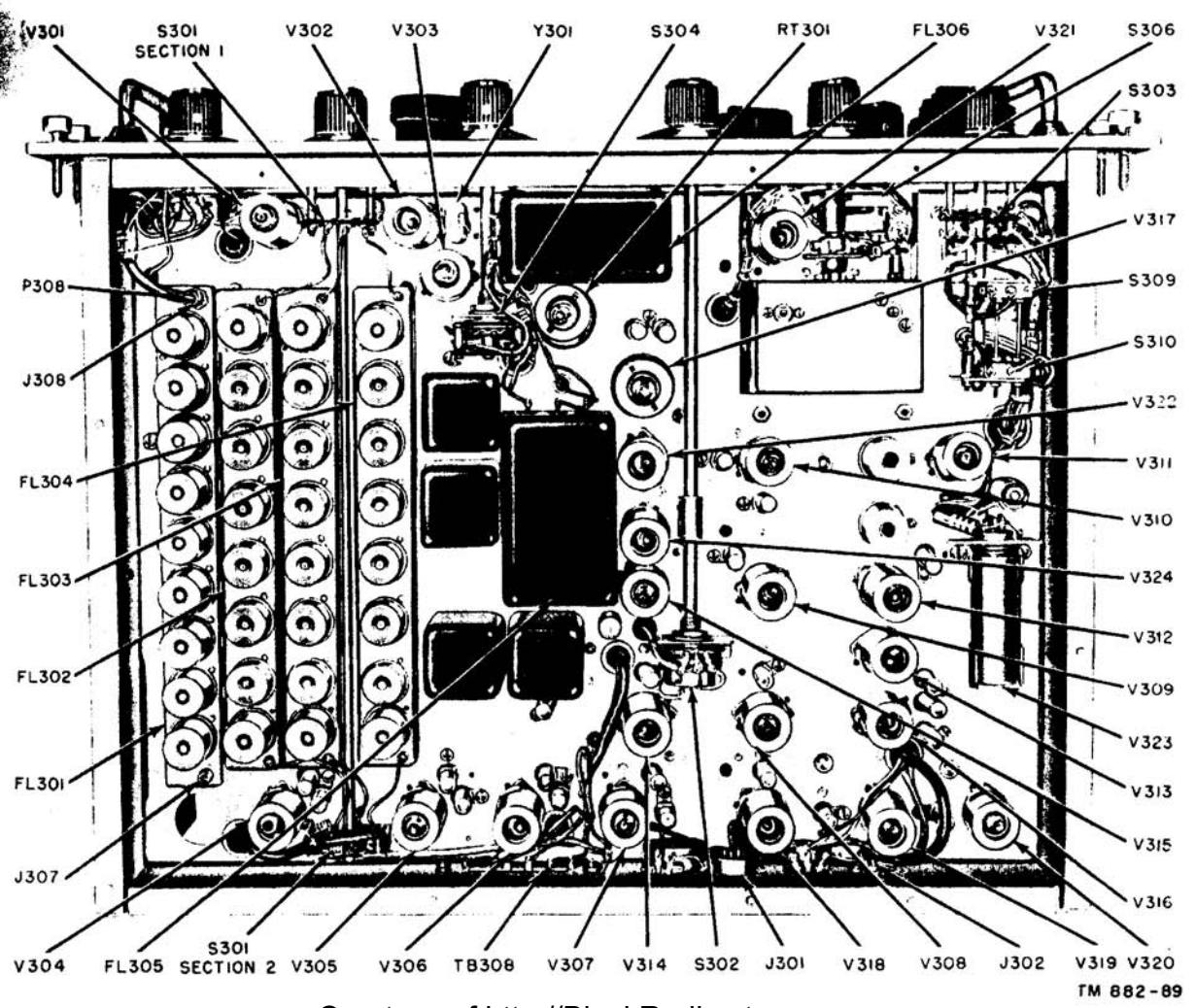
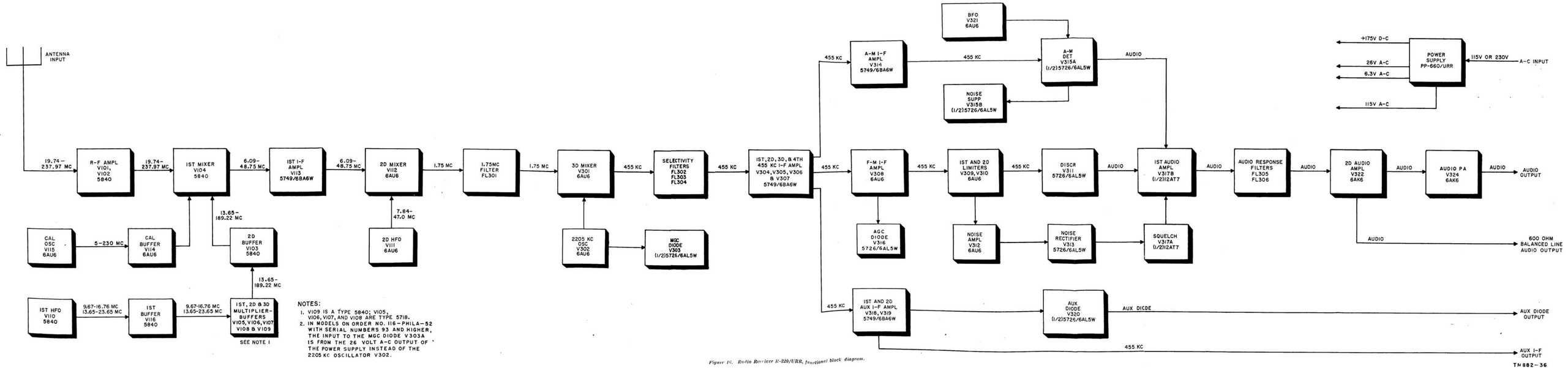


Figure 15. Radio Receiver R-220/URR, main unit, location of tubes.



NOTES:

1. V109 IS A TYPE 5840; V105, V106, V107, AND V108 ARE TYPE 5718.
2. IN MODELS ON ORDER NO. 116–PHILA–52 WITH SERIAL NUMBERS 93 AND HIGHER, THE INPUT TO THE MGC DIODE V303A IS FROM THE 26 VOLT A-C OUTPUT OF THE POWER SUPPLY INSTEAD OF THE 2205 KC OSCILLATOR V302.

Figure 16. Radio Receiver R-220/URR, functional block diagram.

CHAPTER 5

THEORY

Section I. BLOCK DIAGRAM

49. General

The signal path through Radio Receiver R–220/URR is shown on the functional block diagram (fig. 16). Arrows trace the progress of the signal from the point where it is received from the antenna to the various outputs. The operation of the receiver is described as it is used with Power Supply PP–660/URR. Detailed circuitry and power distribution are shown in the schematic diagrams (fig. 56 and 124).

50. Rf Input through Third Mixer

The carrier signal, which may be cw, am, or fm when it is picked up by the antenna, is amplified in the rf amplifier (V101, V102) and fed to the first mixer (V104). Image rejection is achieved by using triple conversion, which reduces the very high-frequency (vhf) signal, ranging from approximately 20 mc to 230 mc, down to an ultimate intermediate frequency (if.) of 455 kc. The first conversion takes place in the first mixer stage (V104), where the signal frequency (19.74 to 237.97 mc) is combined with a harmonic of the first hf oscillator (V110) to produce a difference frequency ranging between 6.09 mc and 48.75 mc. The stability of the first hf oscillator is increased by a thermostatically-controlled heater plate which maintains a constant temperature, and by regulated plate voltages. For precise frequency adjustment and dial calibration, a crystal-controlled calibrating signal from the calibrator oscillator (V115) is also injected into the first mixer. The mixer output is amplified by the first if. amplifier (V113) and enters the second mixer (V112) where it beats with the signal (7.84 to 47.0 mc) generated in the second hf oscillator (V111) to produce a difference frequency of 1.75 mc. This frequency, the result of the first two conversions, is determined by a band-switching arrangement that selects one of seven positions corresponding to the band in use. The 1.75-mc output from the second mixer passes through the 1.75-mc filter (FL301) to the third mixer (V301), where it is combined with the 2,205-kc signal originating in the third hf oscillator (V302) to produce a frequency of 455 kc.

51. Third Mixer through First Audio Amplifier

a. The signal from the third mixer passes through one of the three 455-kc selectivity filters (FL302, FL303, FL304) to the 455-kc if. strip, consisting of four amplifiers in cascade (V304, V305, V306, and V307). From here the signal is fed to the fm circuit, the am. circuit, or the auxiliary circuit.

b. The fm circuit consists of an if. amplifier (V308), two limiters (V309 and V310), and a discriminator (V311). A portion of the second limiter output is also applied to noise amplifier V312, that is followed by noise rectifier V313, where a dc voltage is obtained. This voltage is applied through squelch tube V317A to first audio amplifier V317B, with the audio frequency output from the discriminator.

c. The am. circuit consists of am. if. amplifier V314 and am. detector V315A. This output is also applied to the first audio amplifier. Voltage from the am. detector is also applied to the noise suppressor (V315B). The output from the bfo (V321), when used, is sent to the am. detector where it beats with the output from the 455-kc am. if. amplifier to produce the desired audio beat note when receiving cw signals.

d. The auxiliary circuit consists of two if. amplifiers (V318 and V319), and an auxiliary diode (V320) which rectifies am. signals. Special output terminals, one from the first auxiliary if. am-

plifier to furnish a 455-kc output, and the other from the rectified output of the auxiliary diode, are provided.

52. First Audio Amplifier through Audio Frequency Output

From the first audio amplifier the signal continues, either directly or through one of the audio response filters (FL305 or FL306) to the second audio amplifier (V322), from which a 600-ohm balanced audio output is available. Output from the second audio amplifier is also applied to the audio power amplifier (V324), which provides power to drive the speaker. The output of the power amplifier is available at either of two 600-ohm speaker jacks on the front panel or at the terminal board at the rear of the main chassis.

53. Gain Control Circuits

a. The automatic gain control circuit receives excitation voltage from the fm if. amplifier. This voltage is rectified by the agc diode (V316) and varies the bias of the rf and if. stages in proportion to signal strength, thus automatically controlling the gain of the receiver.

b. The manual gain control voltage, which originates in the 2,205-kc oscillator, is rectified by the mgc diode (V303), and sent to the gain control circuits of the receiver. Selection of either agc or mgc is a function of the OPERATION switch on the front panel. In units with serial numbers 93 and higher, the manual gain control voltage, which is obtained from the 26-volt ac output of the power supply, is rectified by the manual gain control diode (V303A), and sent to the gain control circuits of the receiver.

54. Power Supply Unit

Power Supply PP–660/URR provides all power for the receiver plate, screen, and filament circuits and for the oscillator heater element. Compensation for filament and plate voltage variation is obtained in the first hf oscillator by using a voltage regulator tube to control plate voltage and a ballast tube to regulate the filament current. The input to the power supply may be either 115 or 230 volts ac, 48 to 62 cycles per second (cps).

Section II. STAGE ANALYSIS

55. Radio-Frequency Amplifier (fig. 17)

a. General. The signal fed from antenna input jack J107 is amplified in the rf amplifier and passes into the first mixer. Resistors R101 and R102, each connected between one side of the primary of Z150 and chassis, ground any static charge coming from the antenna or in the coupling circuits. The rf amplifier stage consists of two matched pentodes, V101 and V102, connected in push-pull and operating as class A voltage amplifiers. Grid and plate circuits are both balanced and tuned. Link coupling is used in both the input and output circuits. The operating frequency range is set by a switching arrangement geared to the front panel BAND SELECTOR control, which selects the desired grid and plate tanks from the turret assemblies.

b. Purpose. Radio-frequency amplification ahead of the first mixer discriminates against interference from image frequencies and improves the selectivity and sensitivity. The rf stage isolates the mixer from the antenna, and the push-pull arrangement reduces second-harmonic distortion and provides a large signal to the mixer grid.

c. Push-Pull Amplifier.

(1) A large voltage output is obtained from the push-pull circuit, which has the grids and plates of tubes V101 and V102 connected to opposite ends of the balanced circuits, the grids to Z150 and the plates to Z151. At any instant, terminals 1 and 5 of Z150 will be at opposite polarity with respect to the cathode; therefore, the grid of one tube is swung positive at the same instant that the grid of the other is swung negative and the voltages and currents of one tube are 180° out of phase with those of the other tube. Distortion resulting from even harmonics is balanced out in the plate circuit. The grid circuit is tuned by capacitors C102A and C102B, which are ganged with capacitors in succeeding stages, and operated by the TUNING control on the front panel. Capacitors C101A and C101B are antenna trimmer capacitors, also controlled from the front panel. Capacitor C266

fixes the minimum circuit capacitance at the correct value. The output of V101 and V102 is applied to the plate tank circuit, Z151, which is tuned by C108A and C108B, ganged to the TUNING control.

(2) Because the rf amplifier is operated class A, both tubes are conducting for 360° of the grid input cycle. The plate current flows through load resistors R172 and R173, placing a charge on capacitors C108A and C108B. For example, when the grid of V101 is going positive, the plate current is increasing, which charges C108A and C108B. At the same time, the grid of V102 is going negative, decreasing V102 plate current and causing C108B to discharge. This makes Z151 negative at the bottom and positive at the top. When the grid of V101 swings negative and the plate current is decreasing, C108A is discharging through the primary of Z151, making Z151 negative at the top and positive at the bottom. The current through Z151 will be varying in proportion to the input signal to produce an ac voltage which is link-coupled to the following stage.

(3) Automatic or manual gain control voltages, applied at the junction of resistors R103 and R104, control the amplification of the tubes by varying the negative grid bias. Resistor R112 and capacitor C105 decouple the gain control circuit from the grid circuit.

d. Band Selection. The BAND SELECTOR control on the front panel is used to select the proper coil and capacitor combination for the frequency band being tuned. Turrets Z150 and Z151 each consist of seven coils, one for each of the seven frequency bands on which the receiver operates. Turret Z150 consists of Z101 through Z107. Coils Z108 through Z114 are connected between terminals 1 and 5 on Z151. Slug tuning is used on each band to aid in tracking. Z151 also has a tracking capacitor shunted across each coil and additional tracking capacitors (fig. 124) consist of C252 across Z113, and C253 across Z114. The antenna link, between terminals 2 and 4 on Z150, consists of 1 turn for each band. Variable capacitors across the links on Z101 through Z106, and across the secondary winding on Z107, are used to balance the input circuit. All links on Z151 consist of a single turn.

e. Voltage Supply. B+ from pin B on plug P103 is applied to the rf amplifier stage through B+ decoupling resistor R108. The decoupling capacitors are C107 and C126. Decoupling is provided by R106 and C104 for the screen grids of the tubes. Resistors R105 and R107 are screen grid voltage dropping resistors. Capacitors C103 and C106 are screen grid bypass capacitors. On bands 1 and 2, resistors R219 and R220 on coil assemblies Z108 and Z109 respectively, are switched into the B+ circuit of V101 and V102 to improve screen-grid voltage regulation.

56. First High-Frequency Oscillator

(figs. 18–21)

a. General. The first high-frequency oscillator (V110) is a variable frequency oscillator (vfo) using a modified Colpitts oscillator circuit with each part specially designed and critically placed to maintain a frequency stability within .002 percent.

b. Purpose. The first hf oscillator is variable, to provide a tunable output to beat with the incoming signal in the first mixer. This produces a new radio frequency, the first if.

c. Circuit Description. An oscillator is an amplifier with its circuit arranged so that there is enough positive feedback to sustain oscillations. The desired frequency of oscillation is obtained by using a resonant circuit tuned to that frequency.

(1) *Colpitts oscillator* (fig. 18). The modified Colpitts oscillator shown in figure 18 has a grounded plate circuit, the major frequency-determining components being L108 and C155. The cathode of the tube is connected between grid and plate ends of the tank circuit, at the junction of the capactive divider network at A, and the grid and plate (through C142) are connected to opposite ends of the tuned circuit at B and C. When rf currents flow through L108 in the grid tank circuit, the top of the coil will be of opposite polarity to the bottom and a voltage drop occurs across the oscillator capacitive divider network, C148 and C147. The excitation voltage across C148 causes the oscillations. The ac output of the oscillator is taken across C147. The ratio of excita-

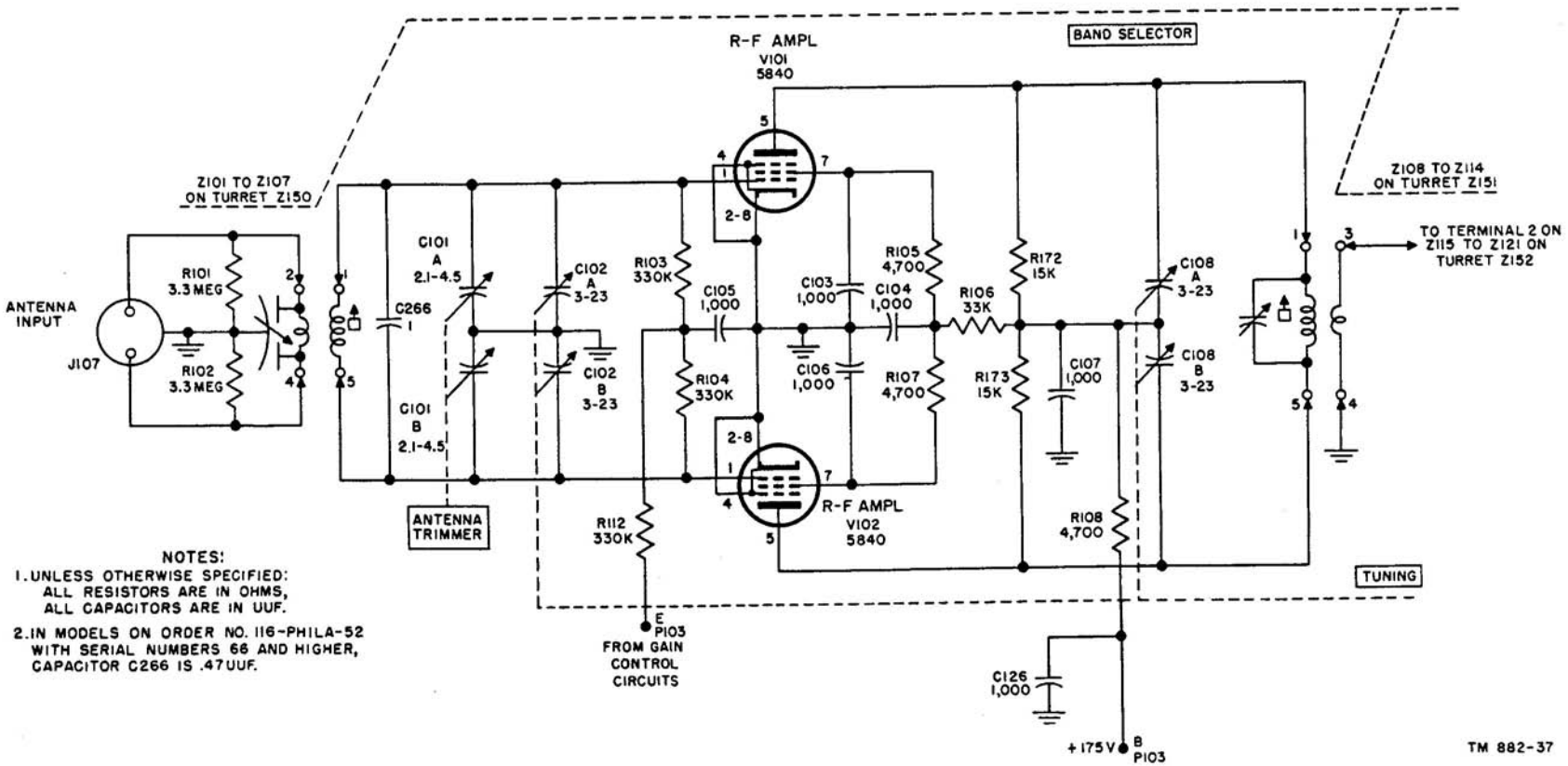


Figure 17. Input circuit and rf amplifier.

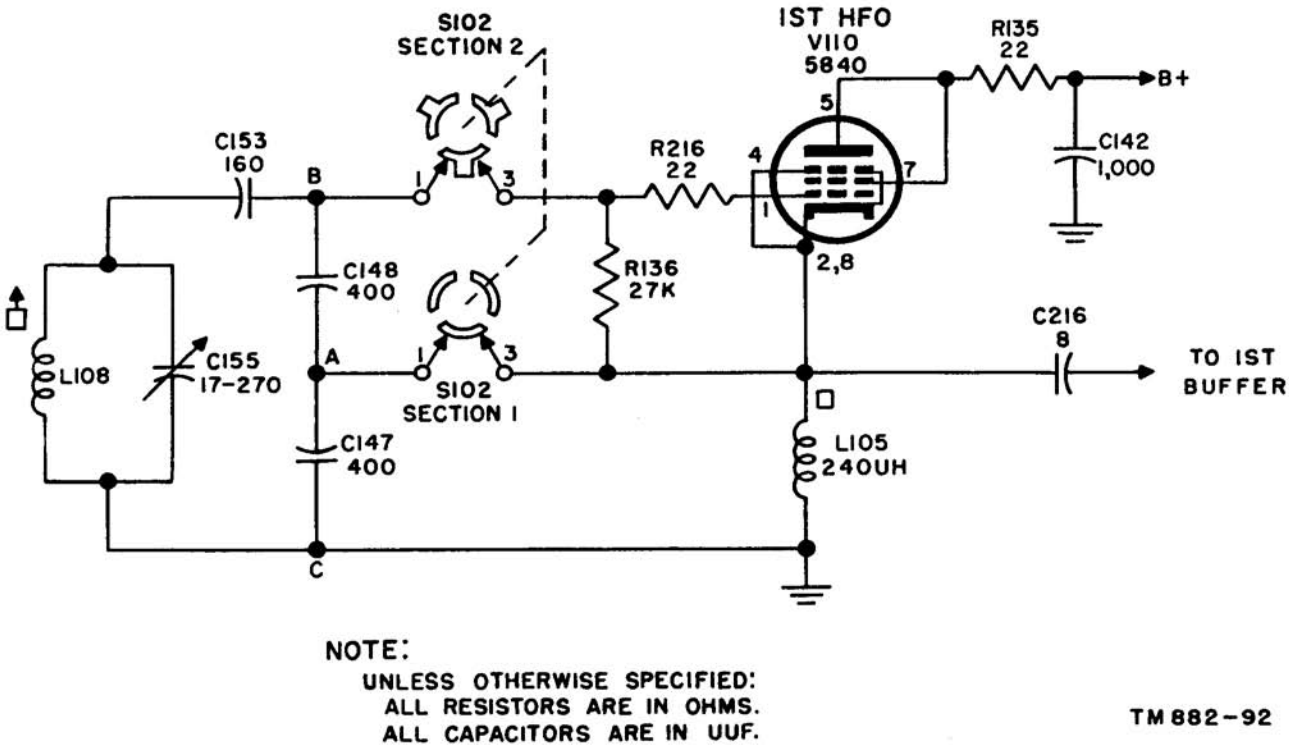


Figure 18. Modified Colpitts oscillator, simplified schematic.

tion voltage to ac output voltage is determined by the ratio of the reactances of C147 and C148. Grid coupling capacitor C153 and grid-leak resistor R136 supply grid-leak bias. In addition to providing the feed-back voltage, capacitors C148 and C147 also mask the tube capacity, so that replacing the tube will have no serious effect on the operation of the oscillator. Cathode rf choke L105 has low distributed capacity and resonates at a frequency lower than the lowest oscillator frequency, and keeps the cathode above ground potential. The output of the oscillator is coupled to the control grid of the first buffer (V116) through C216. The first hf oscillator uses a pentode tube, connected as a triode, to reduce variations in output voltage across the band.

(2) *Band switching* (fig. 19). The cathode and grid are switched between two sets of tuned circuits at points A and B. The seven bands are divided into two groups, the odd-numbered bands (1, 3, 5, and 7) oscillating at frequencies ranging from 13.6523 to 23.6523 mc and the even-numbered bands (2, 4, and 6) from 9.674 to 16.761 mc. There is a separate tank circuit for each of the two groups, one for the *odd bands* and one for the *even bands*. Only one tank is used at a time; the unused tank is grounded through S102 when the other tank is switched into the circuit. The BAND SELECTOR selects the proper coil from the turrets and also rotates S102, which alternately switches in either the odd-band tank or the even-band tank. A, figure 19 shows the switch in position for the even bands. Rotating S102 either clockwise or counterclockwise will transfer V110 to the odd-band position (B, fig. 19).

(3) *Tracking*. Tracking of the tank circuits is accomplished by adjusting two sets of trimmer capacitors: C154 and C156 for the odd bands, and C157 and C158 for the even bands. Capacitors C154 and C158 are adjusted from the front panel with the OSC. TRIM control; C156 and C157 are adjusted through holes in the top of the rf unit. Another set of holes in the rf

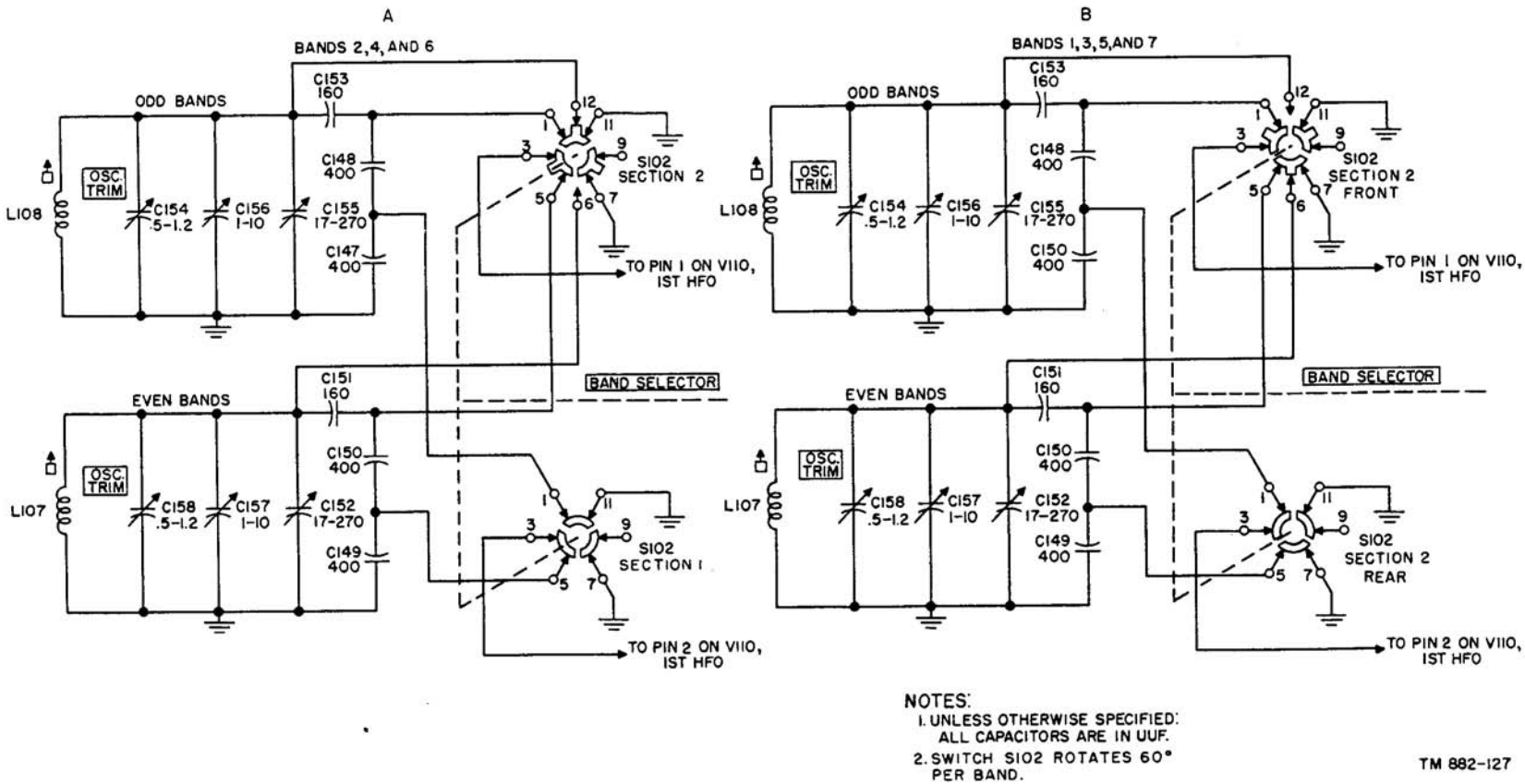


Figure 19. First hf oscillator band switching.

cover permits slug adjustment of the oscillator tuned circuit coils, L107 and L108.

d. Voltage Supply (fig. 20). The plate and screen grid B+ is applied through the regulated output of the main unit at pin 8 on J105. The regulated voltage is filtered by the low-pass, two-section, pi-type filter composed of C220, L126, C218, L106, and C142. Resistors R135 and R216 are parasitic suppressors. Filament current for V110 is obtained from a 6.3-volt ac source in the power supply, where it is held constant by ballast tube, RT301. Filament current enters the rf unit through pin 7 on J105 and is filtered by C219, L127, C217, and L104.

e. Heater Element (fig. 21). The oscillator is kept at a constant temperature of 149° Fahrenheit (65° C.) by the oscillator heater element, which is composed of two sections. The B section is supplied with 115 volts ac by Power Supply PP-660/URR. When a dc power supply is used, the A section of the heater is supplied with 26 volts dc. In either case, the heater dissipates 90 watts while operating. The temperature is regulated by S103, the 65° C. thermostat.

57. First Buffer and First Multiplier-Buffer (fig. 22)

a. First Buffer. The first buffer consists of a pentode (V116) used as an isolating rf amplifier

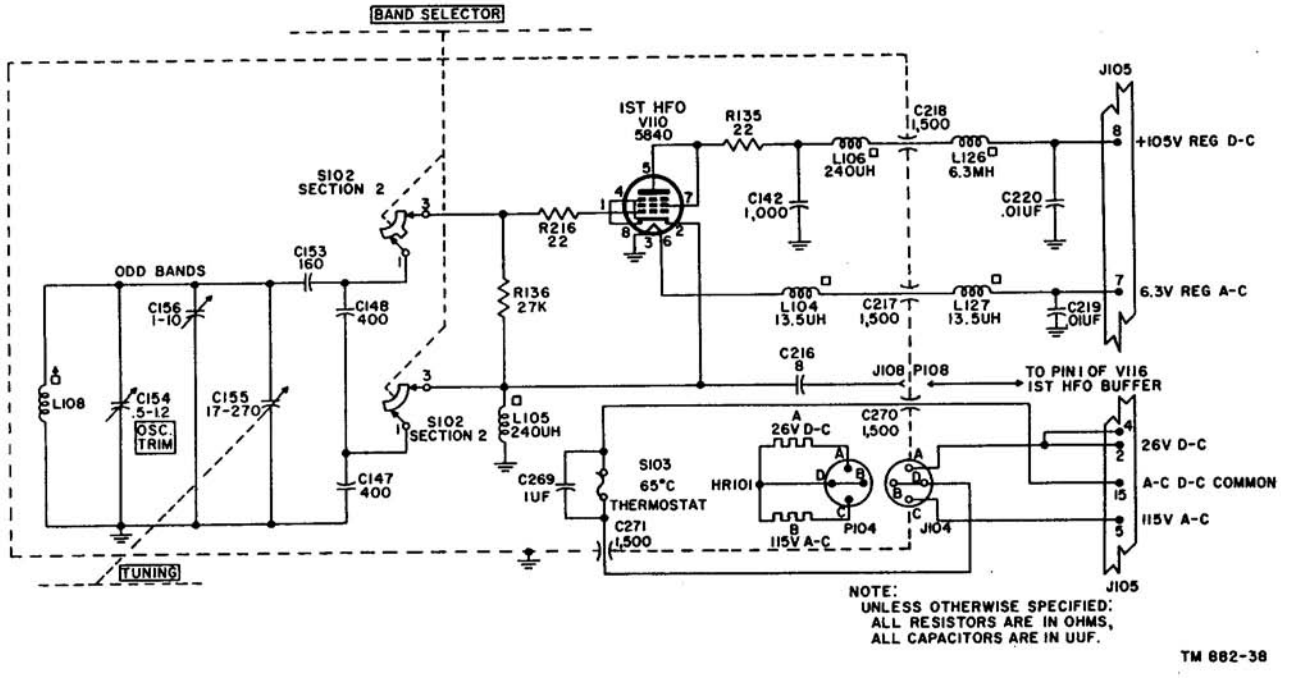


Figure 20. First hf oscillator.

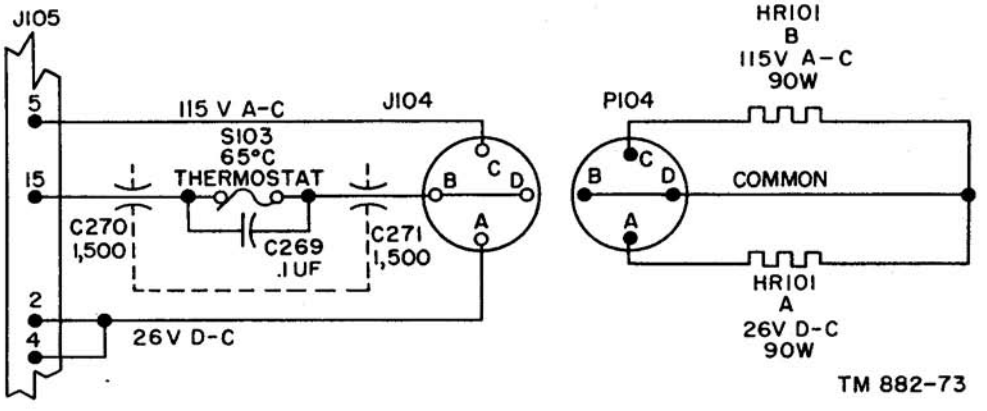


Figure 21. Oscillator heater assembly.

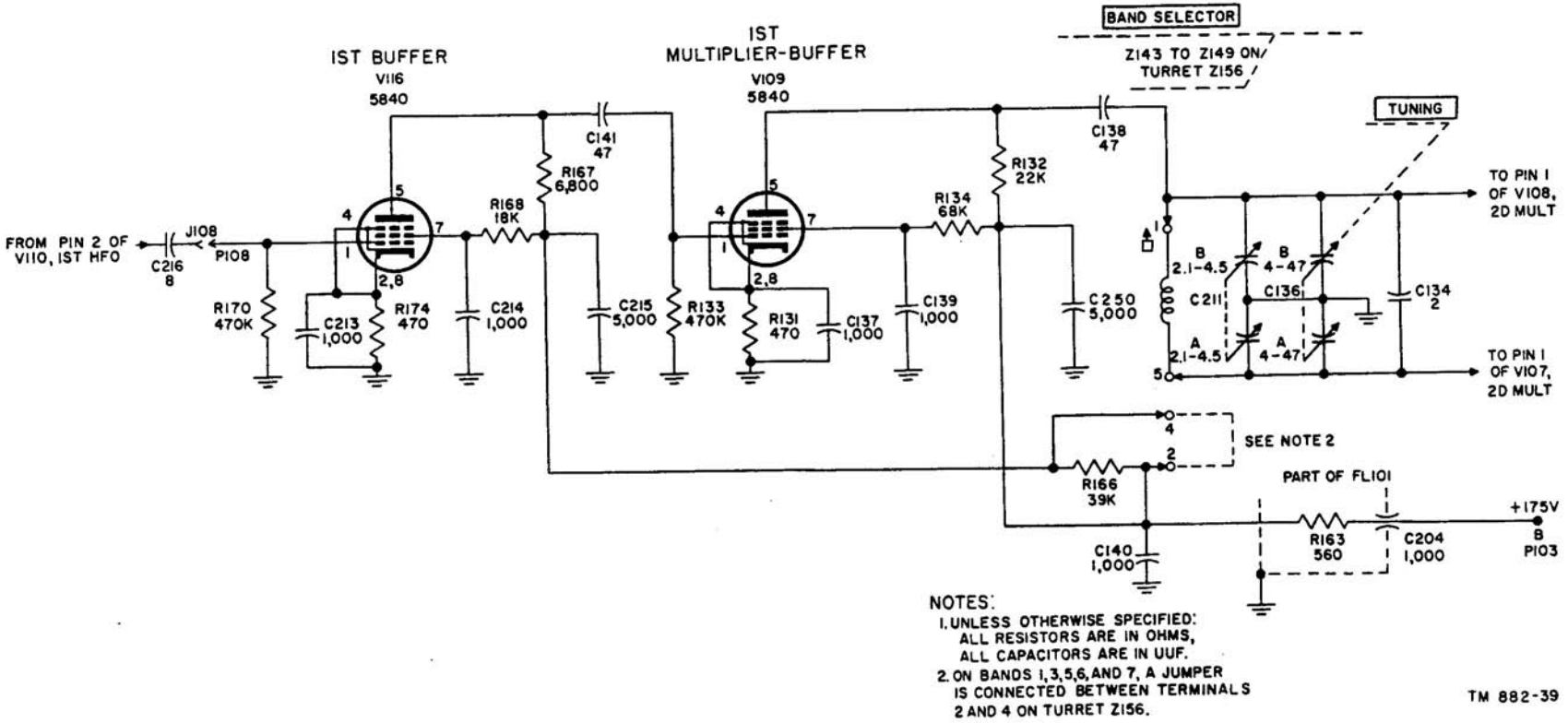


Figure 22. First buffer and first multiplier-buffer.

between the first hf oscillator and the multiplier-buffer stages.

(1) *Purpose.* If the first multiplier-buffer were coupled directly to the first hf oscillator, changes occurring in the plate circuit of the multiplier-buffer such as fluctuations in plate voltage, plate-tank tuning, or loading, would reflect changes in the effective input capacitance of the oscillator tube. The multiplier-buffer would thus react on the frequency of the oscillator, changing the frequency of oscillation. The purpose of the first buffer is to preserve frequency stability by securing isolation of the first hf oscillator from output variations in the following stages.

(2) *Theory and application.* The first hf oscillator is coupled through C216 to the first buffer, which is coupled through C141 to the first multiplier-buffer. Isolation is improved by the use of a fixed, nonresonant circuit, consisting of R167 and C215 instead of a tuned plate tank. The input signal is developed across R170. The higher overall gain of the multipliers and buffers on certain bands is partially compensated for in the first buffer by reducing its B+ voltage on these bands. The plate load and screen-voltage dropping resistors are R167 and R168, respectively. A second voltage-dropping resistor, R166, is in series with the B+ supply on bands 2 and 4 only. On all other bands, this resistor is shorted out by a jumper across terminals 2 and 4 of Z156, increasing the output so that gain will be uniform on all bands. Further gain compensation is effected in the second buffer.

b. First Multiplier-Buffer. The output from the first buffer is used to drive first multiplier-buffer V109. Tube V109 is the first of a series of multipliers used to arrive at the desired output frequency for mixer injection.

(1) *Purpose.* To maintain a high order of frequency stability, the oscillator is operated at a comparatively low frequency (9.67 to 23.65 mc). Frequency multipliers are then used to arrive at the desired output frequency.

(2) *Theory and application.* The tank circuit of the first multiplier-buffer consists of one of the inductances, Z143 through Z149, on turret Z156, chosen by the band selector. Tuning capacitors C136A and C136B, and trimmer capacitors C211A and C211B, are connected across this tank circuit, with their rotors grounded to present a balanced input to the second multiplier-buffer control grids. Capacitor C134 is part of the balanced tank network and is used to fix the minimum circuit capacitance at the correct value. On bands 2 through 7, V109 doubles the output frequency of V116. On band 1, the plate circuit is tuned to resonate at the input frequency, and the first multiplier-buffer acts as a second buffer.

c. Voltage Supply. Plate and screen voltage for both V116 and V109 is decoupled and bypassed by R163 and C140. The plate and screen-grid circuits of V109 consist of plate load resistor R132, rf bypass capacitors C139 and C250, and screen-voltage dropping resistor R134. Rf bypass capacitors are C214 and C215, R174 is the V116 cathode bias resistor, and C213 is the cathode bypass capacitor. Resistor R131 is the V109 cathode bias resistor and C137 is the cathode bypass capacitor.

58. Second and Third Multiplier-Buffer
(fig. 23)

a. General. The output from the first multiplier-buffer is doubled only on bands 4, 5, 6, and 7 in the second multiplier-buffer. Aside from this, the operation of the second and third multiplier-buffer stages is identical. The circuits of the two stages are similar except that the output of the third multiplier-buffer is applied to a single tube. A lower value of cathode bias is used in the third multiplier stage than in the second multiplier, to maintain the signal at a uniform level, but all other values are the same in the two stages. Each stage employs two medium-mu triodes operated class C with the grids connected in push-pull and the plates connected in parallel to form a push-push circuit. The output from V109, the first multiplier, is applied to the grids of V107 and V108, and the amplified output of the tubes is coupled by C131 to Z155, which presents a balanced input to V105 and V106. The output from V105 and V106 is coupled through C122 to Z154,

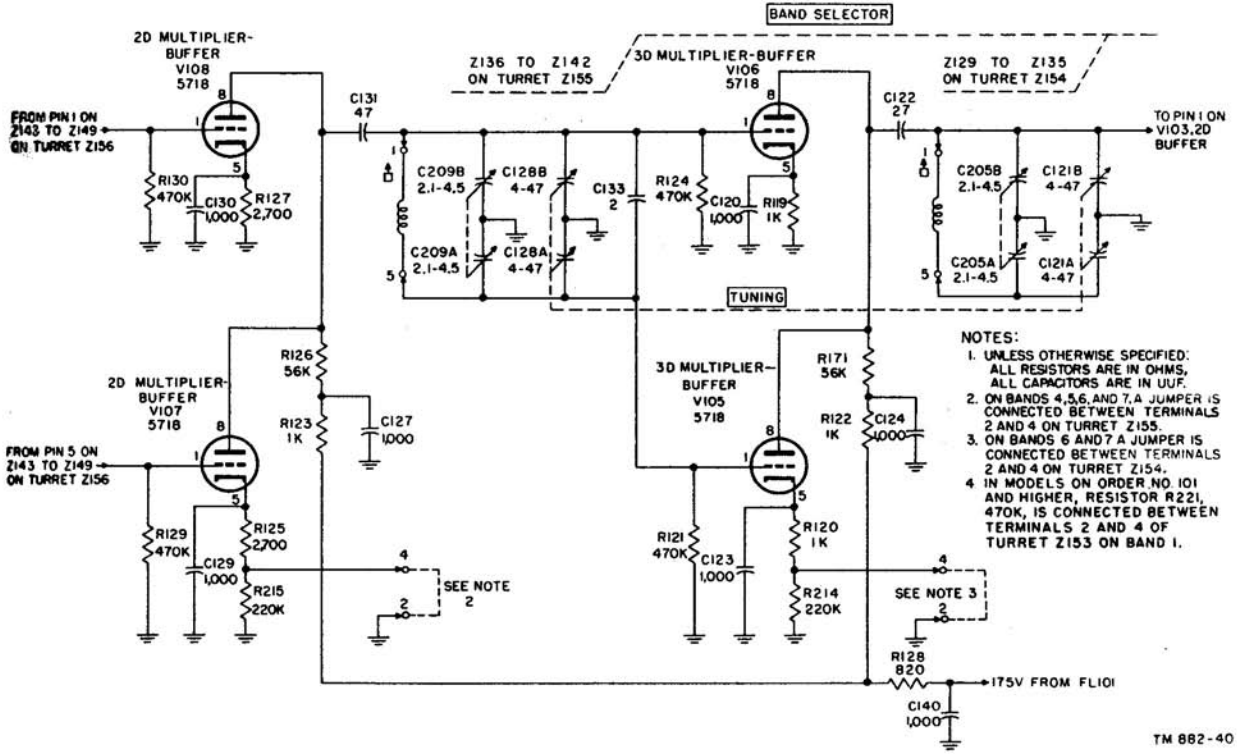


Figure 23. Second and third multiplier-buffer stages.

which is followed by the second buffer (V103). Plate voltage for both multiplier-buffer stages is applied at the junction of R122 and R123 through R128. Capacitor C140 is a decoupling capacitor. Interstage decoupling takes place in the second multiplier-buffer stage through R123 and C127, and in the third multiplier-buffer stage through R122 and C124. Resistors R126 and R171 are plate load resistors for the second and third multiplier-buffer stages, respectively.

b. Second Multiplier-Buffer. When used as straight rf amplifiers, the plate and grid circuits are tuned to the same frequency. Under these conditions, triodes must be neutralized to prevent undesirable oscillations. On bands 1, 2, and 3, an additional resistor (R215) is inserted in the cathode circuit of V107; this higher value of cathode bias cuts the tube off. Tube V108 remains in operation, with the grid-to-plate capacitance of V107 acting as a neutralizing capacitor for V108. The second multiplier-buffer now operates as a conventional single-ended amplifier with the plate tank circuit tuned to the input frequency. On bands 4, 5, 6, and 7, the cathode bias of V107 is reduced to normal. When the jumper wire on turret Z155 shorts out R215, tube V107 conducts and the stage is operating as a push-push multiplier. The output frequency is the second harmonic of the input frequency, and the circuit is operating as a frequency doubler. Neutralization is not necessary when doubling, because the grid and plate tanks are tuned to different frequencies. The output of the second multiplier-buffer stage is fed to a balanced output tank circuit, which is composed of an inductance (Z136 to Z142 on turret Z155, chosen by the BAND SELECTOR) and a capacitance consisting of tuning capacitor C128A and C128B, ganged to the front panel TUNING control. Capacitor C133 is part of the balanced tank network and is used to fix the minimum circuit capacity at the correct value. Capacitors C129 and C130 are cathode bypass capacitors. A combination of grid-leak and cathode bias is used in the second multiplier-buffer stage. Grid bias is obtained when excitation from the first multiplier-buffer causes the flow of grid current. If grid excitation should be removed, there will still be enough cathode bias to protect the tubes from damage.

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c. Third Multiplier-Buffer. On bands 1 through 5, the cathode circuit of V105 must be completed through resistor R214 on turret Z154, and the tube is inoperative, as in the preceding stage. The frequency is doubled on bands 6 and 7 only. Coils Z129 to Z135 on turret Z154, together with C121 and C205, comprise the plate tank of the third multiplier-buffer. On bands 1 through 6, additional capacitors are shunted across the tank circuit to improve tracking. Capacitors C120 and C123 are cathode bypass capacitors. The output of the third multiplier-buffer feeds the grid of the second buffer (V103).

59. Second Buffer

(fig. 24)

The output of the third multiplier-buffer stage is coupled through capacitor C122 to the grid of the second buffer, V103, which operates as a buffer amplifier. Grid current flows through R117 because the third multiplier-buffer output generates an automatic bias. In addition, self-bias is developed across the cathode resistor, R116. B+ is decoupled by R115 and C125, and applied to the plate of V103 through rf choke L101. On band 1, B+ is applied to the screen grid through R118. In units with serial numbers 93 and higher, R118 is paralleled by R221 on band 1. On the remaining bands (2, 3, 4, 5, 6, and 7) as the frequency becomes higher, R118 is shunted by progressively smaller resistors, R208 through R213, on turret Z153, resulting in higher screen voltage and increased amplification. The plate tank circuit is composed of one of the inductances (Z122 through Z128 on turret Z153), tuning capacitors C117A and C117B, and trimmer capacitors C119A and C119B. On all bands, additional capacitors (not shown in figure 24) are shunted across the tank circuit to improve the tracking. Capacitors C114 and C116 are bypass capacitors for the plate and screen circuits. Capacitor C111 is a cathode bypass capacitor. Capacitor C135 is a B+ line bypass capacitor. Coil Z153 is ganged to the BAND SELECTOR control on the front panel and C117A and C117B are ganged and operated from the front panel by the TUNING control. The output from the second buffer tank is fed through C110 to the first mixer circuit.

60. Calibrator Oscillator and Buffer

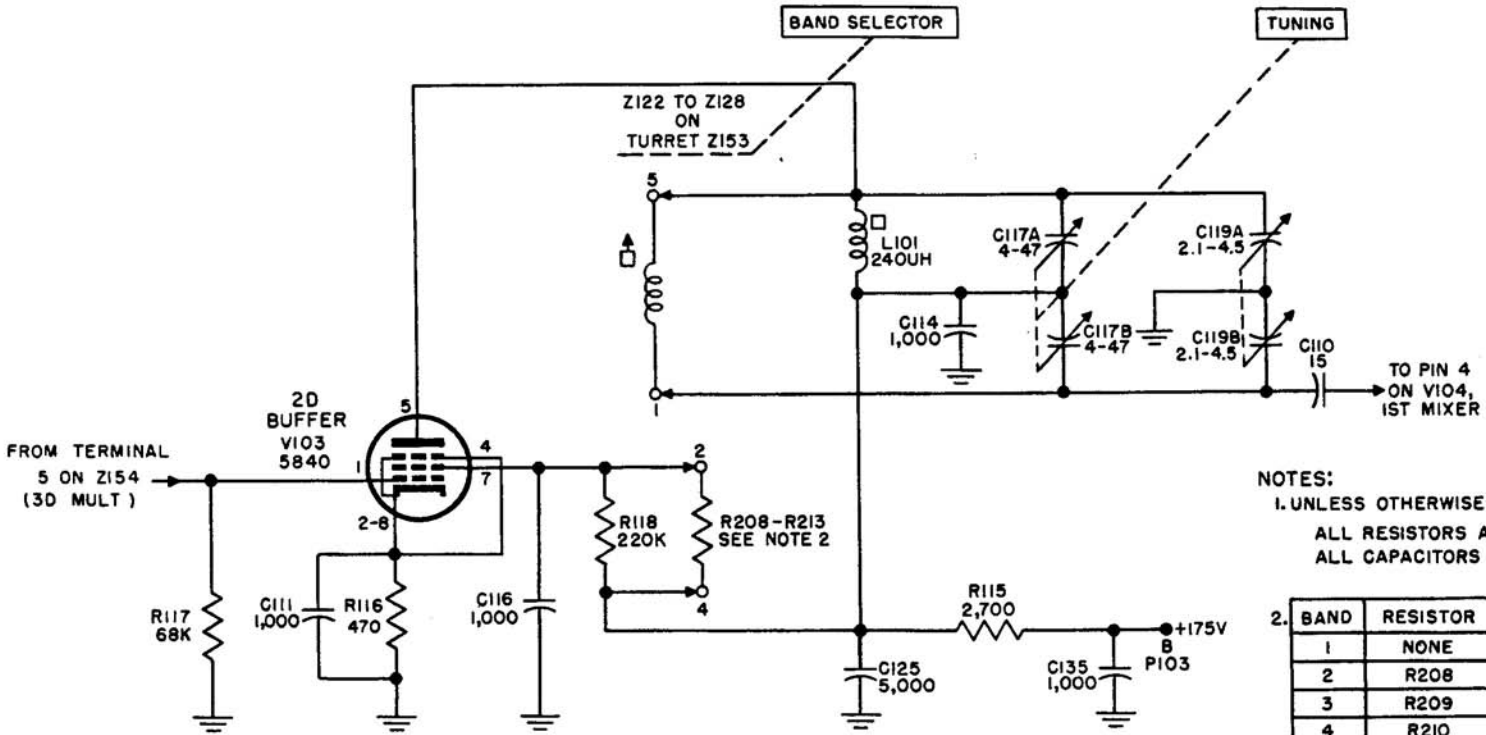
(figs. 25 and 26)

a. General. The calibrator oscillator is a pentode crystal oscillator stage, with external feedback and a low C plate tank circuit, driving a pentode buffer stage. A high order of frequency stability is obtained through the use of a quartz crystal, which is ground to oscillate at 5 mc. The output frequency to the first mixer is further stabilized by the constant load presented by the buffer.

b. Pentode Crystal Oscillator (fig. 25). The crystal, Y101, acts as a sharply tuned resonant circuit in the grid circuit of the oscillator. Phasing capacitor C198, connected in parallel with the crystal, is used to vary the frequency by changing the shunt capacity. Grid-leak resistor R161 furnishes the operating bias. The plate tank circuit is slug-tuned by L124, in parallel with C188. The screen is bypassed to ground through C196, which offers low reactance at the operating frequency. Feedback to sustain oscillation is obtained primarily through the plate-to-grid capacitance of the tube. Because of the thorough screening, however, additional feedback is needed to insure oscillation. This is provided by C197 connected between the plate and control grid. When the tank circuit is tuned to a frequency slightly higher than the natural frequency of the crystal, the feedback through C197 excites the grid circuit, and the crystal oscillates at approximately its natural frequency.

c. Piezoelectricity. A small plate cut in the proper way from a quartz crystal and placed between two conducting electrodes, will be mechanically strained when the electrodes are connected to a source of voltage. Conversely, if the crystal is compressed between two electrodes, a voltage will develop between the electrodes. When an alternating potential is applied to the crystal, the crystal will vibrate at the frequency of the applied electromotive force (emf) and a free oscillation at the natural frequency of the crystal will result. Because of the piezoelectric effect, the crystal can be made to substitute for a coil-and-capacitor resonant circuit.

d. Crystal Circuit Equivalents (fig. 26). The crystal is held between a pair of electrodes in a crystal holder. The electrical coupling to the crystal is through the electrodes between which it is sandwiched; these electrodes form, with the



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS,
   ALL CAPACITORS ARE IN UUF.

2.

BAND	RESISTOR	VALUE
1	NONE	
2	R208	150K
3	R209	150K
4	R210	100K
5	R211	68K
6	R212	10K
7	R213	10K

3. IN MODELS ON ORDER NUMBERS 93 AND HIGHER, RESISTOR R221, 470K, IS CONNECTED BETWEEN TERMINALS 2 AND 4 OF TURRET Z153 ON BAND 1.

TM 882-41

Figure 24. Second buffer.

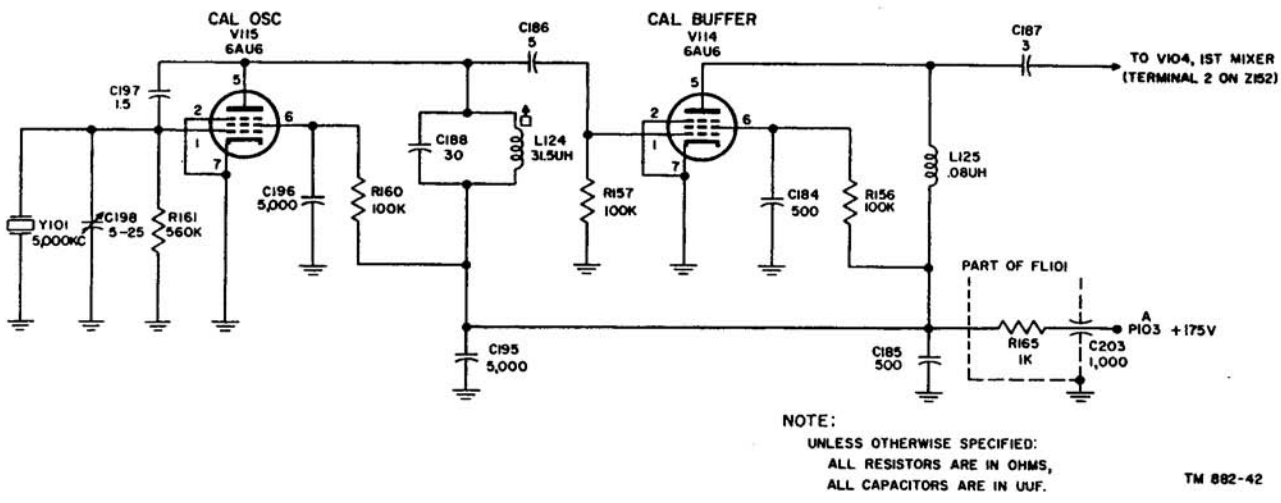


Figure 25. Calibrator oscillator and buffer.

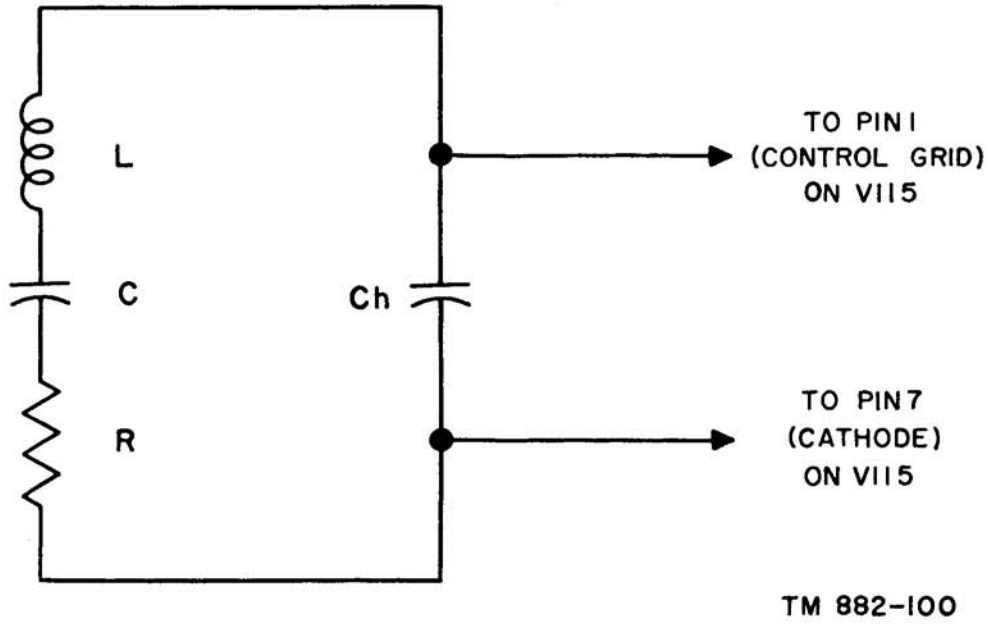


Figure 26. Electrical equivalents of piezoelectric crystals.

crystal as the dielectric, a small capacitor. The crystal, without its holder, is equivalent to an extremely large inductance, L, in series with a correspondingly small capacitance, C, together with a relatively small series resistance, R. This results in a very high Q. These electrical equivalents of the mechanical properties of a crystal are shown in figure 26. The combined shunt capacitance of the holder electrodes, connecting leads, tube capacities and reflected plate impedance, is represented by C_h in figure 26. Shunt C_h is combined, in figure 25, with the phasing capacitor C198. The electrode capacitance is so large compared with the series capacitance of the crystal that it has only a small effect on the series-resonant frequency. It has a great effect, however, on the parallel-resonant frequency. At a critical frequency determined by the values of L and C, the reactance will cancel out and the impedance will be equal to R. At this point, the characteristics of the crystal are those of a series-resonant circuit. This is known as the series-resonant or natural frequency of the crystal. At a slightly higher frequency than this, the effective reactance

of L and C combined will be inductive, and equal to the reactance of C_h. Under these conditions, the crystal has the characteristics of a parallel-resonant circuit. The frequency at which either of these conditions occurs is the operating frequency to which the crystal is ground (when it is used to control the frequency of a vacuum-tube oscillator). Whether the parallel-resonant or the series-resonant type of crystal is used depends on the type of oscillator circuit in which the crystal is used.

c. Circuit Description. When plate voltage is applied to the circuit, and the tube is conducting, an alternating potential is applied across the crystal through the feed-back coupling between the plate and grid circuits; then, because of its piezoelectric properties, the crystal is set into vibration. The voltage fed back is relatively weak, but because it is applied at the natural frequency of the crystal, it causes a free oscillation of the crystal at a much greater amplitude. The alternating potential developed by the free oscillation of the crystal is then applied between the grid and cathode of the tube. This energy compensates for the losses in the plate circuit, similar to the flywheel effect in a self-excited oscillator, and the circuit is kept in constant oscillation. The oscillator output is coupled through C186 to the control grid of the buffer, V114. Resistor R157 is the grid-leak bias resistor and C184 is the screen bypass capacitor. Coil L125 is an rf choke which serves as a plate load for V114 and isolates the rf in the plate circuit from the power supply. The output from the buffer is coupled through C187 to the first mixer coupling link. B+ from pin A on P103 is decoupled by R165 and the rf is bypassed by C185, C195, and C203. Resistors R156 and R160 are screen-grid, voltage-dropping resistors.

61. First Mixer

(figs. 27 and 28)

a. General. The first mixer stage used a pentode, V104. Cathode injection is used for the first hf oscillator signal, and the control grid is used for injection of signals from the rf amplifier and the calibrator buffer.

b. Purpose. The incoming signal is detected and its frequency reduced in the mixer, resulting in a new signal frequency, the first if. The first if. results from combining the signal frequency with the output from the first hf oscillator to produce a *difference* frequency. Three higher frequencies are also present in the mixer output, but they are rejected by selective circuits. These unwanted frequencies consist of the two original frequencies and the sum of these two.

c. Mixer Operation (fig. 27). In mixer operation, two signals, A and B, are injected simultaneously into the mixer (one into the control grid and one into the cathode). Signal A represents the incoming signal and signal B the oscillator signal. Each of these signals is amplified and appears at the output of V104. A mixing action also takes place, resulting in two additional frequencies at the output of V104. If the receiver is tuned to 25 mc, signal A will be 25 mc and signal B will be 18.9058 mc. The chart below lists examples of frequencies A, B, A+B, and A−B for one signal frequency in each of the seven bands. The sum of A and B is 43.9058 mc; the difference between A and B is 6.0942 mc. Thus, four distinct frequencies are present at the output of the mixer. The only frequency desired in this case is the difference frequency. This is the lowest of the four, and it is separated from the other frequencies by the tuned output circuit T101. The tuned circuit offers a high impedance to signals at the difference frequency (first if.). The if. tuned circuit offers a low impedance to these unwanted frequencies, shown in figure 41 as A (25 mc), B (18.9058 mc), and A+B (43.9058 mc).

Freq A (mc) rf signal input	Freq B (mc) osc signal	Freq A+B (mc)	Freq A−B (mc) intermediate freq
25 (band 1)	18. 9058	43. 9058	6. 0942
35 (band 2)	26. 3631	61. 3631	8. 6369
50 (band 3)	37. 8116	87. 8116	12. 1884
65 (band 4)	47. 7262	112. 7262	17. 2738
95 (band 5)	70. 6233	165. 6233	24. 3767
130 (band 6)	95. 4524	225. 4524	34. 5476
200 (band 7)	151. 2465	351. 2465	48. 7535

d. Circuit Description (fig. 28). The signal originating in the first hf oscillator after being multiplied and amplified, is injected into the cathode from the second buffer. Capacitor C110 with C112 forms a voltage divider. In units with serial numbers 93 and higher, C273 is placed in parallel with C112 on bands 1 and 2 to increase the injection voltage applied to the first mixer. The signal is mixed either with the received signal from the rf amplifier (for signal reception), or with the signal from the calibrator buffer (for

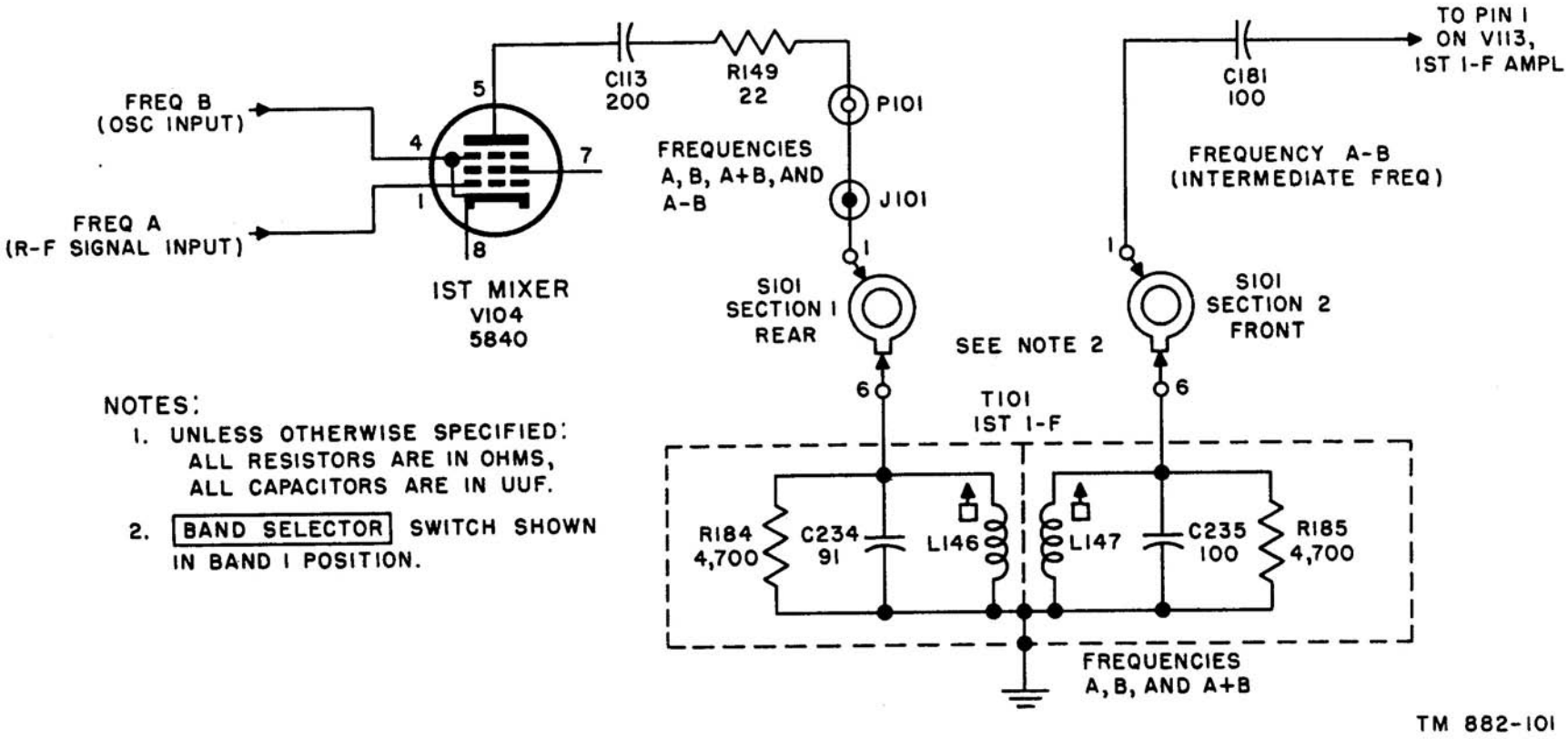


Figure 27. Mixer operation, simplified schematic.

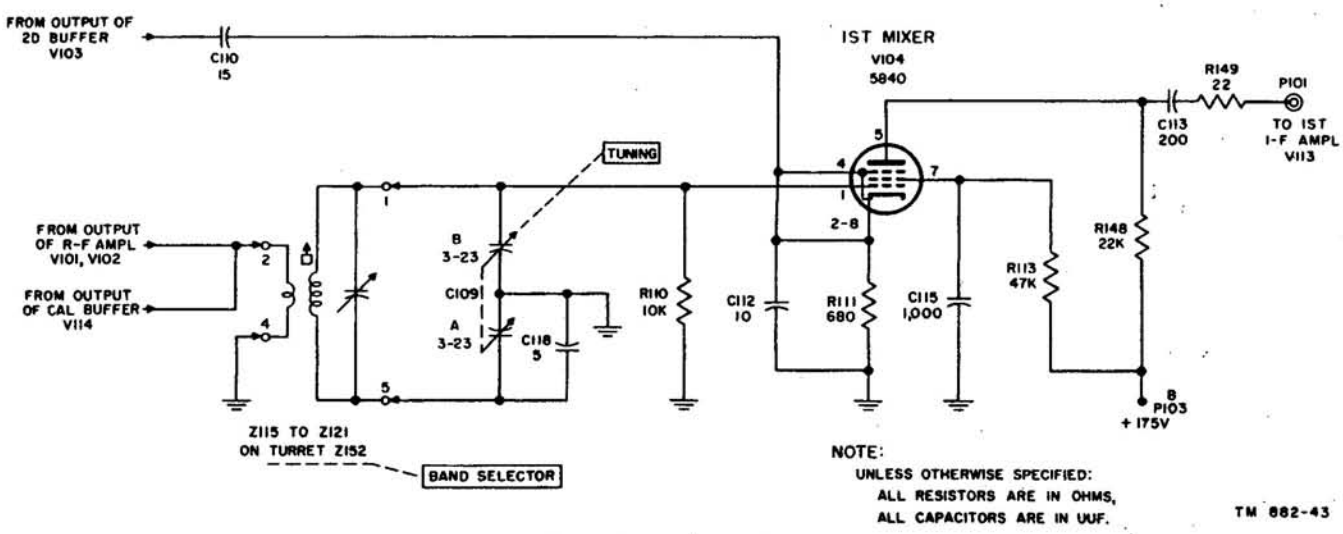


Figure 28. First mixer.

receiver calibration). The rf amplifier output and the calibrator buffer output are both connected to the link on turret Z152, but only one of these two outputs is in operation at any one time. Whichever output is being used is mixed in the tube with the signal from the second buffer. The grid tank consists of the impedance on turret Z152 in parallel with the ganged tuning capacitors C109A and C109B and the padding capacitor C118 across C109A, which balances the input capacity of V104. Turret Z152 is made up of seven impedances, Z115 through Z121, each consisting of a slug-adjusted inductance in parallel with a trimmer capacitor. Coils Z120 and Z121 use a small fixed capacitor in addition to the trimmer capacitor. The proper combination is chosen by the BAND SELECTOR switch on the front panel, and C109A and C109B are tuned by the TUNING control on the front panel. The output from the grid tank appears across R110, and is directly coupled to the control grid of V104, where it is mixed with the first hf oscillator signal. The mixer output is coupled through C113 and R149 to the first if. stage. Resistor R149 is a parasitic suppressor. The if. transformer is permanently tuned to the difference frequency output from the mixer.

e. Voltage Supply. B+ is applied to the plate of V104 from pin B on P103 through R148 and to the screen grid through R113. Capacitor C115 is the screen-grid rf bypass capacitor. The cathode biasing resistor is R111.

62. First If. Amplifier

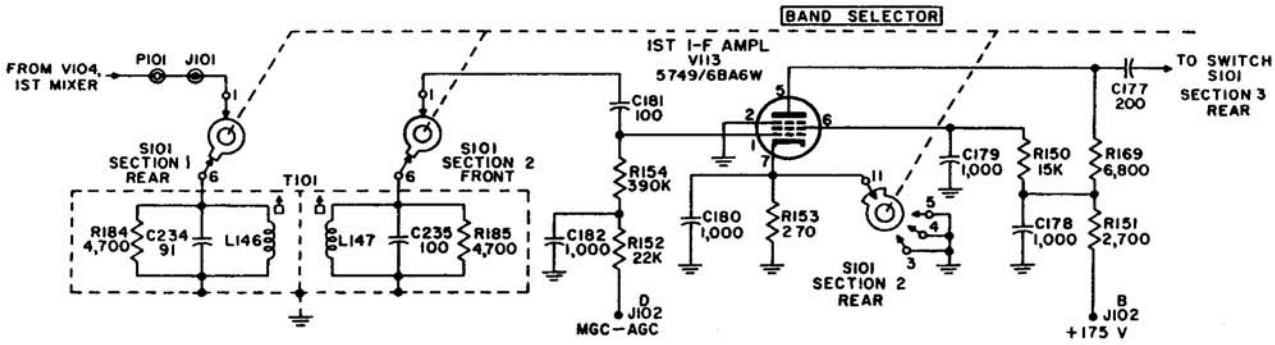
(fig. 29)

a. General. The first if. amplifier uses a remote cutoff pentode, V113, operated as a class A amplifier. Gain control voltage is applied to the control grid. For maximum selectivity and image rejection, double-tuned if. transformers are used for interstage coupling.

b. Purpose. The if. amplifier provides the necessary gain, selectivity, and image rejection. After the incoming signal has been converted to the much lower intermediate frequency, separate if. frequencies and transformers are used on each band for best image rejection. Since they are operated at frequencies far removed from the signal frequency, these amplifier frequencies are not affected by the incoming signal.

c. Intermediate Frequencies. There are three mixer stages used in Radio Receiver R–220/URR to provide triple conversion, but there are actually only two fixed intermediate frequencies as in the ordinary superheterodyne. The first conversion results in seven different intermediate frequencies, as follows: band 1, 6.0942 mc; band 2, 8.6369 mc; band 3, 12.1884 mc; band 4, 17.2738 mc; band 5, 24.3767 mc; band 6, 34.547 mc; and band 7, 48.7535 mc.

d. Gain Control and Bias. The gain of the stage is controlled by applying a negative voltage to the control grid from the gain control circuits through terminal D on J102. The voltage changes the bias on the tube and therefore the gain. The control-grid voltage is applied through grid re-



NOTES:

1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, ALL CAPACITORS ARE IN UUF.
2. BAND SELECTOR SHOWN IN BAND 1 POSITION.
3. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER,

THE FOLLOWING CATHODE BIAS RESISTORS ARE USED:

BAND	RESISTOR	VALUE (OHMS)
1	R222	150
2	R223	100
3	R224	270
4	R225	220
5	R223	100
6	R222	150
7	NONE	

TM 882-44

Figure 29. First if. amplifier.

sistor R154 and mgc-agc decoupling resistor R152. Capacitor C182 is the mgc-agc decoupling capacitor. Resistor R153 is the cathode bias resistor and C180 is the cathode rf bypass capacitor. On bands 5, 6, and 7, R153 and C180 are shorted out through section 2 of S101 so that higher gain can be obtained on these bands. In units with serial numbers 93 and higher, cathode bias resistors for V113 are switched into the circuit by S101, section 2, rear. The cathode bias resistors are as follows: band 1, R222; band 2, R223; band 3, R224; band 4, R225; band 5, R223; band 6, R222; on band 7, the cathode is grounded.

e. Circuit Description. Male input jack J101 connects with female plug P101 to receive the signal from the first mixer, which is applied to the primary of if. transformer T101. The secondary of T101 is coupled by C181 to the control grid of V113. There are seven potted sections in T101, one for each band, selected by S101 (which is ganged to the BAND SELECTOR) (par. 79). Each section is permeability tuned with adjustable slugs in both primary and secondary. Coupling from V113 to the second mixer circuit is through C177.

f. Voltage Supply. The first if. amplifier, second mixer, and second hf oscillator stages are housed in a separate section of the rf chassis, indicated in figure 101 as the second mixer section. This section is connected to the rf unit by plugs and jacks. Main power jack J105 on the rf unit connects directly with female plug P102 (fig. 102), which in turn, is connected to male jack J102 on the second mixer section (fig. 121). The four connections on J102 are filament voltage for V111, V112, and V113, gain control voltage for tube

V113, B+ voltage, and ground. B+ is applied to the plate and screen grid of V113 through B+ decoupling resistor R151, which helps prevent unwanted interstage coupling. Capacitors C178 and C179 are rf bypass capacitors. Resistor R169 is the plate load resistor and R150 is the screen-grid voltage-dropping resistor.

63. Second Hf Oscillator and Second Mixer (figs. 30, 31, and 32)

a. General. The output from the first if. amplifier combines in the second mixer with the signal from the second high-frequency oscillator to produce a fixed if. of 1.75 mc. Quartz crystals are used for frequency control of the second hf oscillator to obtain maximum stability. The output from the first if. amplifier plate is coupled through a second tuned circuit, T102, before entering the second mixer.

b. Second Mixer Input and Switching Circuits. Second mixer V112 is a miniature sharp cutoff pentode with the signal voltage applied to the control grid and the oscillator signal applied to the cathode.

(1) *Input to second mixer stage.* The signal from the first if. amplifier is coupled to if. transformer T102, which is selected by sections 3 and 4 of switch S101 and ganged to the BAND SELECTOR. The transformer secondary is coupled to the control grid of V112 through section 4 of S101. Resistor R147 is the cathode bias resistor. Capacitor C174, in conjunction with C183, forms a capacitive voltage divider for the signal from second hf oscillator V111. In units with serial numbers 93 and higher, C274 is placed in parallel with C174 on bands 1 and 2 to increase the injection voltage applied to the second mixer.

(2) *Band switching and crystal selection.* Separate input and output if. transformers T101 and T102 are provided for each of the seven bands. When a transformer is selected by the BAND SELECTOR switch, the corresponding crystal is also selected and all other crystal circuits are grounded. Grounding of unused tanks and crystals is accomplished by section 5, front, of switch S101 (fig. 124). This is done to prevent the tanks from causing interaction between circuits by adding resonant points through capacitive and magnetic coupling.

c. Second Hf Oscillator Operation. The cathode, control grid, and screen grid of V111 operate as a triode oscillator, the screen grid serving as the anode. Electrons constituting the screen current sustain oscillation; the remainder of the electron stream continues on to the plate and the plate load to form the output. The anode of the triode portion of V111 is thus electron-coupled (through the electron stream between cathode and screen grid) to the output circuit through the plate, and from the output circuit to the cathode of second mixer V112. Crystal oscillator circuits are used with V111 on bands 1, 2, and 3, and crystal resonator circuits are used with V111 on bands 4, 5, 6, and 7.

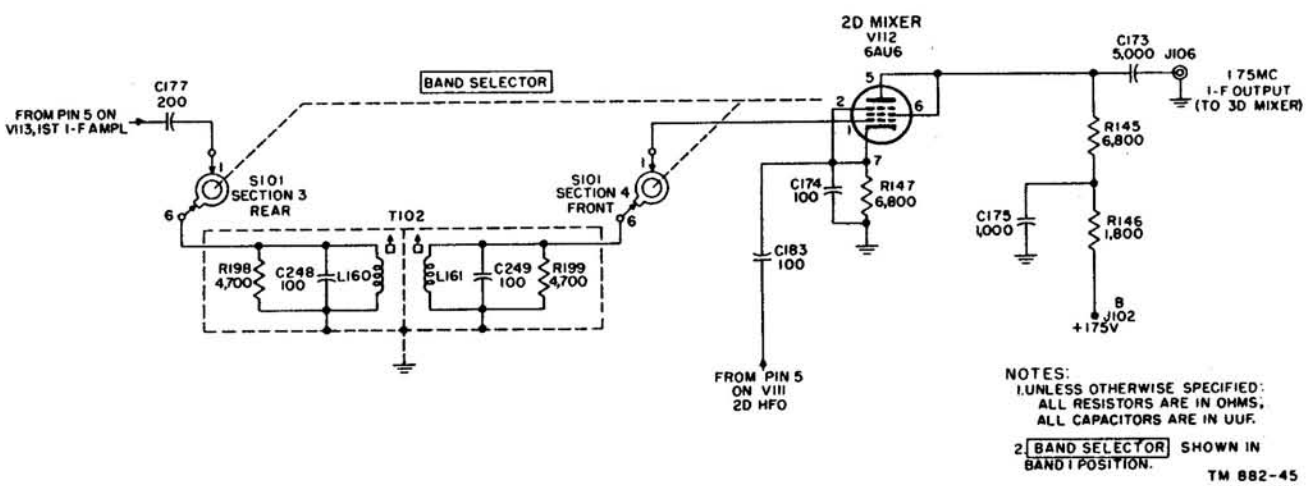


Figure 30. Second mixer.

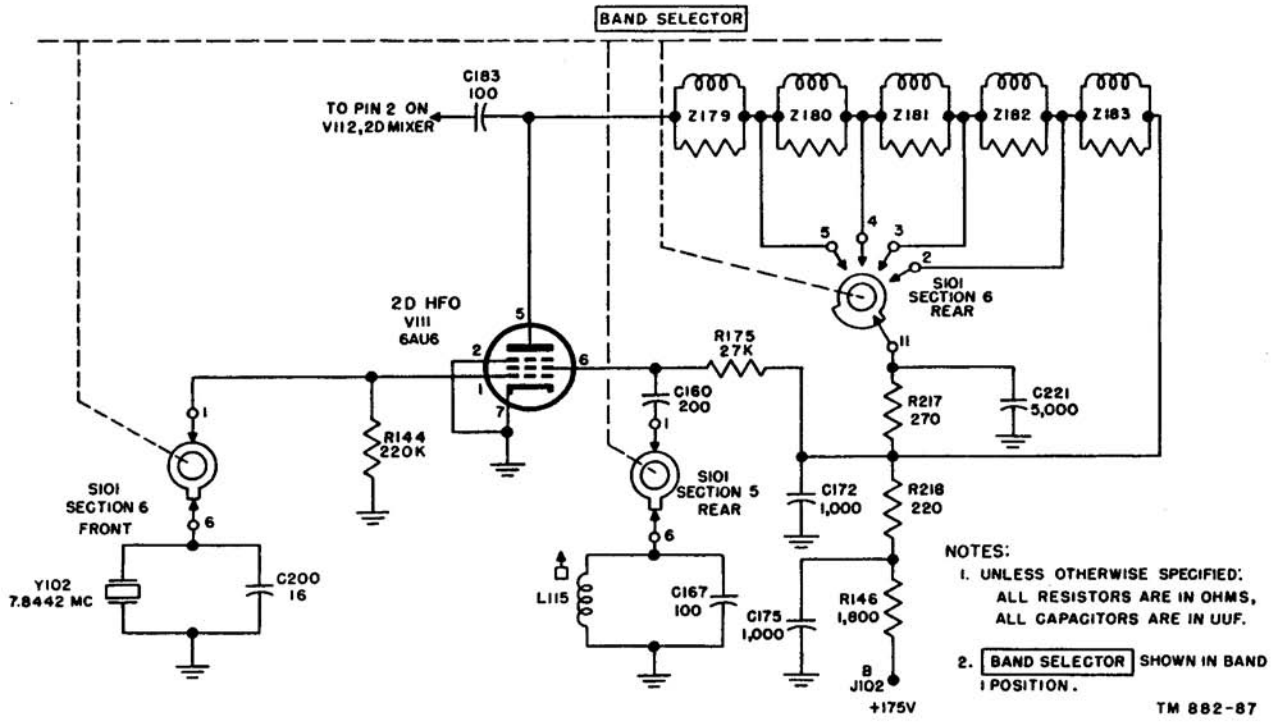


Figure 31. Crystal oscillator on band 1, simplified schematic diagram.

(1) *Bands 1, 2, and 3* (fig. 31). On bands 1, 2, and 3, the second high-frequency oscillator uses a Miller circuit, oscillating at the parallel-resonant frequency of the crystal. The LCR of crystal Y102 are shunted by C200 which masks the capacity of the crystal holder. Resistor R144 limits the crystal current and provides operating bias. The parallel combination acts like the grid tank of a conventional tuned-plate tuned-grid oscillator; the *plate* circuit consists of L115 and C167. Feedback is through the interelectrode capacity of the tube. Capacitor C160 is a blocking capacitor and C183 is the coupling capacitor to the second mixer stage. B+ is applied to the plate (pin 5) of V111 through impedances (Z179 through Z183), and to the screen grid through voltage-dropping resistor R175. Capacitor C175 is an rf bypass used with R146 for decoupling. Additional decoupling is provided by R218 and C172. Capacitor C221 is an rf bypass capacitor.

(2) *Bands 4, 5, 6, and 7* (fig. 32). On bands 4, 5, 6, and 7, the circuit differs considerably from that used on bands 1, 2, and 3. Coupling to the second mixer is the same, and the functions of R175, R144, and impedances Z179 through Z183 remain unchanged, but here the crystal oscillates at its natural or series-resonant frequency. On band 4, the inductance of Z157 cancels the capacitance of the crystal and holder and damps any tendency of the crystal to operate in a spurious mode. The shunt resistance of Z157 further aids the damping action. The series-resonant circuit, consisting of C164 and L112, acts as a selective feed-back path allowing feedback to occur only in the vicinity of the desired frequency. The resistors shunted across the coils are mounted inside the coil forms. Their purpose is to keep the output constant on all bands. Resistor R217 reduces the output on the low-frequency bands still more, so that it will be the same as the output of the others. This is shown in figures 31 and 32. As switch S101 is turned toward the higher numbers, more coils are shorted out, and the stage operates at a higher frequency.

d. Second Mixer Operation and Output Circuit (fig. 30). The output of the crystal circuit is ap-

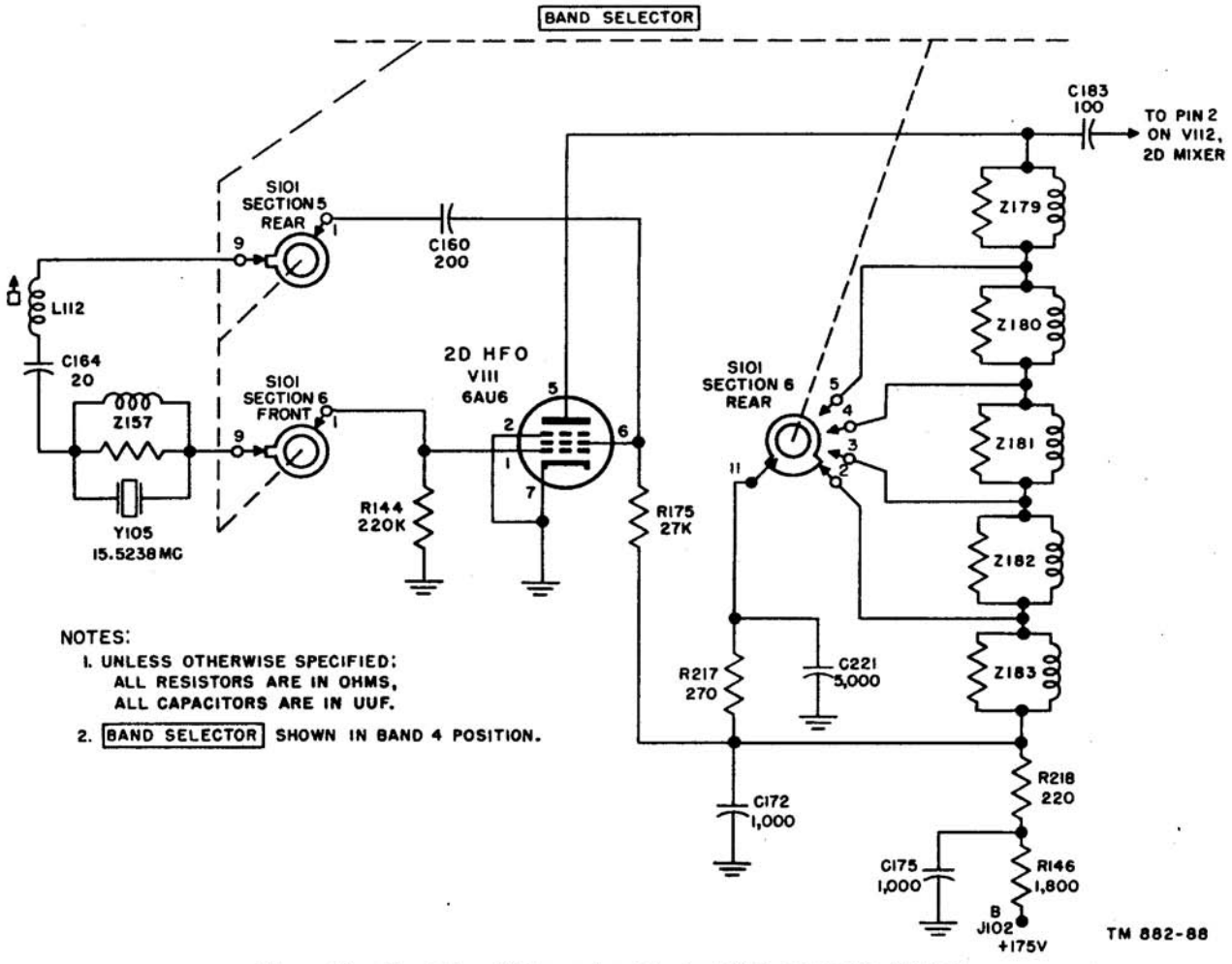


Figure 32. Crystal oscillator on band 4, simplified schematic diagram.

plied to the second mixer cathode and beats with the signal from the first if. amplifier.

(1) *Second mixer operation.* One of the two signals injected into the second mixer tube goes to the cathode from the second high-frequency oscillator. The other signal, which is applied to the control grid, comes from the output of if. transformer T102. B+ from pin B on J102 is applied to V111 and V112 through isolating resistor R146, decoupled by C175. Resistor R145 is the load resistor for the V112 plate.

(2) *Output to third mixer, 1.75 mc.* The output from the plate of the second mixer is the two original frequencies and the sum and difference frequencies. This output is coupled to the main unit components by C173, through J106. The difference frequency, which is always 1.75 mc, is selected by 1.75-mc band-pass filter FL301 and the other frequency components are filtered out.

(3) *Filter, 1.75 mc.* Band-pass filter F301 has a center frequency of 1.75 mc and a 6-db bandwidth of 200 kc. The filter is used to increase the selectivity of the receiver. Input and output jacks J307 and J308, mounted at opposite ends of the hermetically sealed filter case, are connected to the second and third mixers through coaxial cables. Filter FL301 is replaceable as a unit and requires no adjustment.

64. Third Mixer and 2,205-kc Oscillator (fig. 33)

a. General. Third mixer V301 is a miniature sharp cutoff pentode with control-grid injection used for both input signals. The same type tube is used for the 2,205-kc oscillator, which used a quartz crystal in a Pierce circuit for maximum stability.

b. Purpose. The 175-mc signal is applied to the third mixer. It is beat with the output from the 2,205-kc oscillator. A difference frequency of 455 kc is obtained that is fed to the 455-kc if. amplifiers.

c. Crystal Oscillator, 2,205 kc. In the Pierce circuit, the feedback is supplied by the direct coupling between plate and grid circuits provided by the crystal that is connected between these two elements. This effectively represent a coil and capacitor in series. The dc plate voltage cannot be impressed on the crystal because of C302, the plate-to-grid dc blocking capacitor. The crystal operates as a series-resonant circuit, permitting only the crystal frequency rf current to reach the grid. The crystal may be considered as replacing the tank inductance of a self-excited Colpitts oscillator (par. 56). Grid leak bias is provided by R301. No tuned circuits are required in the Pierce oscillator; the constant frequency output of 2,205 kc is determined by crystal Y301.

d. Third Mixer. The output from filter FL301 which appears across R424, is coupled through C301 to the control grid of third mixer V301. Resistor R302 is the grid return resistor and R303 is the cathode bias resistor. The rf is bypassed around R303 by C305. The output of 2,205-kc oscillator V302 is coupled to the control grid of V301 through C303. The 455-kc output from the third mixer is coupled through C309 and section 1 of SELECTIVITY switch S301 to one of the 455-kc filters.

e. Voltage Supply. B+ for both V301 and V302 is filtered by L301 and C313. Plate load resistors are R308 for V301 and R304 for V302. Screen-grid voltage-dropping resistors are R307 and R305 for V301 and V302, respectively. The screen grid of V301 is bypassed for rf by C306. The screen grid of V302 is bypassed for rf by C304.

f. Manual Gain Control Voltage. Voltage for manual gain control is obtained from the 2,205-kc oscillator at the junction of Y301 and C302, and coupled by C308 to mgc diode V303. In units with serial numbers 93 and higher, voltage for manual gain control is obtained from the 26-volt ac output of the power supply and applied to mgc diode V303A.

65. Selectivity Filters, 455-kc and If. Strip, 455-kc (figs. 34, 35, and 36)

a. General. Before final detection takes place, further amplification is provided for the relatively weak 455-kc signal from third mixer V301. The third mixer output is coupled through a selectivity filter to four 455-kc if. amplifiers. The amplified if. signal is then capacity-coupled to the am., if.,

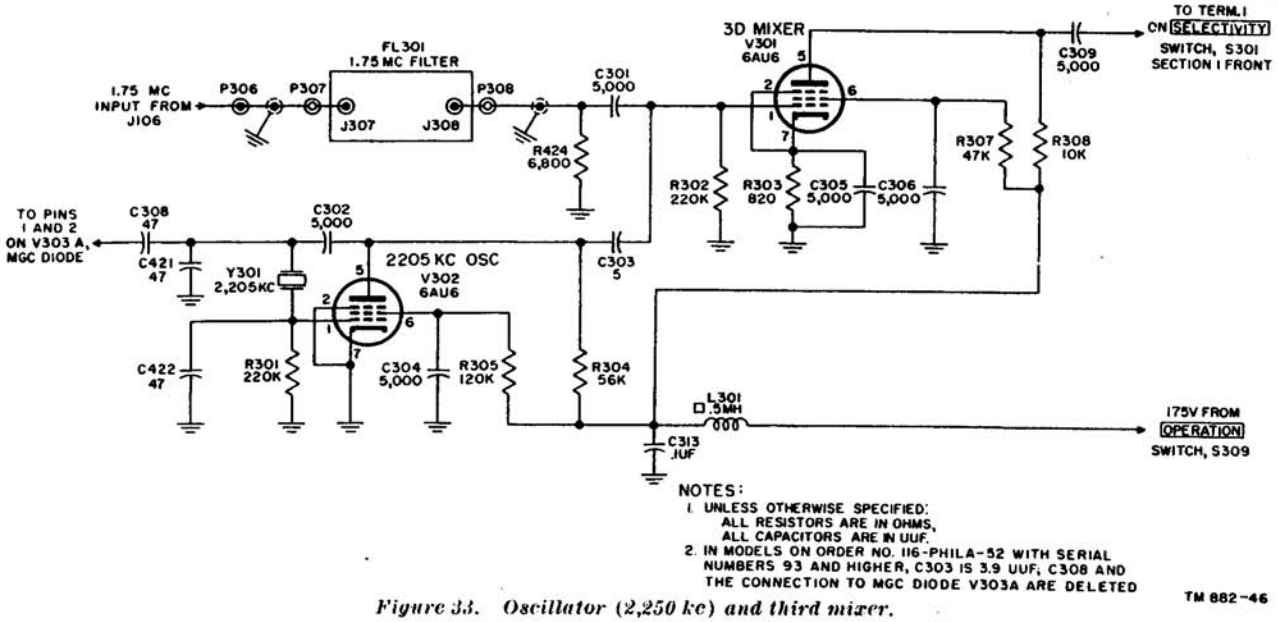


Figure 33. Oscillator (2,250 kc) and third mixer.

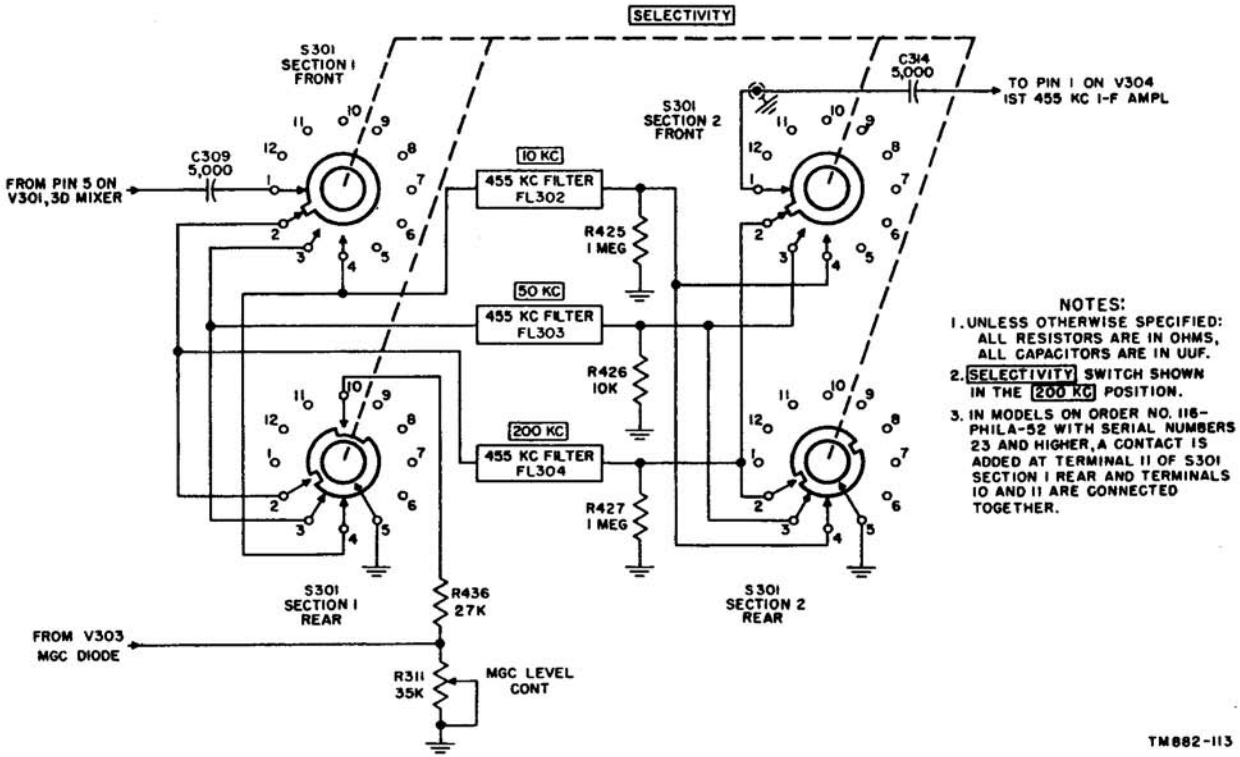


Figure 34. Selectivity filters, 455 kc.

fm if. and auxiliary if. circuits. The four amplifiers constituting the 455-kc if. strip operate generally the same as first if. amplifier V113 (par. 62), except that differences in frequency and signal level require different values for component parts.

b. Filters, 455 kc (fig. 34). A means of varying the selectivity of the receiver is provided by the 455-kc filters, which consist of three independent filter circuits, FL302, FL303, and FL304, with bandwidths of 10 kc, 50 kc, and 200 kc, respectively. The desired bandwidth of the signal is chosen by front panel SELECTIVITY switch S301, the first section being connected to the filter input and the second section to the output. Section 1, rear, of S301, grounds the input to the filter circuits not in use. The output circuits of the unused filters are grounded by section 2, rear, of S301. The output of each filter is loaded by resistor R425, R426, or R427 and is capacity-coupled by C314 to the grid of first 455-kc if. amplifier V304. When 10-kc filter FL302 is switched into the circuit, R436 is placed in parallel with R311 through section 1, rear, of S301, thereby decreasing the output of mgc diode V303. In this manner, the gain of the receiver is increased to compensate for the greater insertion loss of filter FL302. In units with serial numbers 23 and higher, when 200-kc filter FL304 is switched into the circuit, R436 is placed in parallel with R311 through section 1, rear, of S301, decreasing the output of mgc diode V303A. Thus, the gain of the receiver is increased to compensate for the insertion loss of FL304.

c. First and Second 455-kc If. Amplifiers (fig. 35). The grid bias for V304 and V305 is determined by the negative voltage from the gain control circuits and is applied through grid load resistors R313 and R320. The V304 resistor, R313, presents a relatively high impedance to the incoming signal to provide maximum voltage gain in the first 455-kc if. stage; succeeding stages use lower grid impedances. The mgc-agc decoupling network consists of R314 and C315 for V304, and R321 and C321 for V305. Capacitor C382 is the common mgc-agc line filter for both stages. The output circuit of V304 contains a trap consisting of L302 and C316, connected in parallel, which offers maximum impedance at 1.75 mc and 2,205 kc to prevent interference from the second mixer and 2,205-kc oscillator. Resistor R316 broadens the bandwidth to contain both 1.75 mc and 2,205 kc. The V305 plate circuit uses a similar trap

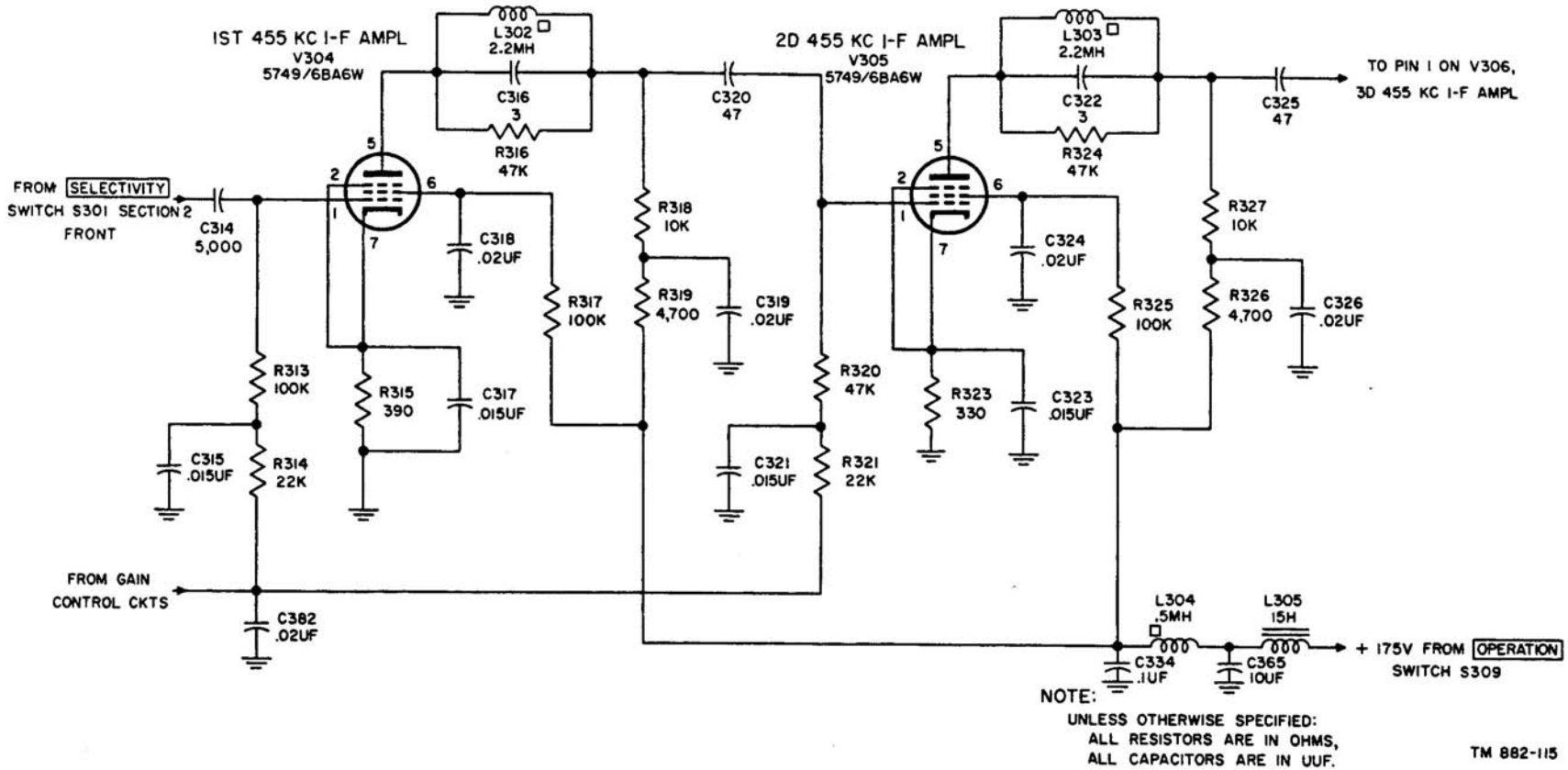


Figure 7. First and second IF amplifiers.

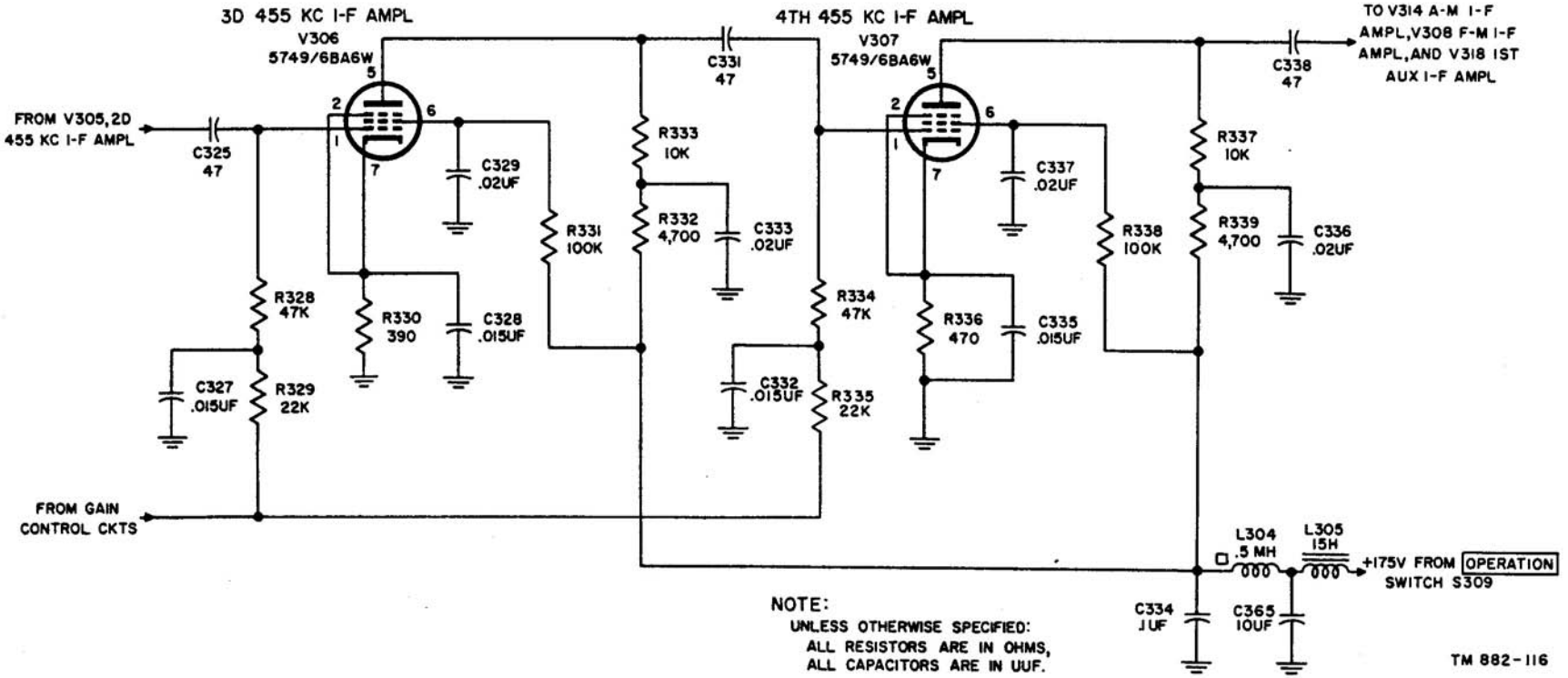


Figure 36. Third and fourth 455-kc if. amplifiers.

consisting of L303, C322, and R324. The V304 cathode is biased and bypassed by R315 and C317, respectively. The cathode bias for V305 consists of R323, bypassed by C323. Tube V304 is coupled to the grid of V305 by C320, and the output from V305 is coupled to the grid of the third 455-kc if. amplifier by C325.

d. Third and Fourth 455-kc If. Amplifiers, (fig. 36). From V305, the signal passes through third and fourth 455-kc if. amplifiers V306 and V307 to the fm if., am. if., and auxiliary if. circuits. Coupling capacitors between these stages are C325, C331, and C338. The V306 cathode is biased and bypassed by R330 and C328, respectively, and the V307 cathode is biased and bypassed by R336 and C335. Grid resistors are R328 for V306 and R334 for V307. The mgs-agc decoupling network consists of R329 and C327 for V306, and R335 and C332 for V307.

e. Voltage Supply. Operating voltage for the plates and screen grids of all four 455-kc if. amplifiers is supplied through L305 and OPERATION switch S309. Capacitor C365 is a B+ line filter capacitor. Capacitor C334 is a B+ filter capacitor and L304 is a B+ filter choke for the 455-kc if. strip. The power supply decoupling networks consist of R319 and C319 for V304, R326 and C326 for V305, R332 and C333 for V306, and R339 and C336 for V307. Plate load resistors are R318 for V304, R327 for V305, R333 for V306, and R337 for V307. Screen grid voltage dropping resistors are R317 for V304, R325 for V305, R331 for V306, and R338 for V307. Screen grid bypass capacitors are C318 for V304, C324 for V305, C329 for V306, and C337 for V307.

66. Am. If. Amplifier

(fig. 37)

The signal from V307, the fourth 455-kc if. amplifier, is coupled through C338 to the control grid of V314, the am. if. amplifier. Tube V314 provides further if. amplification and also isolates the am. if. circuit from load changes taking place in the auxiliary circuit when the circuits are used at the same time. The operation of the circuit is similar to that of V307, the fourth 455-kc if. amplifier. Voltage from the gain control circuits is applied to grid return resistor R444, through the decoupling network composed of R367, R368, and C366. Resistor R369 provides cathode bias and is bypassed by C367. The output of V314 is fed

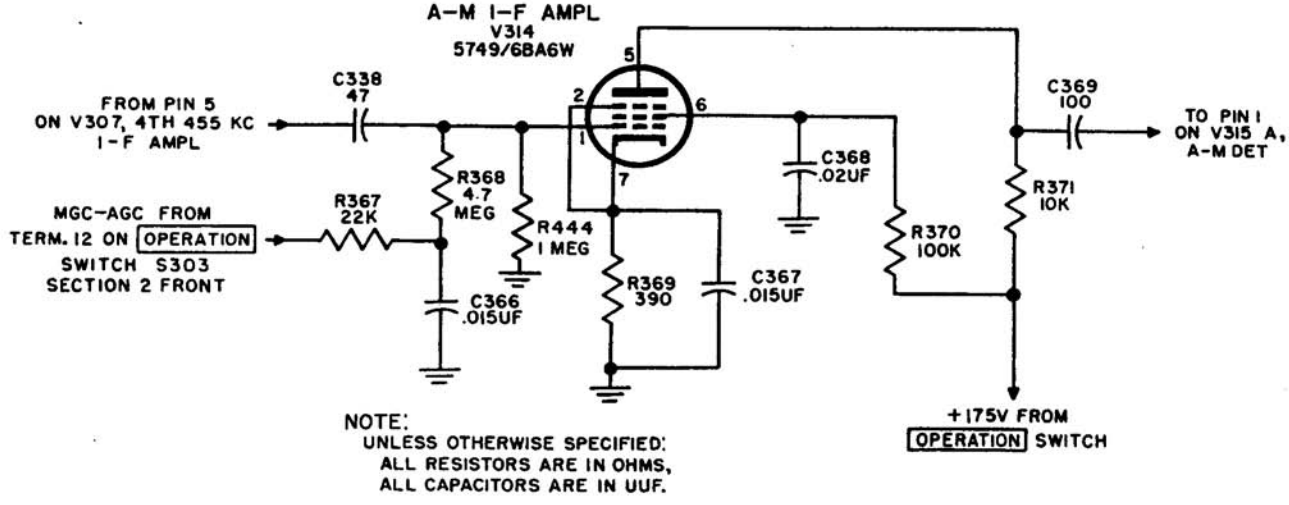


Figure 37. Am. if. amplifier.

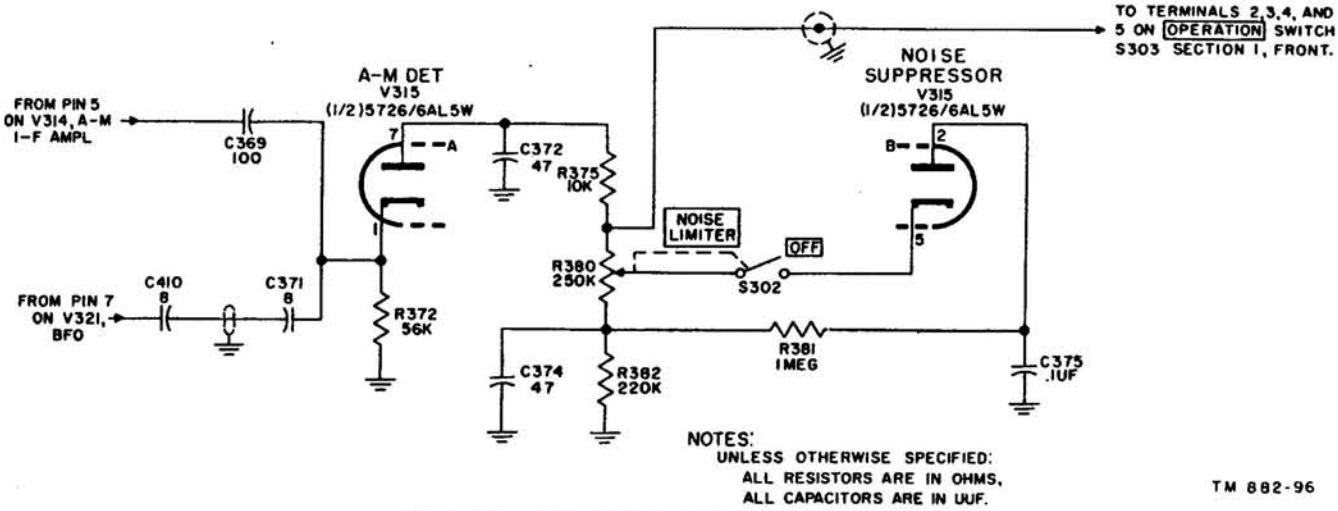


Figure 38. Am. detector and noise suppressor.

to am. detector V315A through C369. B+ for the plate and screen grid is obtained through OPERATION switch S309. Resistor R371 is the plate load resistor, R370 is the screen grid voltage dropping resistor, and C368 is an rf bypass capacitor for the screen grid circuit.

67. Am. Detector, Noise Suppressor, and Noise Limiter

(fig. 38)

a. General. The functions of the am. detector and noise suppressor are combined in dual-diode tube V315. The A section is a diode detector and the B section is a shunt-type noise suppressor. Noise peaks are clipped by the noise suppressor, which conducts only above a predetermined signal level.

b. Description of Circuits. The am. detector is used for the reception of either cw, mcw, or voice signals. The noise suppressor circuit is most effective when receiving voice signals. The bfo (par. 68) must be used to receive cw signals.

(1) *Am. detector.* The 455-kc signal from V314 is coupled through C369 to the cathode of diode detector V315A. For cw reception, the output from bfo V321, is also applied at this point. The use of coupling capacitors C410 and C371, at opposite ends of the shielded coupling cable, reduces the capacitive loading effect of the cable on both stages. The diode detector rectifies the 455-kc signal: this rectified voltage is negative with respect to ground. The rectified voltage, which varies with the amplitude of the rf signal and appears across R375, R380, and R382, is relatively free from rf, because of bypass capacitors C372 and C374. The audio signal output is taken from the junction of R375 and R380 and applied through the OPERATION switch to the first audio amplifier.

(2) *Noise suppressor.* When front panel NOISE LIMITER switch S302 is closed, noise suppressor tube V315B is placed in operation. The plate becomes negative, but the cathode becomes more negative (both with respect to ground). Under these conditions, V315B conducts. This action charges C375 to a potential essentially equal to that of the cathode and the tube no longer conducts. The voltage across C375 is proportional to the carrier level, and cannot change rapidly because of the large time constant provided by C375, R381, and R382. The noise suppressor is normally inactive or non-

conducting because of the negative charge put on its plate by C375, and remains inactive until the negative voltage on its cathode exceeds the negative voltage on its plate. This condition arises when noise peaks exceeding the maximum carrier modulation level drive the cathode negative (instantaneously). This has the effect of driving the plate positive and the tube will conduct to lower the resistance load of the detector. With an effectively lower detector load, less signal is delivered to the audio amplifier.

(3) *Noise limiter.* NOISE LIMITER control R380 is adjusted to the level of the incoming signal by regulating the amount of bias on the cathode of V315B. The algebraic sum of the voltage across R380 and C375 determines the amount of impedance between the audio output and ground. As the contact arm approaches the junction of R380 and R382, decreasing the bias, the suppressor action is decreased. This position is useful when receiving weak signals. As the contact arm is moved in the opposite direction, the bias is increased, and the noise suppressor action is increased. This condition is useful when receiving strong signals.

68. Beat-Frequency Oscillator

(fig. 39)

a. General. Cw signals are made audible by heterodyning them with another signal at the am. detector. A series-tuned Colpitts oscillator generates a signal when its plate circuit is closed by B. F. OSCILLATOR switch S306, which is ganged to pitch control C409, and operated from the front panel.

b. Circuit Description. Tube V321 is a sharp cutoff pentode chosen for its high mutual conductance. It is used with high-Q coil L309 to raise the ratio of the voltage-divider capacitances; a high ratio is desirable for best stability. This voltage-divider network consists of capacitors C412, C413, C407, and C409, connected across the coil. Capacitors C407 and C409 are in parallel and may be considered as a single capacitor; C409 is controlled by a fine adjustment (B. F. OSCILLATOR) to vary the pitch by shifting the resonant frequency slightly. A 1:3 ratio is obtained between this equivalent capacitance and either C412 or C413 (which are equal). The tank circuit is composed of L309, C405, and C408. Ca-

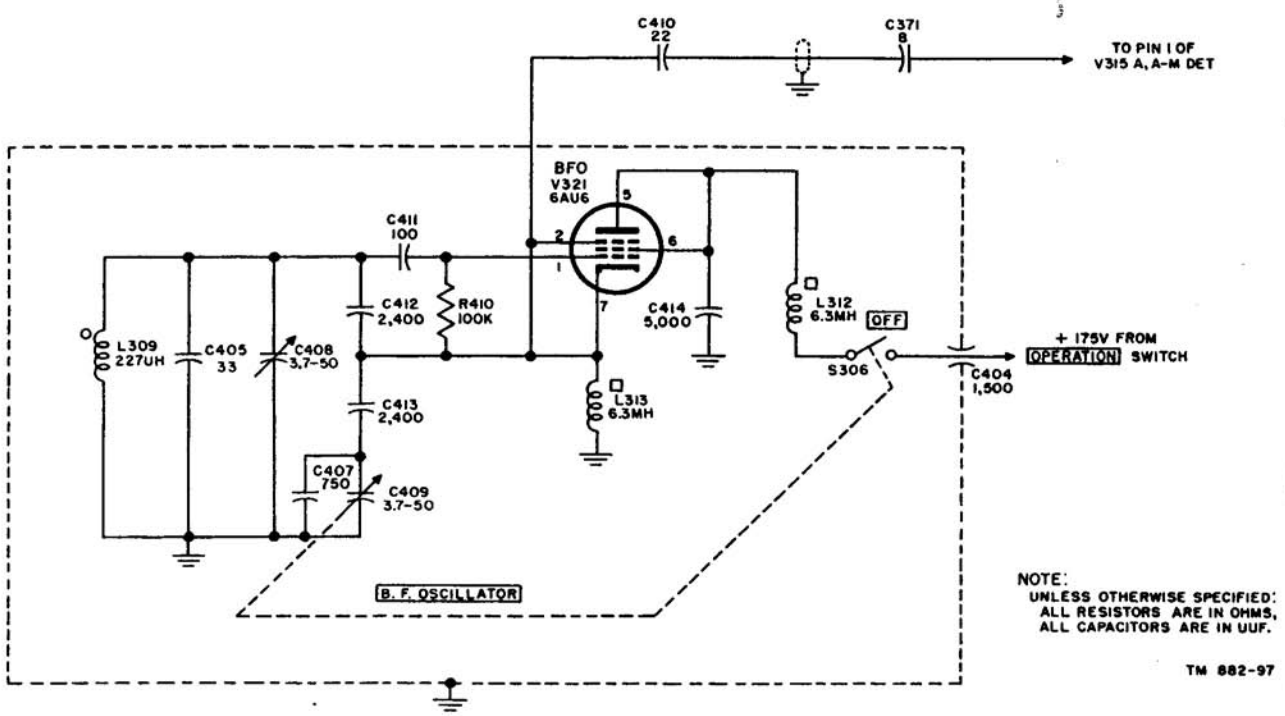


Figure 39. Beat-frequency oscillator.

pacitor C408, accessible from the bottom of the main chassis (fig. 72), is used to adjust the tank to resonate at a center frequency equal to the if., 455 kc. The Q of the tank circuit is kept high by connecting the tube across only a small portion of the oscillating tank circuit, resulting in very loose coupling between the tube and circuit. With the tube capacitances shunted by large capacitors, the effects of changes in supply voltage and loading are reduced. The resulting tank circuit has a high inductance-capacitance (LC) ratio and, therefore, the tank current is much lower than in the circuits using high-C tanks. This greatly reduces drift, thus maintaining the pitch of the cw signal relatively constant during reception. Capacitor C411 couples the tank to the control grid and R410 is the grid bias resistor. The bfo output, taken from the cathode, is coupled through C410 and C371 to the cathode of the am. detector, where it beats or mixes with the cw signal to produce an audible note.

c. Harmonic Prevention. The bfo is carefully shielded to prevent coupling to any part of the receiver except the am. detector and to prevent its harmonics from getting into the front end and being amplified along with the desired signals.

(1) *Shielding.* The entire bfo is housed in a shielded can, grounded to the chassis. Feedthrough capacitor C404 bypasses rf at the point where the plate and screen voltage connection is made through the can. The bfo output is conducted to the am. detector by a shielded cable.

(2) *Voltage supply.* Plate and screen voltage for the bfo is obtained through OPERATION switch S309 and B. F. OSCILLATOR switch S306. The plate and screen grid are tied together to form a triode. Capacitor C414 is the rf plate bypass. Rf is kept out of the power supply by rf choke L312. Cathode rf choke L313 offers a high impedance to the ac from the plate circuit and keeps the cathode above ground potential.

69. Fm If. Amplifier and Fm Limiters (fig. 40)

a. FM If. Amplifier. The function of this stage is to isolate the fm circuit from load changes taking place in the auxiliary circuit when both circuits are operating. Agc voltage is also obtained from this stage. The circuit is similar to that of V307, the fourth 455-kc if. amplifier, except that a sharp cutoff pentode is used; this requires different values for the component parts. The signal from V307 is fed to the control grid of the fm if. amplifier through coupling capacitor C339, which also isolates the V308 grid from the gain control voltage applied to V314 (fig. 124). Resistor R340 is the grid load resistor. Cathode bias resistor R341 is bypassed by C340. In addition to its isolating function, the fm if. amplifier provides the following outputs:

(1) From the plate, through C376, to the agc diode, furnishes excitation voltage for the agc circuit which develops a bias voltage proportional to the average strength of the carrier.

(2) From the plate, through C342, furnishes excitation voltage to drive first limiter V309.

(3) The signal developed across plate load resistor R435 is fed through C428 to carrier meter rectifier V320B. The rectified voltage is developed across carrier meter center control R429. The movable arm of R429 is connected to meter M301 when the METER switch is in the CARRIER position. A bucking voltage is supplied through resistor R447 to carrier meter rectifier V320B to prevent a meter reading, due to noise voltage, when no signal is being received.

b. Fm Limiter Stages. The final if. stages in the fm branch of Radio Receiver R–220/URR are known as *limiters* and differ slightly in circuit arrangement from the preceding if. amplifying stages (fig. 29).

(1) *General.* Limiter stages V309 and V310 are used to reduce the amplitude variations of the input signal. The tubes are operated between cutoff and saturation. The two stages are resistance-capacitance coupled and the second limiter stage is coupled to discriminator V311 through C349 and C350. The amplitude of the limiter output remains practically constant for any increase in the amplitude of the limiter input above that required for limiting action. Therefore, the voltage fed to the discriminator will be of constant amplitude for all signal voltages above the limiting threshold.

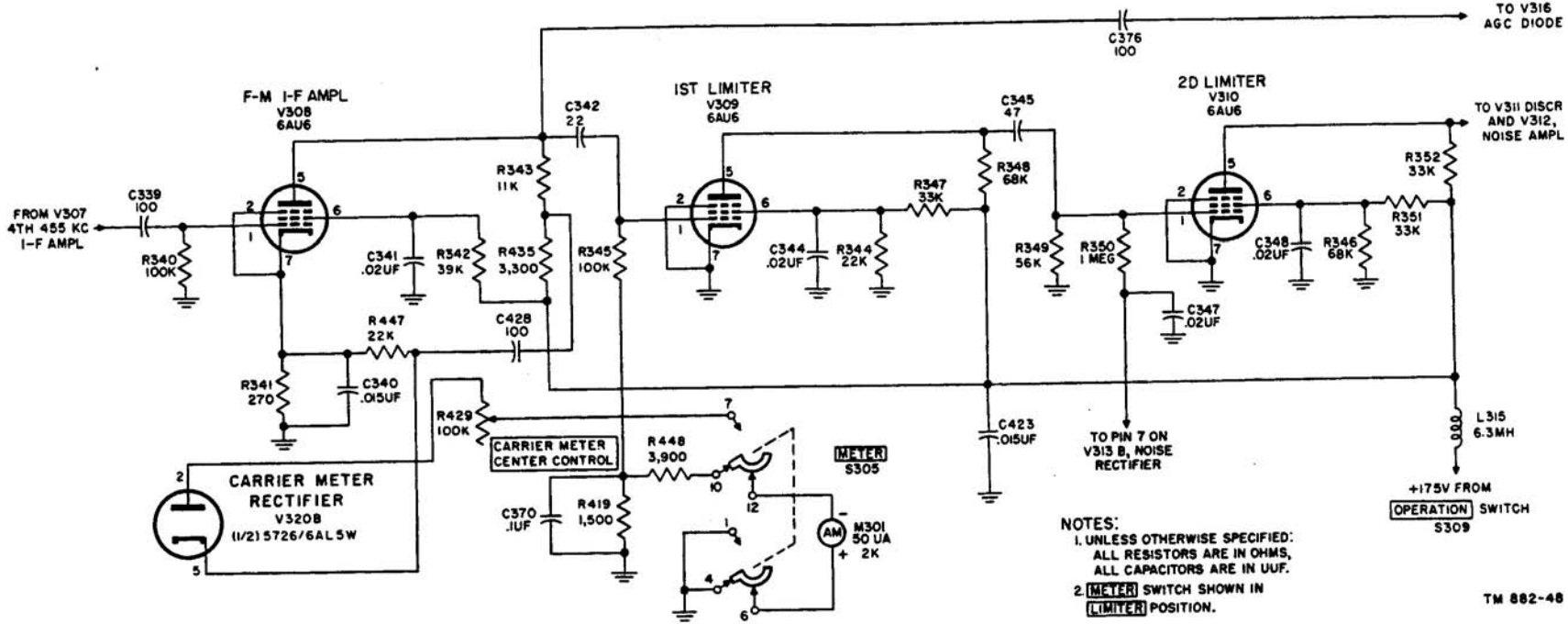


Figure 40. Fm if. amplifier and fm limiters.

(2) *Purpose.* Because the signal being fed into the limiters is not of constant amplitude, limiter action is required to overcome the variations in signal amplitude that are developed in the if. amplifier as a result of the nonuniform selectivity characteristics of the various if. stages (as well as am. noise). The primary purpose of the limiter is to remove all amplitude variations present in the output of the fm if. amplifier system and to pass on to the discriminator a signal of varying frequency but constant amplitude. The limiter also provides a certain amount of gain.

(3) *Circuit description.* The limiter tube acts as an amplifier that is easily driven to saturation or to cutoff; that is, plate-current saturation is produced during a portion of one-half of the signal cycle and plate-current cutoff is brought about during a portion of the other half of the cycle. The required operating conditions result from the use of a sharp cutoff tube with comparatively low values of screen and plate voltage and little or no initial control-grid bias, so that the tube overloads very easily and plate-current cutoff is quickly reached. Signals of comparatively small amplitude will swing the grid voltage into those zones causing either plate-current cutoff or plate-current saturation, thereby limiting the magnitude of signal plate-current variations. The limiter tube has no effect on the frequency of the signal.

(*a*) *First limiter.* The output from the fm if. stage appears across grid return resistor R345 and is applied to the grid of V309. No cathode bias is used. The output from the V309 plate is coupled to the grid of the second limiter by C345.

(*b*) *Second limiter.* The action of second limiter V310 is similar to that of the first limiter. The use of two limiters assures positive limiting. If weak signals do not have noise amplitude variations eliminated in the first limiter, they will be clipped by the second limiter. This is accomplished by using a higher value of grid resistor R349 and by applying a higher value of plate voltage than that used on V309. The output is coupled through C349 and C350 to discriminator stage V311.

(4) *Metering and bias voltage.* Grid current in the first limiter stage is measured by connecting the meter across R419 through current-limiting resistor R448 with METER switch S305 in the LIMITER position. Capacitor C370 is an af bypass capacitor. Bias voltage for noise rectifier V313B is obtained from the second limiter through R350. Capacitor C347 is an af bypass and decoupling capacitor.

(5) *Voltage supply.* B+ is obtained from the power supply through OPERATION switch S309, applied to the plate of V308 through load resistor R343 and decoupling resistor R435, and to the screen grid, through dropping resistor R342. Tube V309 receives plate voltage through load resistor R348 and screen grid voltage through resistor R347. The screen voltage-dropping resistor for V310 is R351 and the plate load is R352. Resistors R344 and R346 are part of a bleeder and are used to improve the screen-grid voltage regulation for V309 and V310, respectively. The screen-grid bypass capacitors for V308, V309, and V310, are C341, C344, and C348.

70. Discriminator

(figs. 41–47)

a. General. Discriminator V311 is a ratio detector where one tuned circuit is peaked at a frequency below the carrier frequency and the other tuned circuit is peaked at a frequency above the carrier frequency. The discriminator operates at a center frequency of 455 kc. A positive voltage is produced when the applied frequency is lower than 455 kc, and a negative voltage is produced when it is higher than 455 kc. This output voltage appears between terminal 6 on OPERATION switch S303, section 1, front, and ground (chassis).

b. Purpose. The basic function of the discriminator is to convert the frequency-modulated if. carrier into audio voltages of different amplitudes. In addition to this rectifying action, the discriminator provides a zone of operation so that a uniform change in frequency results in a linear

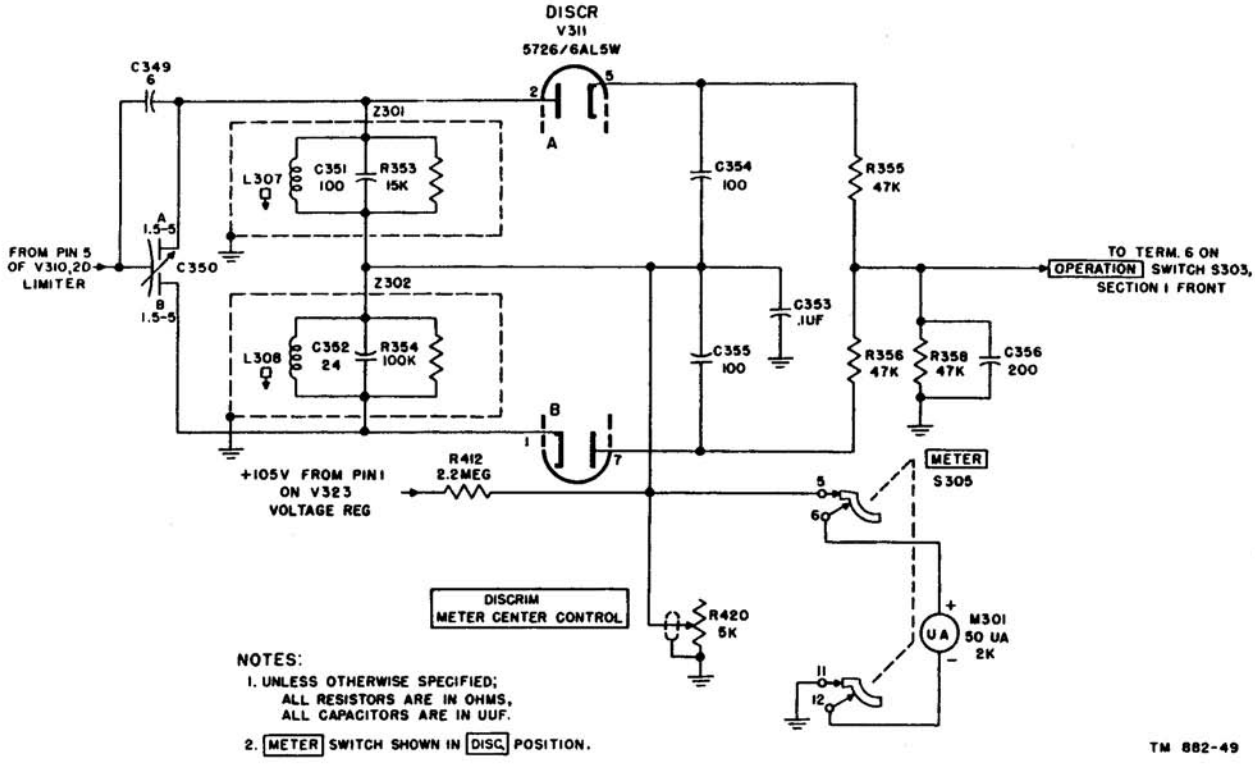


Figure 41. Discriminator.

output provided the frequency deviation does not exceed the linear portion of the discriminator characteristic curve.

c. Circuit Description (fig. 41). The tuned circuits are Z301 tuned below the if., and Z302 tuned above the if.; these circuits have no coupling between them. Coil Z301 consists of L307, C351, and R353 in parallel, with L307 slug-adjusted to peak at 355 kc. Coil Z302 consists of L308, C352, and R354, with L308 slug-adjusted to peak at 555 kc. Resistors R353 and R354 are used to equalize the Q of the tuned circuits, resulting in improved linearity of the output. Second limiter tube V310 feeds a voltage of varying frequency, which is constant in amplitude over the frequency deviation range, to low-frequency circuit Z301. At the resonant frequency of Z301, the current will be minimum and the voltage maximum. This occurs at 355 kc. In the same manner, maximum voltage will appear across Z302 at its resonant frequency of 555 kc. Second limiter output to high-frequency circuit Z302 is obtained through C350B, and low-frequency circuit Z301, through C350A and C349. Variable capacitor C350 is adjusted so that the input applied to the two tuned circuits will be of the same amplitude. Each of the tuned circuits is connected to one-half of diode rectifier V311; Z301 is connected to the plate of V311A, and Z302 is connected to the cathode of V311B. The voltage applied from the limiter to the diodes will cause them to conduct in direct proportion to the amplitude of the signal. When the plate of V311A (pin 2) is positive, it will conduct through Z301, charging C354. The time constants are large enough so that C354 holds its charge until the next positive half-cycle. In this manner, the ac voltage applied to Z301 from the limiter is rectified. The same action takes place in V311B except that its cathode is connected to Z302, and therefore it will conduct only during the negative half-cycle of the signal into Z302. The two tubes are thus conducting on alternate half-cycles. The conduction path for V311B is from its cathode (pin 1) to its plate (pin 7), charging C355, through Z302, and back to its cathode. Again, the time constants are large enough so that C355 holds its charge until the next negative half-cycle.

d. Response Curves (fig. 42). Tuned circuits Z301 and Z302 are peaked to different frequencies; therefore, their response to the signals from the limiter stage will be different. When the response

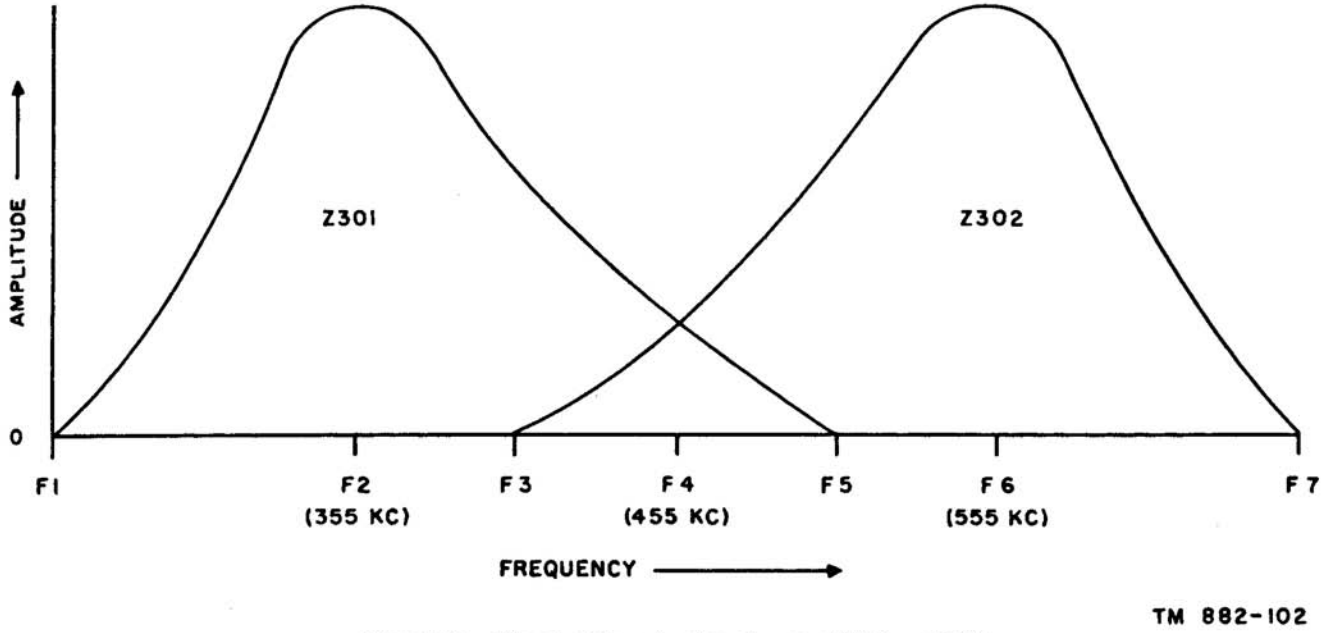


Figure 42. Signal voltage developed across Z301 and Z302.

of these two circuits is plotted in terms of frequency, as in figure 42, it is noted that only at one frequency, 455 kc, is the response of both circuits the same. At all other frequencies, the response of Z301 is different from that of Z302, with the result that the magnitude of signal voltage fed to the two diodes for rectification depends upon the response of the circuit to the frequency of the signal voltage. An important point to remember is that at any one instant only one signal frequency exists in the system, and whether V311A or V311B or both will be rectifying the signal depends upon the frequency of the signal. Thus, if at any one instant the frequency of the signal is 355 kc, the circuit that responds to this frequency is Z301, and rectification will take place in V311A, the rectified voltage appearing across C354. This is true for all frequencies from F1 to F3. Between F3 and F5, both tubes are operating and a differential voltage is developed across C354 and C355. At exactly 455 kc (F4), the signal applied to both diodes will be of the same amplitude. Both diodes will conduct, and C354 and C355 are charged to the same potential. This is the condition when there is no modulation. Between F5 and F7, only Z302 is responsive and the signal is being rectified in V311B, the rectified voltage appearing across C355. When the frequency of the carrier goes up because of modulation, the amplitude of the signal in Z302 will increase as the signal approaches its resonant frequency. At the same time, the signal in Z301 will decrease because the signal frequency is farther away from the resonant frequency of Z301. This greater amplitude signal in Z302 will cause V311B to conduct more than it did when the signal frequency was 455 kc, and will charge C355 to a higher potential. At the same time, the weaker signal in Z301 will cause V311A to conduct less, and C354 will be charged to a lower potential. When the modulation causes the carrier frequency to go down, conditions reverse. The frequency of the carrier nears the resonant frequency of Z301, causing a signal of greater amplitude to be applied to V311A and charging C354 to a higher potential. At the same time, the signal frequency is farther away from the resonant frequency of Z302, and a signal of lower amplitude is applied to V311B, charging C355 to a lower potential. Because a frequency-modulated signal is constantly swinging above and below the *at rest*, or center (zero modulation), frequency in accordance with the modulating signal frequency, the potentials on C354 and C355 will also be changing at the rate of the modulating frequency.

e. Equivalent Circuits (figs. 43, 44, and 45). The two loads upon rectifier sections V311A and V311B are arranged in a bridge circuit as shown in figure 43. Although each diode has its own load impedance, and the rectified voltage de-

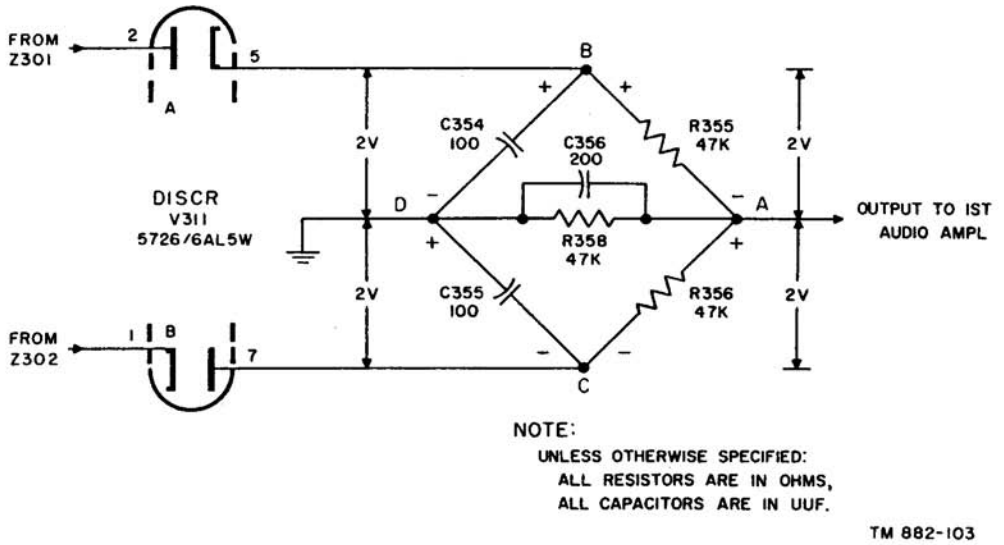


Figure 43. Equivalent circuit of discriminator at zero modulation.

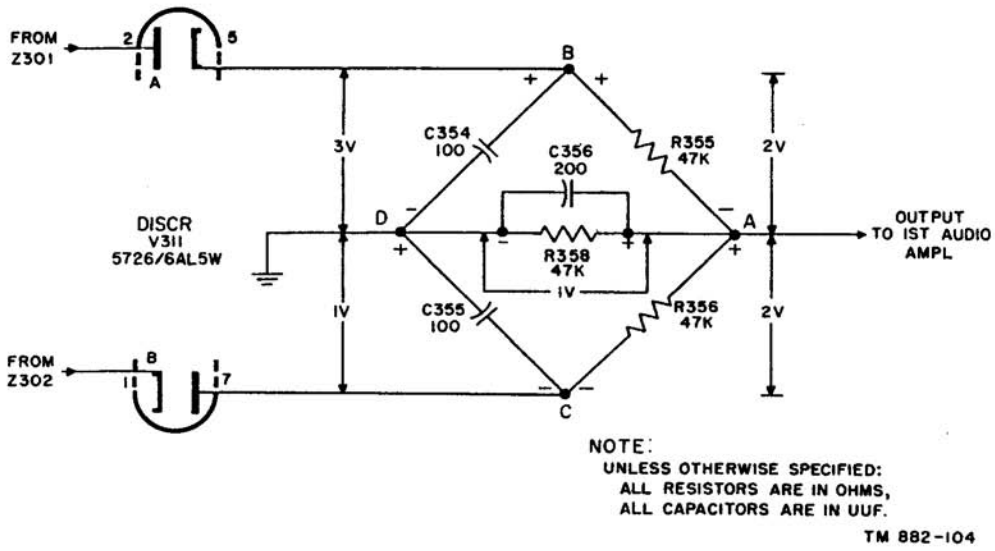


Figure 44. Equivalent circuit values in discriminator when carrier swings downward.

veloped is present across the respective load impedances, resistor R358 and capacitor C356 are common to both diodes, and the discriminator output is taken from across this resistance-capacitance (RC) combination, between point A and ground (point D). As far as point A and ground are concerned, either can be positive or negative with respect to the other, depending upon the magnitude of the voltages across C354 and C355. If the rectified voltages across C354 and C355 are equal, no current will flow in R358, and the voltage between ground and point A is zero. If the voltage across C354 is greater than that across C355, the final voltage between ground and point A is equal to that across C354 minus that across resistor R355. If the voltage across C355 is greater than that across its associated resistor, R356, then the final voltage across R358 is equal to that across C355 minus that across R356. The polarity of the voltage between ground and point A depends upon which capacitor, C354 or C355, has the greater voltage across it. The nature of the output obtained from point A as a result of the variations in potentials of C354 and C355 can be understood more easily by referring to figures 46 and 47.

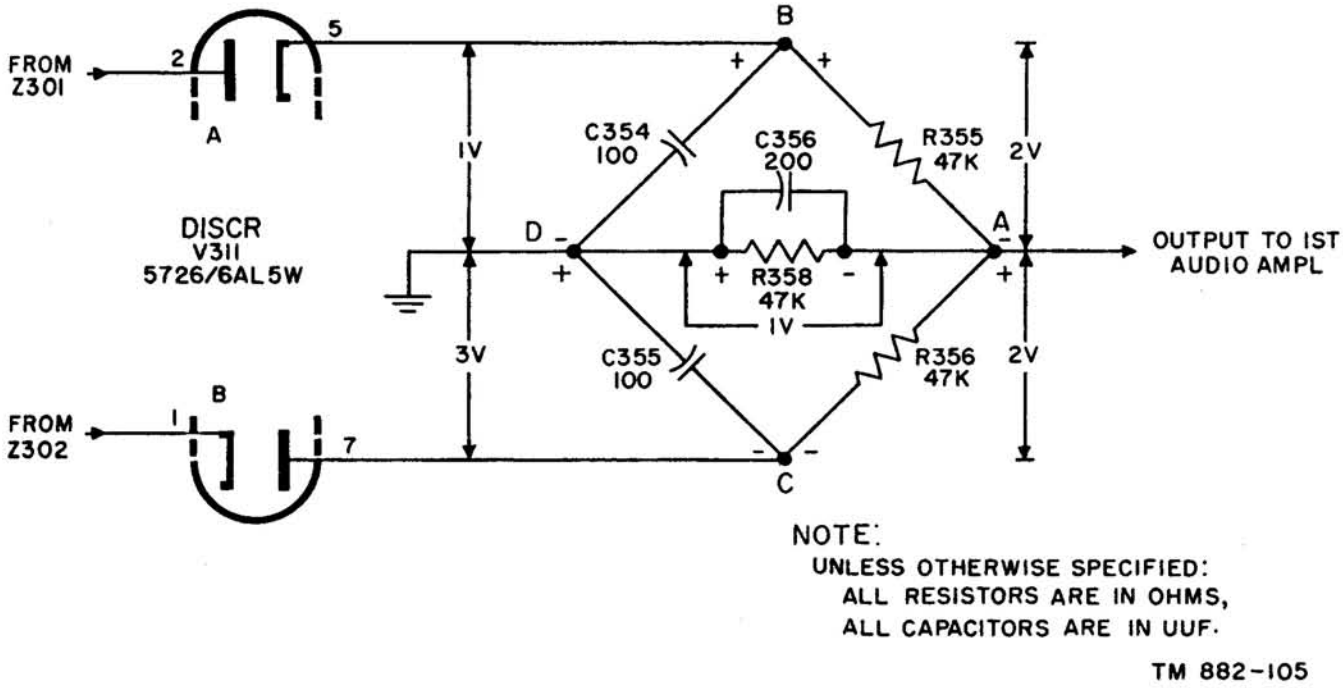


Figure 45. Equivalent circuit values in discriminator when carrier swings upward.

(1) *At zero modulation* (fig. 43). For explanation purposes, arbitrary values are assumed for the potentials on C354 and C355. These potentials will be equal when the carrier frequency is at 455 kc, or zero modulation. Values of 2 volts will be assumed for each capacitor and the polarity will be as shown in figure 43. The difference of potential from point B to point C will then be 4 volts. Because resistors R355 and R356 are equal, the voltage at point A with respect to point B or C will be equal to one-half the voltage from point B to point C. This is always true, no matter what the potential is on C354 and C355. In this case, the voltage across R355 is 2 volts and the voltage across R356 is also 2 volts. The output voltage, taken from point A to point D, is determined by Kirchhoff's voltage law (the algebraic sum of the voltages around a closed loop must be equal to zero). Thus, from point A to point B, there is plus 2 volts; point B to point D, there is minus 2 volts; then, since because the sum of plus 2 and minus 2 is equal to zero, the unknown voltage from point D to point A must be zero. To check this, Kirchhoff's Law is applied to the other loop. From point A to point C there is minus 2 volts, from point C to point D there is plus 2 volts, and from point D to point A the voltage is unknown. Here again, the sum of minus 2 and plus 2 is equal to zero and the unknown, from point D to point A, is equal to zero. This is the desired condition, because the carrier frequency was at rest; that is, there was no modulation.

(2) *Carrier frequency downward swing* (fig. 44). When the carrier swings downward in frequency, and C354 is charged to a higher potential, conditions will be as shown in figure 44. Here a value of 3 volts is assumed for the potential on C354 and 1 volt for C355. Because the potential difference from point B to point C is still 4 volts, the potential of point A with respect to point B or point C is still the same. However, the potential from point A to point D will have changed and this can be determined by again applying Kirchhoff's Law. From point A to point B, there is plus 2 volts; from point B to point D there is minus 3 volts, and from point D to point A there must be plus 1 volt to make the sum of the loop equal to zero. Again checking by adding the volt-

age around the other loop, from point A to point C there is minus 2 volts; from point C to point D there is plus 1 volt, and the potential differences between point D and point A must be plus 1 volt.

(3) *Carrier frequency upward swing* (fig. 45). When the carrier swings upward in frequency, C355 is charged to a higher potential and C354 is charged to a lower potential. By using the same methods that were used with a downward swing of the carrier, it can be shown that the voltage from point A to point D will now be of opposite polarity, or, minus 1 volt.

f. Combining Output from Both Diodes. It has been shown that when the input signal frequency has zero modulation, there is no output from the discriminator.

(1) *Voltages across C354 and C355* (fig. 46). When the carrier swings downward in frequency, a positive voltage is produced, and when the carrier swings upward in frequency, a negative voltage is produced at point A with respect to point D (ground). If we now plot the output voltage across C354 and C355 with respect to frequency, we obtain a graph that looks like that shown in figure 46, arbitrary values again being used. The response of the Z301 system is shown above the frequency reference line because the voltage developed across output load R358, as a result of Z301, is positive with respect to ground. The response of the Z302 system is shown below the reference line because the voltage developed across R358 as a result of Z302 is negative with respect to ground.

(2) *Voltages across R358* (fig. 47). The two curves shown in figure 46 can be combined into the typical *S* characteristic of the discriminator (fig. 47) by algebraically adding the voltages developed across C354 and C355. For example, at the mean frequency of 455 kc, the response of Z301 is the same as that of Z302 and the voltage developed across C354 is the same as that across C355, but they are of

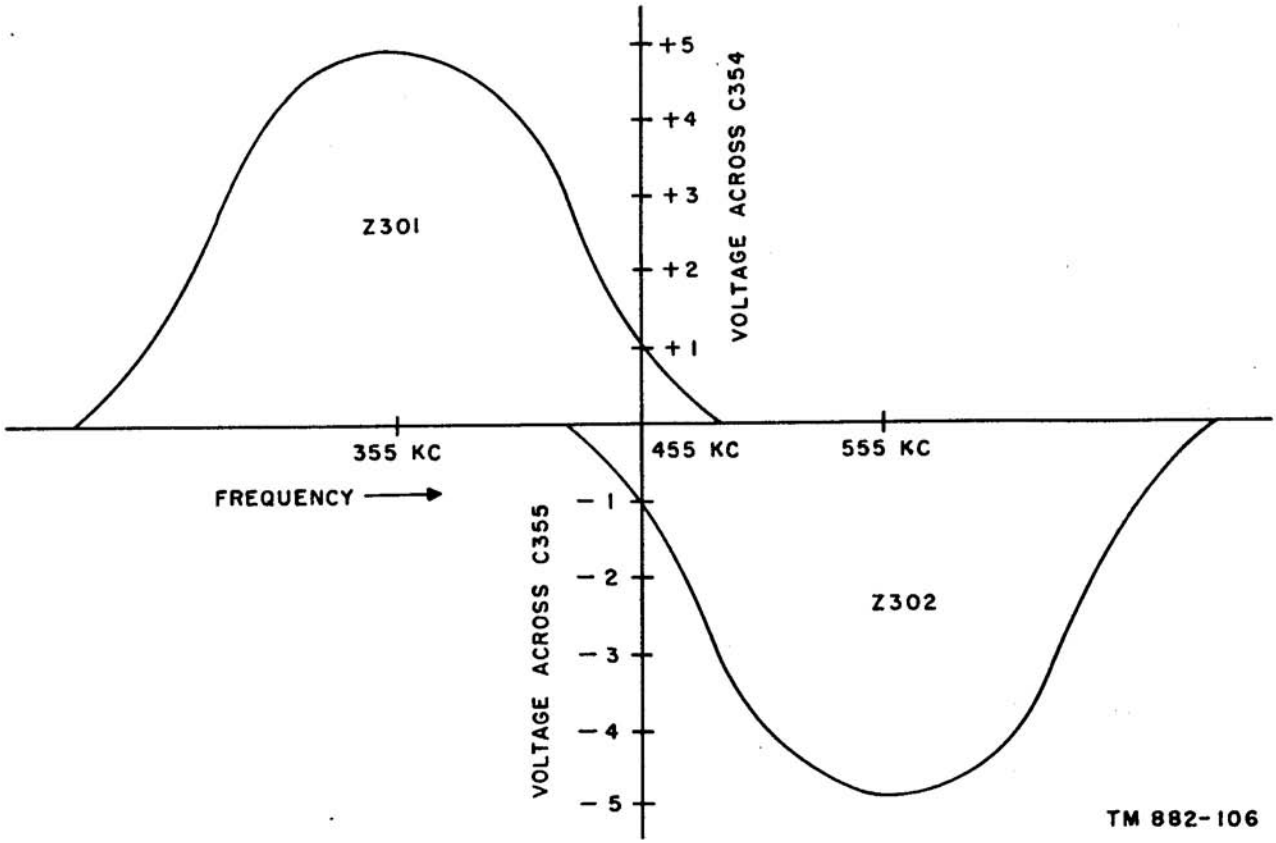


Figure 46. Typical dc voltages developed across C354 and C355.

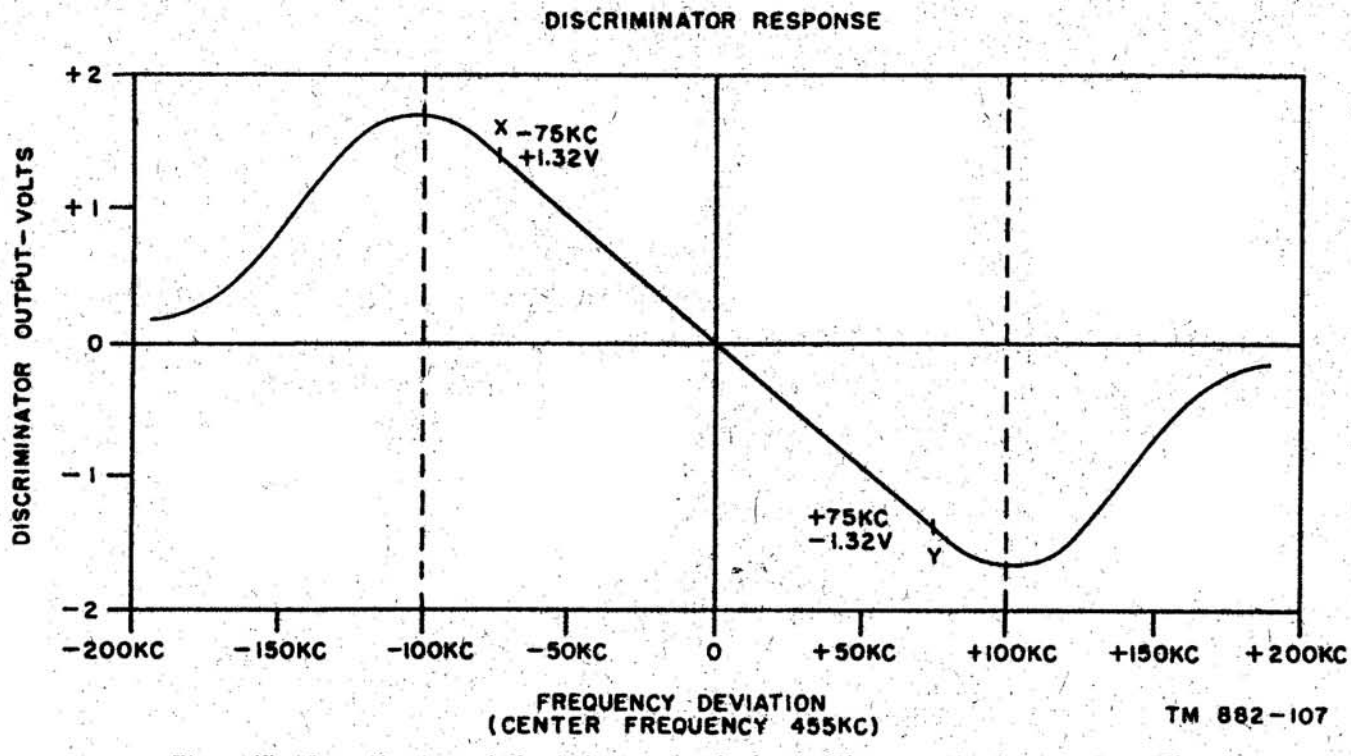


Figure 47. Overall output of discriminator circuit showing linear portion between X and Y.

opposite polarity with reference to ground; therefore, they cancel and the net output voltage across R358 is zero. Because the carrier swings are in accordance with the original modulating audio frequency and the output of the discriminator is in accordance with the swings of the carrier frequency, the original modulating audio frequency is reproduced by the discriminator. Points X and Y show the maximum deviation limits on each side of the center frequency.

g. Application (fig. 41).

(1) Circuit balance is measured at the tank junction by meter M301. Regulated dc voltage is applied to the meter through R412 and, with no signal applied, the meter indicates at DISC. CENTER. Resistor R420 (DISCRIM METER CENTER CONTROL) on the rear apron of the main unit (fig. 12) is adjusted to set the meter needle to this point.

(2) The deemphasis network, across which the discriminator output is developed, consists of R358 and C356, connected between ground and the junction of R355 and R356. From this junction, a connection is made through the OPERATION switch (FM SQUELCH position) to first audio amplifier V317B.

71. Auxiliary Circuits

(figs. 48, 49, and 50)

a. First Auxiliary If. Amplifier (fig. 48). First auxiliary if. amplifier V318 amplifies the signal from the fourth 455-kc if. amplifier. The signal is coupled to the control grid of V318 through common coupling capacitor C338 and auxiliary circuit coupling capacitor C391. The primary function of C391 is to isolate the control grid of V318 from the control grid of am. if. amplifier V314. This permits using the auxiliary circuit with either the fm or the am. circuit at the same time. B+ to V318 is applied through R399 which, with C395, forms a decoupling network. Agc voltage from V316 is developed across the resistor network consisting of R379, R433, and R434, with C379 and C400 functioning as agc decoupling capacitors. Part of this agc voltage is fed through R394 to the control grid of V318. Resistor R397 is a voltage dropping resistor for the screen grid. Resistor R398 is the plate load and R396 is the cathode bias resistor. Rf bypass capacitors are C393 for the cathode and C394 for the screen grid. The output is applied through

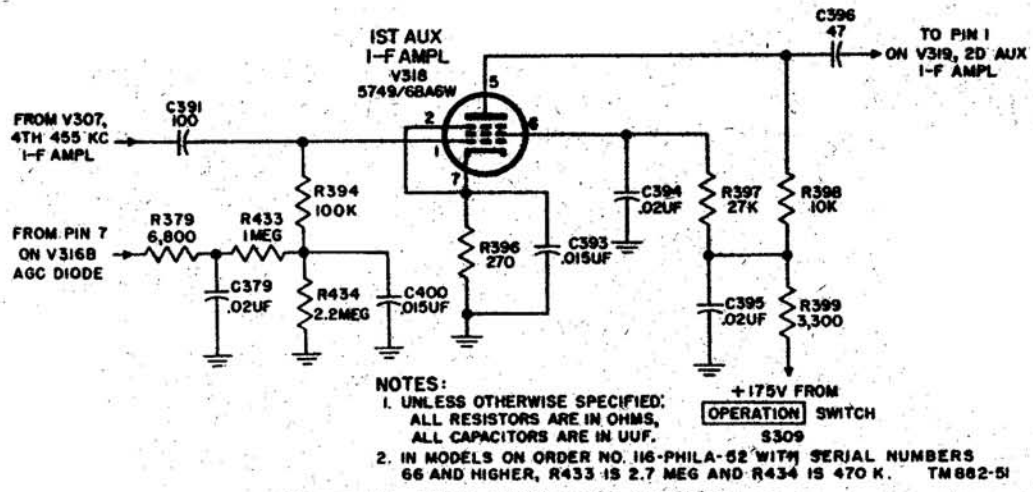


Figure 48. First auxiliary if. amplifier.

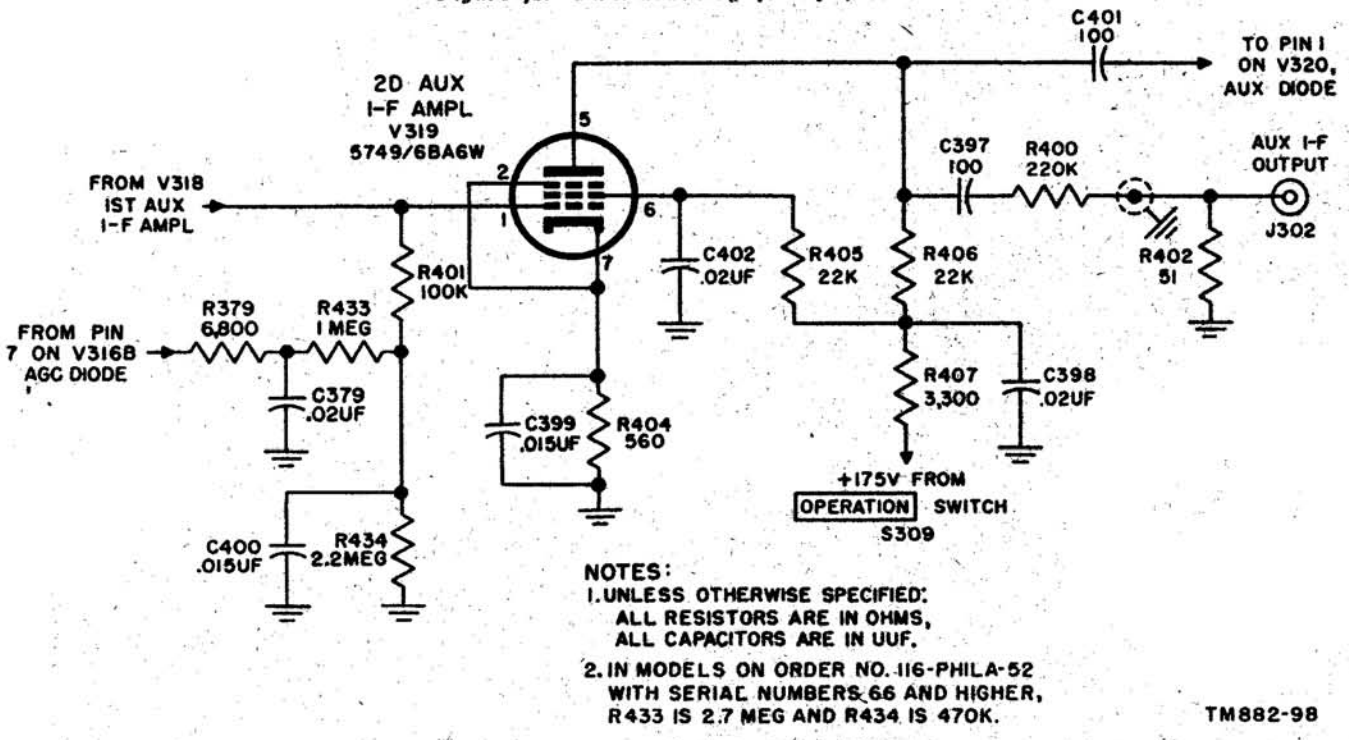


Figure 49. Second auxiliary if. amplifier.

C396 to furnish excitation to the second auxiliary if. amplifier V319.

b. Second Auxiliary If. Amplifier (fig. 49). The primary function of second auxiliary if. amplifier V319 is to increase the gain. The 455-kc if. signal from V318 is fed to the control grid of V319, and the output is coupled through C401 to auxiliary diode V320. The gain is regulated by the agc voltage applied to the control grid through grid resistor R401. The function of the agc decoupling network is the same as for V318. Resistor R406 is the plate load, R404 is the cathode bias resistor, and R405 is a voltage dropping resistor for the screen grid. Rf bypass capacitors are C399 for the cathode and C402 for the screen grid. Decoupling is provided by R407 and C398. Output is taken from R402 and coupled to J302, AUX. IF. OUTPUT (fig. 12) for use with a teletypewriter or other equipment requiring a 455-kc input.

c. Auxiliary Diode (fig. 50). One-half of twin diode V320 is used as an auxiliary detector. The other half of tube V320B is the carrier meter rectifier. Resistor R408 is the cathode resistor. The signal from second auxiliary if. amplifier V319 is coupled to V320 through C401, and the output voltage is developed across R409 and C403. The rectified output of approximately 5 volts is available at J301, AUX. DIODE OUTPUT jack on the rear apron of the main unit (fig. 12). This

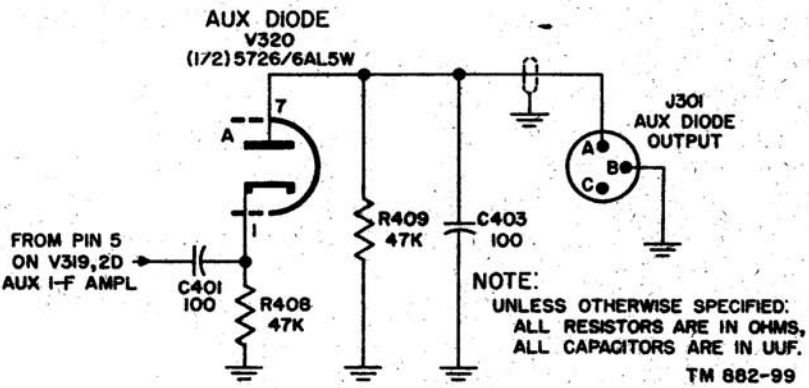


Figure 50. Auxiliary diode.

output may be used in conjunction with the operation of direction finding equipment or with other sets requiring a 5-volt dc input.

72. Squelch and First Audio Amplifier Circuits

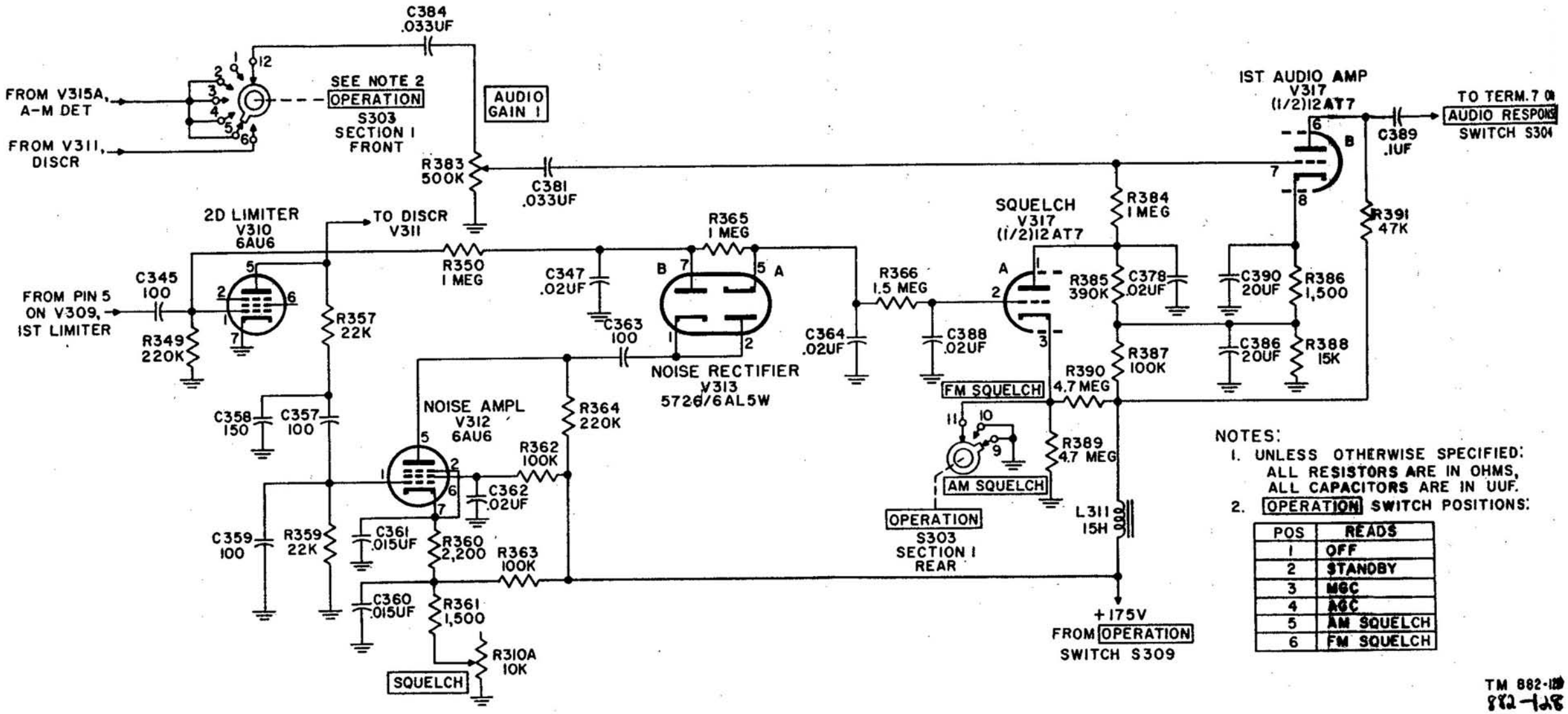
(figs. 51 and 52)

a. General (fig. 51). The squelch circuit consists of noise amplifier V312, noise rectifier V313, section A of V317, and portions of the grid and plate circuits of second limiter V310. Section B of V317 is the first audio amplifier.

b. Purpose and Use. The squelch circuit is used with the first audio amplifier to reduce noise in the output when no signal is being received. In operation, noise from the second limiter, in the absence of a signal, is fed to noise amplifier V312. The amplified noise is fed to pin 1 of noise rectifier V313; this rectified noise voltage biases squelch tube V317A in a positive direction. At the same time, a negative voltage is taken from second limiter V310 control grid (pin 1) and fed to the squelch tube, which biases it in a negative direction. The difference voltage, developed and applied to the V317A grid, ranges from approximately 1/2-volt positive with no signal, to approximately 1.5 volts negative when signals are present. When the total bias is negative (1.5 volts or greater), the squelch tube is inoperative and first audio amplifier V317B is functioning normally. When the bias is zero or positive, the squelch tube operates and furnishes a negative voltage which is used to *squelch* the first audio amplifier, making it inoperative. The setting of R.F. GAIN SQUELCH control determines the rf signal strength required to operate the squelch. The R.F. GAIN SQUELCH control is set at the point where the noise at the speaker is just quieted or *squelched.* A higher setting will block the receiver from reception of the weak signals.

c. Second Limiter Circuit (figs. 40 and 51). Second limiter V310 is normally in virtual saturation from noise excitation and draws increasing grid current as the signal strength increases. The grid current is thus an indication of rf signal strength and is used in a control circuit to turn the receiver output circuits *on* only when a predetermined signal strength is reached. When no rf carrier signal is being received, all rf noise from V310 is fed through decoupling resistor R357 and frequency selective network C357 and R359 to the grid of noise amplifier V312. The flow of grid current in V310 results in the grid end of R349 becoming negative with respect to ground. This negative voltage is applied through R350 to noise rectifier V313, and increases whenever the grid current through V310 increases due to the application of a signal through C345.

d. Noise Amplifier Circuit. The noise output from V310 is amplified by noise amplifier V312 and coupled by C363 to noise rectifier V313. R.F. GAIN SQUELCH threshold control varies the cathode bias and thus the gain of the noise amplifier. Resistor R310A is part of a voltage-divider network consisting of R363, R361, and R310A, with 175 volts B+ applied to the junction of R363 with plate load and screen grid voltage dropping resistors R364 and R362. Cathode bias resistors are R360, R361, and R310A. Capacitors C360, C361, and C362 are rf bypass capacitors.



NOTES:

1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, ALL CAPACITORS ARE IN UUF.
2. OPERATION SWITCH POSITIONS:

POS	READS
1	OFF
2	STANDBY
3	MGC
4	AGC
5	AM SQUELCH
6	FM SQUELCH

Figure 51. Squelch and first audio amplifier circuits.

TM 882-128

366195 O—55 (Face p. 78)

p. 78

e. Noise Rectifier. The noise output from V310, after being amplified by V312 and fed to the noise rectifier, develops a dc voltage across R365. The negative end is at the plate (pin 7) and the positive end at the cathode (pin 5). Capacitor C364, between pin 5 and ground, acquires a positive charge, which is transferred through R366 to C388. A negative voltage developed by second limiter grid current is applied across R350, R365, and C364 in series; pin 5 is negative with respect to ground. The algebraic sum of the positive noise voltage and the negative limiter voltage appears across C364 and forms a bias voltage at pin 2 of V317A. Normal squelch-closed threshold voltage will be approximately 0 to +.5 volt; therefore, the dc amplifier conducts. When an rf carrier signal is received the second limiter draws increasing grid current. This makes the limiter grid voltage more negative, overcoming the positive noise voltage. As the sum voltage becomes negative, the tube is cut off. Thus, V317A is conducting when there is no rf signal being received and nonconducting when a signal is received. A time delay is provided by R366 and C388 to smooth out rapid noise voltage fluctuations. When V317A is conducting, the drop in plate voltage through R385 biases audio amplifier V317B beyond cutoff and, with no amplification in this stage, the speaker is quiet. When V317A is nonconducting, the audio amplifier is biased for normal operation, and the signal is heard at the speaker.

f. First Audio Amplifier (figs. 51 and 52).

(1) The audio signal, fed from the am. detector or the discriminator, reaches first audio amplifier V317B through OPERATION switch S303, section 1, front. The signal is coupled through C384, R383, and C381 to the grid of V317B (fig. 51). AUDIO GAIN 1 control R383 determines the signal amplitude applied to the grid, and the ac voltage is developed across grid return resistor R384. Audio tube V317B operates only when squelch tube V317A is not conducting; that is, when a sufficiently strong signal is being received. The audio tube does not conduct when the squelch tube is conducting; that is, when noise or very weak signals are being received. Thus, noise from inside the receiver is squelched by a control voltage from the squelch tube. This control voltage comes from the junction of R373 and R374 and is applied at the junction of R384 and R385. When the squelch tube is conducting, the bias voltage developed across R385 prevents V317B from operating. When the squelch tube is not conducting, the voltage across R385 drops to a low value. The voltage drop is produced by bleeder current and this reduced voltage opposes the bias voltage developed across cathode bias resistor R386. The resulting bias voltage permits V317B to conduct.

(2) Plate voltage is applied through reactor L311 and plate load resistor R391 to V317B (fig. 52). The plate load resistor for V317A is R374. Capacitor C390 is the cathode bypass capacitor for V317B. Capacitors C386 and C378 are bypass capacitors. The output of V317B is coupled by C389 to AUDIO RESPONSE switch S304.

g. Application (fig. 51). When OPERATION switch S303 is in the STANDBY position, S309 is open and plate voltage is removed from the receiver (with the exception of the first hf oscillator). In positions 2, 3, and 4, S309 is closed and the receiver is operating, but the squelch circuit is inoperative due to the high positive bias applied to the cathode of V317A through R390. In position 5 or 6 on the OPERATION switch, the cathode is grounded to restore operation.

73. Second Audio and Power Amplifiers (fig. 53)

a. AUDIO RESPONSE switch S304, which receives the signal from the first audio stage, is used to select the WIDE, MEDIUM, or SHARP filter through which the signal passes to the second audio amplifier. Resistor R413 is the filter loading resistor and C415 couples the signal to the control grid of V322. Resistor R414 is the grid return resistor, R415 is the cathode bias resistor, and C416 is the cathode bypass capacitor. B+ is applied to the plate through the primary of T301, which is an impedance matching transformer. The primary is the plate load impedance. The secondary provides a balanced 600-ohm output available at TB308. Resistor R428 is a load resistor across the secondary of T301 to keep the primary at a constant impedance.

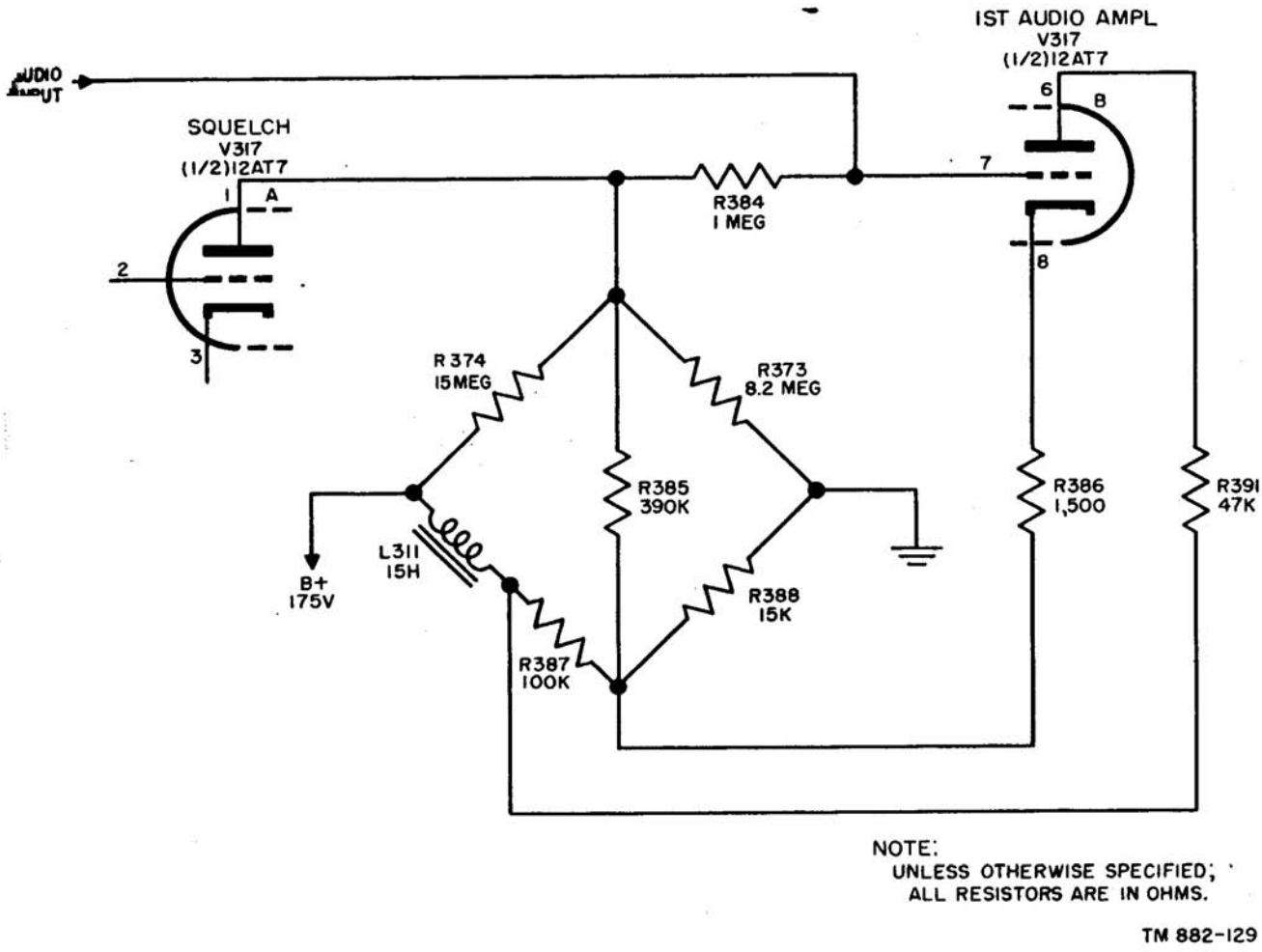


Figure 52. Bias circuit of first audio amplifier.

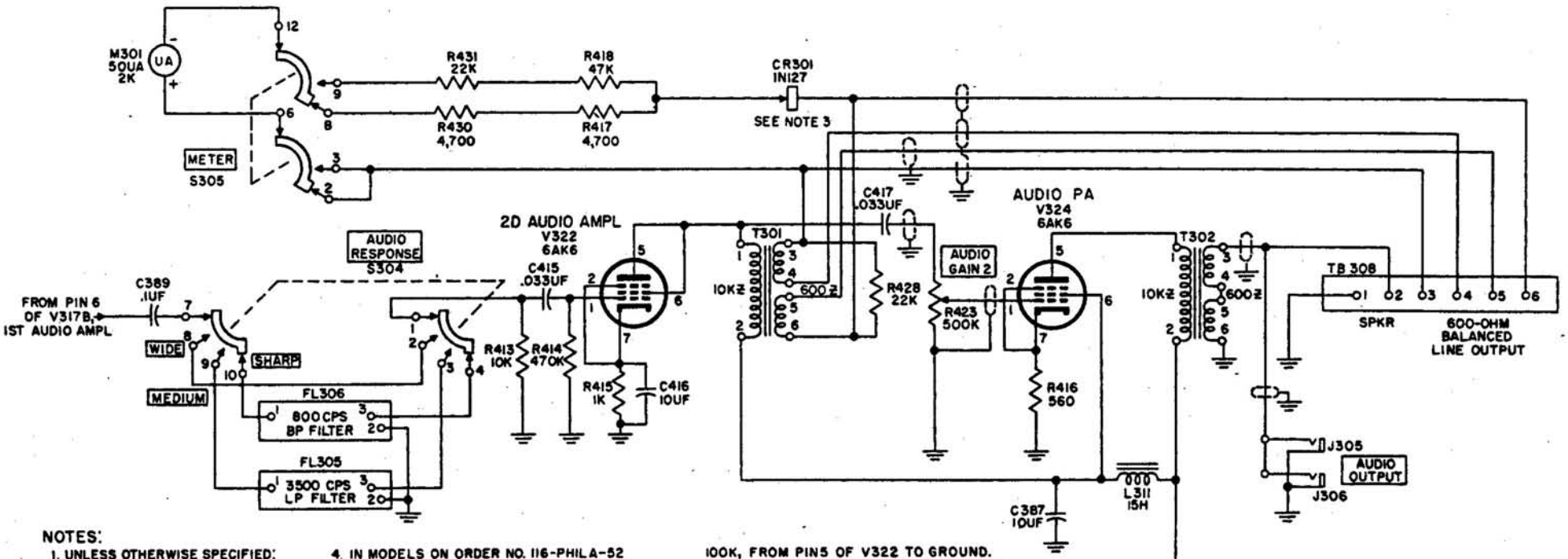
b. The output of the second audio amplifier is measured by the meter across the secondary of T301. Crystal diode CR301 rectifies the audio voltage. Resistors R417, R430, R418, and R431 are voltage dropping resistors to provide for measurement of a wide range of signal strengths (par. 78). In models on Order No. 116–Phila–52 with serial numbers 201 and higher, a series RC circuit consisting of C429 and R449 is connected from the plate of second audio amplifier V322 to ground. The audio voltage developed across R449 is rectified by CR301 and applied to the meter through dropping resistor R417 in the OUTPUT LOW position of the METER switch or dropping resistors R418 and R431 in the OUTPUT HIGH position of the METER switch.

c. The output of the second audio amplifier is coupled by C417 to the control grid of V324, the power amplifier. Resistor R423 (AUDIO GAIN 2) is used to control the audio output level to front panel jacks J305 and J306 and to terminals 1 and 2 of terminal board TB308. Resistor R416 provides cathode bias. B+ from S309 is applied to the plate of V324 through the primary of T302. Screen grid voltage for V324 is applied through audio filter choke L311 and is bypassed by C387. The secondary of T302 is a 600-ohm output connected to J305 and J306 for speaker use, and to TB308 for line or auxiliary use.

74. Mgc and Agc Control Circuits

(figs. 54 and 55)

a. General. Manual and automatic gain control voltage is applied to the rf amplifier tubes, the first if. amplifier, the four 455-kc if. amplifiers, the am. if. amplifiers, and the first and second auxiliary if. amplifiers. The grid circuits of these tubes receive a negative bias from either mgc

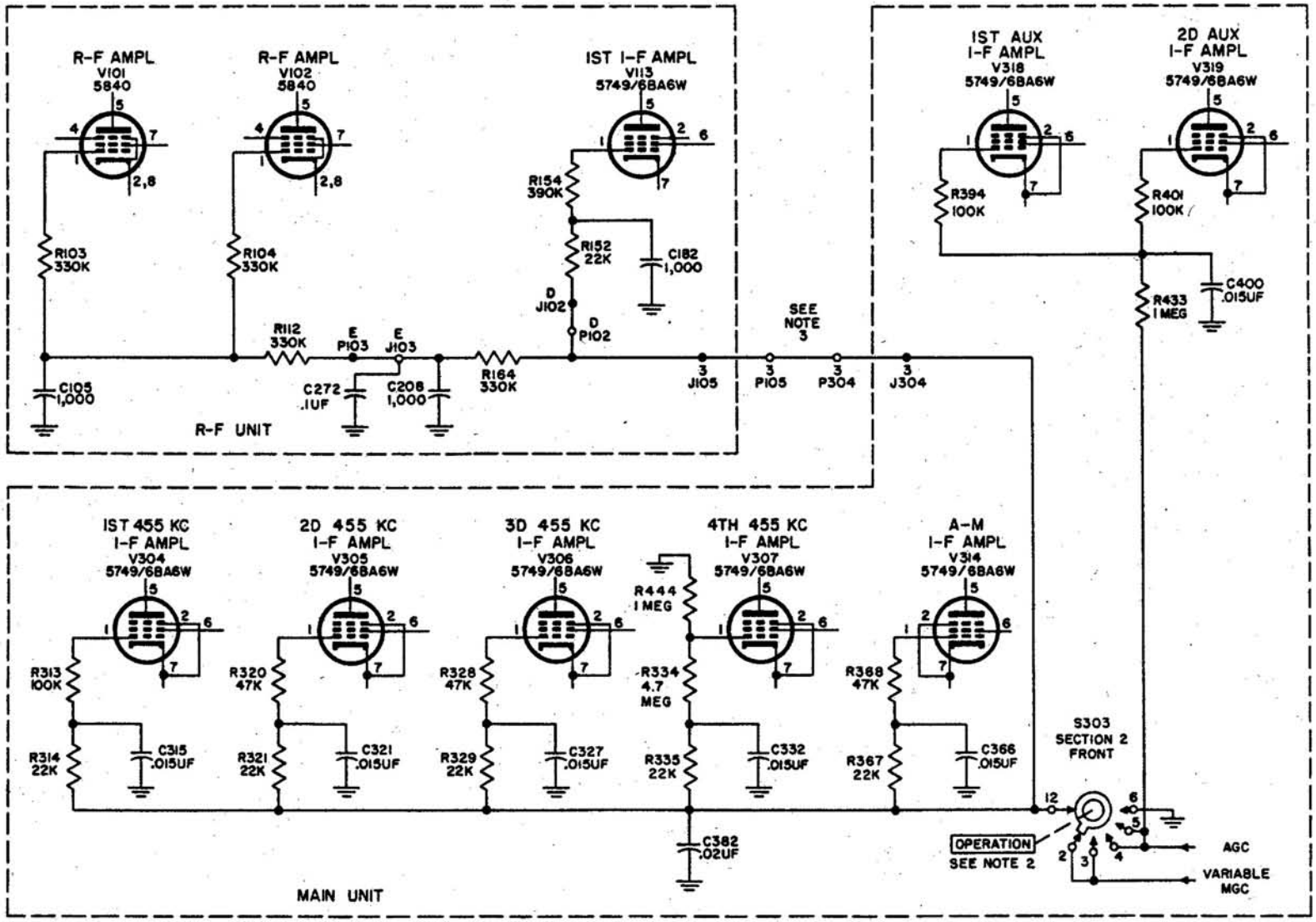


NOTES:

1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, ALL CAPACITORS ARE IN UUF.
2. METER SWITCH SHOWN IN OUTPUT LOW POSITION.
3. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS BELOW 51, CR301 IS A 1N63 TYPE CRYSTAL DIODE.
4. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER TERMINALS 4 AND 5 OF T302 ARE CONNECTED INTERNALLY; THE LEAD FROM TERMINAL 4 OF T301 TO TERMINAL 4 OF TB308 IS REMOVED, AND A JUMPER IS CONNECTED BETWEEN TERMINALS 3 AND 4 OF TB308.
5. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 201 AND HIGHER THE FOLLOWING DIFFERENCES EXIST: C429, .1UF IS ADDED IN SERIES WITH R449, 100K, FROM PIN5 OF V322 TO GROUND. CR301, IS CHANGED TO A TYPE HD6009 CRYSTAL DIODE AND IS CONNECTED TO THE JUNCTION OF C429 AND R449 INSTEAD OF TO PIN 6 OF T301. R418 IS 200K R431 IS 200K R430 IS DELETED AND R417, 27K, IS CONNECTED FROM PIN 8 OF S305 TO CR301. PINS 2 AND 3 OF S305 ARE DISCONNECTED FROM PIN 3 OF T301 AND CONNECTED TO GROUND.

TM 882-53

Figure 53. Second audio and power amplifiers.



NOTES:

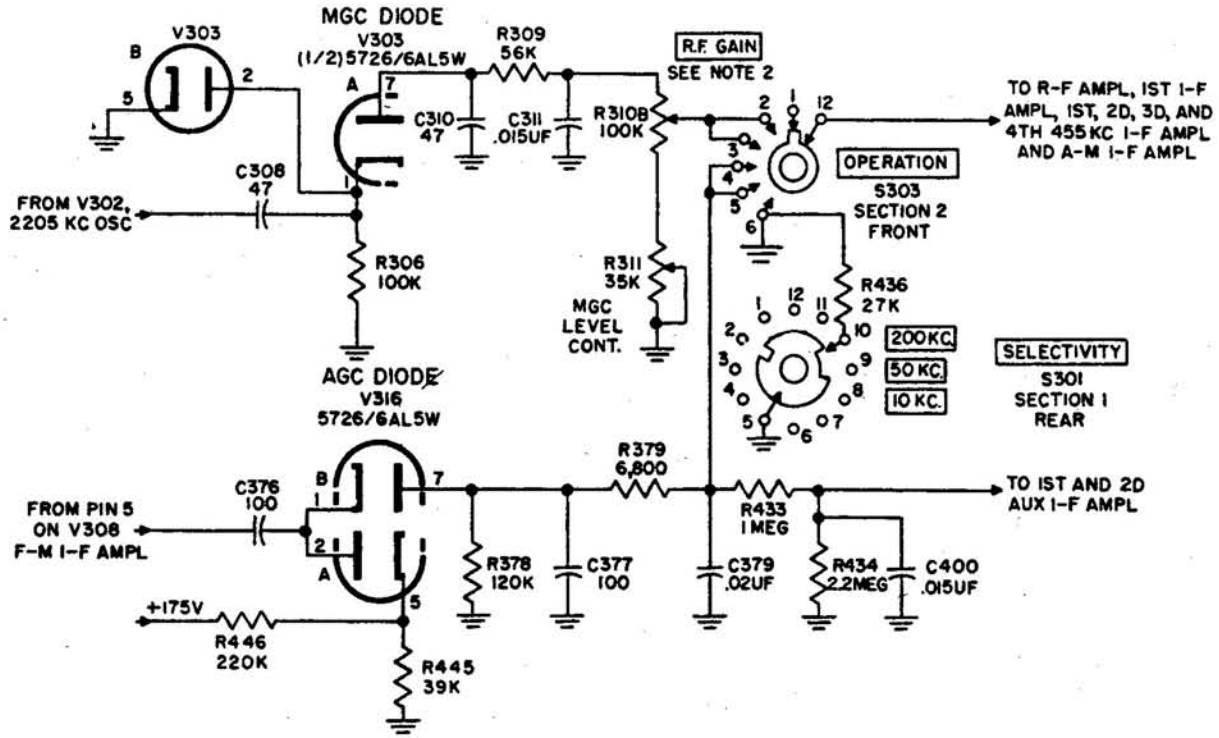
1. UNLESS OTHERWISE SPECIFIED; ALL RESISTORS ARE IN OHMS, ALL CAPACITORS ARE IN UUF.
2. OPERATION SWITCH POSITIONS:

POS	READS
1	OFF
2	STANDBY
3	MGC
4	AGC
5	AM SQUELCH
6	FM SQUELCH

3. THE R-F UNIT AND MAIN UNIT ARE INTERCONNECTED BY CABLE ASSEMBLY W302.
4. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 66 AND HIGHER, R443 IS 2.7 MEG.

TM 882-121

Figure 54. Mgc and agc distribution.



NOTES:

1. S303 POSITIONS:

POS	READS
1	OFF
2	STANDBY
3	MGC
4	AGC
5	AM SQUELCH
6	FM SQUELCH

2. R.F. GAIN CONTROL R310B IS GANGED TO SQUELCH CONTROL R310A.
3. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, ALL CAPACITORS ARE IN UUF.
4. SELECTIVITY SWITCH SHOWN IN THE 200 KC. POSITION.
5. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 23 AND HIGHER, A CONTACT IS ADDED AT TERMINAL 11 OF S301, SECTION 1 REAR, AND TERMINALS 10 AND 11 ARE CONNECTED TOGETHER.
6. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 66 AND HIGHER, R433 IS 2.7 MEG AND R434 IS 470K.
7. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER, THE FOLLOWING DIFFERENCES EXIST:
   C310 IS 1UF
   C311 IS 10UF
   R309 IS 120K
   C308 AND R306 ARE DELETED
   26 VOLTS A-C IS CONNECTED TO THE CATHODE, PIN 1, OF V303A

TM 882-54

Figure 55. Gain control circuits.

rectifier V303 or agc diode V316. Both V303 and V316 are twin diodes that function as voltage doublers.

b. Manual Gain Control. Manual gain control voltage is developed in the 2,205-kc oscillator and capacitively coupled through C308 to the cathode, pin 1, and the plate, pin 2, of manual gain control rectifier V303. On the positive half-cycle of the input signal, V303B conducts, charging C308 negative on the plate side. This voltage adds to the peak value of the following negative half-cycle applied to C303A and the circuit functions as a half-wave voltage doubler. In units with serial numbers 93 and higher, 26 volts ac is applied to manual gain control rectifier V303A from the output of the power supply. Resistor R306 is the cathode load resistor. The rectified voltage at the plate (pin 7) is filtered by the network composed of C310, R309, and C311. The rectified and filtered voltage, negative with respect to ground, is taken from R310B, the rf gain potentiometer, and applied to the OPERATION switch. This voltage is used for MGC operation. A fixed negative voltage from the lower end of R310B is also sent to the OPERATION switch through R436 and S301 and is used for FM SQUELCH operation. The same front panel control is used to operate R. F. GAIN R310B and SQUELCH threshold R310A, but whenever one of these circuits is operating, the other is disconnected by S303, section 2.

c. Automatic Gain Control.

(1) *Description of circuit.* Automatic gain control voltage from the agc circuit is also fed to the OPERATION switch. This voltage is used in the AGC and AM SQUELCH positions. Agc voltage is obtained from the output of fm if. amplifier V308, and is coupled through C376 to the cathode of V316B and the plate of V316A. The tube rectifies this voltage (as in detector operation) and the dc output is proportional to the average signal input. This output appears across R378, being negative at pin 7 of V316B with respect to ground. The output is filtered by C377, R379, and C379 and this voltage is fed to the OPERATION switch, becoming part of the gain control circuit between terminal 12 of S303, section 2, and ground. Because this is a negative voltage, it has the effect of increasing the negative bias applied to the tubes which are affected. Agc automatically controls the gain of these stages in inverse proportion to the signal strength, thus keeping the receiver output constant over a wide range of input signal levels.

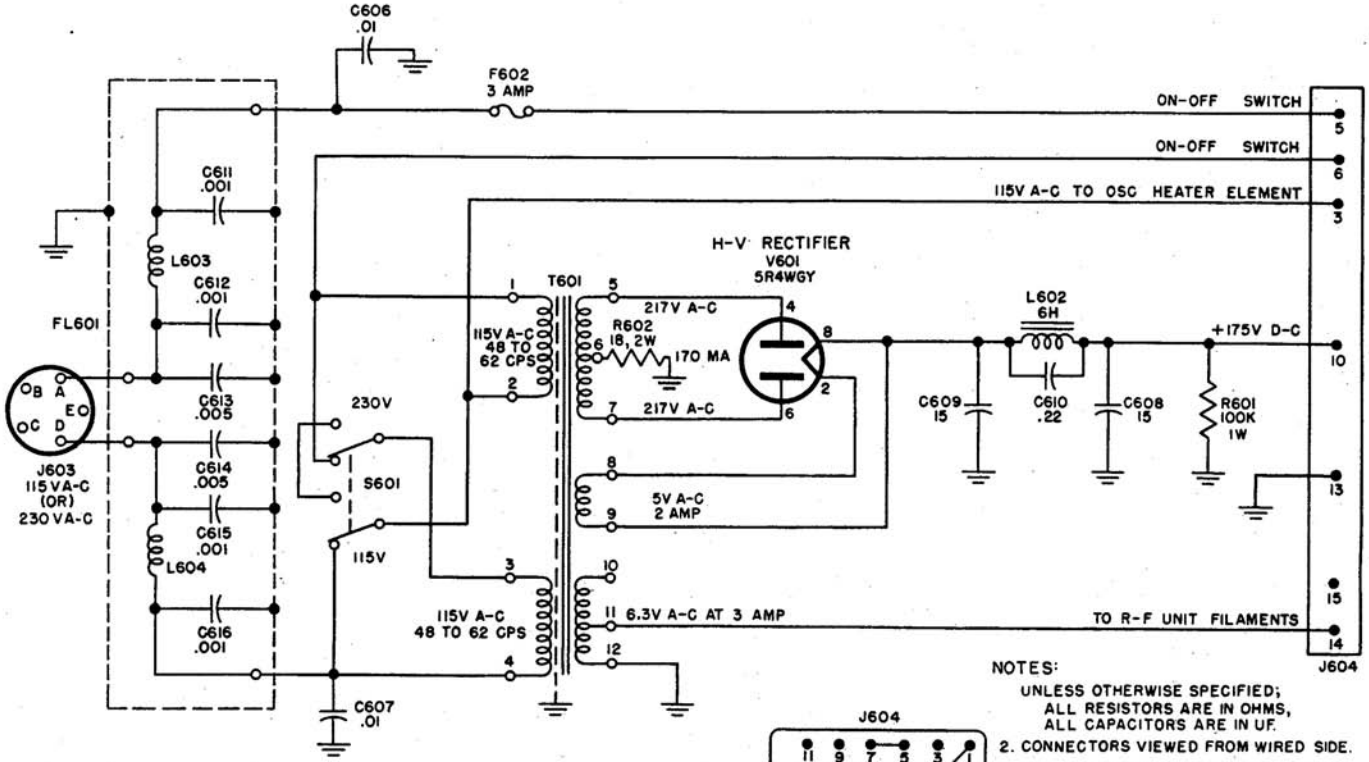
(2) *Auxiliary voltage divider.* An auxiliary voltage divider network consisting of R433 and R434 is connected between section 2 of S303 and ground to provide about two-thirds of the agc voltage to the first and second auxiliary if. amplifiers, independent of the OPERATION switch. Capacitor C400 is an rf bypass capacitor.

(3) *Positive voltage.* A positive voltage from the junction of voltage divider resistor R445 and R446 is fed to the cathode, pin 5, of V316A, to render V316A inoperative at lower signal levels. The positive voltage across R445 opposes the negative voltage across R378 so that agc is not effective at low signal levels, and the rf voltage is not strong enough to overcome the cathode bias on V316B. Under these conditions, V316B acts as a normal half-wave rectifier. As the signal is increased beyond the point where its peak positive value is more than the voltage on the cathode of V316A, the tube conducts, charging C376. This voltage adds to the peak value of the following (negative) half-cycle. The circuit now acts as a half-wave voltage doubler.

75. Power Supply and B+ Voltage Distribution

(figs. 56, 57, and 58)

a. Power Supply PP-660/URR is operated by 115-volt or 230-volt ac power through connector J603, and turned on or off by S310, ganged to the OPERATION control. The 3-ampere fuse, F602, provides protection to the power supply from overloads. Filter network FL601, composed of coils L603 and L604 and capacitors C611 through C616 and C606 and C607, filters out any rf voltage that may be present on the ac line. Input power is applied to the two primary windings of power transformer T601. When ac line switch S601 is set at the 115 position, the two primary windings are connected in parallel. Setting S601



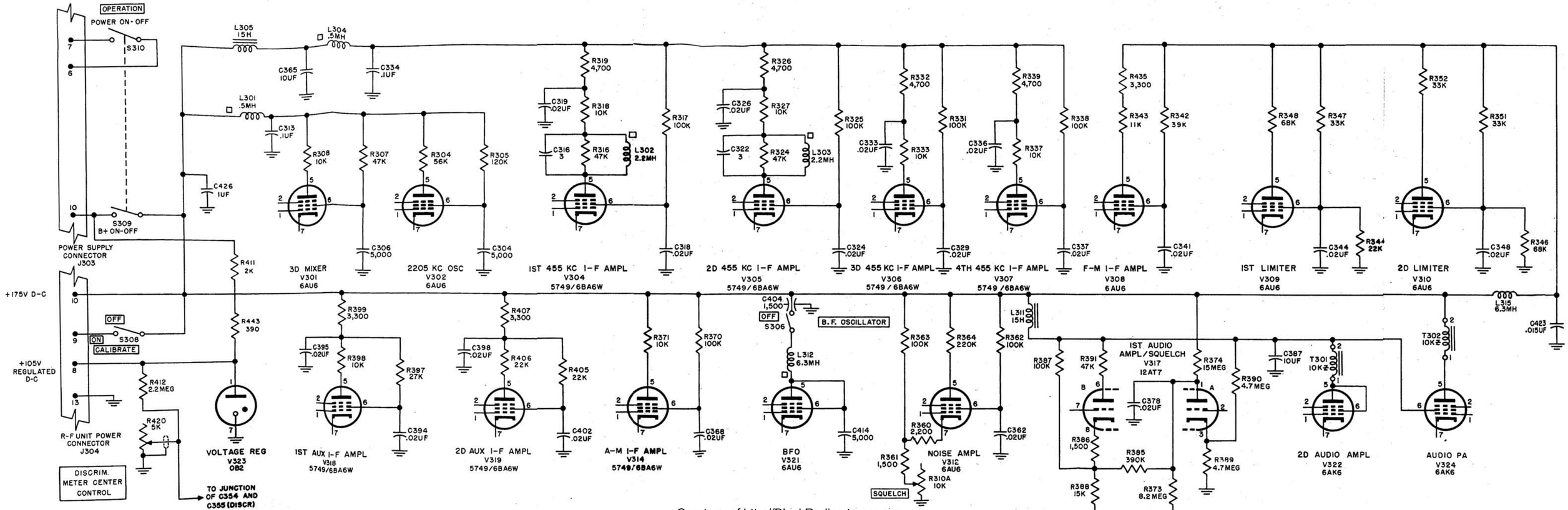
NOTES:

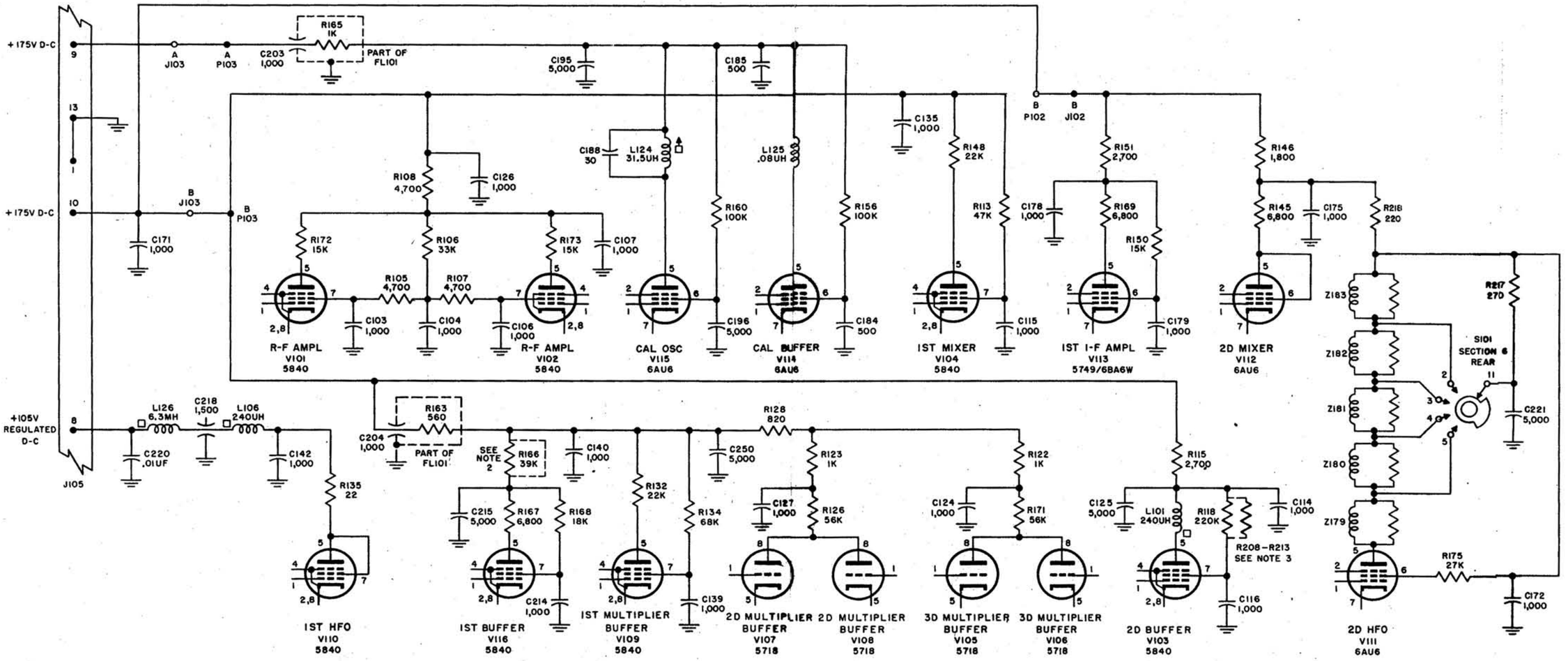
UNLESS OTHERWISE SPECIFIED;
ALL RESISTORS ARE IN OHMS,
ALL CAPACITORS ARE IN UF.

2. CONNECTORS VIEWED FROM WIRED SIDE.
3. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER, PINS 12 AND 15 OF J604 ARE CONNECTED TOGETHER; R603, 1 OHM, 5 WATT, AND R604, 1 OHM, 5 WATT, ARE CONNECTED IN PARALLEL FROM PIN 10 OF T601 TO PIN 15 OF J604.

TM882-166

Figure 30. Power Supply PP-860/URR, Schematic Diagram





NOTES:

1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, ALL CAPACITORS ARE IN UUF.
2. R166 IS SHORTED OUT ON BANDS 1, 3, 5, 6, AND 7 BY TURRET Z156.
3. RESISTORS ON TURRET Z153:

BAND	RESISTOR	VALUE
1	NONE	
2	R208	150K
3	R209	150K
4	R210	100K
5	R211	68K
6	R212	10K
7	R213	10K

4. ON BAND 1, RESISTOR R219, 330K, IS CONNECTED FROM THE JUNCTION OF R105 AND R107 TO GROUND ON BAND 2, RESISTOR R220, 470K IS CONNECTED FROM THE JUNCTION OF R105 AND R107 TO GROUND.

TM 882-123

Figure 58. B+ distribution, rf unit.

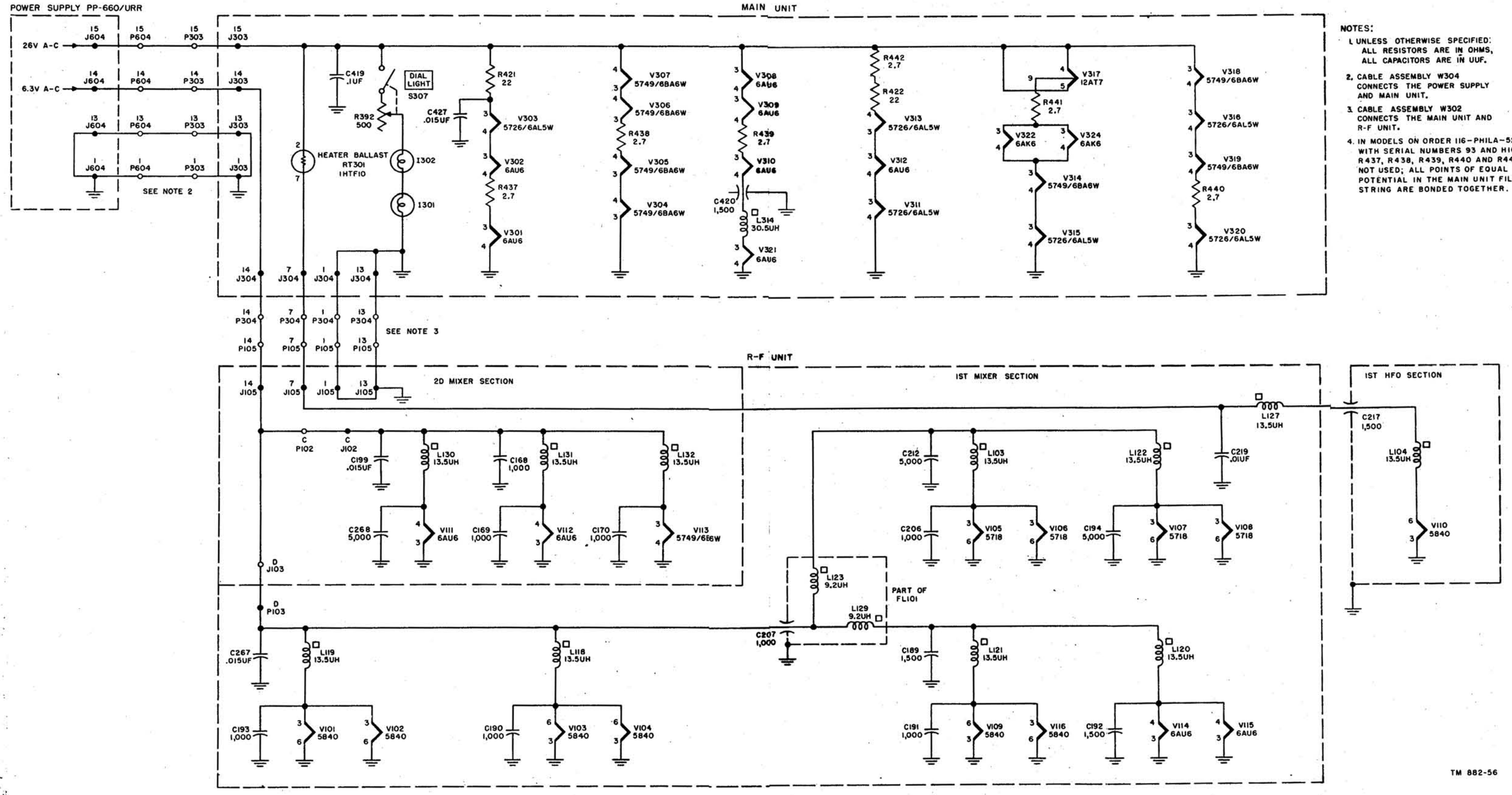


Figure 59. Filament circuits.

at the 230 position connects the primaries in series. Each primary winding is rated at 115 volts, 48 to 62 cycles.

b. The three secondary windings of T601 provide all necessary operating voltages for the receiver. Secondary winding 10–11–12 provides 26 volts ac between terminals 10 and 12 for the filaments of tubes located in the main unit of the receiver, and voltage for mgc rectifier V303A. The same winding provides 6.3 volts ac between terminals 11 and 12 for the filaments of tubes in the rf unit. Full-wave rectifier V601 obtains 5 volts ac for its filament from terminals 8 and 9 connected to a separate secondary winding, and the high-voltage secondary winding, 5–6–7, provides 217 volts ac each side of the center tap, terminal 6. The center tap is grounded through R602 and terminals 7 and 5 are connected to plates 6 and 4, respectively, of V601. Each half of the tube conducts during alternate half-cycles. Resistor R602 limits the peak current drawn by V601. The rectified output is taken from pin 8 of V601 and filtered by C608, L602, and C609. The parallel resonant circuit consisting of L602 and C610 offers maximum impedance to the ripple frequency. Voltage regulation is improved by bleeder resistor R601. All outputs from the power supply are connected to J604.

c. Power for the main and rf units is available when cable connectors J604, J303, J304, and J105 are interconnected by the two power cables, and when J603 is connected to a suitable power source. B+ is turned on and off by S309, which is ganged to the OPERATION control. When the OPERATION control is in the OFF position, all power is removed from the receiver. In the STANDBY position, 105 volts dc is applied to the plate and screen grid of first hf oscillator V110 and to the discriminator meter center control. All other B+ circuits remain off. In all other switch positions, B+ is on.

d. The plate and screen grid voltages of all tubes on the main and rf units except V110 are supplied through S309. Capacitor C426 is a B+ line bypass capacitor. B+ for first hf oscillator V110 is regulated by V323, the voltage regulator tube. This tube has a variable internal resistance that is inversely proportional to the current being drawn, thus keeping the supply voltage for V110 at a constant value. Because agc-mgc bias is used throughout the receiver, removal of plate and screen voltage will also remove all bias. In the STANDBY position, the grid bias circuits are completed through R310B and R311, but they remain inoperative until B+ is applied through S309.

76. Filament Circuits

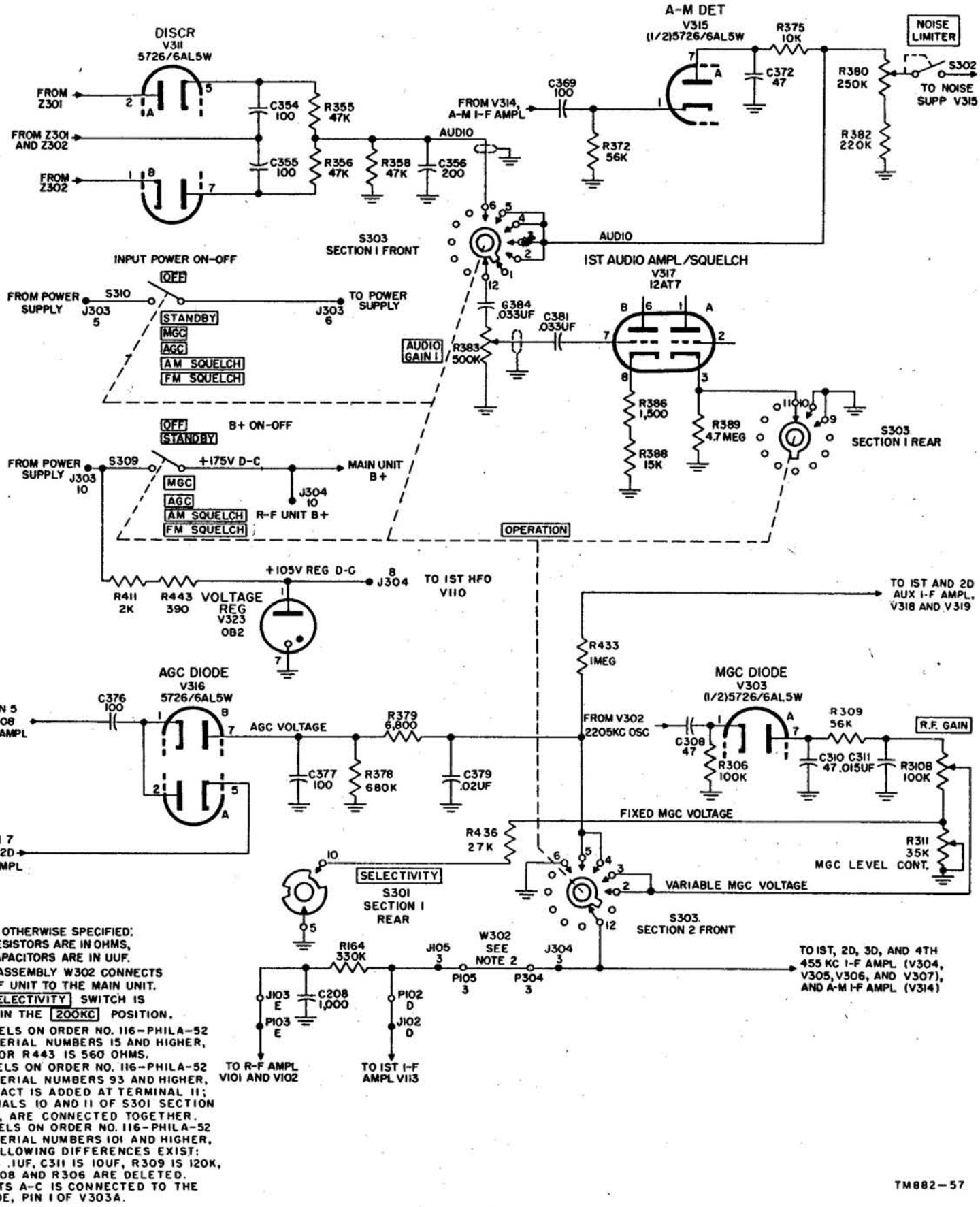
(fig. 59)

a. Main Unit. Filament voltage for all tubes in the main unit is applied between terminals 15 and 1 on J303. The ac at terminal 15 is bypassed by C419 and divided into three circuits.

(1) The electron tube filaments in the main unit are wired in a series-parallel circuit consisting of five series circuits and one series-parallel circuit, with all six circuits connected in parallel. Where four tubes are connected in series, the 26 volts is distributed across their filaments through voltage dropping resistors R438, R439, R440, and R441. One of these circuits contains 12-volt tube V317, but because its two 6-volt filaments are connected in parallel, the rest of the circuit is not disturbed. In this circuit, V322 and V324 are also parallel connected. Two of the series circuits contain only three tubes each. In these circuits, the voltage drop is equalized by means of R421, R437, R442, and R422. Capacitor C427 bypasses the rf in the filaments of V301, V302, and V303. The filament of beat-frequency oscillator V321 is isolated from fm if amplifier and limiter tubes V308, V309, and V310 by rf choke L314 and rf bypass capacitor C420. In units with serial numbers 93 and higher, all points of equal potential are bonded together to insure an even voltage distribution.

(2) A second connection is made to terminal 15 on J303 to drop the 26 volts ac through heater ballast RT301 to 6.3 volts ac for the first hf oscillator heater. This voltage is available at terminal 7 of J304.

(3) Dial lamps I 301 and I 302 form a series circuit with DIAL LIGHT control R392, which is ganged to S307 on the front panel. Rotation of R392 increases or decreases the voltage applied to the dial lamps, thereby controlling their brightness.



NOTES:

1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, ALL CAPACITORS ARE IN UUF.
2. CABLE ASSEMBLY W302 CONNECTS THE R-F UNIT TO THE MAIN UNIT.
3. THE SELECTIVITY SWITCH IS SHOWN IN THE 200KC POSITION.
4. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 15 AND HIGHER, RESISTOR R443 IS 560 OHMS.
5. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER, A CONTACT IS ADDED AT TERMINAL 11; TERMINALS 10 AND 11 OF S301 SECTION I REAR, ARE CONNECTED TOGETHER.
6. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 101 AND HIGHER, THE FOLLOWING DIFFERENCES EXIST: C310 IS .1UF, C311 IS 10UF, R309 IS 120K, AND C308 AND R306 ARE DELETED. 26 VOLTS A-C IS CONNECTED TO THE CATHODE, PIN 1 OF V303A.

Figure 60. OPERATION control.

b. Rf Unit. Terminal 14 of J303 is connected in the main unit to terminal 14 of J304. Filament power for the rf unit is thus available at terminal 14 on J105. With the exception of first hf oscillator V110, all tube filaments on the rf unit are supplied from terminal 14 on J105.

(1) The V110 filament receives its regulated voltage from terminal 7 on J105. This voltage is filtered by C219, L127, C217, and L104.

(2) Through terminal C on J102, 6.3-volts ac is applied to V111, V112, and V113, connected in parallel. Capacitors C168 and C199 are the rf bypass capacitors for all three tubes. An inductance-capacitance rf filter is connected in series with each of these tubes.

(3) The remaining tubes on the rf unit receive their filament voltage through terminal D on J103. The rf bypass capacitor at this point is C267. The twelve tubes are arranged in six parallel groups, with an rf choke and bypass capacitor for each group. Four of these tubes, V101, V102, V103, and V104, receive filament current from J103 through their respective filter chokes, L118 and L119. Additional filtering for the remaining eight tubes is provided by FL101, C212, and C189.

Section III. CONTROL CIRCUITS

77. OPERATION Control

(fig. 60)

a. General. Rotary switch S303 is ganged to two single-pole, single-throw (spst) sensitive microswitches, S310 and S309, and is operated from the front panel by the OPERATION control. The microswitches are identical in construction, differing only in function. The rotary switch consists of two sections. Section 1 is equipped with a set of contacts on the front and another set of contacts on the rear; section 2 has one set of contacts only, located on the front. Because each set of contacts consists of six terminal positions, the rotary switch is effectively a three-pole, six-position device.

b. Purpose. Section 1, front, of S303, is used to transfer the audio signal from the am detector or fm discriminator to the first audio amplifier. The rear contacts on this section are used to ground the cathode of V317A when either AM SQUELCH or FM SQUELCH is used. Section 2 of S303 controls the age-mgc circuits. Switch S310 is in series with the ac line and is an on-off switch. Switch S309 is the B+ switch. All plate, screen, and bias voltages, with the exception of B+ to the first hf oscillator and meter M301, are removed from the receiver when S309 is open. This is the STANDBY position of the OPERATION switch.

c. Application. In the OFF position of the OPERATION control, the ac line is open and the receiver is turned off as shown. Switch S601 on the power supply is set to either the 115 or the 230 position, depending on the power source being used. Rotating the control to position 2 (STANDBY) applies filament voltage to all tubes, including the rectifier, and closes the circuit to the oscillator heater element. Plate and screen voltage is also applied to V110. B+ is applied to the remaining tubes in positions 3, 4, 5, and 6. Mgc operates at position 3, and age at position 4. The squelch circuit is in operation in positions 5 and 6, position 5 closing the circuit from the am detector and position 6 selecting the discriminator output. The R.F. GAIN SQUELCH control operates the rf gain only when the OPERATION control is in the MGC position. This control regulates the squelch threshold only when the OPERATION switch is in position 5 or 6.

78. Meter Circuits

(figs. 61 and 62)

a. General (fig. 62). Meter M301 on the front panel is a microammeter with a resistance of approximately 2,000 ohms and requiring 50 microamperes for full-scale deflection. It is accurate to within ±2 per cent. The meter face is equipped with four scales: CARR. db, DBM HIGH, DBM LOW, and 0 to 50 microamperes. The top scale (CARR. db) is calibrated in db and the two lower scales are calibrated in units of dbm, which is an audio power level referenced to 1 milliwatt (mw) of audio power developed across a 600-ohm load. The 25-microampere position on the lowest scale is plainly indicated for use with the discriminator meter center control.

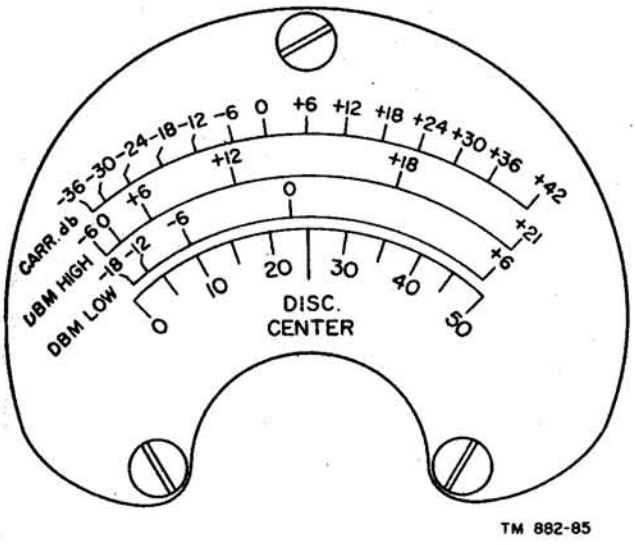


Figure 61. Meter scale.

b. Purpose and Use (fig. 62). METER switch S305 switches the meter to any one of five positions. These positions are CARRIER, OUTPUT LOW, HIGH, LIMITER, and DISC.

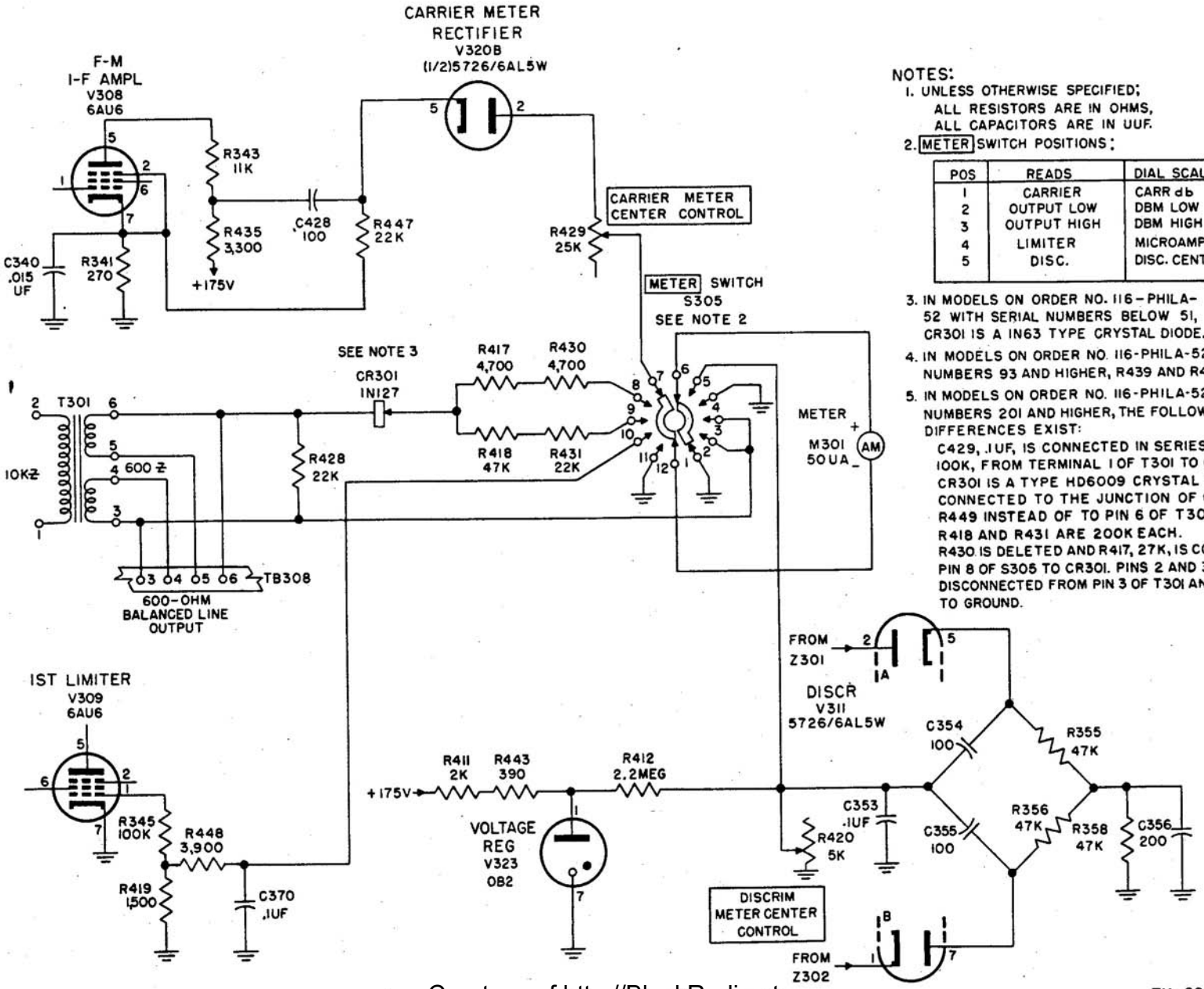
(1) *Position 1, CARRIER.* The dc output from carrier meter rectifier V320B is applied to carrier meter control R429, where it is negative with respect to ground. Because this voltage is proportional to the average signal input, the current through R429 will vary accordingly. Current is taken from R429 and fed through S305 to M301, returning through S305 to ground. Carrier level in decibels is read directly on the CARR. db scale. When no signal is being received, a bucking voltage, taken from R341, is applied to the meter, causing the meter needle to be deflected to the left. In this manner, the meter will not respond to noise voltages. When a signal is received, the bucking voltage is overcome and the meter indicates upscale.

(2) *Position 2, OUTPUT LOW.* The 600-ohm balanced line output provided by T301 to terminals 3 and 6 of TB308 is shunted across the two secondaries of T301 by resistor R428, and when S305 is set to position 2, M301 is shunted across R428. The ac output is rectified by germanium crystal unit CR301 and the rectified voltage is dropped by R417 and R430 to operate the meter. Thus, audio power levels as low as −18 dbm may be read on the DBM LOW scale. In models on Order No. 116–Phila–52 with serial numbers 201 and higher, C429, .1 μf, is connected in series with R449, 100K, from pin 5 of V322 to ground. The audio voltage developed across R449 is rectified by silicon diode CR301. When S305 is in position 2, the rectified voltage is dropped through R417, 27K, to operate the meter.

(3) *Position 3, OUTPUT HIGH.* The only difference in this circuit from position 2, is that the rectified current is fed to S305 through R418 and R431 instead of R417 and R430. This position effectively extends the meter scale to +21 dbm. OUTPUT HIGH is read on the DBM HIGH scale. In models on Order No. 116–Phila–52 with serial numbers 201 and higher, the rectified voltage from silicon diode CR301 is applied to the meter through R418, 200K, and R431, 200K, when S305 is in position 3.

(4) *Position 4, LIMITER.* Limiter current is taken from the grid circuit of first limiter V309 at the junction of R419 and R345, which is negative with respect to ground. It is then fed through R448 and S305 to M301 and returns through ground to V309. Limiter current, in microamperes, is read directly on the lowest scale of M301.

(5) *Position 5, DISC.* A regulated 105 volts dc from voltage regulator V323 is dropped by R412 to effect a half-scale deflection on M301. The needle is centered on the DISC. CENTER scale by DISCRIM METER CENTER CONTROL, R420. This is a screwdriver adjustment, that is set with no signal applied. When discriminator V311 is in operation, both sections of the tube conduct at the center frequency, 455 kc, but in opposite directions, so that no voltage appears at the condition of proper balance and M301 continues to be deflected at 25 microamperes because of the regulated voltage from V323. When the discriminator is unbalanced, one section of the tube conducts more than the other. This results in a voltage output at the junction of C354 and C355. The output from this



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS,
   ALL CAPACITORS ARE IN UUF.
2. METER SWITCH POSITIONS:

POS	READS	DIAL SCALE
1	CARRIER	CARR db
2	OUTPUT LOW	DBM LOW
3	OUTPUT HIGH	DBM HIGH
4	LIMITER	MICROAMPS
5	DISC.	DISC. CENTER

3. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS BELOW 51, CR301 IS A IN63 TYPE CRYSTAL DIODE.
4. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER, R439 AND R440 ARE DELETED.
5. IN MODELS ON ORDER NO. 116-PHILA-52 WITH SERIAL NUMBERS 201 AND HIGHER, THE FOLLOWING DIFFERENCES EXIST:
   C429, .1UF, IS CONNECTED IN SERIES WITH R449, 100K, FROM TERMINAL 1 OF T301 TO GROUND.
   CR301 IS A TYPE HD6009 CRYSTAL DIODE AND CONNECTED TO THE JUNCTION OF C429 AND R449 INSTEAD OF TO PIN 6 OF T301.
   R418 AND R431 ARE 200K EACH.
   R430 IS DELETED AND R417, 27K, IS CONNECTED FROM PIN 8 OF S305 TO CR301. PINS 2 AND 3 OF S305 ARE DISCONNECTED FROM PIN 3 OF T301 AND CONNECTED TO GROUND.

Figure 60. Meter circuit.

TM 882-60

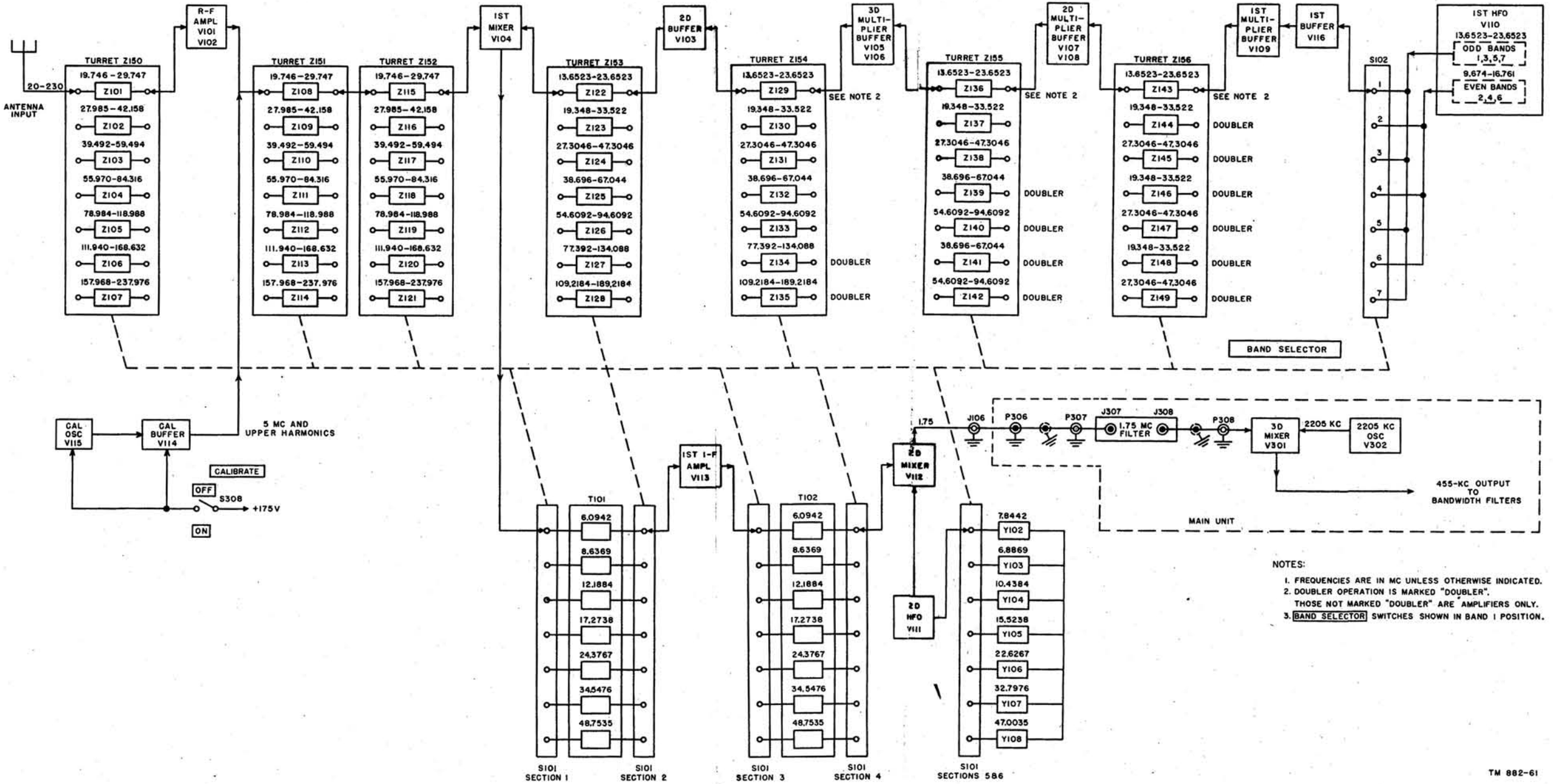


Figure 63. Band selector, functional block diagram.

point is fed to M301 at the junction of R412 and R420 and acts to either increase or decrease the current through M301, causing a deflection either to the right or left.

79. BAND SELECTOR and TUNING Controls (fig. 63)

a. General. All band switching and band tuning devices are located in the rf unit. Band switching is accomplished with seven turret assemblies, a two-position rotary switch, and a six-section, seven-position rotary switch, all turrets and switches being ganged by gears to the BAND SELECTOR control on the front panel. Each turret assembly consists of seven tuned circuits, one for each band within the range of the receiver. Six-section rotary switch S101 also has seven positions, one for each band. Two-position rotary switch S102 alternates between odd numbered bands 1, 3, 5, and 7, and even bands 2, 4, and 6. All tuning capacitors in the rf unit are ganged to another gear train and are operated from the front panel by the TUNING control.

b. Purpose and Use. Band switching is used in the rf amplifier, first buffer, first mixer, second buffer, first, second, and third multiplier-buffers, first high-frequency oscillator, first if. amplifier, second high-frequency oscillator, and second mixer circuits. Band tuning is used in the rf amplifier, first mixer, first, second, and third multiplier-buffers, and first high-frequency oscillator circuits. The purpose of band switching is to provide a means for the proper tuned circuits, consisting of grid and plate tanks, if. transformers, and second hf oscillator crystals, to be selected quickly from the front panel with a single switch. The tuning arrangement permits tuning across any band within the range of the receiver with a single control.

c. Frequency Chart. The following chart shows the various frequencies throughout the rf unit signal path. The frequencies indicated refer to the minimum and maximum range of each unit. Where only one frequency is indicated, the response range is ±200 kc. The bands overlap to provide continuous coverage, and there is a margin of at least 200-kc frequency deviation at the beginning and end of each band to allow for transmitter modulation. In addition to meeting specifications (par. 4), band 7 has an extended range up to 237,976 mc. The columns contain the frequencies of all bands in all sections of the rf unit. The rows indicate the frequencies of any tuning unit for all bands.

Tuning unit	Frequency (mc)						
	Band 1	Band 2	Band 3	Band 4	Band 5	Band 6	Band 7
Turret Z150	19. 746 to 29. 747	27. 985 to 42. 158	39. 492 to 59. 494	55. 970 to 84. 316	78. 984 to 118. 988	111. 940 to 168. 632	157. 968 to 237. 976
Turret Z151	19. 746 to 29. 747	27. 985 to 42. 158	39. 492 to 59. 494	55. 970 to 84. 316	78. 984 to 118. 988	111. 940 to 168. 632	157. 968 to 237. 976
Turret Z152	19. 746 to 29. 747	27. 985 to 42. 158	39. 492 to 59. 494	55. 970 to 84. 316	78. 984 to 118. 988	111. 940 to 168. 632	157. 968 to 237. 976
First hf oscillator output	13. 6523 to 23. 6523	9. 674 to 16. 761	13. 6523 to 23. 6523	9. 674 to 16. 761	13. 6523 to 23. 6523	9. 674 to 16. 761	13. 6523 to 23. 6523
Turret Z156	13. 6523 to 23. 6523	19. 348 to 33. 522	27. 3046 to 47. 3046	19. 348 to 33. 522	27. 3046 to 47. 3046	19. 348 to 33. 522	27. 3046 to 47. 3046
Turret Z155	13. 6523 to 23. 6523	19. 348 to 33. 522	27. 3046 to 47. 3046	38. 696 to 67. 044	54. 6092 to 94. 6092	38. 696 to 67. 044	54. 6092 to 94. 6092
Turret Z154	13. 6523 to 23. 6523	19. 348 to 33. 522	27. 3046 to 47. 3046	38. 696 to 67. 044	54. 6092 to 94. 6092	77. 392 to 134. 088	109. 2184 to 189. 2184
Turret Z153	13. 6523 to 23. 6523	19. 348 to 33. 522	27. 3046 to 47. 3046	38. 696 to 67. 044	54. 6092 to 94. 6092	77. 392 to 134. 088	109. 2184 to 189. 2184
T101	6. 0942	8. 6369	12. 1884	17. 2738	24. 3767	34. 5476	48. 7535
T102	6. 0942	8. 6369	12. 1884	17. 2738	24. 3767	34. 5476	48. 7535
Second hf oscillator output	7. 8442	6. 8869	10. 4384	15. 5238	22. 6267	32. 7976	47. 0035

CHAPTER 6

FIELD MAINTENANCE

Section I. TROUBLESHOOTING AT FIELD MAINTENANCE LEVEL

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.

80. Troubleshooting Procedures

The first step in servicing a defective radio set is to sectionalize the fault. Sectionalization means tracing the fault to the *major component or circuit* responsible for the abnormal operation of the set. The second step is to localize the fault. Localization means tracing the fault to the defective *part* responsible for the abnormal condition. Some faults, such as burned-out resistors, arcing, and shorted transformers, can often be located by sight, smell, and hearing. The majority of faults, however, must be localized by *checking voltages and resistance.*

81. Sectionalization of Trouble to Unit

a. General. Sectionalization of trouble to a unit of Radio Receiving Set AN/URR–29 consists of tracing the fault to a unit or circuit responsible for the abnormal operation of the receiver. Localization means tracing the fault to a particular defective component part. Radio Receiving Set AN/URR–29 consists of three units: the main unit, the power supply, and the rf unit. The rf unit consists of three sections: first mixer, second mixer, and first hf oscillator. The following information is presented as an aid in tracing a defect to a unit or section.

(1) Observing the performance of the receiver during normal operation and keeping a record of meter readings will often sectionalize the fault to a particular stage when breakdown occurs. See the equipment performance checklist (par. 47) for normal operating indications.

(2) If only one unit is inoperative, the trouble is probably in that unit and generally the result of a defective tube or an open fuse. Check the line fuse and tubes at an early stage of the troubleshooting procedure.

(3) Replace the unit or section suspected of being faulty with one known to be good. If the replacement corrects the trouble, the one removed is faulty.

b. Stage Localization. The tests listed below aid in isolating the source of trouble. To be effective, the procedure should be followed in the order given. Remember that servicing procedures should cause no further damage to the receiver. First, trouble should be localized to a single stage or circuit; then the trouble may be isolated within that stage or circuit by voltage, resistance, and continuity measurements. The service procedure is summarized as follows:

(1) *Visual inspection.* The purpose of visual inspection is to locate any visible trouble. Through this inspection alone, the repairman may discover the trouble or determine the stage in which the trouble exists. This inspection is valuable in avoiding additional damage to the receiver which might occur through improper servicing methods and in preventing future failures.

(2) *Operational test.* The operational test (par. 86) is important because it frequently indicates the general location of trouble. In many instances, the information gained will determine the exact nature of the fault.

(3) *Troubleshooting chart.* The trouble symptoms listed in this chart (par. 87) will aid greatly in localizing trouble.

(4) *Signal substitution.* The principal advantage of the signal substitution method (par. 88) is that it usually enables the repairman to localize a trouble accurately and quickly to a given stage when the general location of the trouble is not immediately evident from the above tests.

(5) *Stage gain charts.* These charts (par. 90) can be used to localize obscure, hard-to-find troubles.

(6) *Intermittents.* In all these tests the possibility of intermittents should not be overlooked. This type of trouble often may be made to reappear by tapping or jarring the set. It is possible that the trouble is not in the receiver itself but in the installation, or the trouble may be due to external conditions. In this event, test the installation and antenna system.

82. Troubleshooting Data

Take advantage of the material supplied in this manual. It will help in the rapid location of faults. Consult the following troubleshooting data:

a. Radio Receiver R–220/URR.

Par. No.	Fig. No.	Description
	67	Tube location, main unit.
	68	Tube location, right side of rf unit.
	69	Tube location, left side of rf unit.
	15	Radio Receiver R–220/URR, main unit, location of tubes.
	72	Radio Receiver R–220/URR, under chassis view.
	73	Radio Receiver R–220/URR, main unit, location of sections E through K.
	71	Parts location, main unit, section E.
	70	Parts location, main unit, section F.
	76	Parts location, main unit, section G, showing capacitors.
	81	Parts location, main unit, section G, showing resistors.
	82	Parts location, main unit, section H.
	83	Parts location, main unit, section J, showing resistors.
	84	Parts location, main unit, section J, showing capacitors.
	85	Parts location, main unit, section K, showing resistors.
	86	Parts location, main unit, section K, showing capacitors.
	77	Sections E, F, and H, voltage and resistance measurements.
	78	Section G, voltage and resistance measurements.
	79	Section J, voltage and resistance measurements.
	80	Section K, voltage and resistance measurements.
	75	Rf unit, oscillator side.
	115	Rf unit, location of sections A through D.
	87	Rf unit, section A.
	89	Rf unit, sections B and D.
	90	Rf unit, section C, top view.
	91	Second hf oscillator, part location.
	94	First mixer section, voltage and resistance measurements.
	95	Second mixer and first hf oscillator sections, voltage and resistance measurements.
	102	Rf unit, bottom view.
	103	Rf unit, rear view.
	104	Control head, over-all view.
	124	Radio Receiver R–220/URR, schematic diagram.
	125	Radio Receiver R–220/URR, main unit, schematic diagram (serial numbers 101 and higher).
81	----	Sectionalization of trouble to unit.
47	----	Equipment performance checklist.
48	----	Troubleshooting chart for Radio Receiving Set AN/URR–29.
83	----	Test equipment required for troubleshooting.
85	----	Checking B+ circuits for shorts.
87	----	Troubleshooting charts.
88	----	Signal substitution.
90	----	Stage gain charts.

b. Power Supply PP–660/URR.

Par. No.	Fig. No.	Description
	65	Power Supply PP–660/URR, bottom view.
	66	Power Supply PP–660/URR, voltage and resistance measurements.
	56	Power Supply PP–660/URR, schematic diagram.
47	----	Equipment performance checklist.
86	----	Test equipment required for troubleshooting.
94	----	Checking key circuits for shorts.
96	----	Troubleshooting charts.

83. Test Equipment and Tools Required for Troubleshooting

The test equipment required for troubleshooting Radio Receiving Set AN/URR–29 is listed below. In addition to this equipment, Tool Equipment TE–113 and Tool Equipment TE–114 are available for maintenance. Tool Equipments TE–33

and –41, and Moisture-Fungus Proofing Equipment MK–2/GSM are available for second echelon maintenance.

Test equipment

Multimeter TS–297/U
Multimeter TS–352/U
Electronic Multimeter TS–505/U
Electronic Multimeter ME–6A/U
Electronic Tube Test Set TV–2/U
Electronic Tube Test Set TB–7/U
Signal Generator TS–497/URR
Signal Generator AN/URM–70
Signal Generator AN/URM–25
Audio Oscillator TS–382A/U
Frequency Meter Set SCR–211
Output Meter TS–585/U
Signal Generator AN/URM–48

84. Special Tools Supplied

The special tools discussed in this paragraph are supplied with Radio Receiving Set AN/URR–29.

a. Slotted Alinement Tool. An alinement tool, suitable for high-frequency adjustments, is necessary for tuning all variable inductors and all screw-type shaft variable capacitors. The alinement tool is fastened to the rear of the main unit chassis by a clip (fig. 12).

b. Offset End Wrench. The offset end wrench, used for removing the shaft water seals on the front panel, is located on the left side of the main unit (fig. 96).

c. Spanner Wrench. The spanner wrench, used in conjunction with the offset end wrench for shaft water seal removal, is also located on the left side of the main unit (fig. 96).

85. Checking B+ Circuits for Shorts

a. When beginning the troubleshooting procedure, always check the resistance of key circuits (B+ and filaments). Doing so may prevent damage to the power supply, or further damage to the receiver if a short or near short is present in the circuit.

b. Compare the resistance readings shown in the charts below with those measured at J604, J303, J304, J105, P103, and J102. When the difference in readings is greater than 30 per cent, consider the circuit defective. Continue resistance measurement of component parts within the circuit until the shorted or otherwise defective item is found. Replace the faulty component part before continuing with any further maintenance.

c. When operational failure occurs, and the trouble is not a defective tube or fuse, the next most common form of trouble is a shorted component part in the B+ distribution circuit. A quick, accurate method of isolating the unit or section containing a B+ short is to make resistance readings at the interconnecting jacks. The following charts indicate the proper resistance readings for the jacks of all units and sections as measured from the pin indicated to ground.

(1) *Power Supply Jack J604.*

Pin No.	Resistance (ohms)	Pin No.	Resistance (ohms)
1	0	9	No connection
2	No connection	10	100K
3	Infinity	11	No connection
4	No connection	12	No connection
5	Infinity	13	0
6	Infinity	14	.5
7	Infinity	15	2.5
8	Infinity		

(2) *Main Unit, Power Supply Jack, J303.*

Pin No.	Resistance (ohms)	Pin No.	Resistance (ohms)
1	0	9	No connection
2	Infinity	10	20K*
3	Infinity	11	No connection
4	Infinity	12	No connection
5	Infinity	13	0
6	Infinity	14	Infinity
7	Infinity	15	2.8
8	Infinity		

*OPERATION switch in AGC position.
R.F. GAIN SQUELCH control set to midposition.

(3) *Main Unit, Rf Unit Jack J304.*

Pin No.	Resistance (ohms)	Pin No.	Resistance (ohms)
1	0	9	20K [b]
2	Infinity	10	20K [b]
3	127K [a]	11	No connection
4	Infinity	12	No connection
5	Infinity	13	0
6	Infinity	14	Infinity
7	39	15	Infinity
8	21K [b]		

[a] OPERATION switch in AGC position.
[b] CALIBRATE switch to ON.
OPERATION switch in AGC position.
R.F. GAIN SQUELCH control set to midposition.

(4) *Rf Unit, Main Unit Jack J105.*

Pin No.	Resistance (ohms)
1	0
2	Infinity
3	Infinity
4	Infinity
5	Infinity
6	Infinity
7	16
8	Infinity
9	Infinity
10	368K (band 1), 508K (band 2), Infinity (bands 3 through 7)
11	No connection
12	No connection
13	0
14	Infinity
15	Infinity

(5) *Rf Unit, First Mixer Section, P103.*

Pin No.	Resistance (ohms)
A	Infinity.
B	368K (band 1), 508K (band 2), Infinity (bands 3 through 7)
D	6.5
E	Infinity
H	0

(6) *Rf Unit, Second Mixer Section, J102.*

Pin No.	Resistance (ohms)	Pin No.	Resistance (ohms)
A	0	C	0.5
B	Infinity	D	Infinity

86. Operational Test

Operate the receiver as described in the equipment performance checklist in paragraph 47. This checklist is important because it frequently indicates the general location of trouble. Also listed for crackling or buzzing noises that could indicate high-voltage (hv) arcing. Check the receiver for smoke and the odor of burned or overheated parts.

87. Troubleshooting Charts

a. General. The charts in this paragraph will aid in rapidly localizing defects to any of the component parts of Radio Receiving Set AN/URR–29. A separate chart is listed for each of the three major units (main unit, rf unit, and power supply). The items shown in the symptom column are operating indications of a complete Radio Receiving Set AN/URR–29. The items listed in the probable trouble column are those component parts or stages thought to be defective. The items listed in the correction column are the necessary follow-up procedures required to correct the probable troubles. Voltage and resistance charts, referred to in figures 66, 77, 78, 79, 80, 94, and 95, aid in locating the defective component part after isolating the defective stage. Refer to the data given in paragraph 82.

Caution: Some of the corrective measures listed in the troubleshooting charts refer to voltage, resistance, and continuity checks. Be sure that the power is on for voltage measurements and off for resistance or continuity checks.

b. Power Supply PP–660/URR.

Symptom	Probable trouble	Correction
1. Receiver inoperative; dial lamps and tube filaments on; no B+ output from power supply.	Shorted C608, C609, and/or R601; open L602.	Make voltage and resistance measurements (fig. 66); replace as necessary.
	Defective V601	Replace V601.
2. Receiver inoperative; dial lamps and tube filaments do not light.	Shorted C606 or C607; defective T601 or S601. Open fuse F602 or open wiring on J603.	Make voltage and resistance measurements (fig. 66); replace as necessary.
	Power plug disconnected	Connect power plug.
3. Excessive hum in audio output	Leaky C608 and/or C609; shorted or open C610.	Check by substitution; replace if necessary.
	One-half of T601 h-v winding open	Replace T601.
4. Tube filaments in main unit do not light; all other filaments normal.	T601 filament secondary open	Replace transformer.
5. Tube filament in power supply rectifier does not light; all other filaments normal.	T601 filament secondary open	Replace transformer.
	Open filament in V601	Replace V601.

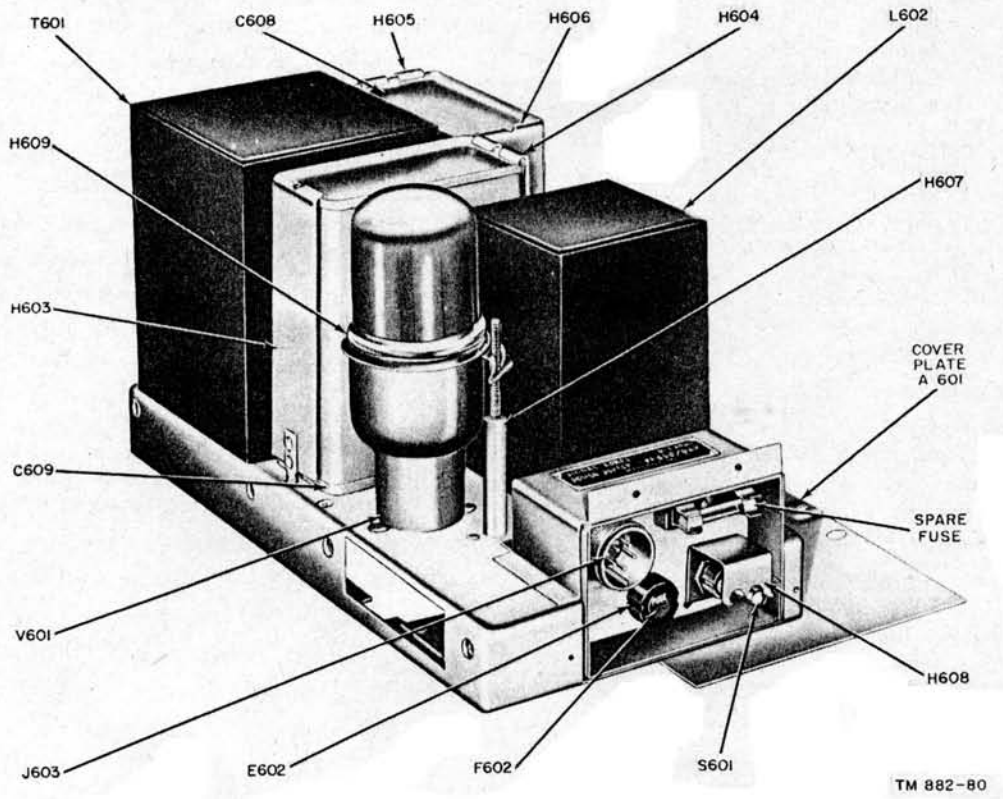


Figure 64. Power Supply PP-660/URR.

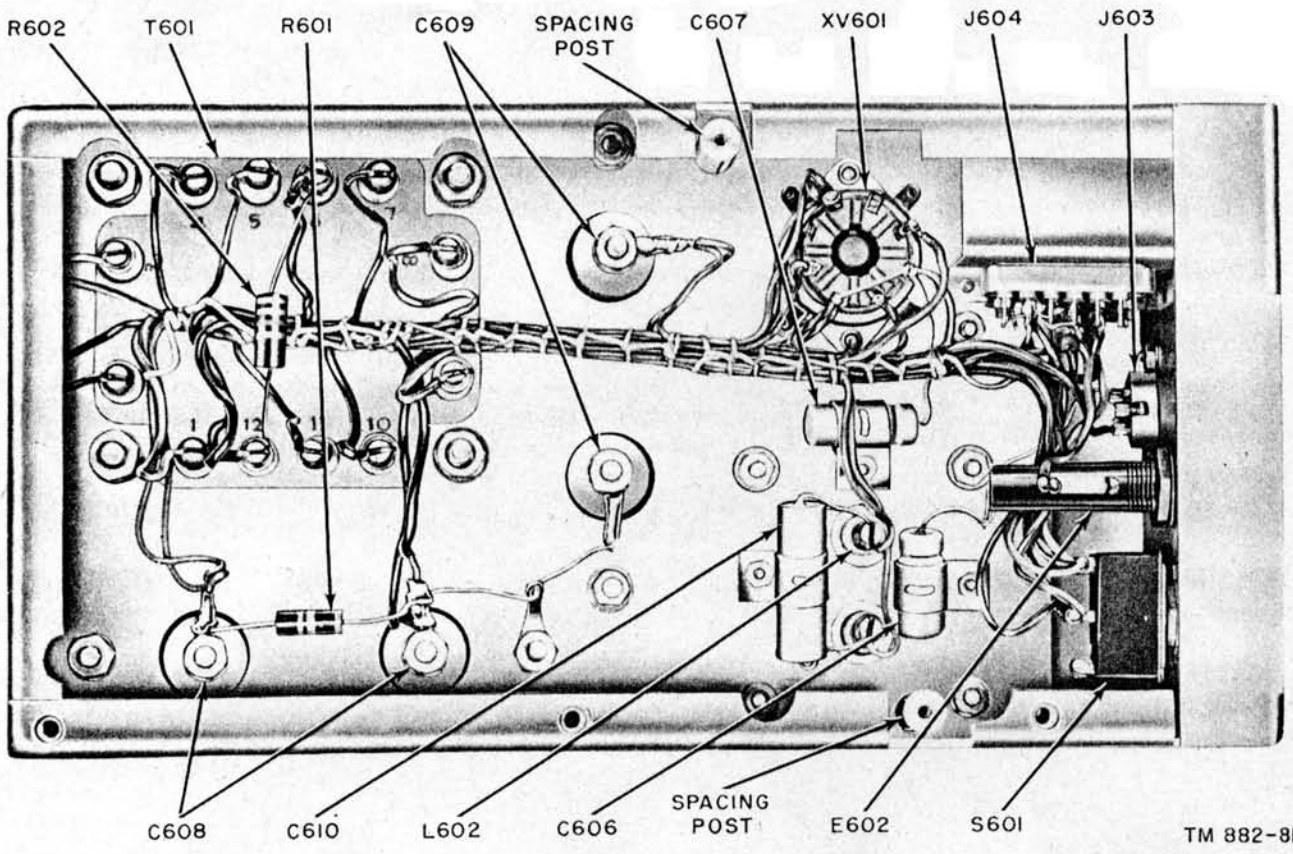
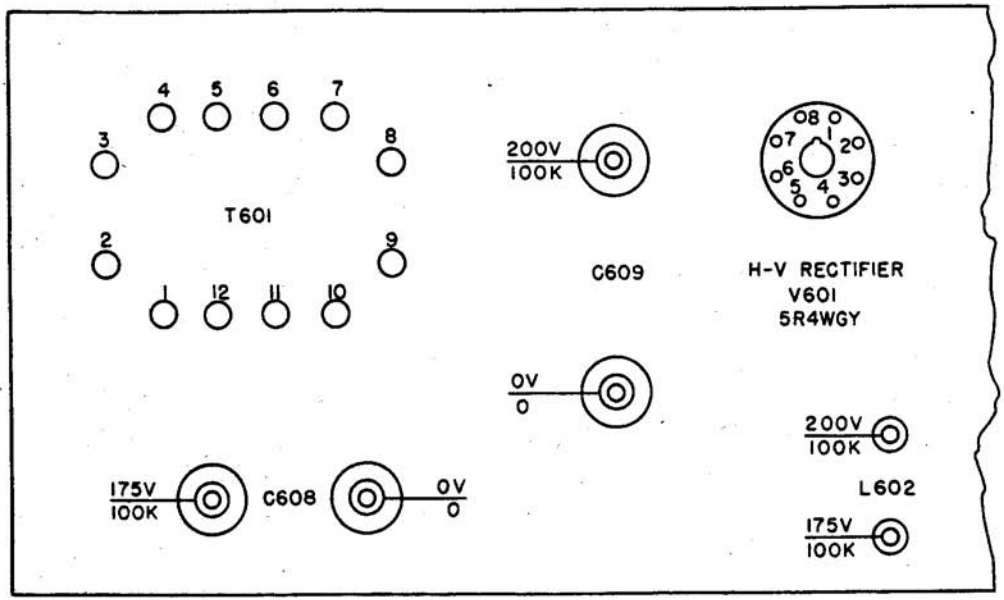
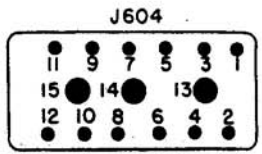


Figure 65. Power Supply PP-660/URR, bottom view.





T601

TERMINAL	VOLTAGE(A-C)	RESISTANCE
1 TO 2	115	40
3 TO 4	115	40
5 TO 6	228	20
6 TO 7	228	20
8 TO 9	5	LESS THAN 1
10 TO 11	20	LESS THAN 1
11 TO 12	6.3	LESS THAN 1

V601

PIN	VOLTAGE(A-C)	RESISTANCE
2 TO 8	5	LESS THAN 1
4 TO 6	456	40

J604

TERMINAL	VOLTAGE	RESISTANCE
3 TO 5	115V A-C	∞
5 TO 6	115V A-C	∞
10 TO 1	175V A-C	100K
14 TO 1	6.3V A-C	LESS THAN 1
15 TO 1	26V A-C	LESS THAN 1

J603

TERMINAL	VOLTAGE(A-C)	RESISTANCE
A TO D	115	∞

NOTES:

1. ALL VOLTAGE MEASUREMENTS ARE D-C POSITIVE, UNLESS OTHERWISE SPECIFIED, MADE WITH A 20,000 OHMS PER VOLT METER.

2. RESISTANCE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT AND MAIN UNIT DISCONNECTED. VOLTAGE MEASUREMENTS ARE MADE TO GROUND WITH THE [OPERATION] SWITCH IN THE [MGC] POSITION AND THE POWER SUPPLY CONNECTED TO A 115V A-C SOURCE.

3. NC INDICATES NO CONNECTION.

TM 882-138

Figure 66. Power Supply PP-660/URR, voltage and resistance measurements.

c. Main Unit.

Symptom	Probable trouble	Correction
1. No audio output; meter indication normal in OUTPUT LOW and OUTPUT HIGH positions.	Defective headset	Repair or replace.
	Defective audio power amplifier stage	Check voltage and resistance at V324 socket, and replace defective component.
	Open AUDIO GAIN 2 potentiometer control (R423).	Check resistance; replace if necessary.
	Defective V324	Replace V324.
2. No audio output. No meter indication in OUTPUT LOW and OUTPUT HIGH positions; all other readings normal.	Defective first audio amplifier V317 and/or second audio amplifier V322.	Check voltage and resistance at V317 and/or V322 sockets, and replace defective component.
3. No audio output during fm operation; meter readings normal in CARRIER and LIMITER positions.	Defective first limiter V309, second limiter V310, and/or discriminator V311 stages.	Check voltage and resistance at V309, V310, and/or V311 sockets, and replace defective component.
	Defective V309, V310, or V311	Replace V309, V310, or V311.
4. No audio output during fm operation; no meter reading in LIMITER position; meter reading normal in CARRIER position.	Defective first limiter stage V309	Check voltage and resistance at V309 socket, and replace defective component.
	Defective V309	Replace V309.
5. No audio output during am. operation; meter readings normal in CARRIER and LIMITER positions.	Defective am. if. amplifier V314 and/or am. detector V315 stages.	Check voltage and resistance at V314 and/or V315 sockets, and replace defective component.
	Defective V314	Replace V314.
6. No audio output during am. or fm. operation; no meter reading in CARRIER position.	Defective if. amplifiers V304, V305, V306, V307, third mixer V301, and/or 2,205-kc osc V302.	Check voltage and resistance at V304 through V307, V301 and/or V302. If defective component is not found, use signal substitution method (par. 89).
	Defective 1.75-mc filter FL301	Replace FL301.
	Defective V301, V302, V304, V305, V306, or V307.	Replace V301, V302, V304, V305, V306, or V307.
7. No reception of cw signals	Defective bfo V321	Isolate the defective part using voltage and resistance measurements. Replace defective part.
	Defective V321	Replace V321.
8. Reception normal; no meter reading in CARRIER position.	Defective fm if. amplifier V308 or carrier meter rectifier V320B.	Check voltage and resistance at V308 sockets. Replace defective part.
	Defective V320B	Replace V320.
9. Receiver operation normal; no auxiliary diode output.	Defective first aux if. amplifier V318, second aux if. amplifier V319, or aux diode V320.	Check voltage and resistance at V318, V319, and/or V320 sockets, and replace defective part.
	Defective V318, V319, or V320	Replace V318, V319, or V320.
10. No noise limiter action	Defective noise suppressor V315	Check voltage and resistance at V315 socket.
	Defective NOISE LIMITER control	Check resistance; replace if necessary.
	Defective V315	Replace V315.
11. Receiver will not squelch	Defective noise amplifier V312, noise rectifier V313, and/or squelch V317.	Check voltage and resistance at V312, V313, and/or V317 sockets, and replace defective part.
	Defective SQUELCH control R310A	Check resistance; replace if necessary.
	Defective V312, V313, or V317	Replace V312, V313, or V317.
12. R.F. GAIN SQUELCH inoperative when OPERATION switch is in the MGC position.	Defective mgc diode V303	Check voltage and resistance at V303 socket, and replace defective part.
	Defective R.F. GAIN control R310B	Check resistance; replace if necessary.
	Defective V303	Replace V303.
13. No audio output when AUDIO RESPONSE switch is set to the WIDE position.	Defective AUDIO RESPONSE switch S304.	Check continuity of switch; replace if necessary.
	Defective C389	Replace C389.

c. Main Unit—Continued.

Symptom	Probable trouble	Correction
14. No audio output when AUDIO RESPONSE switch is set to the SHARP position.	Defective low-pass filter FL305	Replace FL305.
15. No audio output when AUDIO RESPONSE switch is set to the SHARP position.	Defective band-pass filter FL306	Replace FL306.
16. No audio output when SELECTIVITY switch is set to the 200 position.	Defective 455-kc filter FL304	Replace FL304.
	Defective switch S301	Check continuity through contacts replace if necessary.
17. No audio output when SELECTIVITY switch is set to the 50 K. C. position.	Defective 455-kc filter FL303	Replace FL303.
	Defective switch S301	Check continuity through contacts; replace if necessary.
18. No audio output when SELECTIVITY switch is set to the 10 position.	Defective 455-kc filter FL302	Replace FL302.
	Defective switch S301	Check continuity through contacts; replace if necessary.
19. Receiver operates normally; no meter indications.	Defective meter M301	Repair or replace meter M301.
	Defective METER switch S305	Check and replace if necessary.
20. Receiver output lower than normal.	Rf section out of alinement	Refer to paragraph 101 for alinement procedure.
	Open coupling capacitors C381, C384, C389, C415, or C417.	Replace suspected capacitors.
	Low line voltage	Check power source.
	Low B+ voltage	Replace V601. Make resistance measurements (fig. 66).
21. Audio output distorted	Discriminator out of alinement	Refer to paragraph 106 for alinement procedure.
	Leaky coupling capacitors C381, C384, C389, C415, or C417.	Check resistance of capacitors, and replace defective parts.
	Defective audio tubes V317, V322, or V324.	Check and replace if necessary.

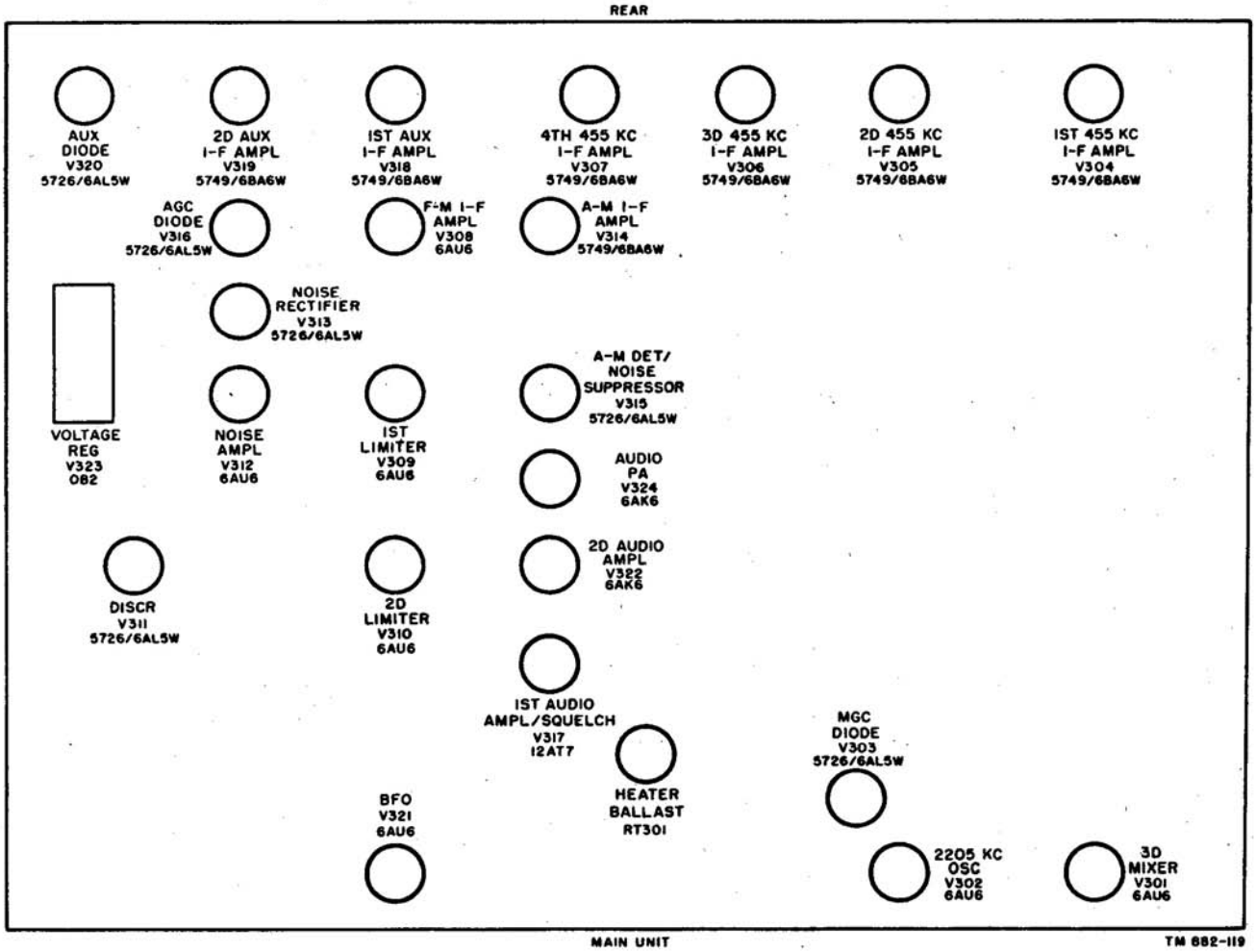


Figure 67. Tube location, main unit.

d. Rf Unit.

Symptom	Probable trouble	Correction
1. Calibrator oscillator note heard in output, but no signals heard.	Defective antenna	Check antenna system, and repair it.
	Defective rf amplifiers V101 and/or V102.	Check voltage and resistance at V101 and/or V102 sockets, and replace defective part.
	Defective V101 or V102	Replace V101 or V102.
	Defective Z150 and/or Z151	Repair or replace.
2. Calibrator oscillator note not heard in output but signals are received.	Defective calibrator oscillator V115 and/or calibrator buffer V114.	Check voltage and resistance measurements at V114 and/or V115 sockets and replace defective part.
	Calibrator oscillator misalined	Refer to paragraph 109 for alinement procedure, and aline it.
	Defective crystal Y101	Replace Y101.
	Defective V114 or V115	Replace V114 or V115.
3. Receiver inoperative on bands 6 and 7.	Defective third multiplier-buffer V105 or V106.	Check voltage and resistance at V105 and V106 sockets. Replace defective part.
	Defective V105 or V106.	Replace V105 or V106.
4. Receiver inoperative on bands 4, 5, 6, and 7.	Defective second multiplier-buffer V107 or V108.	Check voltage and resistance at V107 and V108 sockets. Replace defective part.

d. Rf Unit—Continued.

Symptom	Probable trouble	Correction
5. Receiver inoperative on all bands.	Defective V107 or V108	Replace V107 or V108.
	Defective first hf oscillator stage V110.	Check voltage and resistance at V110 socket, and replace defective part.
	Defective second buffer V103, first mixer V104, third multiplier-buffer V106, second multiplier-buffer V108, first multiplier-buffer V109, or first buffer V116.	Check voltage and resistance at V103, V104, V106, V108, V109, and/or V116 sockets. If trouble still exists, refer to paragraph 88 on signal substitution.
	Defective V103, V104, V106, V108 or V109.	Replace V103, V104, V106, V108 or V109.
	Defective second hf oscillator V111, second mixer V112, and/or first if amplifier V113.	Check voltage and resistance at V111, V112, and/or V113 sockets.
	Defective V111, V112, or V113	Replace V111, V112, or V113.
6. Receiver inoperative on one band only.	Defective turret coil	Refer to paragraph 87*e*.
	Defective component part of T101 and/or T102.	Check resistance of parts in T101 and T102 and replace defective part.
	Defective crystal in 2d hf oscillator	Replace crystal.
7. Receiver output drifts	Open first hf oscillator heating element.	Check continuity through heating element; replace if necessary.
	Defective S103	Replace S103.
8. Receiver inoperative on even bands.	Defective switch S102	Check for continuity through contacts; replace if necessary.
	Even band oscillator circuit of V110	Check component continuity and repair or replace.
9. Receiver inoperative on odd bands.	Defective switch S102	Check for continuity through contacts; replace if necessary.
	Odd band oscillator circuit of V110	Check component continuity and repair or replace.
10. Receiver inoperative on bands 2 and 4.	Open resistor R166	Replace R166.

e. Turret Cross-Reference Chart.

Turret	Band number						
	1	2	3	4	5	6	7
Z150	Z101	Z102	Z103	Z104	Z105	Z106	Z107
Z151	Z108	Z109	Z110	Z111	Z112	Z113	Z114
Z152	Z115	Z116	Z117	Z118	Z119	Z120	Z121
Z153	Z122	Z123	Z124	Z125	Z126	Z127	Z128
Z154	Z129	Z130	Z131	Z132	Z133	Z134	Z135
Z155	Z136	Z137	Z138	Z139	Z140	Z141	Z142
Z156	Z143	Z144	Z145	Z146	Z147	Z148	Z149

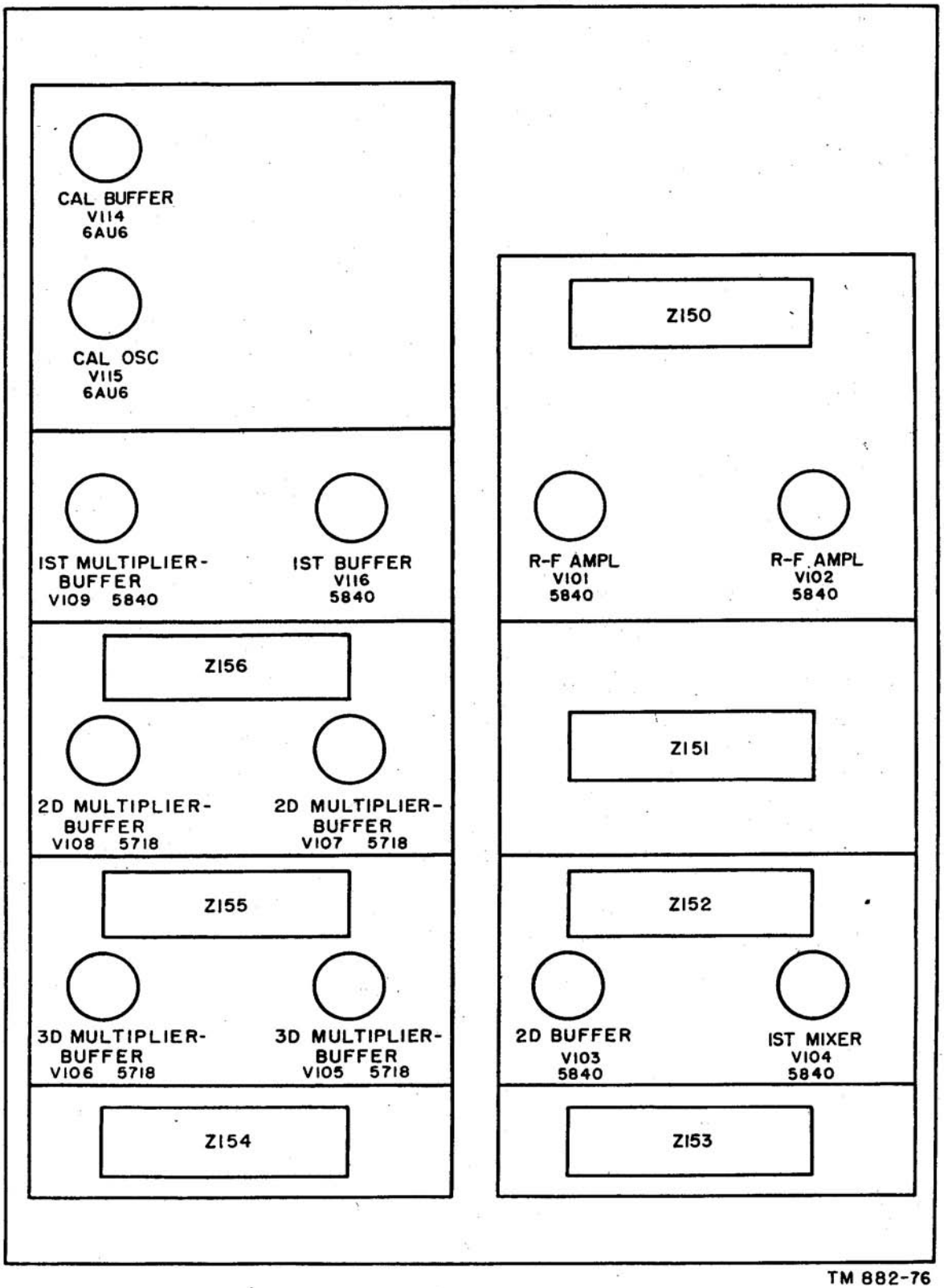


Figure 68. Tube location, right side of rf unit.

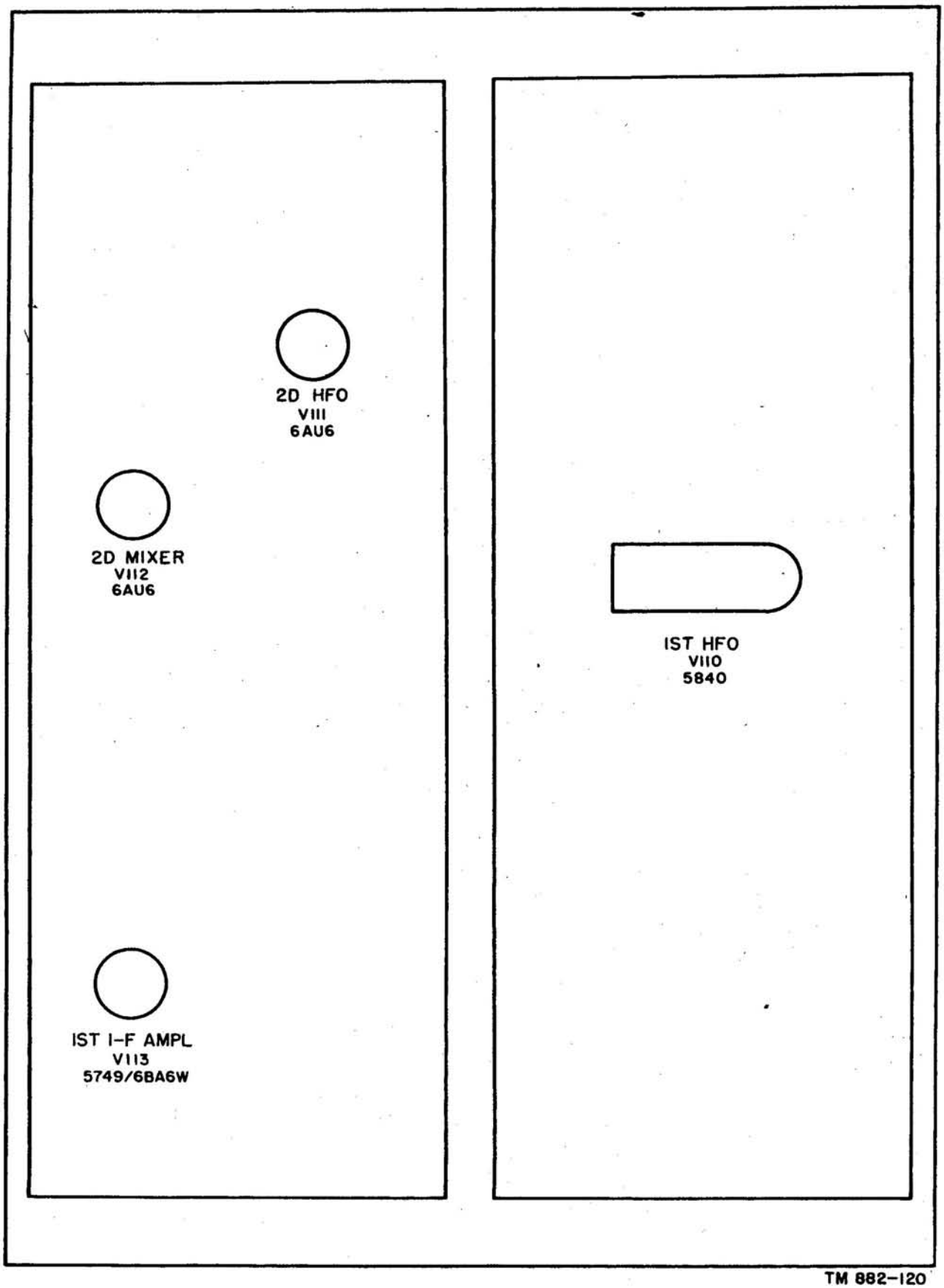


Figure 69. Tube location, left side of rf unit.

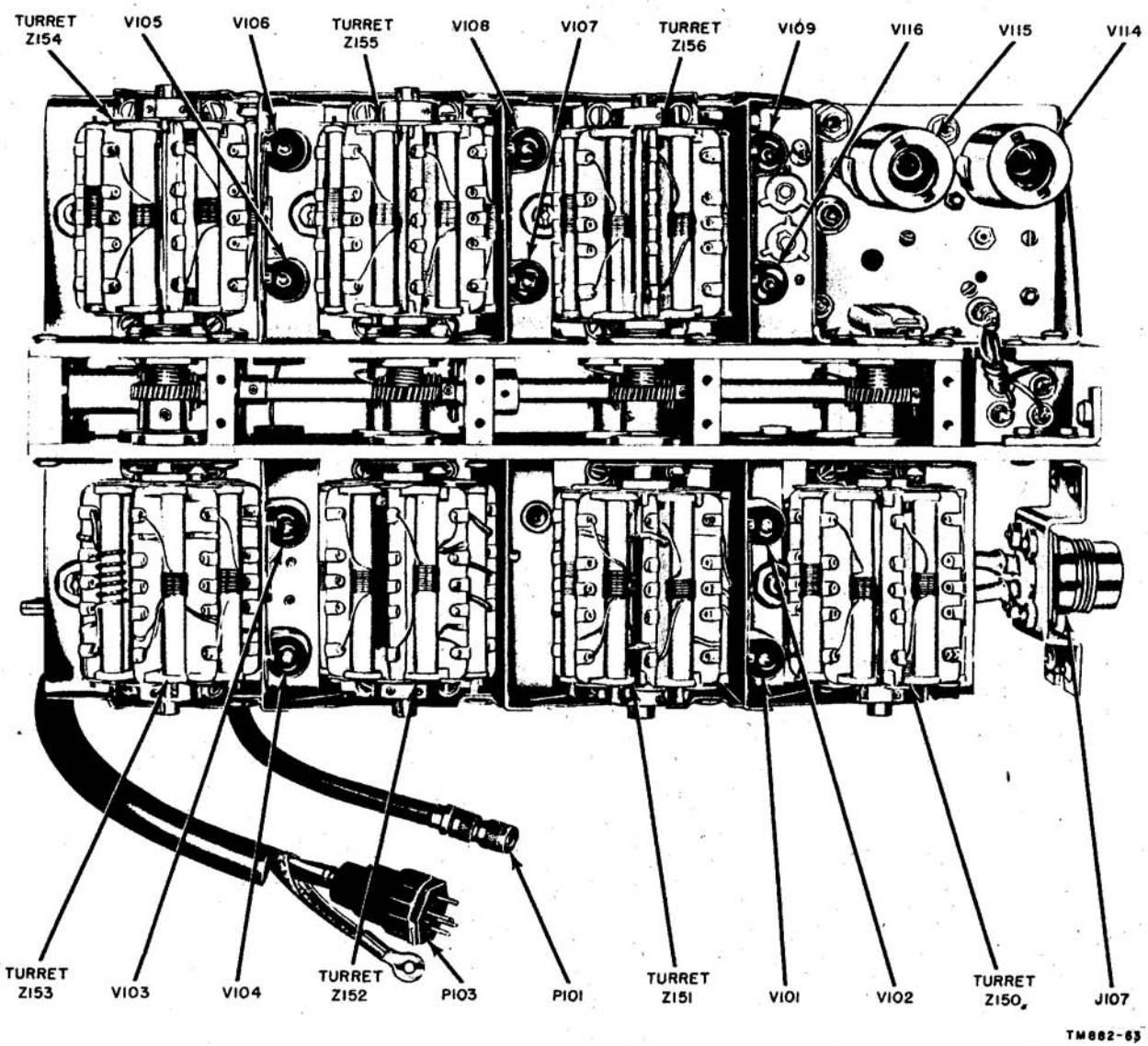


Figure 70. Turret side of rf unit.

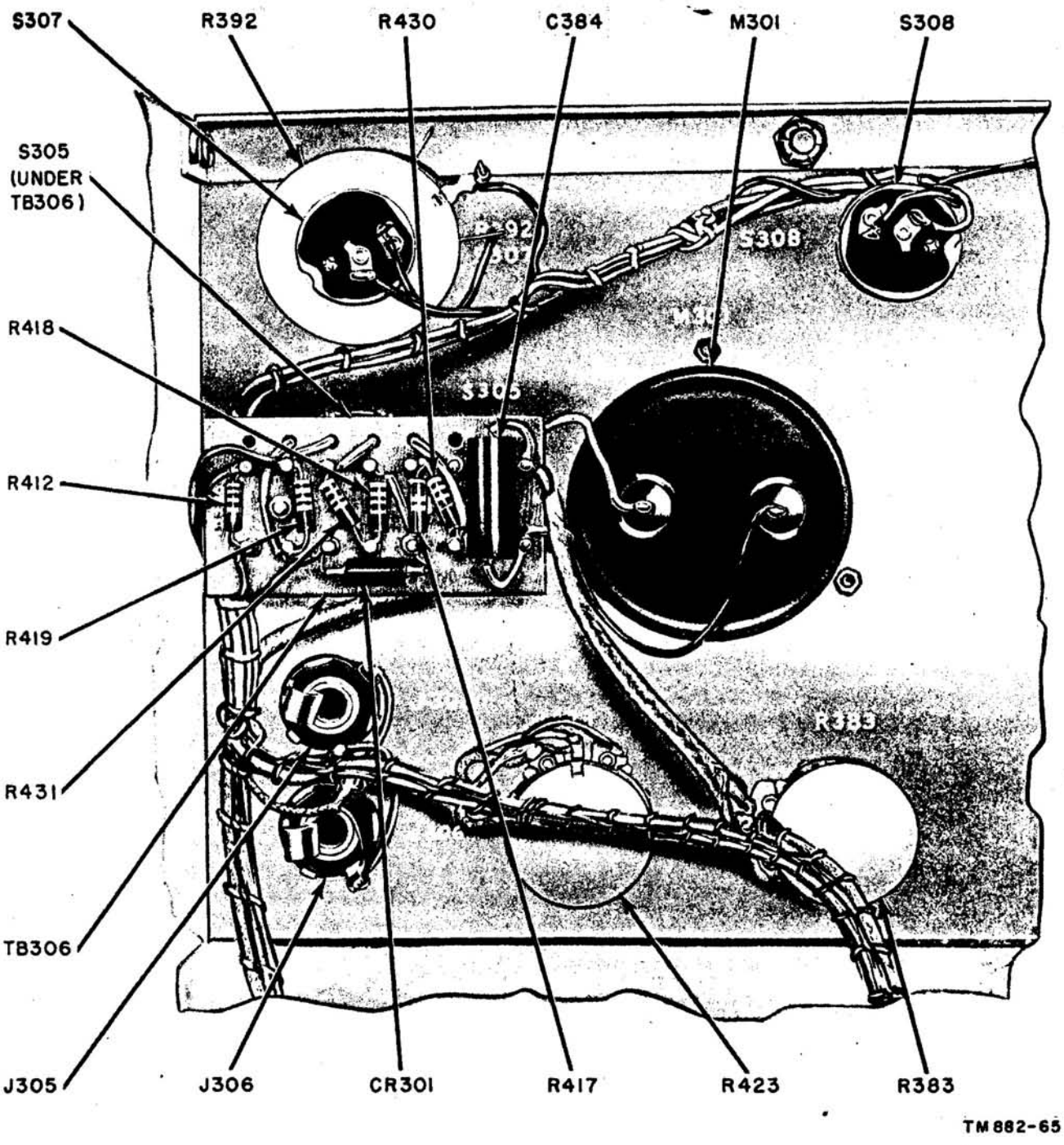


Figure 71. Parts location, section E.

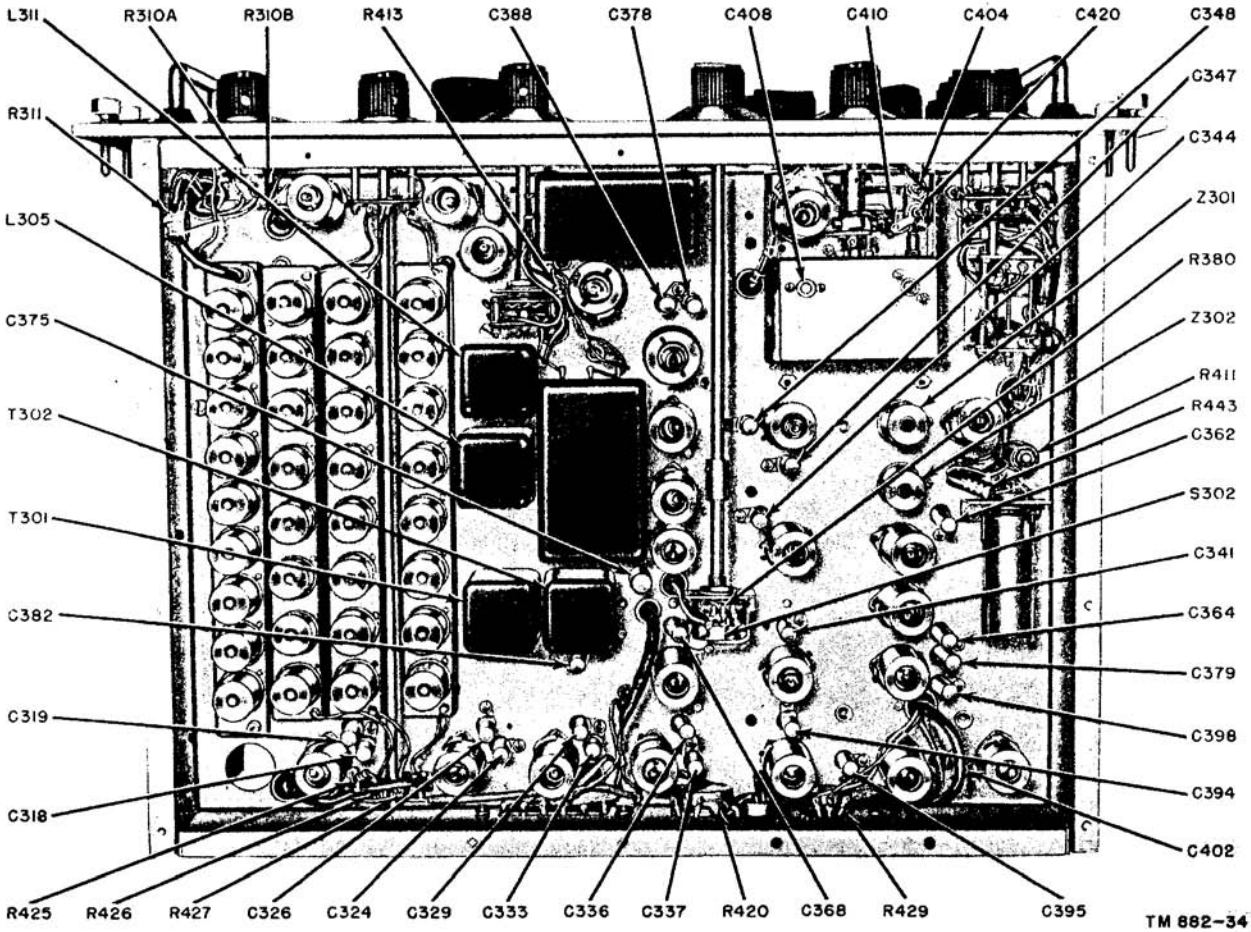


Figure 72. Radio Receiver R-220/URR, under chassis view.

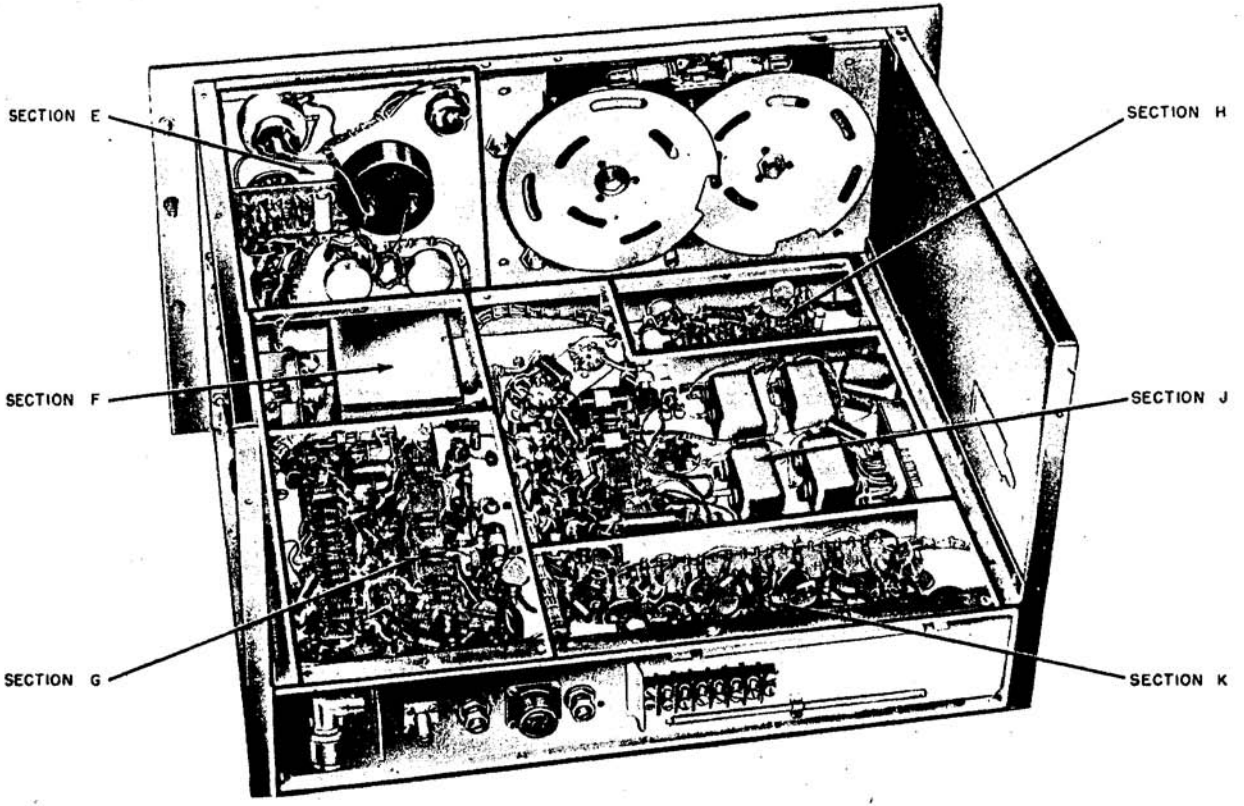


Figure 73. Radio receiver R-220/URR, showing location of sections E through K.

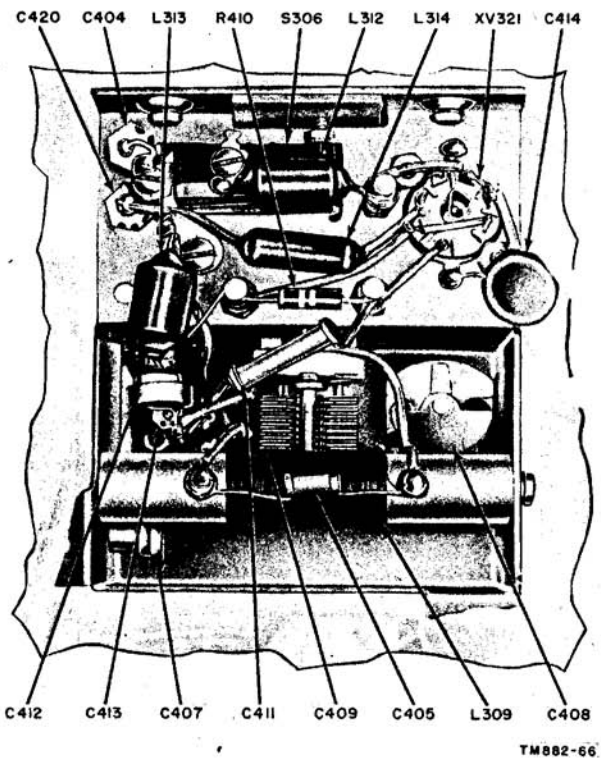


Figure 74. Parts location, section F.

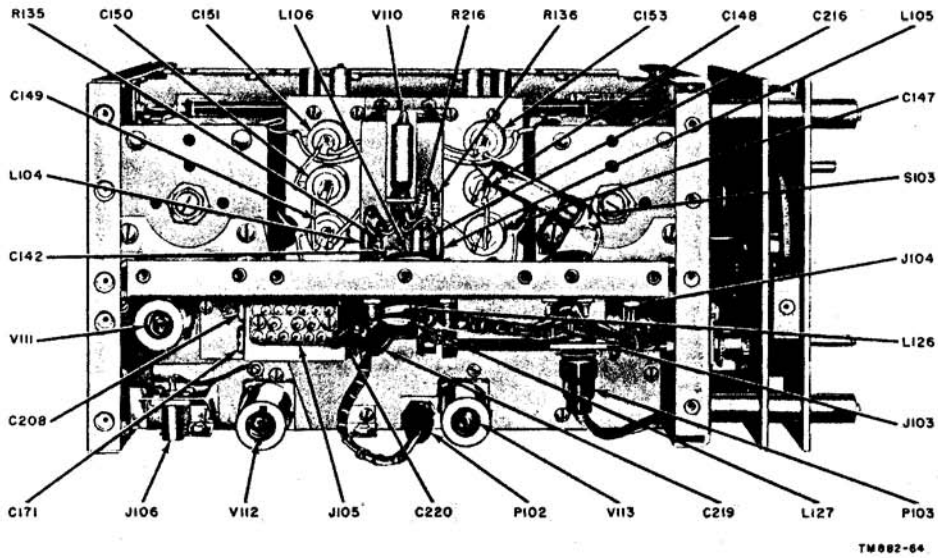
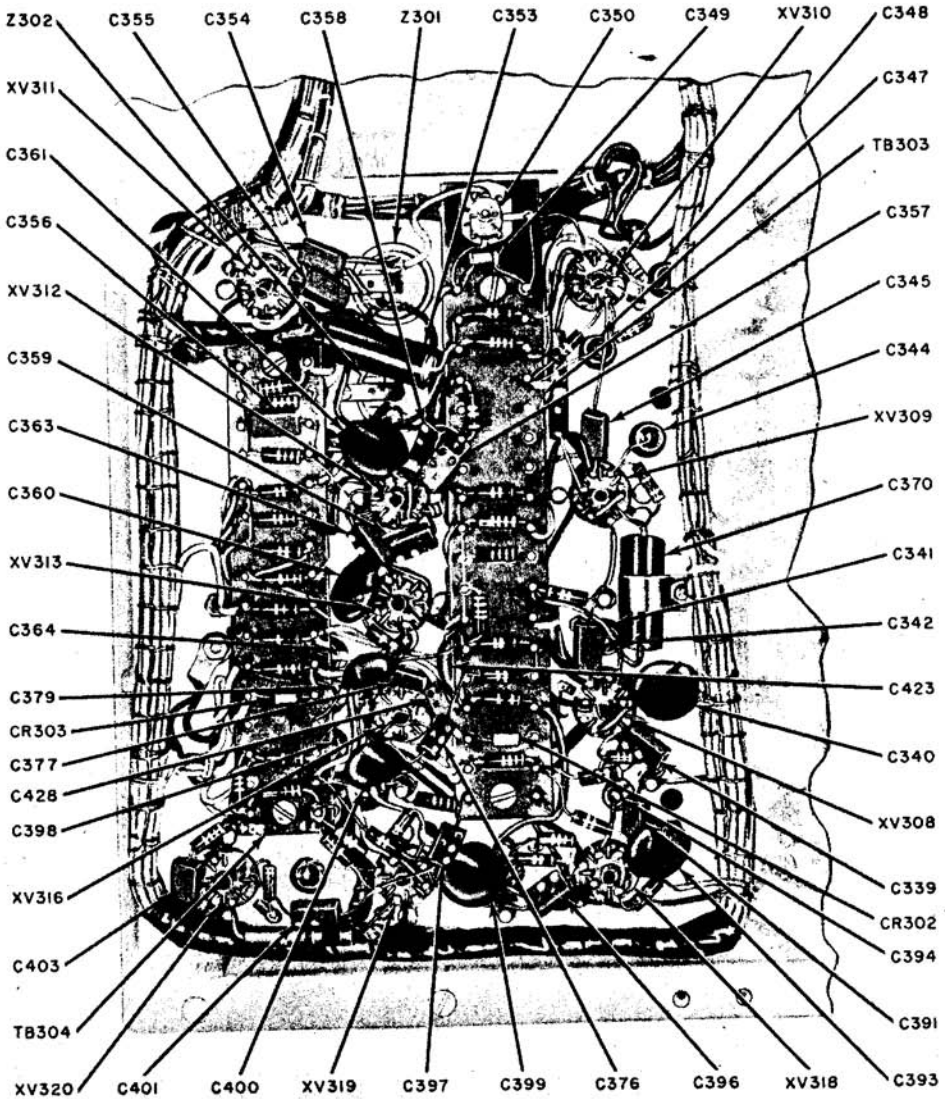


Figure 75. Rf unit, oscillator side.



P.107

Figure 10. Parts location, section of shielding capacitors.

88. Signal Substitution

The signal substitution method of troubleshooting quickly isolates a defective stage or circuit. This method of troubleshooting is the process of substituting an externally generated signal for the signal normally present in each stage of the receiver. For example, injecting a 1,000-cycle signal into the audio section of a properly operating receiver results in hearing a 1,000-cycle audio note at the speaker. When checking the if. section, a 455-kc signal modulated by an audio note, is injected into the grid of one of the if. amplifier tubes. If that portion of the receiver is operating properly, again an audio note will be heard in the speaker. Proper use of the troubleshooting chart (par. 87) may indicate the approximate location of trouble within the receiver. For this reason, the signal substitution procedures are listed in separate charts for various sections of the receiver. After determining which section is defective, reference can be made to the appropriate chart (par. 89) to eliminate time spent in checking circuits known to be working properly.

a. Signal substitution requires a source of audio, if., and rf signals. Use one of the signal generators listed in paragraph 83 which will produce the signal required in any specific test.

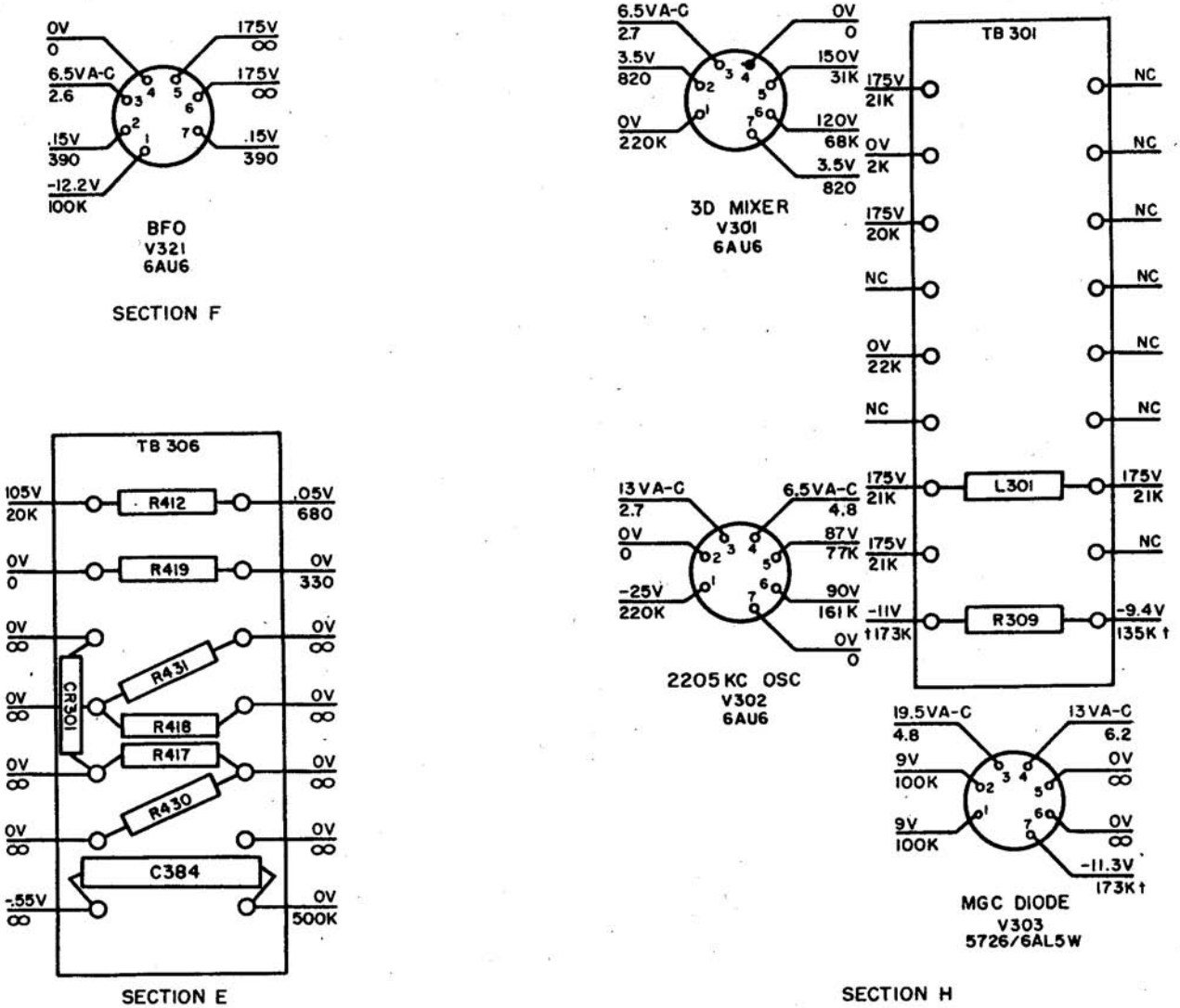
b. A vacuum-tube voltmeter (vtvm) and tube tester are needed to isolate the defective component part after the faulty stage has been located. A headset or speaker is also required as an indicating device.

c. Use a capacitor in series with the signal generator lead; .05 microfarad (μf) for audio signals; 100 micromicrofarad ($\mu\mu$f) for if. and rf signals.

d. Note the volume obtained; listen for serious distortion. When working back through the receiver from the audio output stage toward the input stages, reduce the signal generator output as required to eliminate the possibility of forcing a signal through a defective circuit. If a spare receiver in good operating condition is available, compare the results obtained from the receiver being tested with the receiver known to be operating properly.

e. If the instructions direct a signal injection at a point which is difficult to reach, use another point which is electrically the same, but more accessible.

f. Be very careful when probing in the receiver. Component parts are small, and wired very close to each other. Check the wiring and the solder connections while testing by signal substitution. A poor solder connection or similar fault may be the trouble.



NOTES:

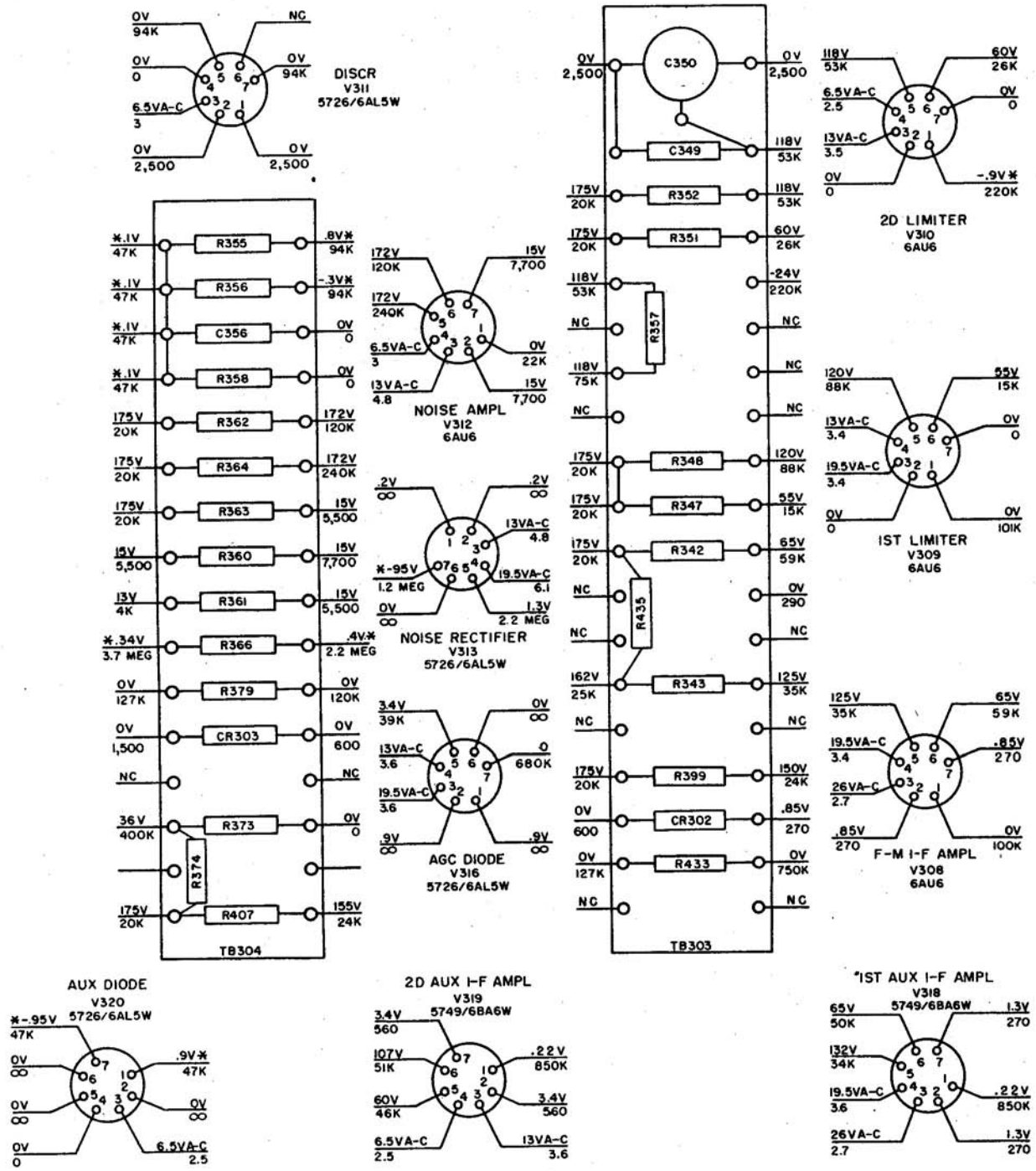
1. ALL VOLTAGE MEASUREMENTS ARE D-C POSITIVE, MADE WITH A 20,000 OHMS PER VOLT METER, UNLESS OTHERWISE SPECIFIED. * INDICATES MEASUREMENTS MADE WITH A VTVM.
2. RESISTANCE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT AND POWER SUPPLY DISCONNECTED. VOLTAGE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT DISCONNECTED.
3. ALL MEASUREMENTS ARE MADE WITH THE FOLLOWING CONTROL SETTINGS:

CONTROL	SETTING
OPERATION	MGC
R.F. GAIN SQUELCH	MIDPOSITION
B.F. OSCILLATOR	MIDPOSITION
SELECTIVITY	50K

4. NC INDICATES NO CONNECTION.
5. † DEPENDS ON SETTING OF R311.

TM882-137

Figure 77. Sections E, F, and H, voltage and resistance measurements.



NOTES:

1. ALL VOLTAGE MEASUREMENTS ARE D-C. POSITIVE MADE WITH A 20,000 OHMS PER VOLT METER, UNLESS OTHERWISE SPECIFIED. * INDICATES MEASUREMENTS MADE WITH A VTVM.
2. RESISTANCE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT AND POWER SUPPLY DISCONNECTED. VOLTAGE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT DISCONNECTED.
3. ALL MEASUREMENTS MADE WITH THE FOLLOWING CONTROL SETTINGS:

CONTROL	SETTING
OPERATION	MGC
R. F GAIN SQUELCH	MID-POSITION
DISCRIM METER CENTER CONTROL	MID-POSITION

4. NC INDICATES NO CONNECTION.

TM 882-135

Figure 78. Section G, voltage and resistance measurements.

NOTES:

1. ALL VOLTAGE MEASUREMENTS ARE D-C POSITIVE, MADE WITH A 20,000 OHMS PER VOLT METER, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT AND POWER SUPPLY DISCONNECTED. VOLTAGE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT DISCONNECTED.
3. ALL MEASUREMENTS MADE WITH THE FOLLOWING CONTROL SETTINGS:

CONTROL	SETTING
OPERATION	AM SQUELCH
SELECTIVITY	50 K.C.
R.F. GAIN SQUELCH	FULLY CLOCKWISE (SEE NOTE 4)

4. READINGS IN PARENTHESES TAKEN WITH THE R. F. GAIN-SQUELCH CONTROL FULLY COUNTERCLOCKWISE.
5. NC INDICATES NO CONNECTION.

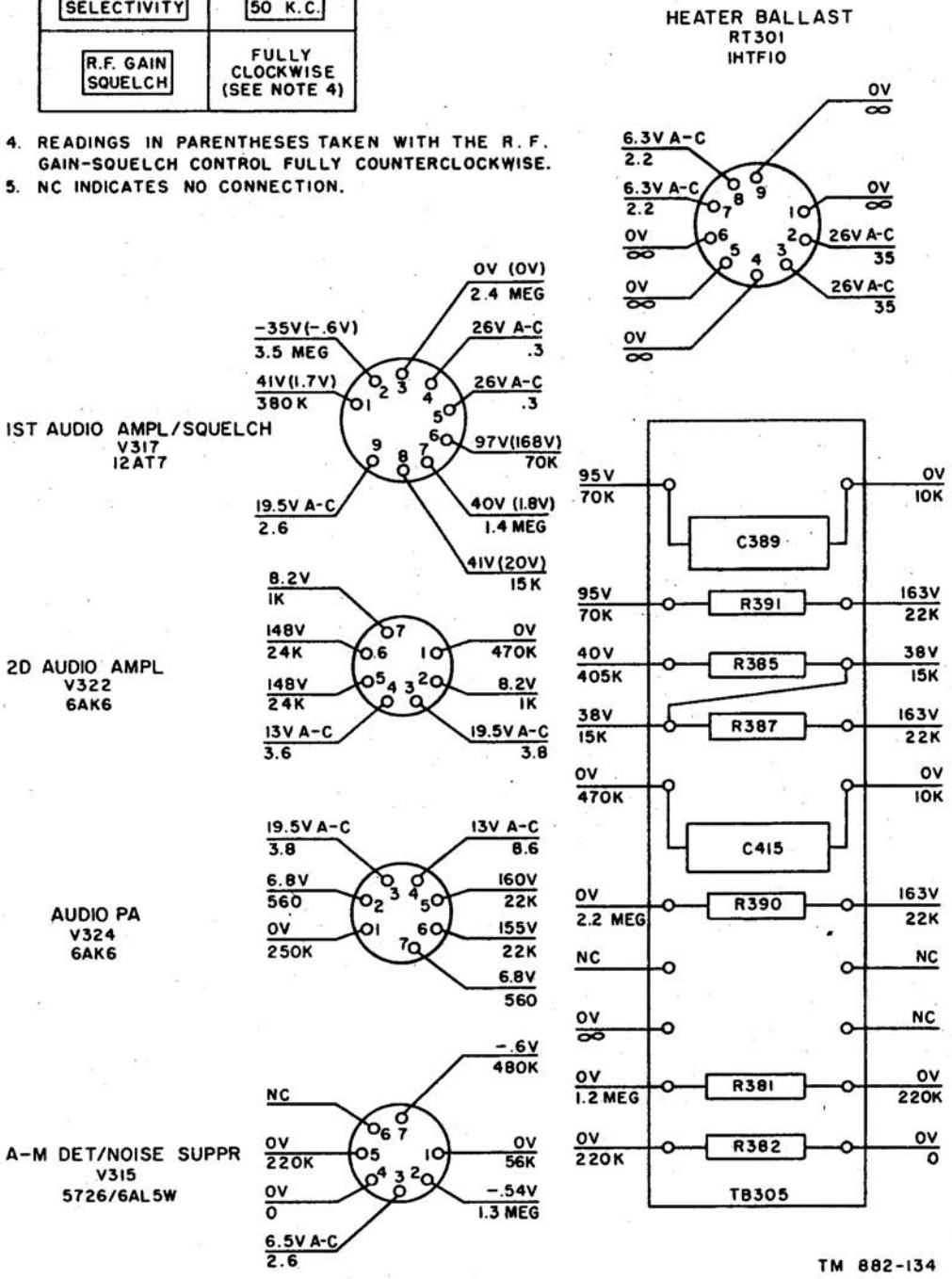


Figure 79. Section J, voltage and measurements.

NOTES:

1. ALL VOLTAGE MEASUREMENTS ARE D-C POSITIVE, MADE WITH A 20,000 OHMS PER VOLT METER, UNLESS OTHERWISE SPECIFIED. * INDICATES MEASUREMENTS MADE WITH A VTVM.

2. RESISTANCE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT AND POWER SUPPLY DISCONNECTED. VOLTAGE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT DISCONNECTED.

3. ALL MEASUREMENTS ARE MADE WITH THE FOLLOWING CONTROL SETTINGS:

CONTROL	SETTING
OPERATION	MGC
SELECTIVITY	200 K.C.
R.F. GAIN SQUELCH	MID-POSITION

4. NC INDICATES NO CONNECTION.

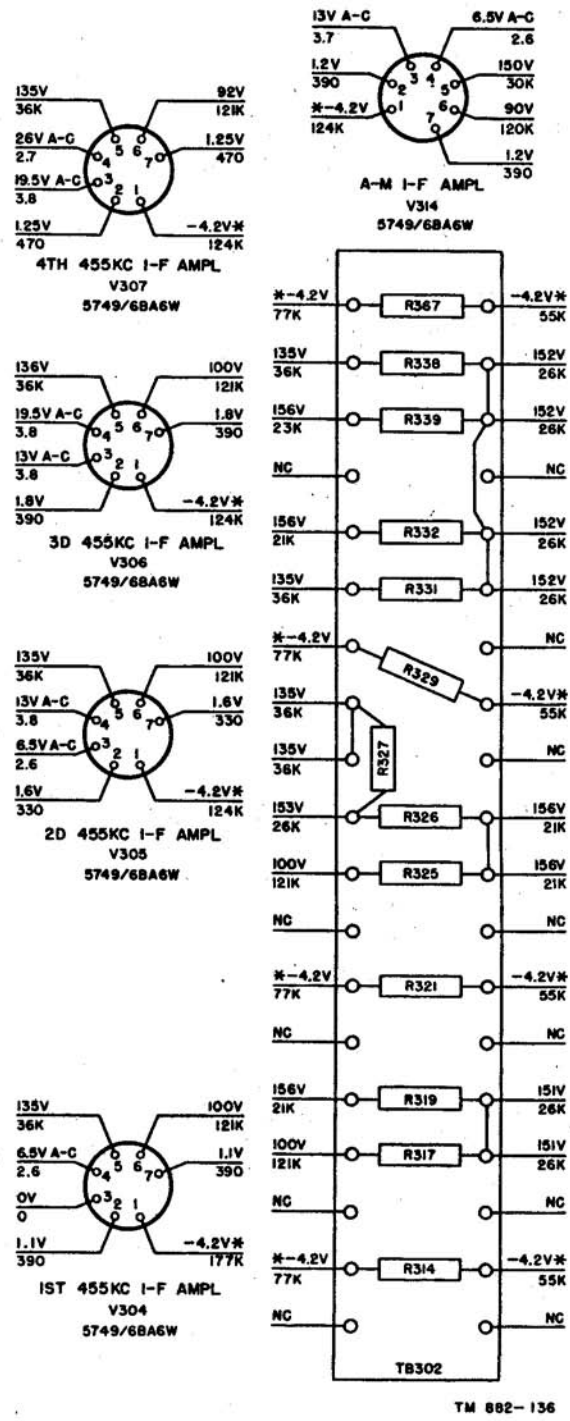


Figure 80. Section K, voltage and resistance measurements.

89. Signal Substitution Charts

Directions for signal substitution are contained in the charts in *a* through *f* below. Each chart contains specific instructions for a particular section of the receiver, such as the 455-kc if. and the 1.75-mc if. If the items listed in the possible trouble column check favorably, make voltage and resistance measurements on individual parts of the circuit to determine the trouble. Use Audio Oscillator TS–382A/U. If an audio tone is not heard in the speaker, consult the possible trouble column. This applies to the entire paragraph.

a. Audio Chart.

Signal frequency	Connection	Possible trouble
1 kc	V324, power amplifier grid, pin 1	Defective speaker, phones, V324, J305, J306, T302, or R423.
1 kc	V322, second audio amplifier grid, pin 1	Defective V322, T301, or C417. Open connections on TB308.
800 cps	V317, first audio amplifier grid, pin 7	Defective V317 or S304. Check applicable filter if signal is lost on one setting of S304.

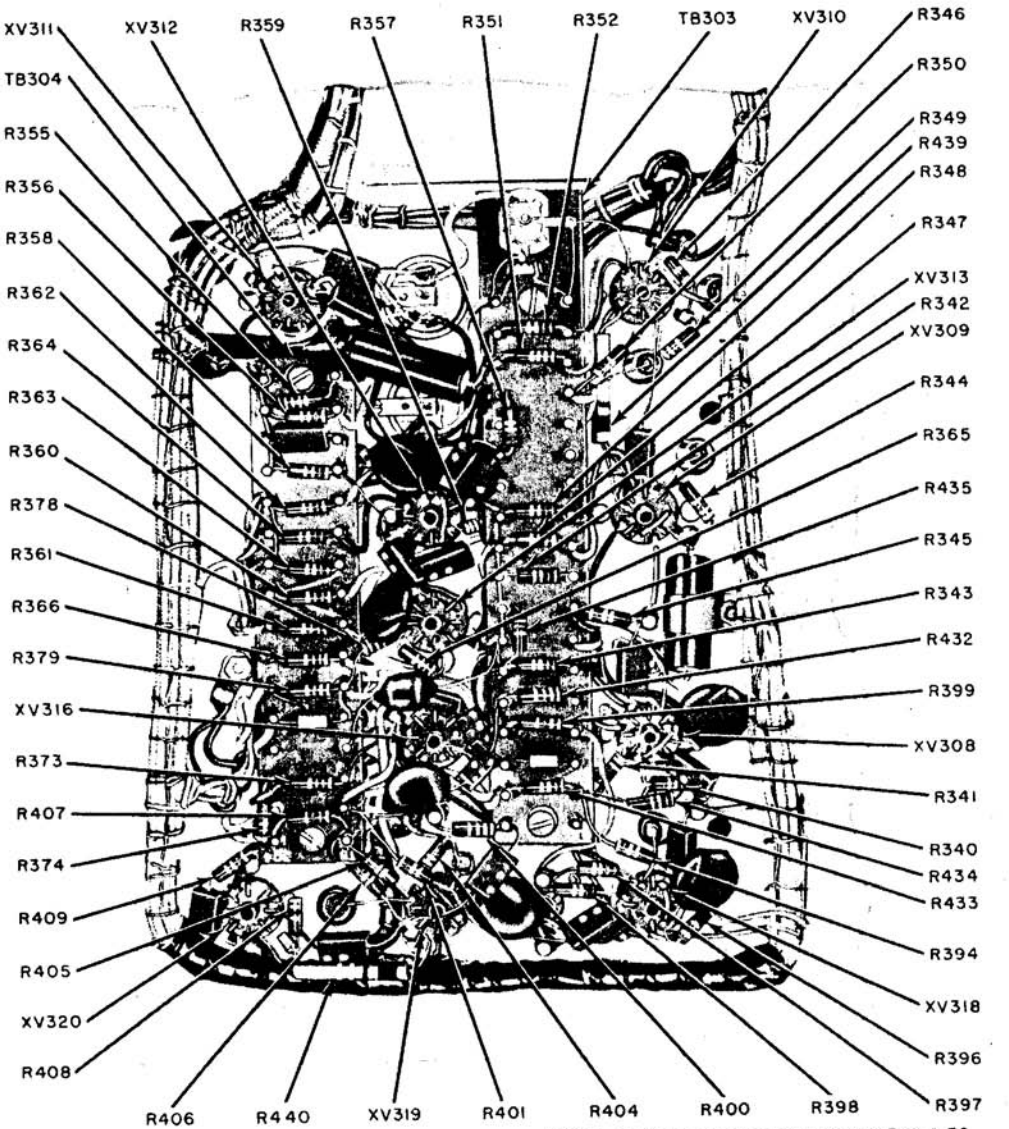
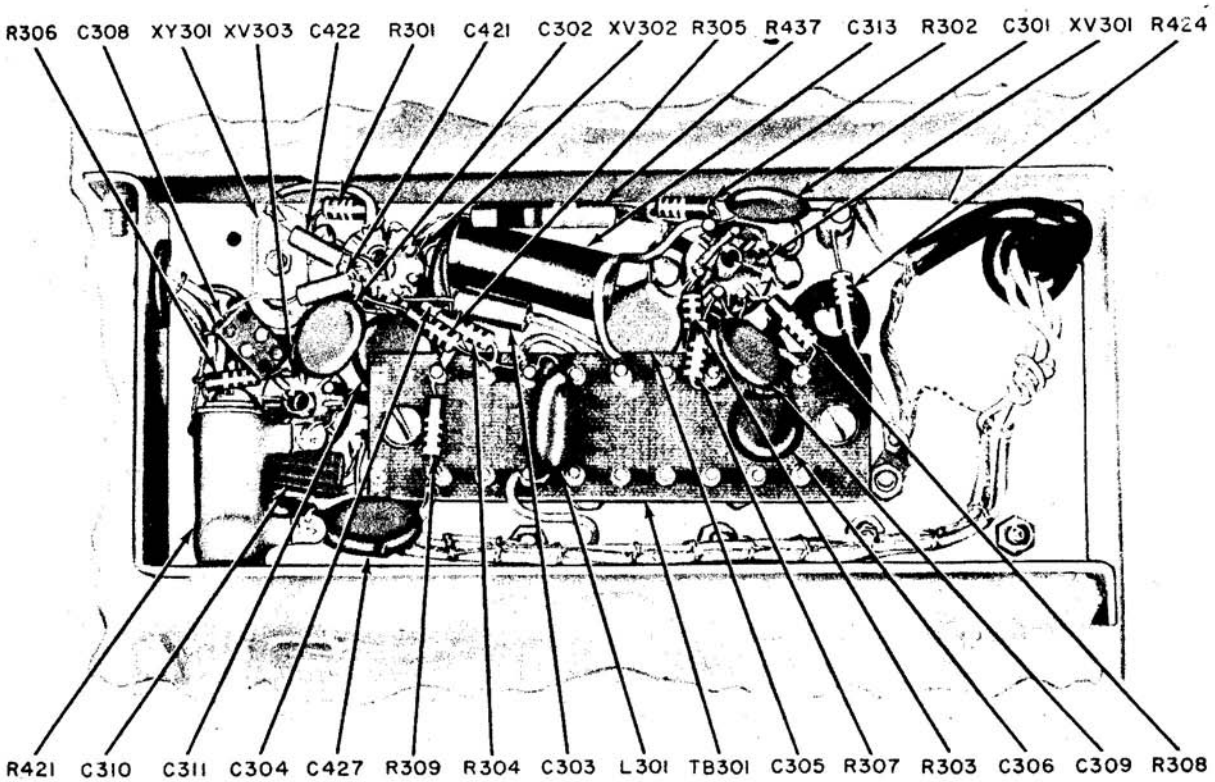


Figure 81. Parts location, section G, showing resistors.



NOTE: IN MODELS ON ORDER NO 116-PHILA-52 WITH SERIAL NUMBERS 93 AND HIGHER, R437 IS DELETED.

TM 882-31

P.115

Figure 82. Parts location, section H.

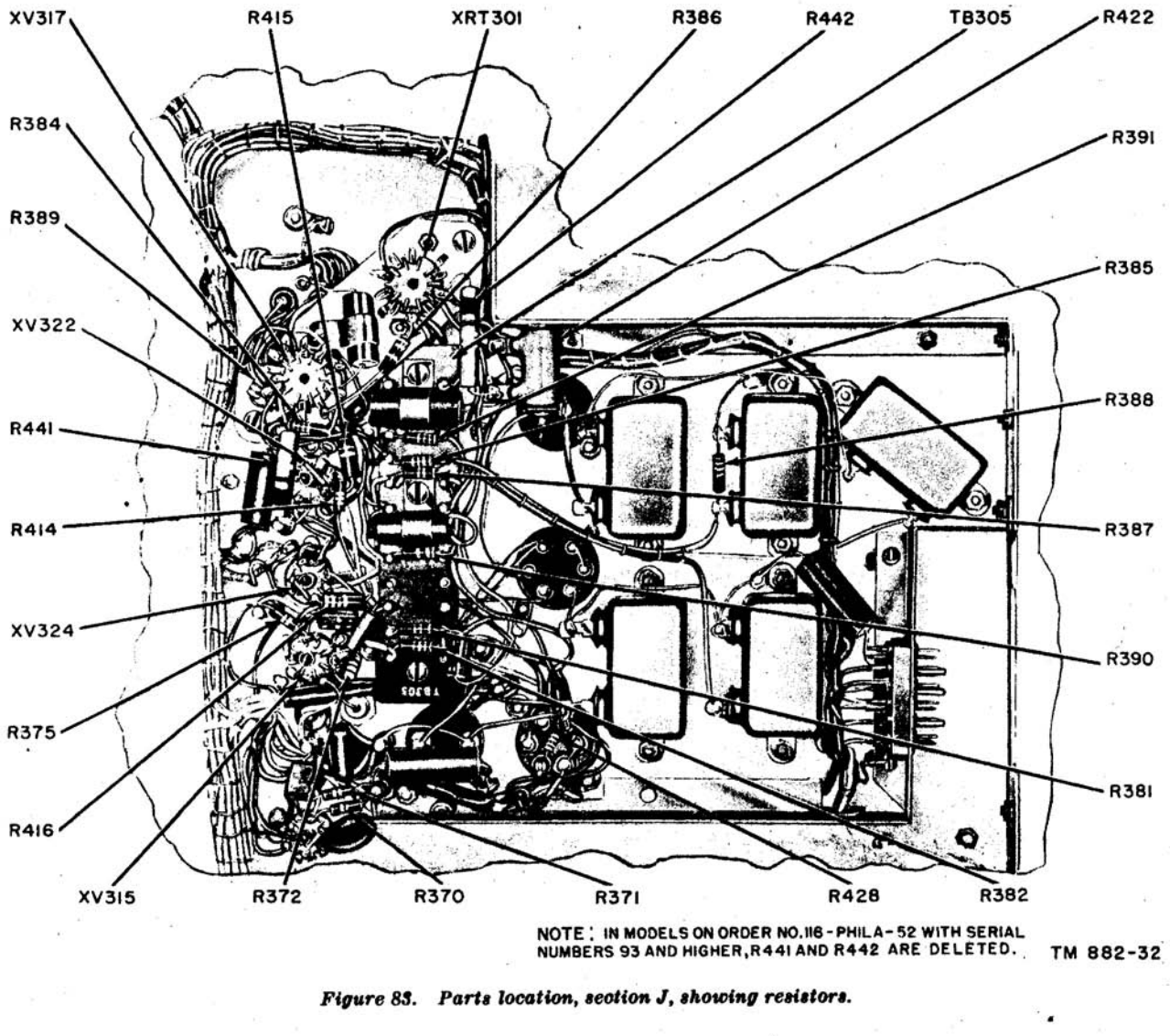


Figure 83. Parts location, section J, showing resistors.

b. Am. If. Chart. The chart below is used when the trouble has been isolated to the am. if. circuit by using the equipment performance checklist (par. 47). A signal generator, such as the AN/URM-25, is required.

Signal frequency	Connection	Possible trouble
455 kc, am	V315A, am. detector cathode, pin 1	Defective V315 or S303, section 1.
455 kc, am	V314, am. if. amplifier grid, pin 1	Defective V315, C367, or C368.

c. Auxiliary Circuit Chart. The chart below is used when the trouble has been isolated to the auxiliary circuit by using the equipment performance checklist (par. 47). The speaker or headset cannot be used as an indicating device. Use a vacuum-tube voltmeter (vtvm) such as TS–505/U and connect it between pin 7 of V320 and chassis, or between pins A and B of J301 AUX. DIODE OUTPUT (fig. 50). Use AN/URM–25 as a signal source. During each test, the vtvm should indicate an output, the amount depending on the strength of the signal fed in.

Signal frequency	Connection	Possible trouble
455 kc	V320A, auxiliary diode cathode, pin 1	Defective V320, R409, or C403.
455 kc	V319, second auxiliary if. amplifier grid, pin 1.	Defective V319, C398, C399, C401, or C402.
455 kc	V318, first auxiliary if. amplifier grid, pin 1	Defective V318, C393, C394, C396, or C397.

d. Fm If. Chart. The chart below is used when trouble has been isolated to the fm circuit by using the equipment performance checklist (par. 47). The speaker or headset may be used as an indicating device. Set the OPERATION switch to FM SQUELCH. Use Signal Generator AN/URM–25.

Signal frequency	Connection	Possible trouble
455 kc, fm	V310, second limiter grid, pin 1	Defective V310, L307, L308, V311, C344, or C345.
455 kc, fm	V309, first limiter grid, pin 1	Defective V309, C344, or C345.
455 kc, fm	V308, fm amplifier grid, pin 1	Defective V308, C340, C341, or C342.

e. 455 Kc If. Chart. The chart below is used when the trouble is present for all settings of the OPERATION switch. For this test and the remaining tests, set the OPERATION switch to MGC. Use Signal Generator AN/URM–25.

Signal frequency	Connection	Possible trouble
455 kc, am	V307, fourth 455 kc if. amplifier grid, pin 1	Defective V307, C335, C336, or C337.
455 kc, am	V306, third 455 kc if. amplifier grid, pin 1	Defective V306, C328, C329, C331, or C333.
455 kc, am	V305, third 455 kc if. amplifier grid, pin 1	Defective V305, L303, C323, C324, C325, C326, or C327.
455 kc, am	V304, first 455 kc if. amplifier grid, pin 1	Defective V304, C317, C318, C319, C320, or C321.
455 kc, am	V301, third mixer plate, pin 5	Defective FL302, FL303 or FL304 (depending on S301 setting). Defective C309 and C314 if. signal is lost on all settings of S301.
1.75 mc, am	V301, third mixer grid, pin 1	Defective V301, Y301, V302, C301, C303, C305, or S301.

f. Rf Unit.

(1) *Band 1.* Tune the receiver to 25 mc. Use Signal Generator AN/URM–25.

Signal frequency	Connection	Possible trouble
6.0942 mc, am	V112, second mixer grid, pin 1	Defective V112, C160, C172, C173, C174, C175, C183, C221, or cable assembly W301.
6.0942 mc, am	V113, first if. amplifier grid, pin 1	Defective V113, C177, C178, C179, or C180.
6.0942 mc, am	V104, first mixer plate, pin 5	Defective V104, C112, C113, C115, C181, S101. Faulty P101 connection.
25 mc, am	V104, first mixer grid, pin 1	Defective V104, V105, V106, V107, V108, V109, or associated components.
25 mc, am	V101, rf amplifier plate, pin 5	Defective V101, V102, Z108, or Z115.
25 mc, am	V101, rf amplifier grid, pin 1	Defective V101, C103, C105, or C106.
25 mc, am	Antenna input jack J107	Defective V102, Z101; poor contact at J107.

(2) *Band 2.* Tune the receiver to 35 mc. Use Signal Generator AN/URM–25.

Signal frequency	Connection	Possible trouble
8.6369 mc, am	V113, first if. amplifier grid, pin 1	Defective V113, L158, L159, C246, C247 or S101 contacts.
8.6639 mc, am	V104, first mixer plate, pin 5	Defective V104, L144, L145, C232, C233, or S101 contacts.
35 mc, am	V101, rf amplifier plate, pin 5	Defective V101, Z109, or Z116.
35 mc, am	Antenna input jack J107	Defective Z102.

(3) *Band 3.* Tune the receiver to 50 mc. Use Signal Generator AN/URM–70.

Signal frequency	Connection	Possible trouble
12.1884 mc, am	V113, first if. amplifier grid, pin 1	Defective V113, L156, L157, C244, C245, or S101 contacts.
50 mc, am	V101, rf amplifier plate, pin 5	Defective V101, Z110, or Z117.
50 mc, am	Antenna input jack J107	Defective Z103.

(4) *Band 4.* Tune the receiver to 65 mc. Use Signal Generator AN/URM–70.

Signal frequency	Connection	Possible trouble
17.2738 mc, am	V113, first if. amplifier grid, pin 1	Defective L154, L155, C242, C243, or S101.
17.2738 mc, am	V104, first mixer plate, pin 5	Defective L140, L141, C228, C229, or S101.
65 mc, am	V101, rf amplifier plate, pin 5	Defective Z111 or Z118.
65 mc, am	Antenna input jack J107	Defective Z104.

(5) *Band 5.* Tune the receiver to 95 mc. Use Signal Generator AN/URM–70.

Signal frequency	Connection	Possible trouble
24.3767 mc, am	V113, first if. amplifier grid, pin 1	Defective L152, L153, C240, C241, or S101.
24.3767 mc, am	V104, first mixer plate, pin 5	Defective L138, L139, C226, C227, or S101.
95 mc, am	V101, rf amplifier plate, pin 5	Defective Z112 or Z119.
95 mc, am	Antenna input jack J107	Defective Z105.

(6) *Band 6.* Tune the receiver to 130 mc. Use Signal Generator AN/URM–70.

Signal frequency	Connection	Possible trouble
34.5476 mc, am	V113, first if. amplifier grid, pin 1	Defective L150, L151, C238, C239, or S101.
34.5476 mc, am	V104, first mixer plate, pin 5	Defective L136, L137, C224, C225, or S101.
130 mc, am	V101, rf amplifier plate, pin 5	Defective Z113 or Z120.
130 mc, am	Antenna input jack J107	Defective Z106.

(7) *Band 7.* Tune the receiver to 200 mc. Use Signal Generator AN/URM–70.

Signal frequency	Connection	Possible trouble
48.7535 mc, am	V113, first if. amplifier grid, pin 1	Defective L148, L149, C236, C237, or S101.
48.7535 mc, am	V104, first mixer plate, pin 5	Defective L134, L135, C222, C223, or S101.
200 mc, am	V101, rf amplifier plate, pin 5	Defective Z114 or Z121.
200 mc, am	Antenna input jack J107	Defective Z107.

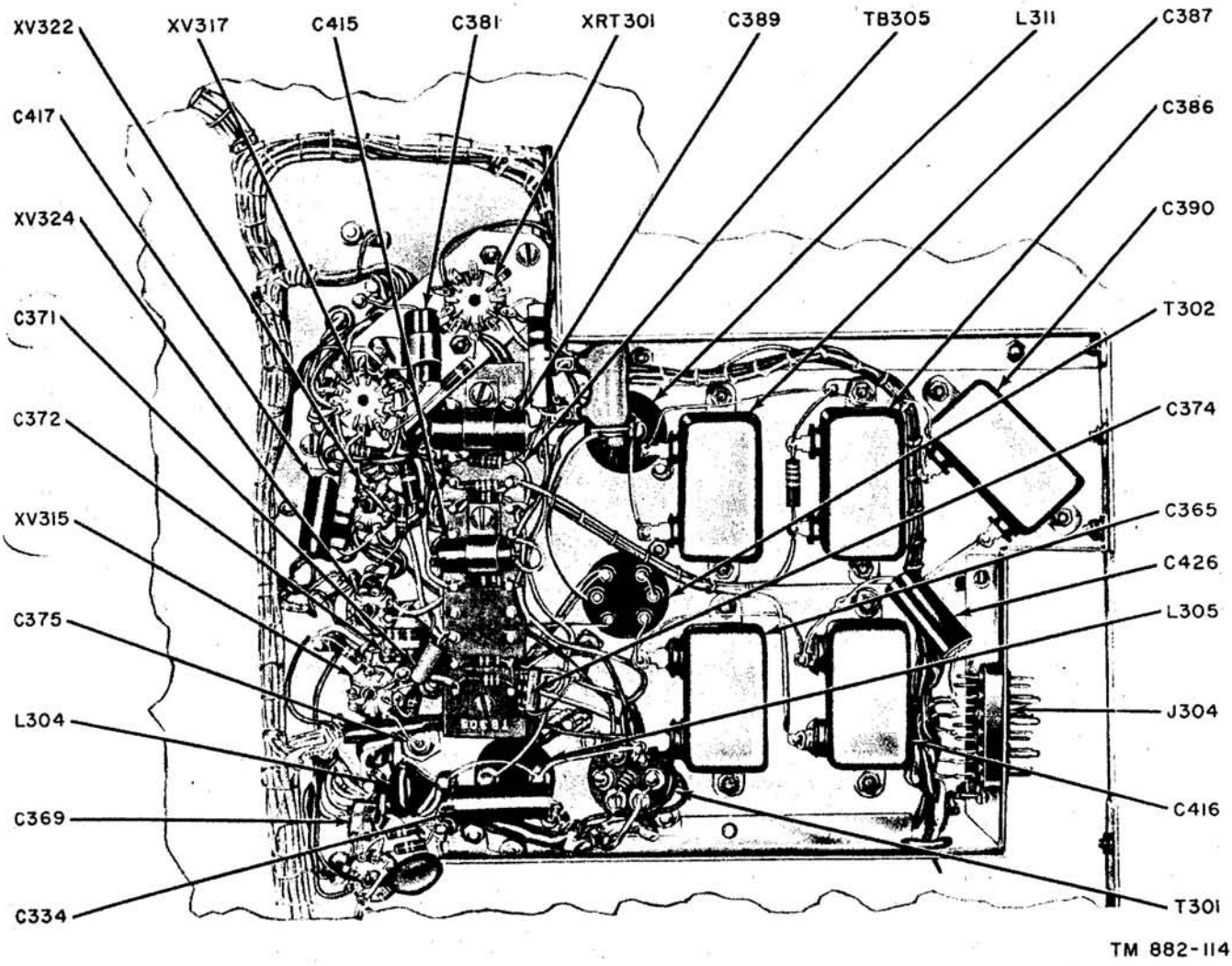


Figure 84. Parts location, section J, showing capacitors.

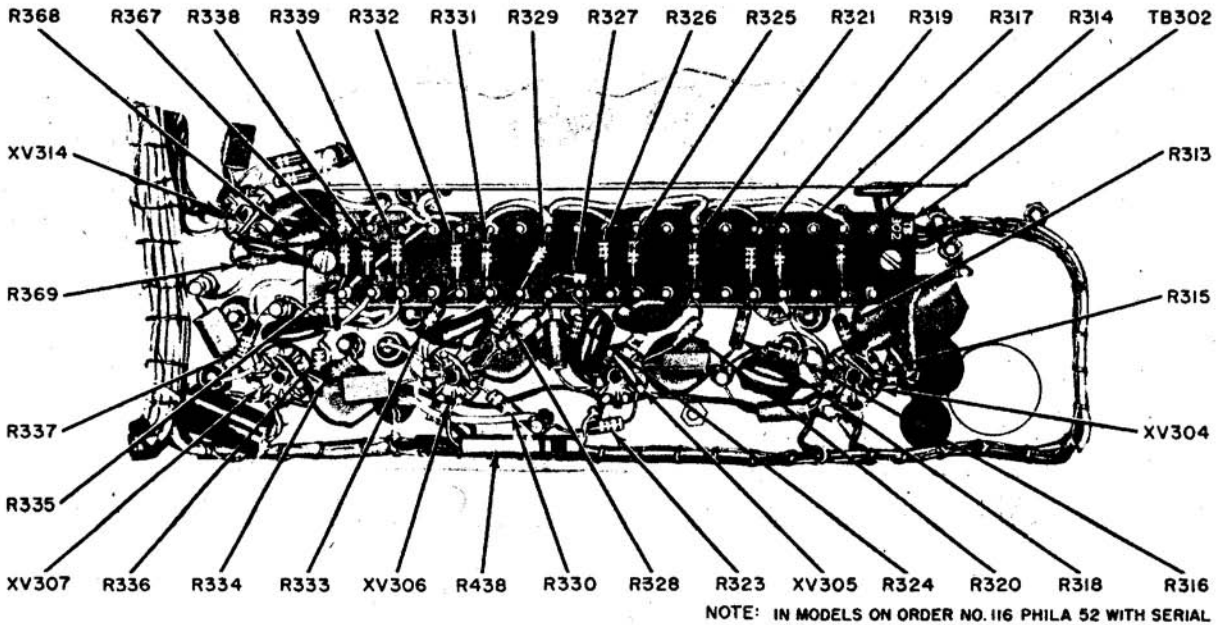


Figure 85. Parts location, section K, showing resistors.

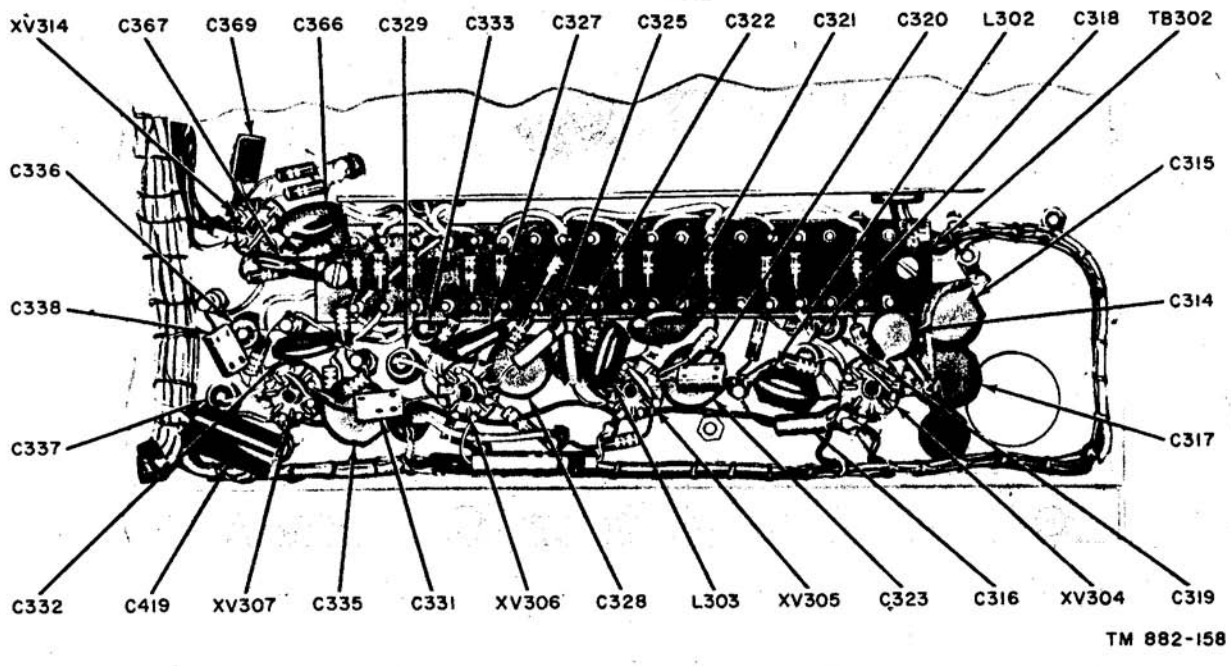
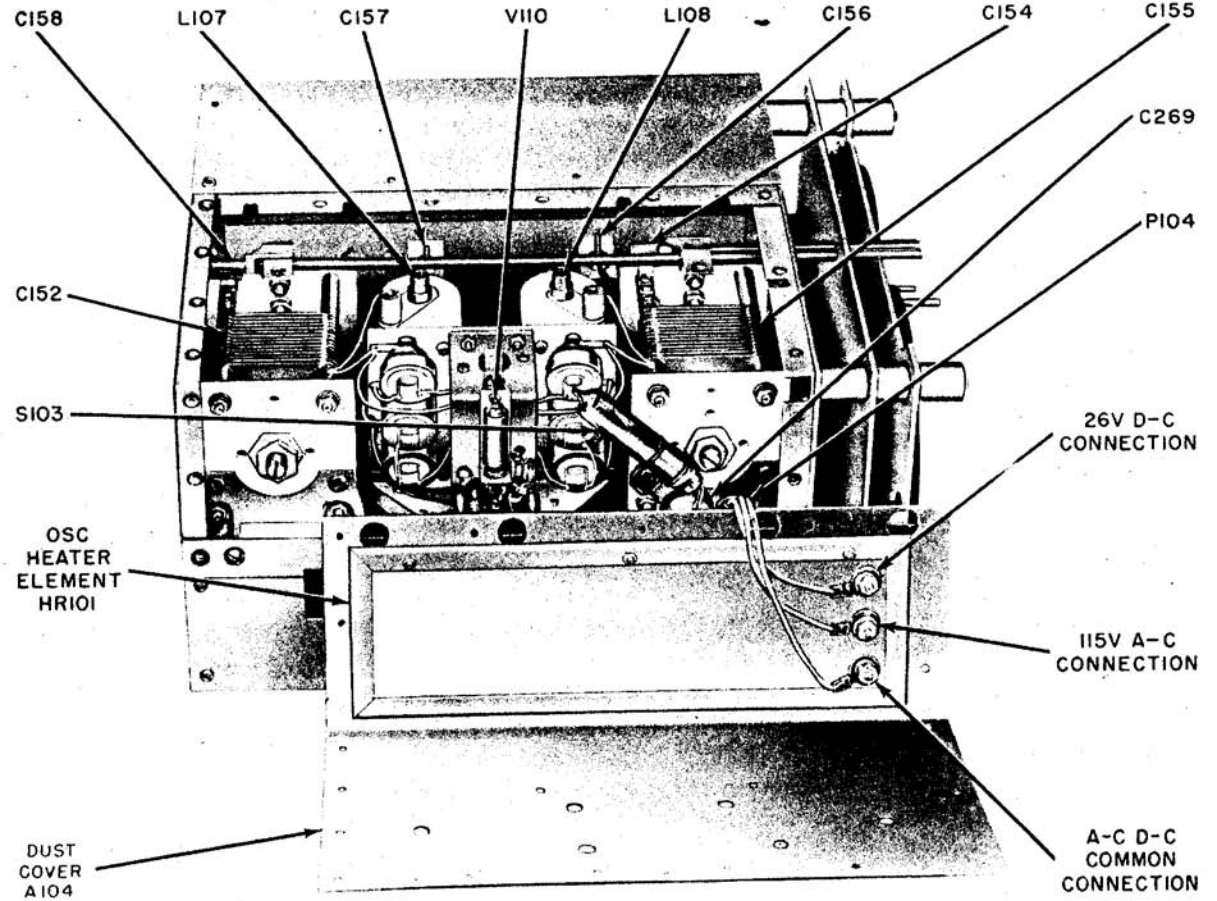
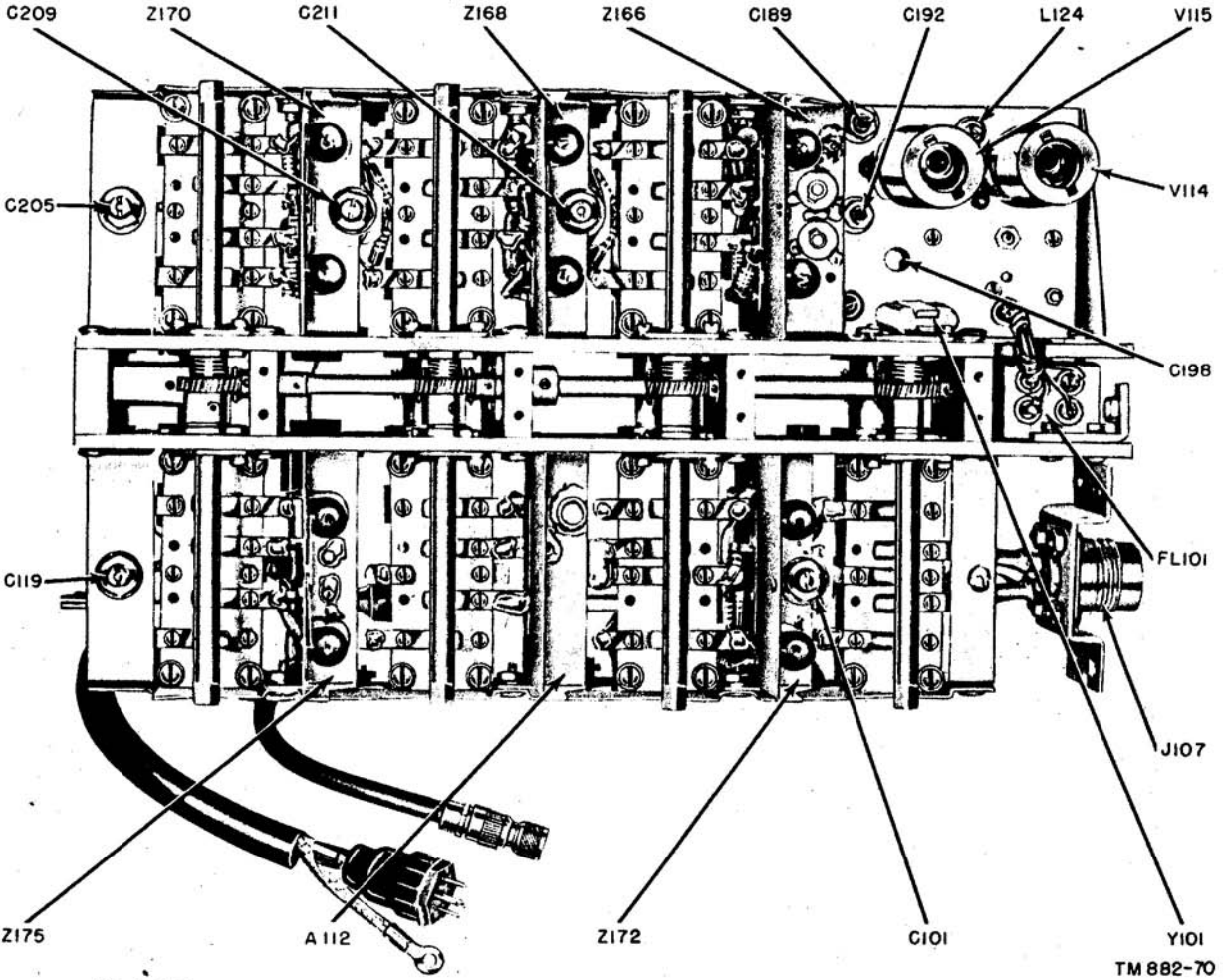


Figure 86. Parts location, section K, showing capacitors.

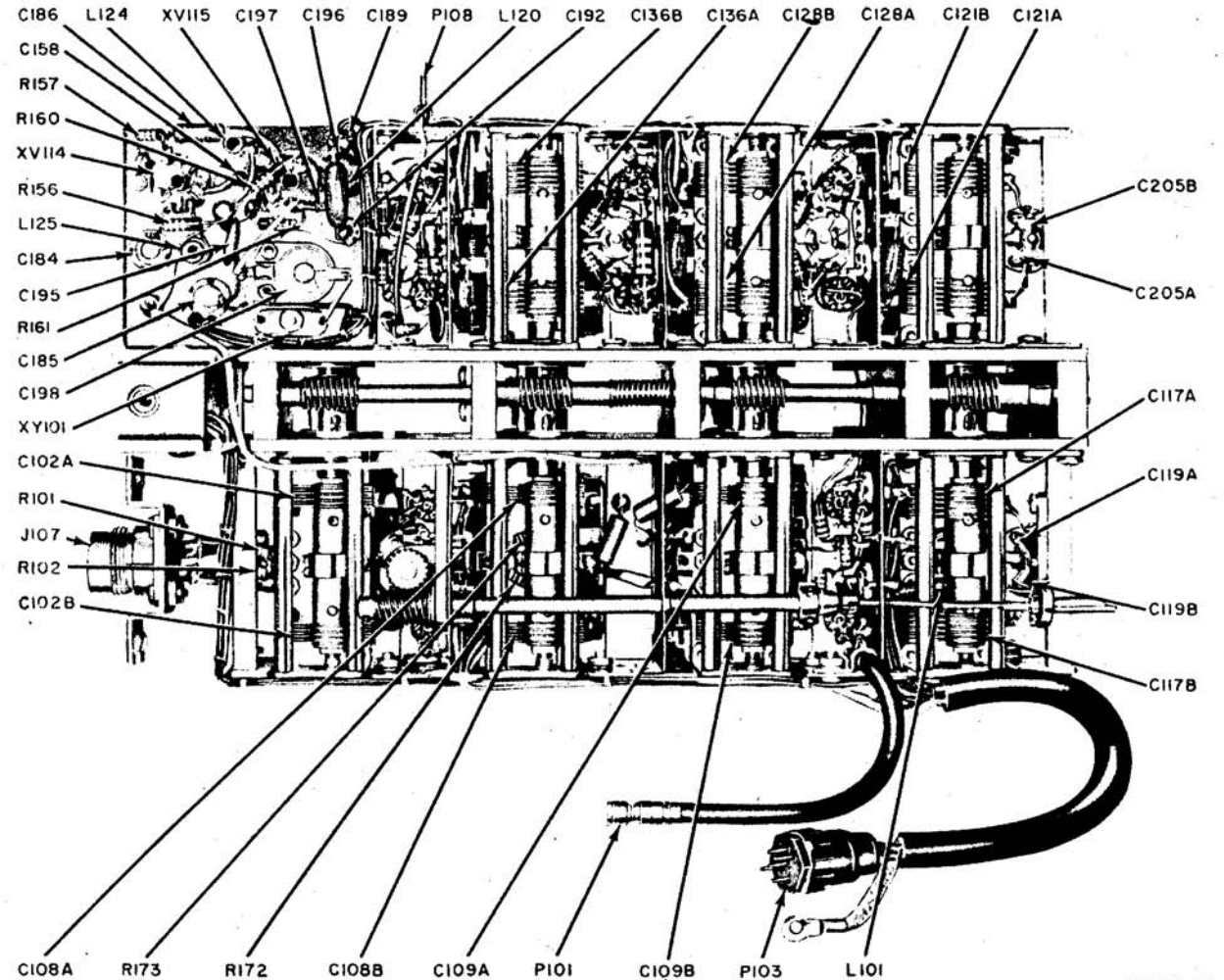


P. 121



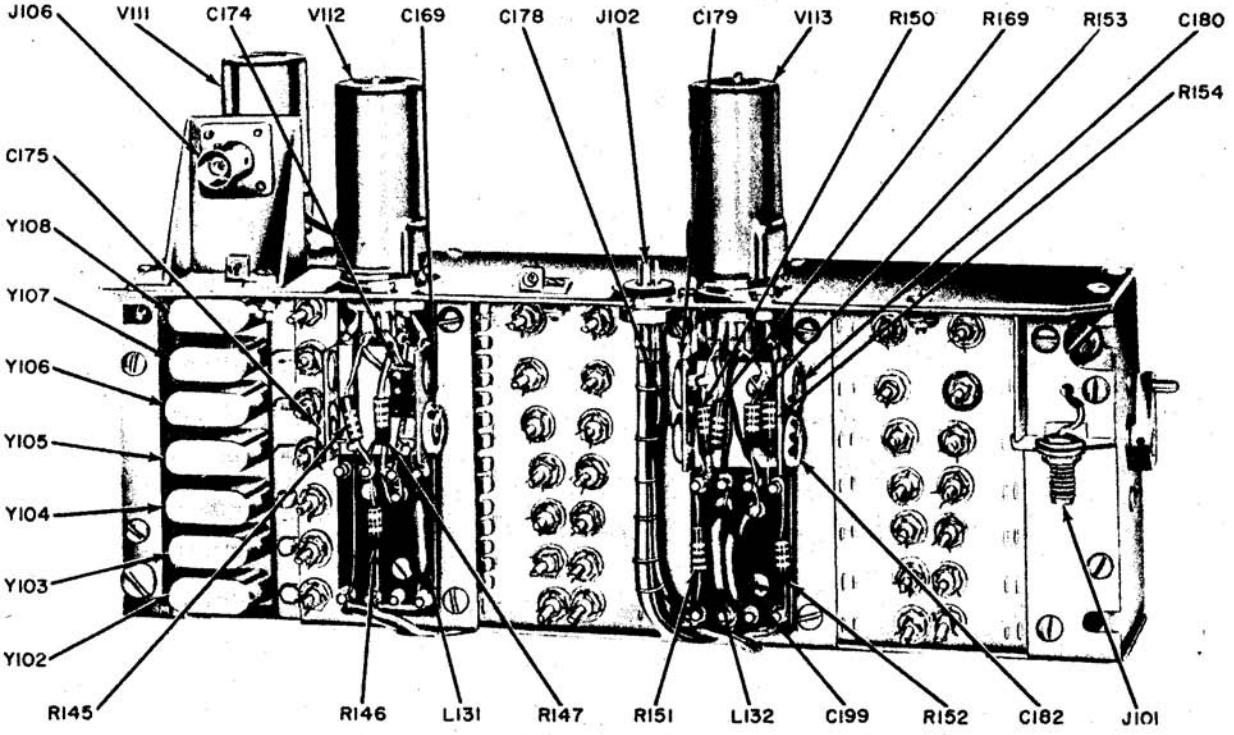
P.122

Figure 88. RF unit, turret side, with turrets removed.



P.123

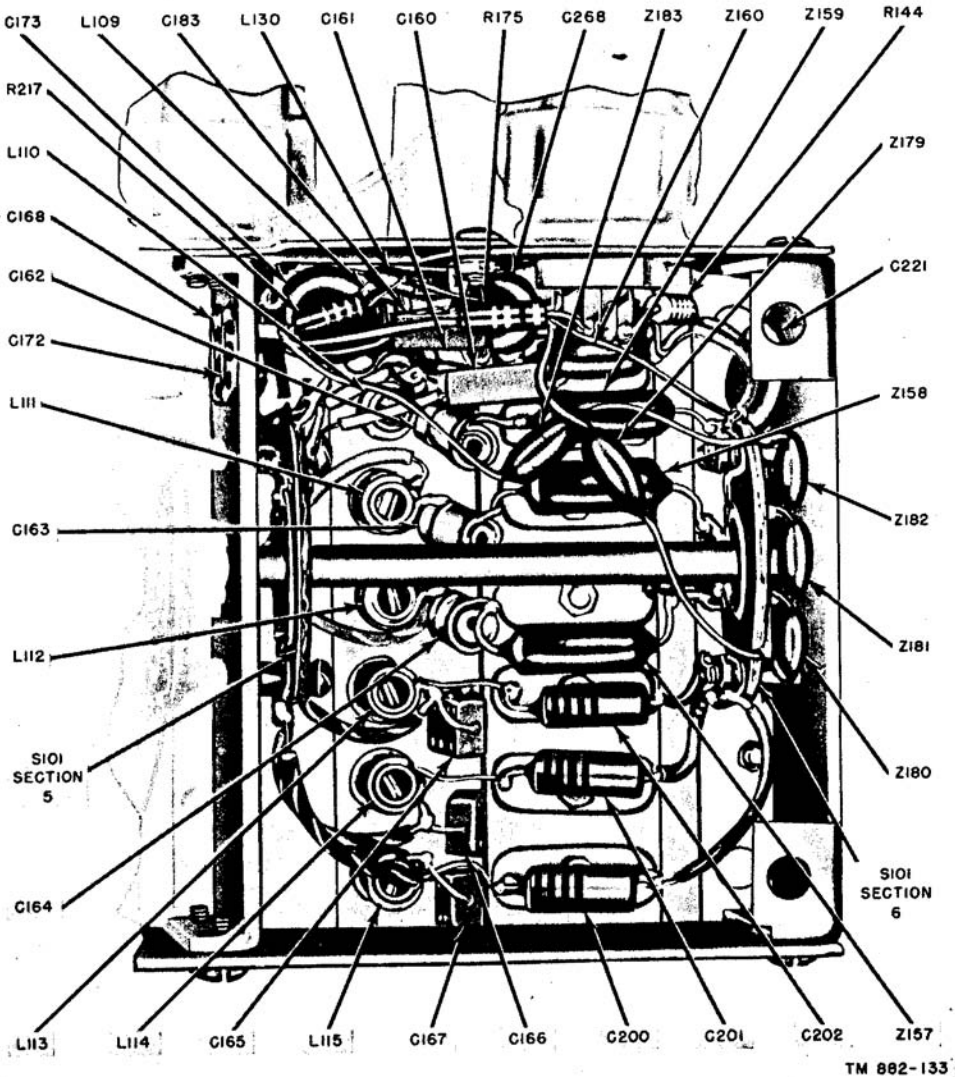
Figure 89. RF unit, sections B and D.



TM 882-94

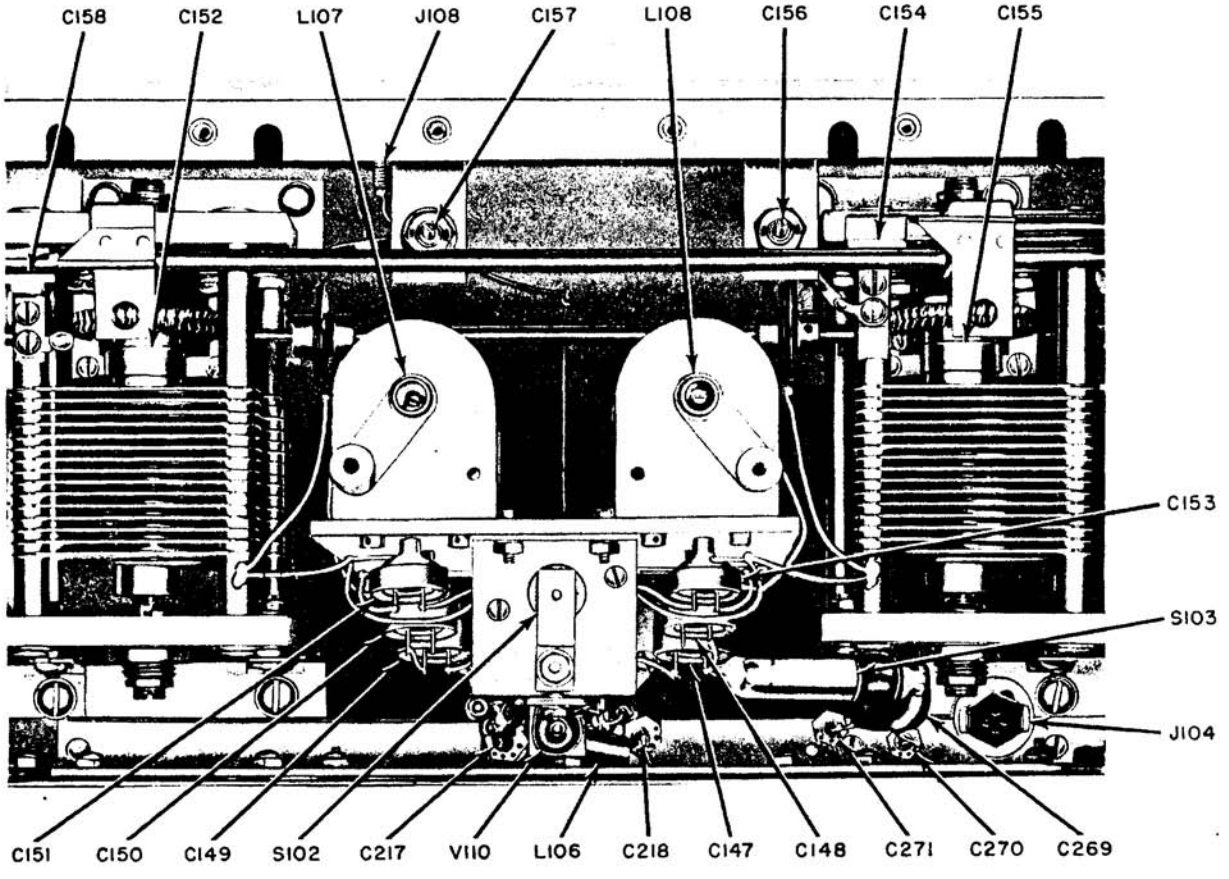
P.124

Figure 90. RF unit, section C, top view.



P. 125

Figure 31. Second IF oscillator, parts location.



TM 882-72

P, 126

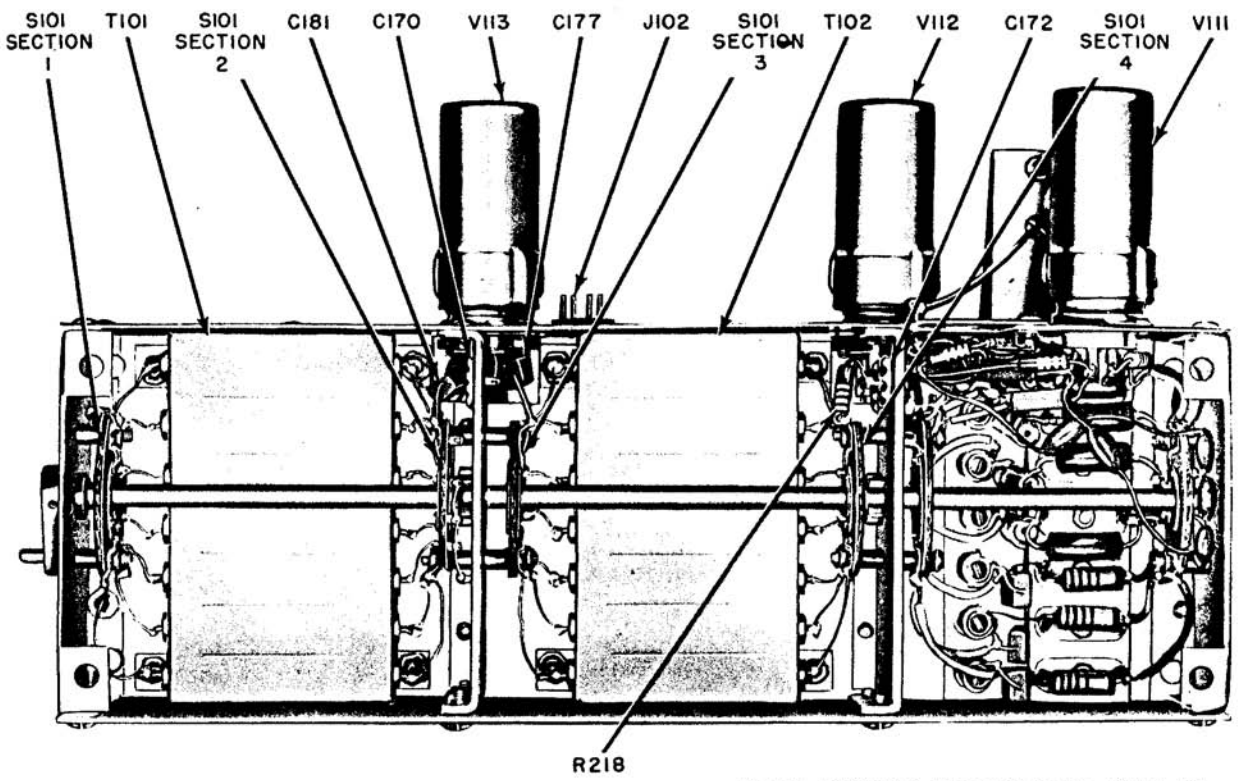


Figure 93. First if. amplifier, parts location.

90. Stage Gain Chart

a. General. The stage gain chart (*d* below) and oscillator injection voltage chart (*e* below) are primarily intended to aid in localizing the defect when low sensitivity is encountered. In the stage gain chart, the input value is the amount of signal required to produce 200 mw of output. The value varies from one receiver to another even with normally operating equipment. An appreciable difference between the value given in the chart and the observed value indicates a defect. After the defective stage has been localized, refer to the voltage and resistance diagrams for aid in isolating the defective component. The oscillator injection voltage chart lists the amount of injection voltage that should be present at the cathode of first mixer stage V104. If no reading is observed, troubleshooting will be necessary. If a lower than normal reading is observed, alinement of the first hf oscillator and multipliers may be necessary.

b. Procedure. Connect the applicable signal generator between the point indicated in the stage gain chart and ground. Suitable equipment is listed in paragraph 83. For protection to the signal generator, place a .05-μf capacitor in series with the ungrounded lead. The output of the rf signal generator should be amplitude modulated 30 percent at 400 cycles. Connect Output Meter TS-585/U between terminals 1 and 2 of TB308. When making stage gain measurements always adjust the signal generator output to obtain 200 mw of audio output. Compare the amount of signal generator output with the nominal value listed in the chart. If there is an appreciable difference, consider the stage defective. When measuring the oscillator injection voltage, connect a vtvm to the cathode (pin 2) of first mixer V104

and ground. To do this, first remove the first mixer dust cover (fig. 101). Remove V104 (fig. 70) and insert a piece of wire into terminal 2 of the socket. Connect the ac probe of the TS–505/U to the wire.

c. Control Settings. Unless otherwise specified set the receiver front panel controls to the following positions:

(1) BAND SELECTOR to band 1.
(2) TUNING to 20 mc.
(3) B. F. OSCILLATOR to OFF.
(4) SELECTIVITY to 200.
(5) AUDIO RESPONSE to MEDIUM.
(6) R. F. GAIN-SQUELCH to approximate midposition.
(7) AUDIO GAIN 1 and AUDIO GAIN 2 fully clockwise.
(8) NOISE LIMITER to OFF.
(9) OPERATION to MGC.
(10) METER switch to CARRIER.
(11) CALIBRATE to OFF.

d. Stage Gain Measurements.

Frequency	Applied to		Input value
	Pin	Tube	
400 cps	1	V324	7.1 v
	1	V322	.83 v
	7	V317B	.035 v
	7	V315A	.04 v
455 kc am	1	V315A	260,000 μv
	1	V314	65,000 μv
	1	V307	15,000 μv
	1	V306	2,400 μv
	1	V305	320 μv
	1	V304	45 μv
SELECTIVITY switch in the 200 position.	5	V301	32 μv
SELECTIVITY switch in the 50 K. C. position.	5	V301	185 μv
SELECTIVITY switch in the 10 position.	5	V301	290 μv
SELECTIVITY switch in the 200 position.	1	V301	22 μv
SELECTIVITY switch in the 50 K. C. position.	1	V301	20 μv
SELECTIVITY switch in the 10 position.	1	V301	20 μv
1.75 mc, am	1	V112	55 μv
6.0942 mc, am (band 1)	1	V112	45 μv
8.6369 mc, am. (band 2)	1	V112	70 μv
12.1884 mc, am. (band 3)	1	V112	35 μv
17.2738 mc, am. (band 4)	1	V112	30 μv
24.3767 mc, am. (band 5)	1	V112	35 μv
34.5476 mc, am. (band 6)	1	V112	35 μv
48.7535 mc, am. (band 7)	1	V112	40 μv
6.0942 mc, am. (band 1)	1	V113	60 μv
8.6369 mc, am. (band 2)	1	V113	95 μv
12.1884 mc, am. (band 3)	1	V113	45 μv
17.2738 mc, am. (band 4)	1	V113	40 μv
24.3767 mc, am. (band 5)	1	V113	9 μv
34.5476 mc, am. (band 6)	1	V113	7 μv
48.7535 mc, am. (band 7)	1	V113	8 μv
6.0942 mc, am. (band 1)	1	V104	55 μv
8.6369 mc, am. (band 2)	1	V104	55 μv
12.1884 mc, am. (band 3)	1	V104	28 μv
17.2738 mc, am. (band 4)	1	V104	17 μv
24.3767 mc, am. (band 5)	1	V104	5.7 μv
35.5476 mc, am. (band 6)	1	V104	2.2 μv
48.7535 mc, am. (band 7)	1	V104	6.5 μv
20 mc, am. (band 1)	1	V104	79 μv
29 mc, am. (band 2)	1	V104	90 μv
40 mc, am. (band 3)	1	V104	41 μv
57 mc, am. (band 4)	1	V104	41 μv
80 mc, am. (band 5)	1	V104	11.5 μv
114 mc, am. (band 6)	1	V104	3.8 μv
160 mc, am. (band 7)	1	V104	14.5 μv

e. Oscillator Injection Voltage.

Band	Frequency (mc)	Injection voltage (volts)
1	20	1. 67
	29	2. 25
2	28. 5	1. 43
	41	3. 0
3	40	1. 82
	58	2. 20
4	57	1. 08
	82	2. 57
5	81	1. 5
	116	1. 78
6	115	1. 53
	164	1. 97
7	160	1. 04
	232	1. 63

91. Replacement of Parts

Most of the component parts in the main unit and power supply are readily accessible and may easily be replaced. However, to replace certain component parts in the rf unit, disassembly is necessary. When repair of Radio Receiving Set AN/URR–29 is required, follow the disassembly procedures outlined in paragraph 92 through 98. When replacement of parts is necessary, observe the following precautions.

a. Tagging of Leads. Tagging of leads is essential to assure correct rewiring when a part is replaced. Small tags or short pieces of adhesive tape will identify all wires in accordance with their connections. Identify every lead to be removed.

b. Parts and Substitutions. When defective 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 be approximately the same *physical* size and have equal or higher voltage and current ratings.

c. Location. Place the new parts in exactly the same position as that formerly occupied by the defective part. Changing the position of parts or leads, especially in the rf unit, will affect tuning and alinement.

d. Mounting. Mount the new part in the same mounting as that formerly occupied by the defective part. Fasten all mountings securely.

e. Soldering. Before soldering any connections, carefully scrape all parts that will be touched by the solder until all traces of rust, corrosion, paint, or varnish are removed. Remove the scrapings with a small clean brush. Tin all surfaces to be soldered. Wrap the wire around the lug to obtain mechanical support. Use a small amount of solder to make the connection and use sufficient heat to make the solder flow evenly around the tinned surfaces.

f. Retropicalization. If the parts to be replaced require special treatment, such as retropicalization, follow the instructions given in TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, and TB SIG 72, Tropical Maintenance of Ground Signal Equipment.

92. Disassembly of Radio Receiver R–220/URR

a. General. Before the equipment can be completely checked, it must be disassembled.

b. Disconnecting Units (figs. 96 and 97). Radio Receiver R–220/URR is made up of three major components: the rf unit, the main (base) unit, and the power supply unit (PP–660/URR). These three units are interconnected by two power cables and one coaxial cable. The coaxial cable connects the rf unit with the main unit. The power supply and main unit are interconnected by a power cable on the right side of the receiver (fig. 96); the main unit and rf unit are interconnected by a similar cable on the left side of the receiver. Before attempting to disassemble the receiver units, always disengage both power cables from their recessed jacks and remove the coaxial cable from the jacks to which it is connected in the main rf units.

Note. A spanner wrench and a hexagonal wrench are fastened to the main unit at the right side of the receiver. These tools are used for removing front panel water seals when disassembling the receiver.

c. Removal of Dust Cover (fig. 97). A dust cover is fastened by 16 screws to the top and rear of the receiver. While this dust cover is in place, the alining tool and wrenches and all controls and jacks at the rear of the receiver are accessible. The dust cover and base plate must be removed, however, before the power supply or the rf unit can be withdrawn from the main unit. To remove the dust cover, release the eight screws that fasten it to the top of the main unit, the four screws that fasten it to the rear of the main unit, and the four screws that fasten it to the rear of the power supply unit. With the dust cover removed, the rectifier tube is accessible. To remove the base plate, release the 18 screws that hold the plate to the bottom of the main unit.

d. Removal of Power Supply Unit (fig. 98). Observe the following procedure in removing the power supply unit from the receiver:

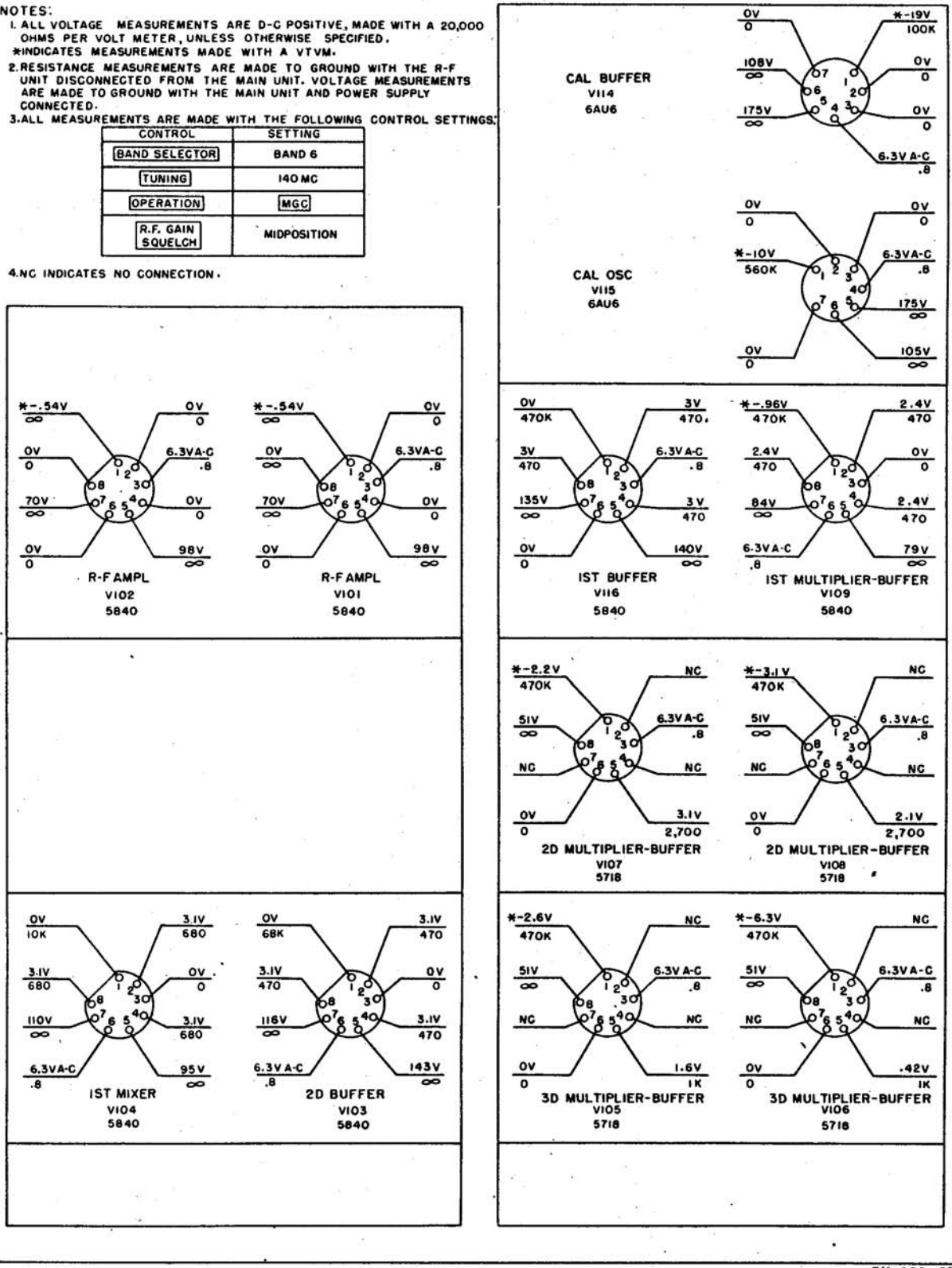
(1) Remove the three screws that hold the power supply to the middle guide rail of the main unit. These screws are accessible from the bottom of the main unit chassis.

NOTES:

1. ALL VOLTAGE MEASUREMENTS ARE D-C POSITIVE, MADE WITH A 20,000 OHMS PER VOLT METER, UNLESS OTHERWISE SPECIFIED.
   *INDICATES MEASUREMENTS MADE WITH A VTVM.
2. RESISTANCE MEASUREMENTS ARE MADE TO GROUND WITH THE R-F UNIT DISCONNECTED FROM THE MAIN UNIT. VOLTAGE MEASUREMENTS ARE MADE TO GROUND WITH THE MAIN UNIT AND POWER SUPPLY CONNECTED.
3. ALL MEASUREMENTS ARE MADE WITH THE FOLLOWING CONTROL SETTINGS:

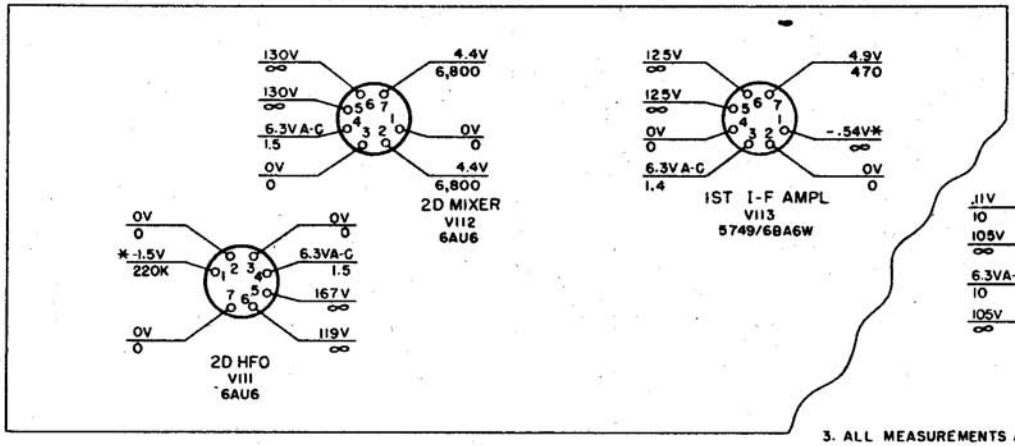
CONTROL	SETTING
BAND SELECTOR	BAND 6
TUNING	140 MC
OPERATION	MGC
R.F. GAIN SQUELCH	MIDPOSITION

4. NC INDICATES NO CONNECTION.



TM 882-139

Figure 94. First mixer section, voltage and resistance measurements.



NOTES:

1. ALL VOLTAGE MEASUREMENTS ARE D-C POSITIVE, MADE WITH A 20,000 OHMS PER VOLT METER, UNLESS OTHERWISE SPECIFIED.
   *INDICATES MEASUREMENTS MADE WITH A VTVM.
2. RESISTANCE MEASUREMENTS ARE MADE TO GROUND WITH THE MAIN UNIT DISCONNECTED. VOLTAGE MEASUREMENTS ARE MADE TO GROUND WITH THE MAIN UNIT AND POWER SUPPLY CONNECTED.
3. ALL MEASUREMENTS ARE MADE WITH THE FOLLOWING CONTROL SETTINGS:

CONTROL	SETTING
BAND SELECTOR	BAND 1
TUNING	25 MC
OPERATION	M G C
R.F. GAIN SQUELCH	MID-POSITION

TM 882-152

Figure 95. Second mixer and first hf oscillator sections, voltage and resistance measurements.

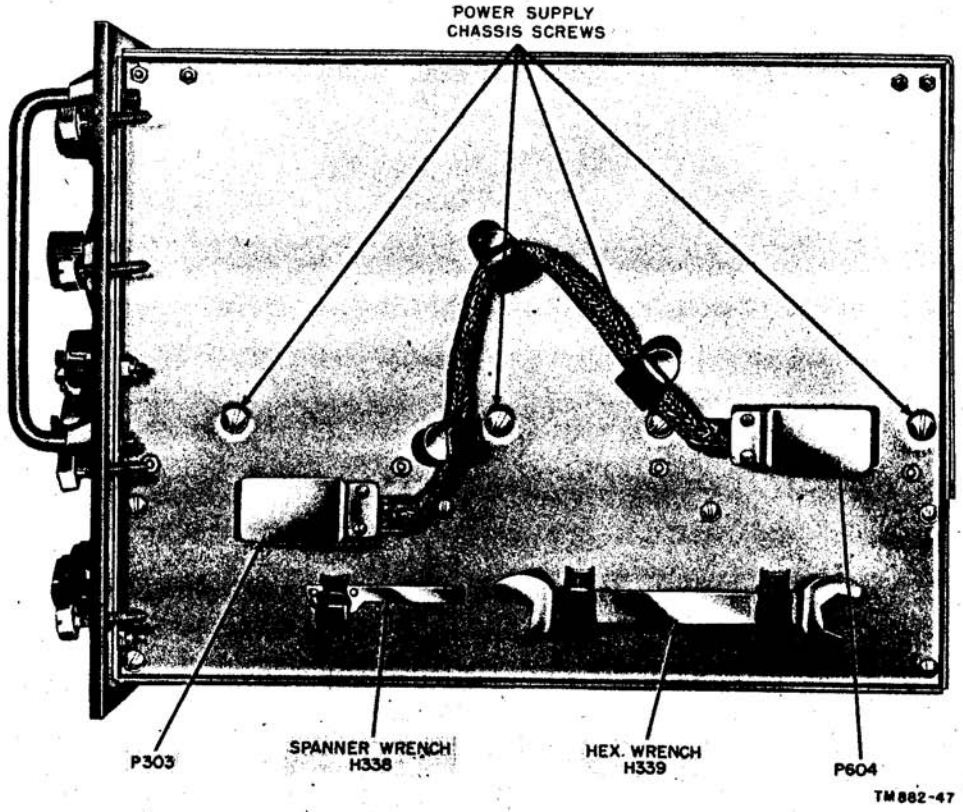


Figure 96. Radio Receiver R-220/URR, cable connections on power supply side of main unit.

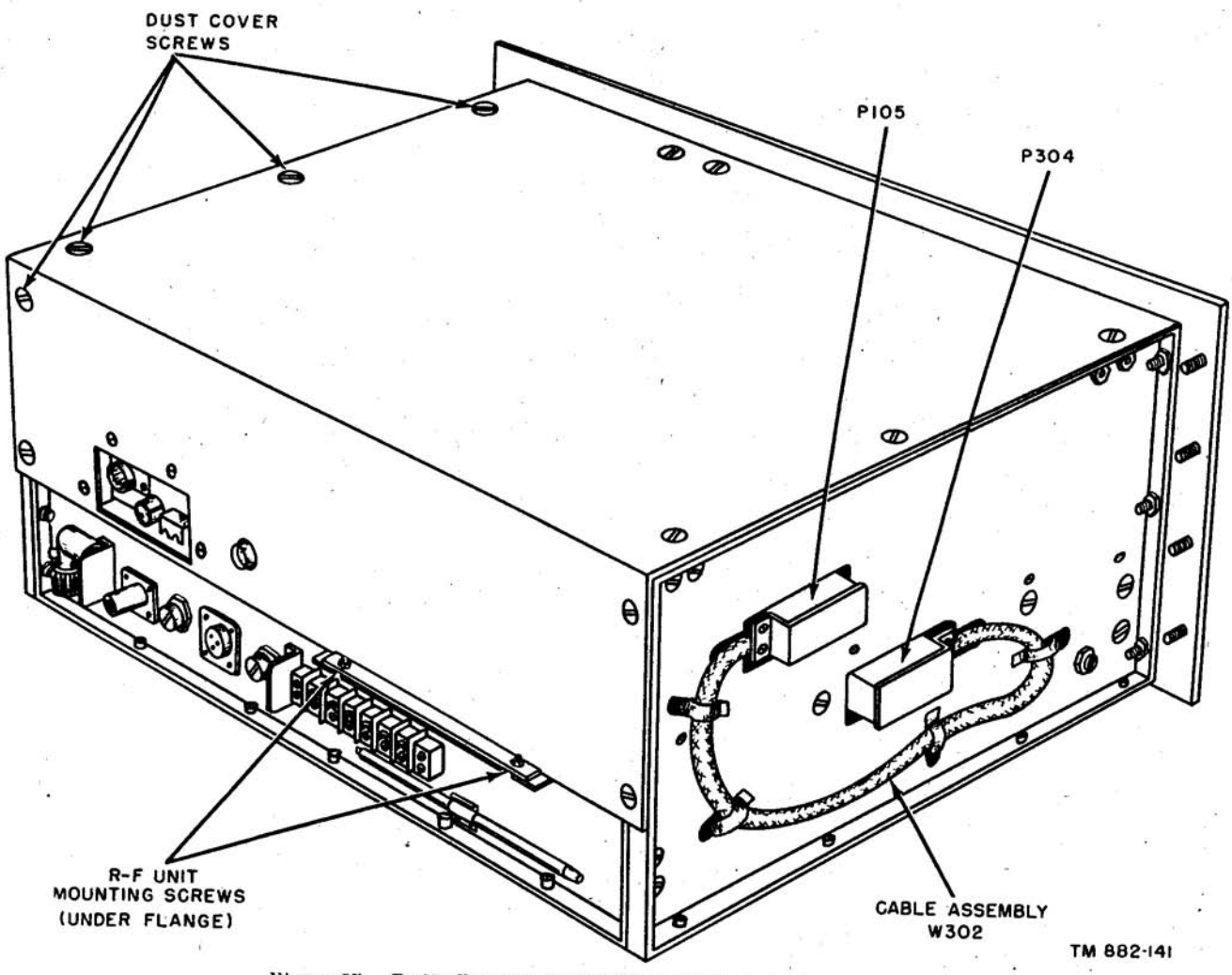


Figure 97. Radio Receiver R-220/URR, showing dust cover removal.

(2) Remove the four screws that hold the power supply to the right side of the main unit.

(3) Disengage interconnecting power cable assembly W304 from the power supply unit.

(4) Slide the power supply out of the main unit.

Note. When replacing the power supply, do not push the unit too far toward the front panel; parts on the panel may be struck and damaged. Push the power supply in carefully, and stop when the screw holes in the power supply line up with the screw holes in the main unit.

e. Removal of Rf Unit (figs. 99 and 100). Observe the following procedure in removing the rf unit from the receiver:

(1) Remove the TUNING, BAND SELECTOR, and ANTENNA TRIMMER controls from the front panel (fig. 99). To remove the BAND SELECTOR control, refer to paragraph 102*c*.

(2) Remove the four front-panel screws that hold the rf unit in place (fig. 96). Remove the two mounting screws at the rear of the rf unit (fig. 97).

(3) Disengage the interconnecting cable assembly, W302, from the rf unit (fig. 97).

(4) Free the coaxial cable from the rf unit, drawing it down through the opening in the main unit.

(5) Slide the rf unit completely out of the main unit (fig. 101).

Note. When replacing the rf unit, be sure to aline the TUNING and BAND SELECTOR shafts with the holes in the front panel. Also be sure that the turret positions coincide with the front panel band designations.

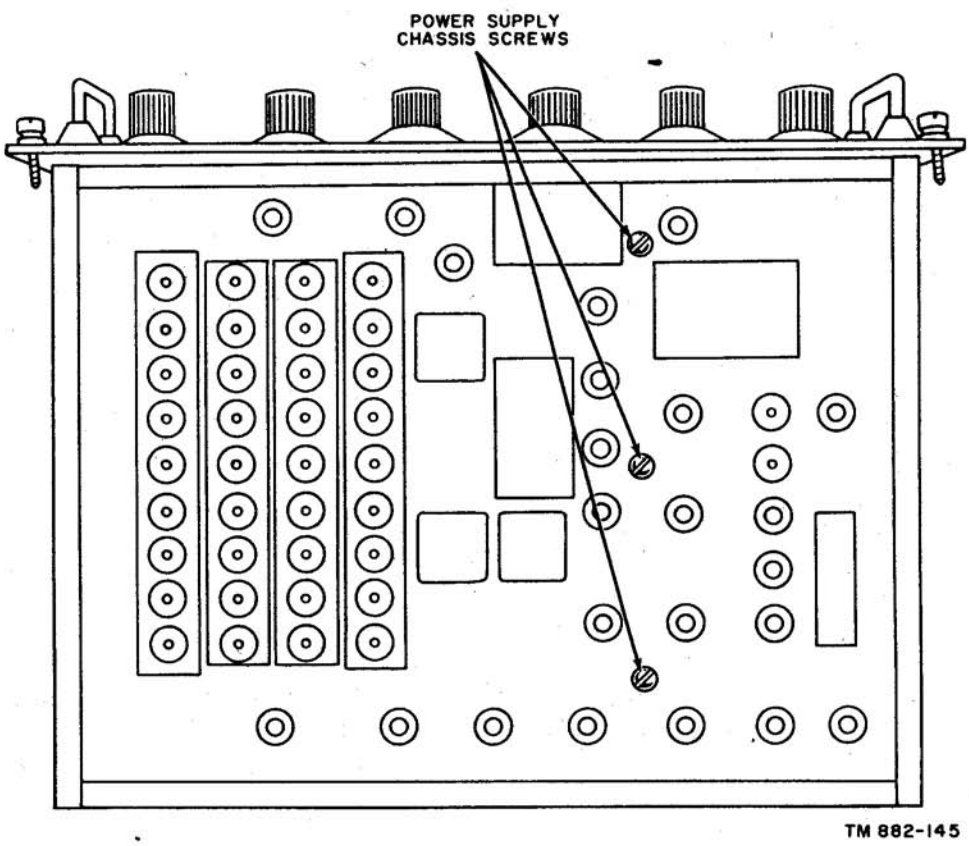


Figure 98. Bottom view, showing power supply chassis screws.

93. Disassembly of Rf Unit

a. General. The control head is connected to the front of the rf unit and mechanical connections are made from it to each of the major sections. It is important therefore that no adjustment of any of the controls be made, once the control head is disconnected from the rf unit, or complete realinement will be necessary. Rotate the BAND SELECTOR control to band 4. Remove the rf unit from the receiver by following the instructions in paragraph 92*e*.

b. Removal of Dust Covers (fig. 101). The rf unit contains the first hf oscillator section, first mixer section, and the second mixer section. All band selection and tuning of the received signal is done in the rf unit. The rf unit is shielded on all sides by dust covers, but most adjustments that apply to the rf unit can be made through small holes in the covers of the several sections without removing the covers. For changing tubes and making minor replacements, it is also possible to remove one cover to gain access to a given section without disturbing the covers of the other sections. Remove the dust covers from the rf unit in the following order:

(1) Remove the screws that fasten the cover over the first mixer section.
(2) Remove the screws that fasten the covers over the second mixer section.
(3) Remove the screws that fasten the first hf oscillator section cover to the rear cover.
(4) Remove the remaining screws on the first hf oscillator section cover.

c. Removal of Rear Cover (fig. 101).

(1) Remove the four No. 4 flat head screws holding the rear cover to the frame.
(2) Remove the four No. 6 flat head screws that hold the antenna input connector bracket.
(3) Remove the rear cover.

d. Removal of Second Mixer Section (fig. 102 and 118).

(1) Disconnect second mixer section power plug 102 from J102.
(2) Disconnect plug P101 from J101.

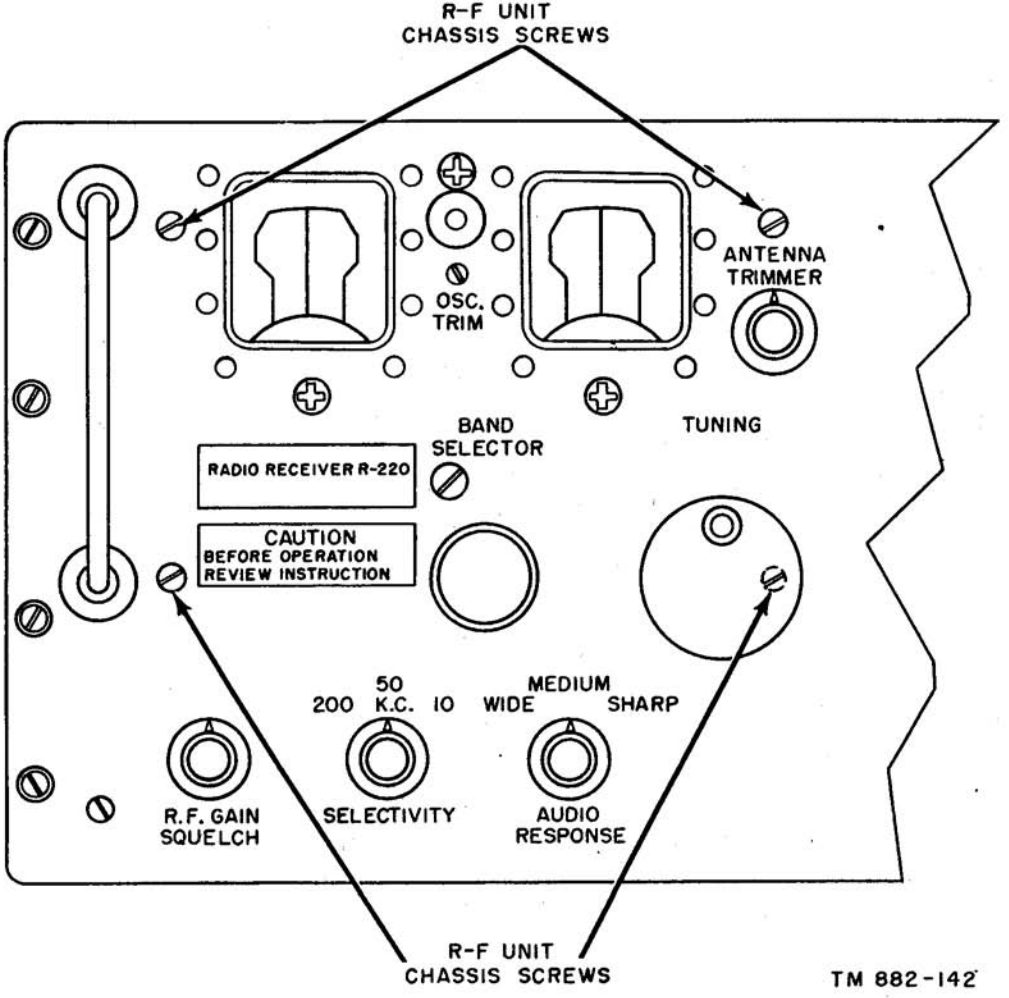


Figure 99. Receiver front panel, showing rf chassis screws.

(3) Loosen the four captive chassis screws at the corners of the second mixer section (fig. 118).

(4) Tilt the back of the chassis up and then draw the assembly up away from the base plate.

(5) Replace the second mixer section by reversing the above procedure.

e. Removal of First Mixer Section (figs. 102 and 101).

(1) Disconnect plug P101 of the first mixer section from jack J101 of the second mixer section.

(2) Disconnect P108 from J108 of the first hf oscillator section by using a long thin screwdriver to pry up on the shoulder of the plug (fig. 103).

(3) Remove plug P103 from jack J103. Bend the cable clamp that holds the power cable to the control head bearing plate and pull the cable out so that it is hanging free.

(4) Remove the No. 10 screw that fastens the rear of the first mixer section to the frame of the rf unit (fig. 103).

(5) Remove the No. 6 screw that holds the front of the first mixer section to the control head bearing plate.

(6) The first mixer section may now be removed from the rf unit by sliding it back and away from the base plate.

(7) To replace the first mixer section, reverse the order of instructions given above.

94. Control Head Disassembly

(figs. 104, 105, 106, 122, and 123)

a. General. The control head of Radio Receiver R-220/URR consists of various gear assemblies that are used to tune the receiver to any frequency

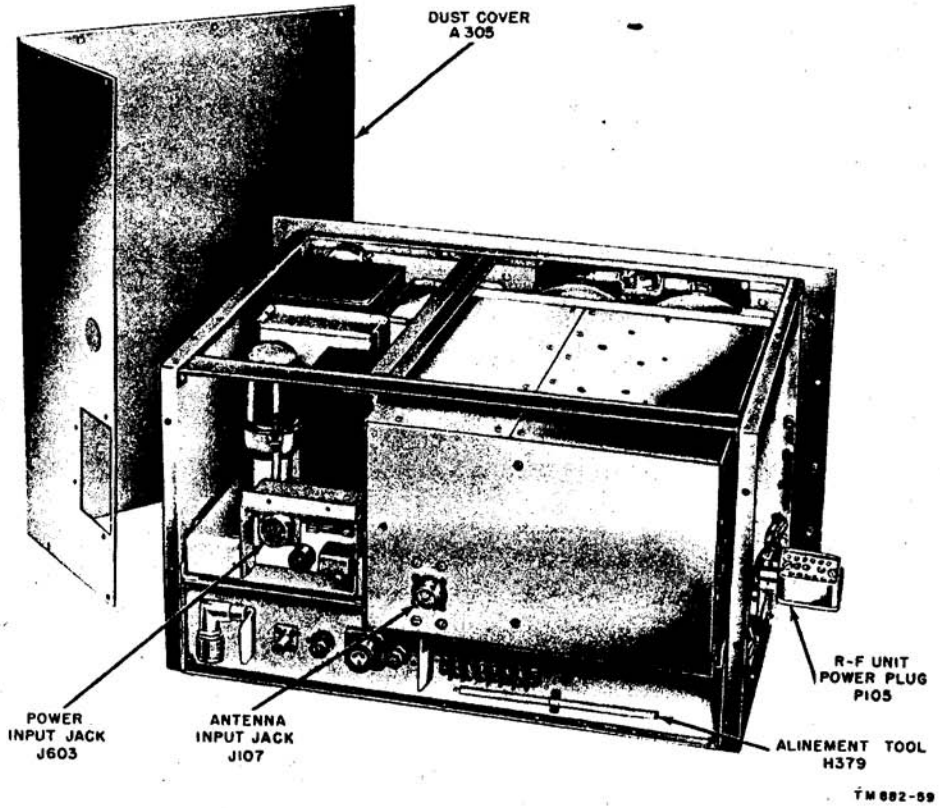


Figure 100. Radio Receiver R-220/URR removed from Receiver Case CY-956/URR.

within the range of 20 to 230 mc. An overall view of the control head is shown in figure 104. The various parts of the control head are mounted on the control plate No. 1 assembly (AA), the control bearing plate No. 2 assembly (BB), and the control bearing frame No. 3 assembly (CC). Figure 105 shows the assemblies located between control bearing plate No. 1 and control bearing plate No. 2 (assemblies A–L); an exploded view of these assemblies is shown in figure 122. Figure 106 shows the assemblies located between control bearing plate No. 2 and control bearing frame No. 3 (assemblies M–X); an exploded view of these assemblies is shown in figure 123. Parts shown in figures 104, 105, 106, 122, and 123 are identified by a letter or a letter and number combination. When following the disassembly procedure, refer to figures 104, 105, and 106 to locate the assembly; then to figures 122 and 123 to locate individual parts of the assembly.

Caution: Disassembly of the control head should be limited to those parts that are maintenance items (*h* below).

b. Partial Disassembly (figs. 104, 105, 106, 122, and 123). The control head parts are mounted on the control bearing plate No. 1 assembly (AA), the control bearing plate No. 2 assembly (BB), and the control bearing frame No. 3 assembly (CC). The procedure for partial disassembly is outlined below.

(1) Rotate vernier drive shaft B5 clockwise until the mechanical stop is reached. This occurs when main dial stop stud A 4 comes in contact with main dial stop C5 (fig. 122).

(2) Remove four hexagonal nuts DD6 and four lockwashers DD5 at the rear corners of control bearing frame No. 3 CC1 (fig. 123).

(3) Remove the 12 bearing plate spacer posts DD2, DD3 (fig. 122), and DD4 (fig. 123).

(4) Loosen two setscrews E4 from odd band dial hub E1 (fig. 122).

(5) Remove the control bearing plate No. 1 assembly (AA) with assemblies C, D, E, F, G, and H intact. Assemblies A, B1,

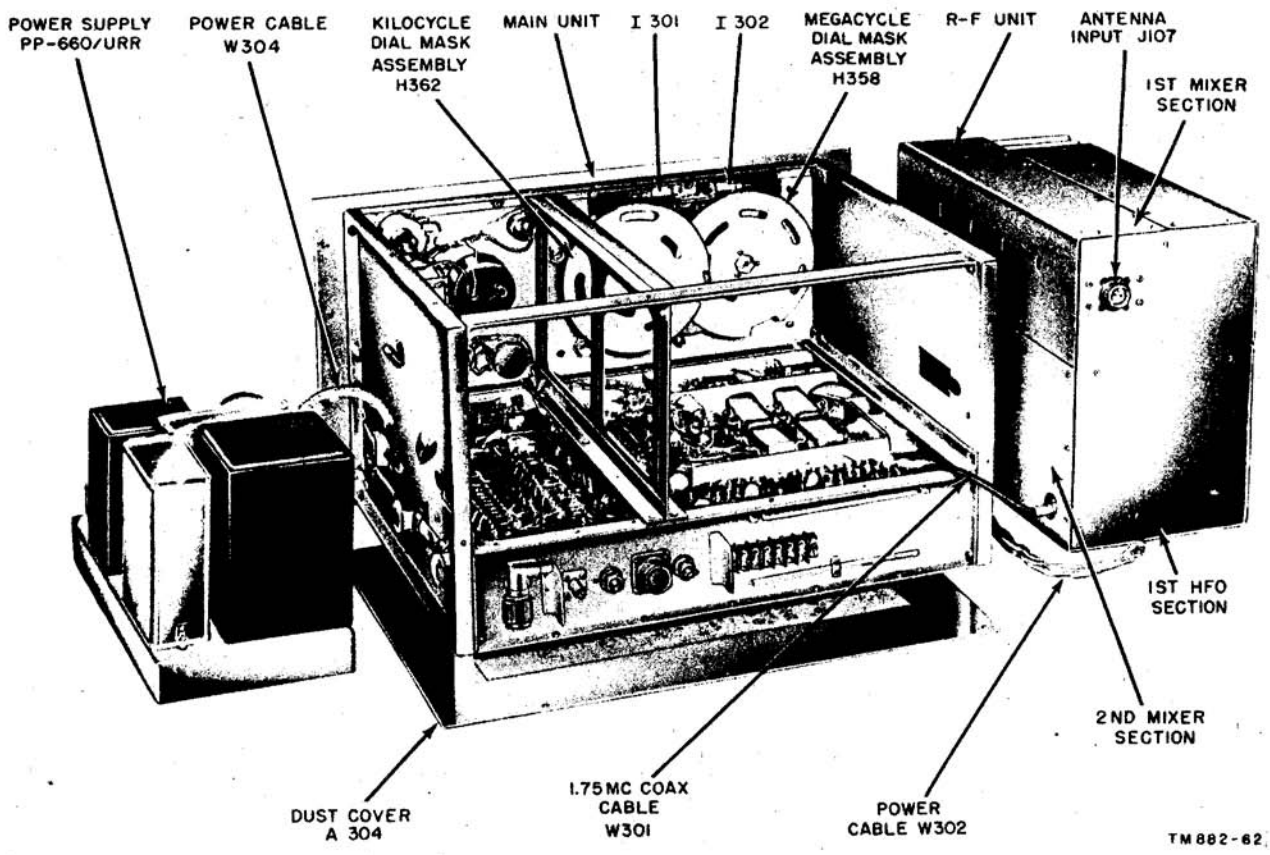


Figure 101. Radio Receiver R-220/URR, with rf unit and power supply removed.

B2, J, and K will remain on control bearing plate No. 2 (BB).

Caution: Do not use undue force because damage to the gear teeth may result.

(6) The parts contained on the control bearing plate No. 1 assembly (AA) may be removed by following the instructions given in *c* below.

(7) Remove the six plate No. 2 stops L4 and Plate No. 1 stop L5 from stop collar L1 (fig. 122).

(8) Loosen the three setscrews L3 on stop collar L1 (fig. 122).

(9) Pry up on stop collar L1 and remove it from band switch tuning shaft U3 (fig. 123).

(10) Remove control bearing plate No. 2 (BB) by lifting straight up.

(11) The parts contained on the control bearing plate No. 2 assembly (BB) may be removed by following the instructions given in *d* below.

(12) The parts contained on the control bearing frame No. 3 assembly (CC) may be moved by following the instructions given in *e* below.

c. Control Bearing Plate No. 1 Assembly (AA) (fig. 122). The following parts are located on the control bearing plate No. 1 assembly (AA): main dial gear assembly (C); main dial and hub assembly (D); odd band hub and dial assembly (E); even band dial assembly (F); rf even band dial driven gear (G); and even band dial intermediate gear assembly (H). Instructions are given in (1) through (8) below for removing these assemblies from the control bearing plate. Assemblies C through H are removed as follows:

(1) *Assembly C.* Loosen two set screws C3 from gear hub C2. Slide assembly C off main dial shaft D4.

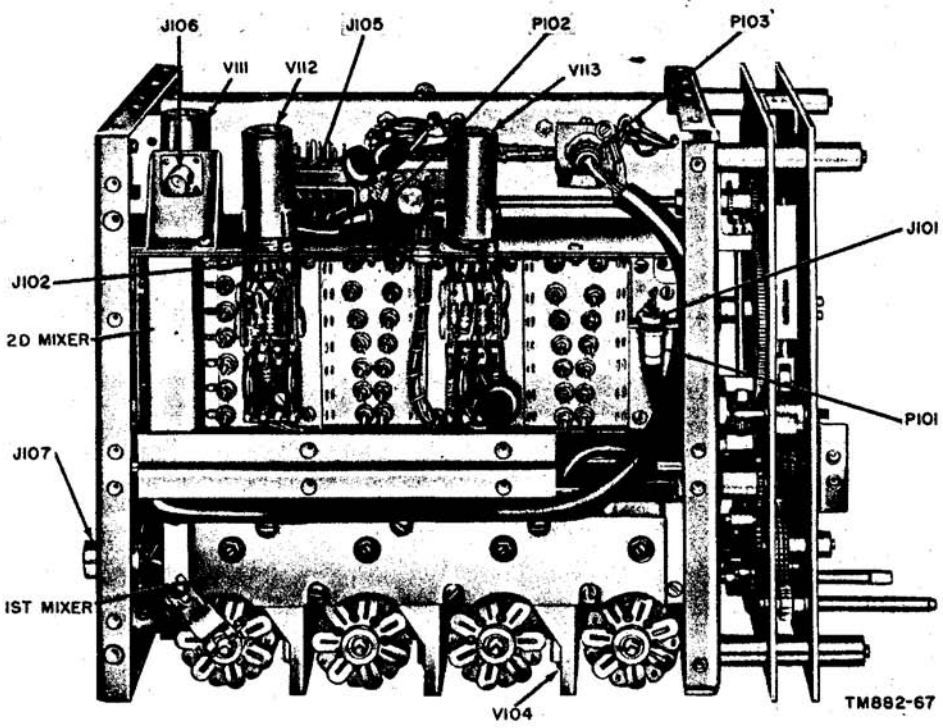


Figure 102. Rf unit, bottom view.

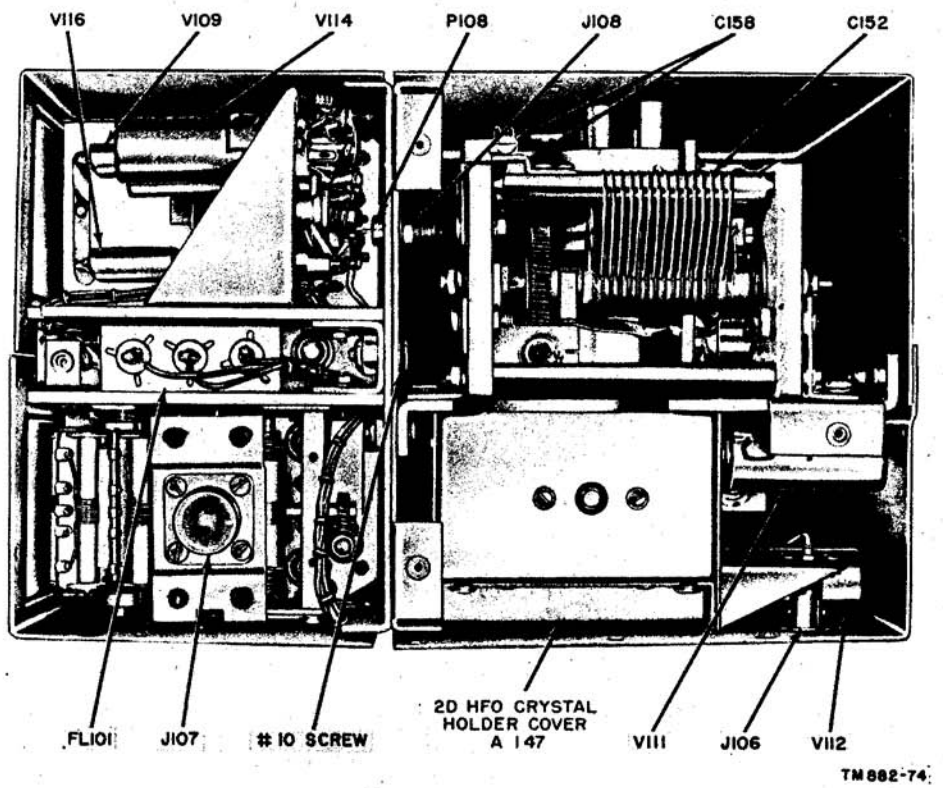


Figure 103. Radio Receiver R-220/URR, rf unit, rear view.

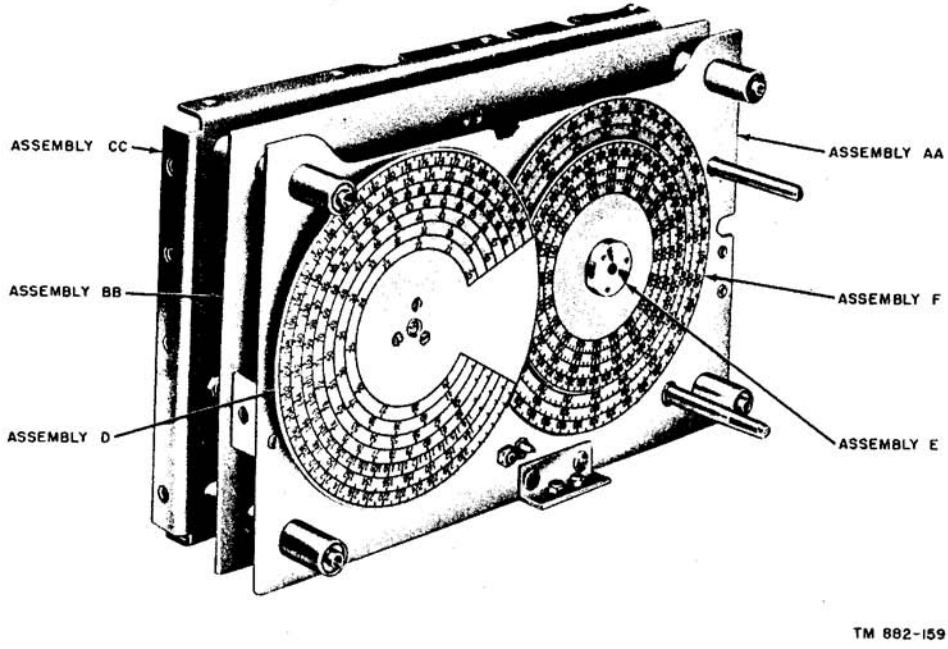


Figure 104. Control head, overall view.

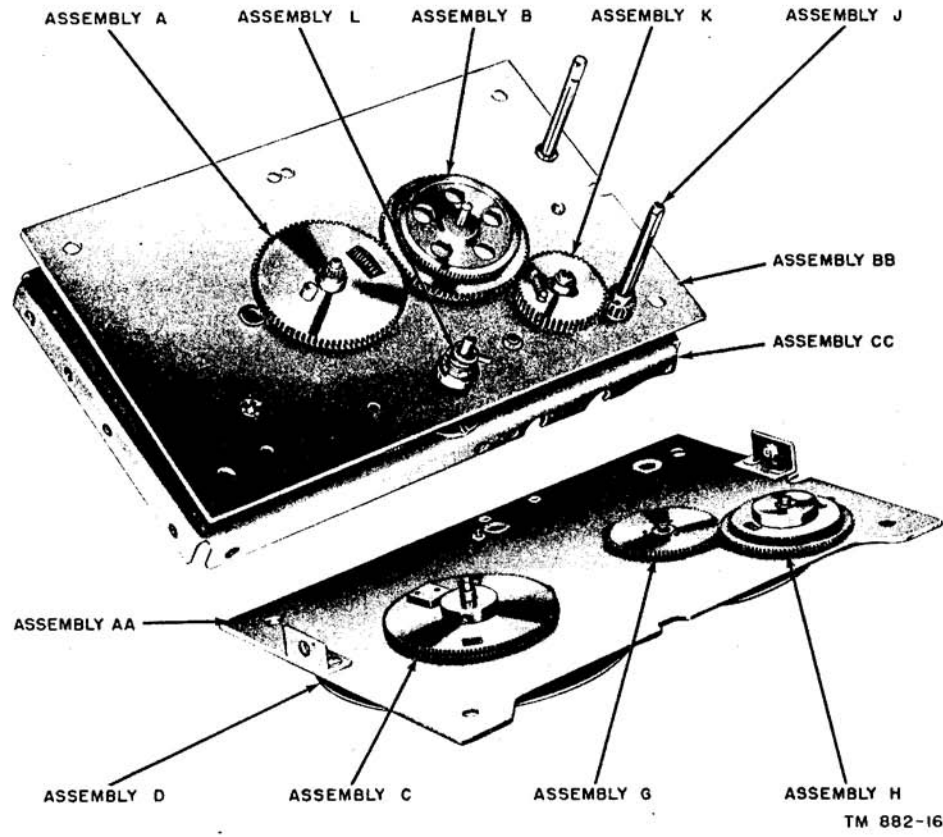


Figure 105. Control head, assemblies A through L.

(2) *Assembly D.* Remove assembly D by lifting away from control bearing plate No. 1 (AA).

(3) *Assembly E.* Loosen two setscrews E4 on odd band dial hub E1. Remove odd band dial E2 and odd band dial hub E1 by pulling forward off vernier drive shaft B5.

(4) *Assembly F.* Remove three machine screws F3 and lift assembly F off vernier drive shaft B5.

(5) *Assembly G.* With machine screws F3 removed, lift assembly G off vernier drive shaft B5.

(6) *Assembly H.* Remove Tru-arc retainer ring H6 from intermediate gear stud H5. Lift H1, H2, H3, H4, H7, H8, and H9 off intermediate gear stud H5.

d. Control Bearing Plate No. 2 Assembly (BB) (figs. 105 and 106). The following parts are contained on the control bearing plate No. 2 assembly (BB): oscillator gear and pinion assembly (A); even band dial gear assembly (B); tuning shaft and gear assembly (J); tuning shaft intermediate gear assembly (K); stop collar assembly (L); antenna trimmer intermediate gear No. 1 assembly (M); and antenna trimmer intermediate gear No. 2 assembly (N). Remove assemblies A, B, and J through N as instructed below.

(1) *Assembly A.* Be sure that the teeth on fixed oscillator antibacklash gear A 2 are in line with the teeth on free oscillator antibacklash gear A5; then lift assembly A straight up to disengage it from rf-to-oscillator gear B1 (fig. 122).

(2) *Assembly B.* Loosen the three setscrews, B4, on the collar of the rf even band dial driver gear B2 with a No. 4 Bristo wrench. Lift the rf-to-oscillator gear B1 and rf even band dial driver

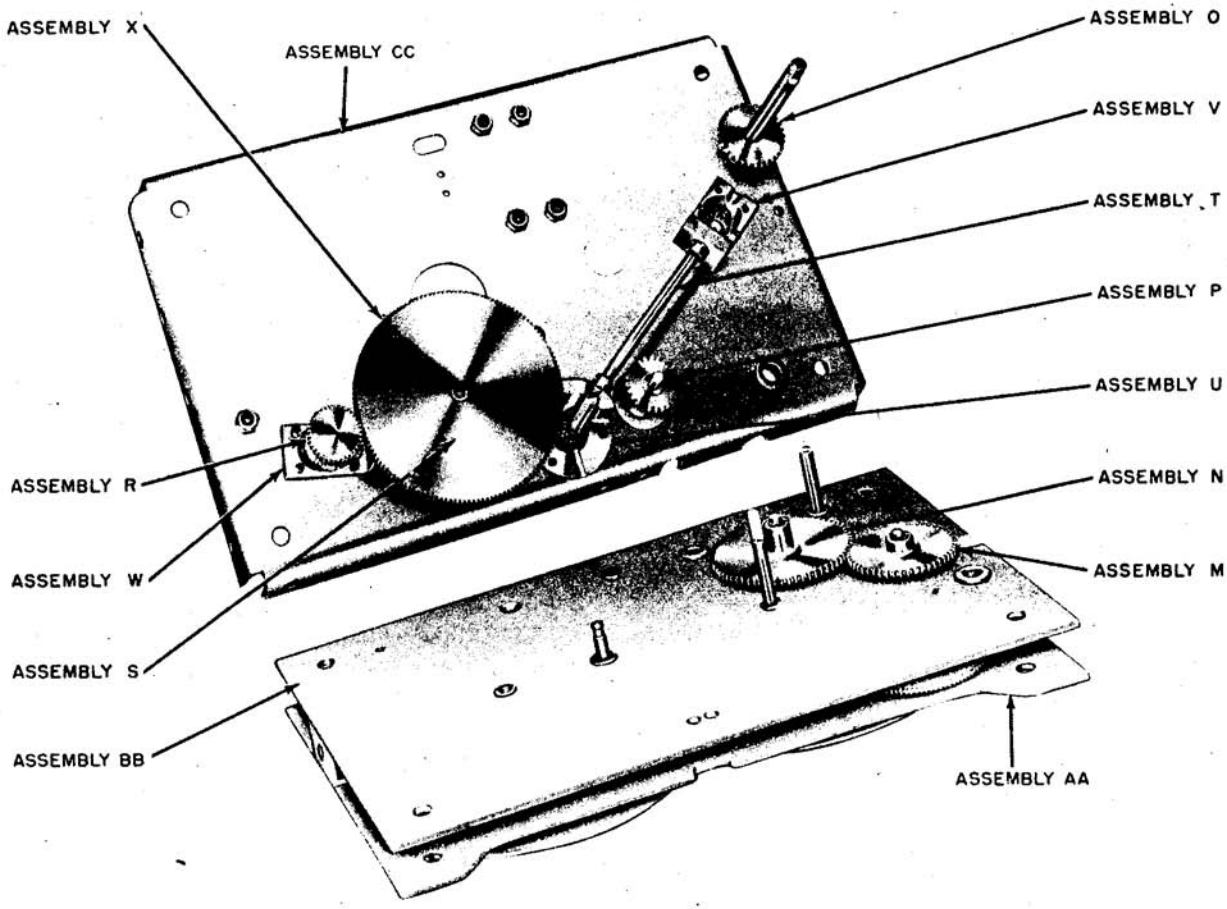


Figure 106. Control Bld. and Parts, M through Y

gear B2 off vernier drive shaft B5, disengaging assembly B from assembly K (fig. 122).

(3) *Assembly J.* To remove tuning shaft and gear assembly J, lift it out of control bearing plate No. 2 BB1 (fig. 105).

(4) *Assembly K.* Remove Tru-arc retainer ring K7 from intermediate gear stud K9 and lift intermediate gears K1, K3, and K4 and associated parts K2, K5, K6, and K8 off intermediate gear stud K9 (fig. 122).

(5) *Assembly L.* Most of the parts of assembly L have been removed in the partial disassembly procedure given in *b* above. To remove stop stud L6, remove hexagonal nut L7 and lockwasher L8 (fig. 122).

(6) *Assembly M.* Remove Tru-arc retainer ring M1 from antenna trimmer intermediate gear No. 1 stud M3 and pull antenna trimmer intermediate gear No. 1 M2 off antenna trimmer intermediate gear No. 1 stud M3 (fig. 123).

(7) *Assembly N.* Remove Tru-arc retainer ring N1 from antenna trimmer intermediate gear No. 2 stud N3 and pull antenna trimmer intermediate gear No. 2 N2 off antenna trimmer intermediate gear No. 2 stud N3 (fig. 123).

e. Control Bearing Frame No. 3 Assembly (CC) (fig. 106). The following parts are contained on the control bearing frame No. 3 assembly (CC): antenna trimmer gear and drive shaft assembly (O); antenna trimmer gear and shaft pinion (P); if. and oscillator switch gear assembly (R); oscillator bevel gear and shaft assembly (S); turret miter gear and shaft assembly (T); miter gear terminal bracket assembly (U); miter gear turret bracket assembly (V); oscillator bevel gear bracket assembly (W); and if. switch spur gear assembly (X). Remove assemblies O, P, R, and X as instructed below.

(1) *Assembly O.* Assembly O consists of antenna trimmer drive gear O1 pinned to antenna trimmer drive shaft O2; to remove the assembly lift it off control bearing frame No. 3 (CC1) (figs. 106 and 123).

(2) *Assembly P.* Assembly P consists of antenna trimmer pinion gear P1 pinned to antenna trimmer pinion shaft P2; to remove the assembly, lift it off control bearing frame No. 3 (CC1) (figs. 106 and 123).

(3) *Assembly R.* Loosen two setscrews R3 and remove if. spur gear R1 and bevel gear R2 from oscillator switch drive shaft W2. To remove bevel gear R2, remove rollpin S11 from bevel pinion gear S2, then remove bevel pinion gear S2 from bevel gear shaft S3; bevel gear R2 may now be removed (figs. 106 and 123).

(4) *Assemblies S, T, U, and V.* Defective assemblies S, T, U, and V are replaced as complete assemblies; therefore disassembly instructions for these assemblies are not given.

(5) *Assembly W.* With assembly R removed, oscillator switch drive shaft W2, with oscillator switch shaft coupler W3 attached, can be removed from control bearing frame No. 3 (CC1) (fig. 123).

(6) *Assembly X.* Loosen setscrews X2 and lift if. switch spur gear X1 from if. switch gear shaft X4. Remove if. switch gear shaft X4, if. switch coupler arm X7 and rollpin X8. Remove if. switch gear shaft bearing X3 by removing hexagonal nut X6 and washer X5 (fig. 123).

f. Assembly of Control Head. When replacing the individual assemblies on the control bearing plates, reverse the instructions given for their removal. To reassemble the control bearing plates, proceed as follows and refer to figures 101, 106, 122, and 123.

(1) Place control bearing frame No. 3 assembly CC face up on a bench. Put a block of wood under each corner to protect the parts that protrude at the rear of the frame. Figure 106 shows the assemblies located on control bearing frame No. 3 assembly CC.

(2) Be sure that antenna trimmer intermediate gear No. 1 assembly M is meshed with antenna trimmer intermediate gear No. 2 assembly N on control bearing plate No. 2 assembly BB. Slide assembly BB over assembly CC. Engage antenna trimmer drive gear O1 with antenna trimmer intermediate gear No. 1 assembly M and antenna pinion gear P1 with

antenna trimmer intermediate gear No. 2 assembly N. To insure the proper spacing between control bearing plate No. 2 assembly BB and control bearing frame No. 3 assembly CC, insert spacer posts DD4 at each of the four corners.

(3) Slide stop collar L1 (fig. 122) on band switch tuning shaft U3 until L1 is flush with control bearing plate No. 2 assembly BB. Tighten three setscrews L3. Slide stops L4 and L5 over shaft U3. Spring-load assembly K by rotating intermediate gear No. 1 K1 counterclockwise three teeth positions. Maintain the proper tension by engaging tuning shaft gear J1 with assembly K. Slide rf to oscillator gear B1 and rf even band dial driver gear B2 on vernier drive shaft B5 and tighten setscrew B4. Spring-load assembly A by holding free oscillator antibacklash gear A5 and rotating fixed oscillator antibacklash gear A2 counterclockwise three teeth positions. Position assembly A so that main stop stud A4 will come in contact with main dial stop C5 when control bearing plate No. 1 is assembled (fig. 122). Maintain the proper tension on assembly A by engaging it with rf-to-oscillator gear B1. Figure 104 shows control bearing plate No. 2BB assembled to control bearing frame No. 3CC.

(4) Spring-load gears H2 and H8 by rotating loose gear H2 counterclockwise one or two teeth positions. Maintain the proper tension by engaging the gears with assembly G. Spring-load gears H1 and H4 by rotating loose gear H1 counterclockwise one or two teeth positions. Use a paper clip or similar device to maintain the proper tension on these gears. Spring-load gears C1 and C4 by rotating loose gear C4 counterclockwise one or two teeth positions. Use a paper clip or similar device to maintain the proper tension. Figure 104 shows the assemblies contained on control bearing plate No. 1 assembly AA.

(5) Place control bearing plate No. 1 assembly AA over control bearing plate No. 2 assembly BB. Place spacer posts DD3 at each corner to maintain proper spacing between the plates. Engage spring-loaded gears H1 and H4 with rf even band dial driver gear B1 and spring-loaded gears C1 and C4 with assembly A. Make sure that all gears are properly engaged; then remove the locking device on the spring-loaded gears. Slide bearing plate alinement bars DD1 through spacer posts DD2 and bearing plates AA, BB, and CC, and fasten them at the rear of control bearing frame No. 3 assembly CC with hexagonal nuts DD6 and lockwashers DD5. Figure 103 shows an overall view of the control head assembled.

g. Cross-Reference Chart.

Assembly	Name	Reference symbol
A	Oscillator gear and pinion assembly.	
A1	Esna roll pin	
A2	Fixed oscillator antibacklash gear	
A3	Hub for oscillator gears	
A4	Main dial stop stud	
A5	Free oscillator antibacklash gear	Part of O171
A6	Oscillator to main dial pinion	Part of O171
A7	Antibacklash spring	H193
AA	Control bearing plate No. 1 assembly	
AA1	Control bearing plate No. 1	
AA2	Even dial bearing	
AA3	Oilite bearing F-303-1	
AA4	Oilite bearing F-220-2	
AA5	Oilite bearing F-310	
AA6	Front cover tie angle	
AA7	Esna clinchnut (4)	
AA8	Control bearing plate No. 1 angle (2)	
AA9	Rivet (6)	
B	Even band dial gear assembly	
B1	Rf to oscillator gear	Part of O169
B2	Rf even band dial driver gear	Part of O169
B3	Esna rollpin	
B4	Bristo setscrews (3)	
B5	Vernier drive shaft	O211
BB	Control bearing plate No. 2 assembly.	
BB1	Control bearing plate No. 2	
BB2	Oilite bearing (2)	
BB3	Oilite bearing	
BB4	Oilite bearing	
BB5	Oilite bearing	
BB6	Oilite bearing F-303-1	
C	Main dial gear assembly	
C1	Gear, tight	Part of O170
C2	Gear hub	Part of O170
C3	Bristo setscrews (2)	

Assembly	Name	Reference symbol
C4	Gear, loose	
C5	Main dial stop	H220
C6	Spring (2)	
CC	Control bearing frame No. 3 assembly.	O187
CC1	Control bearing frame No. 3	
CC2	Oilite bearing F–303–1	
CC3	Oilite bearing F–310	
CC4	Control frame No. 3 bearing	
CC5	Clinchnut (16) No. 68 NC–2–40.	
CC6	Clinchnut (6) No. 68 NC–2–62.	
D	Main dial and hub assembly	
D1	Main dial hub	O214
D2	5" dial	H215
D3	Machine screws (3)	
D4	Main dial shaft	
DD	Spacer post assembly	
DD1	Bearing plate alinement bar (4).	H209 to H212
DD2	Bearing plate No. 1 spacer posts (4).	H197 to H200
DD3	Bearing plate No. 2 spacer posts (4).	H205 to H208
DD4	Bearing plate No. 3 spacer posts (4).	H201 to H204
DD5	Lockwashers (4)	
DD6	Hexagonal nuts (4)	
E	Odd band hub and dial assembly.	
E1	Odd band dial hub	O213
E2	Odd band dial	H214
E3	Machine screws (3)	
E4	Bristo setscrews (2)	
F	Even band dial assembly	
F1	Even band dial	H213
F2	Even band dial gear hub	O167
F3	Machine screws (3)	
G	Rf even band dial driven gear	O168
H	Even band dial intermediate gear assembly.	
H1	Gear, loose	
H2	Gear, loose	
H3	Even band dial intermediate gear hub.	
H4	Gear, tight	
H5	Intermediate gear stud	
H6	Tru-arc retainer ring	
H7	Spring (2)	
H8	Gear, tight	
H9	Spring (2)	
J	Tuning shaft and gear assembly.	O172
J1	Tuning shaft gear	Part of O172
J2	Tuning shaft	Part of O172
J3	Esna rollpin	
K	Tuning shaft intermediate gear assembly.	
K1	Intermediate gear No. 1	
K2	Intermediate gear No. 1 stud	
K3	Intermediate gear No. 2	O174
K4	Intermediate gear No. 3	
K5	Intermediate gear No. 3 stud	
K6	Intermediate gear spring	Part of O173
K7	Tru-arc retainer ring	
K8	Tru-arc retainer ring	
K9	Intermediate gear stud	
K10	Washer	
L	Stop collar assembly	
L1	Stop collar	
L2	Rollpin	
L3	Bristo setscrews (3)	
L4	Plate No. 2 stops (6)	O307 to O310, O317, and O318
L5	Plate No. 1 stop	O306
L6	Stop stud	
L7	Hexagonal nut	
L8	Lockwasher	
M	Antenna trimmer intermediate gear No. 1 assembly.	
M1	Tru-arc retainer ring	
M2	Antenna trimmer intermediate gear No. 1.	O180
M3	Antenna trimmer intermediate gear No. 1 stud.	
N	Antenna trimmer intermediate gear No. 2 assembly.	
N1	Tru-arc retainer ring	
N2	Antenna trimmer intermediate gear No. 2.	O181
N3	Antenna trimmer intermediate gear No. 2 stud.	
O	Antenna trimmer gear and drive shaft assembly.	O179
O1	Antenna trimmer drive gear	
O2	Antenna trimmer drive shaft	
O3	Esna rollpin	
P	Antenna trimmer gear and shaft pinion	O178
P1	Antenna trimmer pinion gear	
P2	Antenna trimmer pinion shaft	
P3	Esna rollpin	
R	If. and oscillator switch gear assembly.	Part of O200
R1	If. spur gear	
R2	Bevel gear	
R3	Bristo setscrews (2)	
S	Oscillator bevel gear and shaft assembly.	Part of O200
S1	Miter gear	
S2	Bevel pinion gear	O191
S3	Bevel gear shaft	
S4	Thrust collar	
S5	Thrust bearing	
S6	Thrust collar	
S7	Thrust bearing	
S8 to S11	Esna rollpin (4)	

Assembly	Name	Reference symbol
T	Turret miter gear and shaft assembly.	O190
T1	Miter gear	O192
T2	Miter gear	O193
T3	Miter gear turret shaft	
T4	Thrust collar	
T5	Thrust bearing	
T6	Thrust collar	
T7	Thrust bearing	
T8 to T11	Esna rollpin (4)	
U	Miter gear terminal bracket assembly.	
U1	Miter gear terminal bracket	A123
U2	Miter gear	
U3	Band switch tuning shaft	
U4	Screws (3)	
U5	Esna rollpin	
V	Miter gear turret bracket assembly	
V1	Miter gear turret bracket	A121
V2	Turret worm shaft (short)	O194
V3	Miter gear	
V4	Screws (3)	
V5	Esna rollpin	
W	Oscillator bevel gear bracket assembly	
W1	Oscillator bevel gear bracket	A143
W2	Oscillator switch drive shaft	
W3	Oscillator switch shaft coupler	
W4	Esna rollpin	
W5	Screws (3)	
X	If switch spur gear assembly	
X1	If switch spur gear	O198
X2	Bristo setscrews (2)	
X3	If switch gear shaft bearing	O197
X4	If switch gear shaft	Part of O196
X5	Washer	H196
X6	Hexagonal nut	
X7	If switch coupler arm	Part of O196
X8	Esna rollpin	

h. Control Head Maintenance Items.

Parts	Reference symbol
Control Head	O164
A1 through A6	O171
A7	H193
B1 through B4	O169
B5	O211
C1, C2, C4, C5, C6	O221
C6	H236
D1	O214
D2	H215
D4	O222
DD1	H209 through H212.
DD2	H197 through H200.
DD3	H205 through H208.
DD4	H201 through H204.
E1	O213
E2	H214
F1	H213
F2	O167
G	O168
H1, H2, H3, H4, H7, H8, and H9	O166
J1 through J3	O172
K1 through K7	O173
K6	H194
K7	H192
L1, L2	O320
L4	O307
L5	O306
L6	H235
M2	O180
N2	O181
O1 through O3	O179
P1 through P3	O178
R1 through R3	O220
W2 through W4	O199
X1	O198
X4, X7, and X8	O196
X5	H196
CC, S, T, U1, U2, U4, U5, V, W, X	O186

95. Disassembly of First Mixer Section

a. General. The first mixer section is a compact subchassis containing six amplifier subassemblies and a crystal calibrator subassembly. Replacement of parts on the crystal calibrator subassembly is not difficult but because of compactness, it may be necessary to remove the amplifier subassemblies to make repairs. To remove a subassembly, first remove the turret.

b. Removal of Turrets (figs. 107 and 108). Each turret is fastened to its shaft by two Bristo setscrews. To remove any one of the seven turrets, proceed as follows:

(1) Loosen the two setscrews with a Bristo wrench. Do not remove the setscrews from the holes. The turret will now be free to rotate on the shaft.

(2) Rotate the turret so that the contacts on the turret coil assemblies do not touch the wiper contacts on the frame.

(3) Remove the turret by pulling it forward off the shaft.

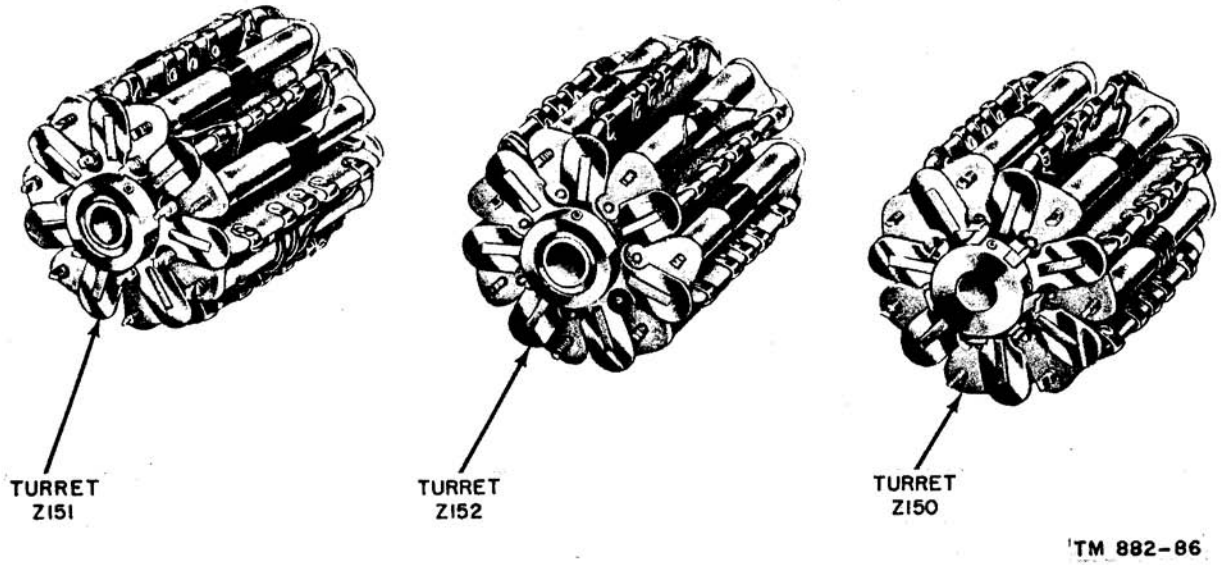


Figure 107. Radio Receiver R-220/URR, turrets, Z150, Z151, and Z152.

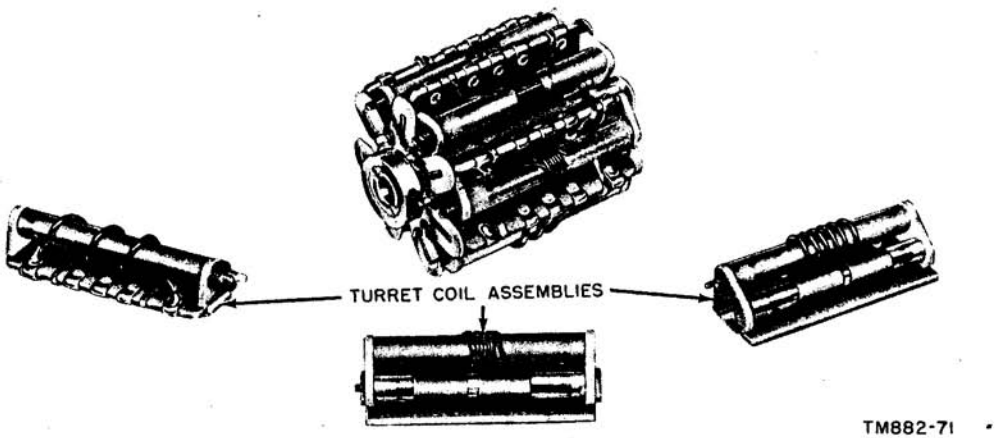


Figure 108. Radio Receiver R-220/URR, rf turret assembly.

(4) To remove the turret coil assemblies, from the turret, pry the end plates apart and lift them out (fig. 104).

(5) To replace the turrets, reverse the instructions given for disassembly. When putting the turret back on the shaft, be sure that the setscrew holes line up with the flatted portions of the shaft.

c. Removal of Subassemblies (figs. 109, 110, 111, and 112). To remove the subassemblies from the subchassis, first remove the turrets as instructed in *b* above. To remove the subassemblies, proceed as follows:

(1) Remove the side plates by removing the screws around the outside of the plates (fig. 110).

(2) Unsolder all the connections on the subassembly that go to other parts of the subchassis. Tag each connection as it is removed so that proper rewiring will be made.

(3) Remove the three screws that fasten the subassembly to the frame.

(4) Subassemblies Z166, Z168, and Z170 may now be removed from the frame.

(5) To remove subassembly Z175, loosen the two setscrews on the flexible shaft

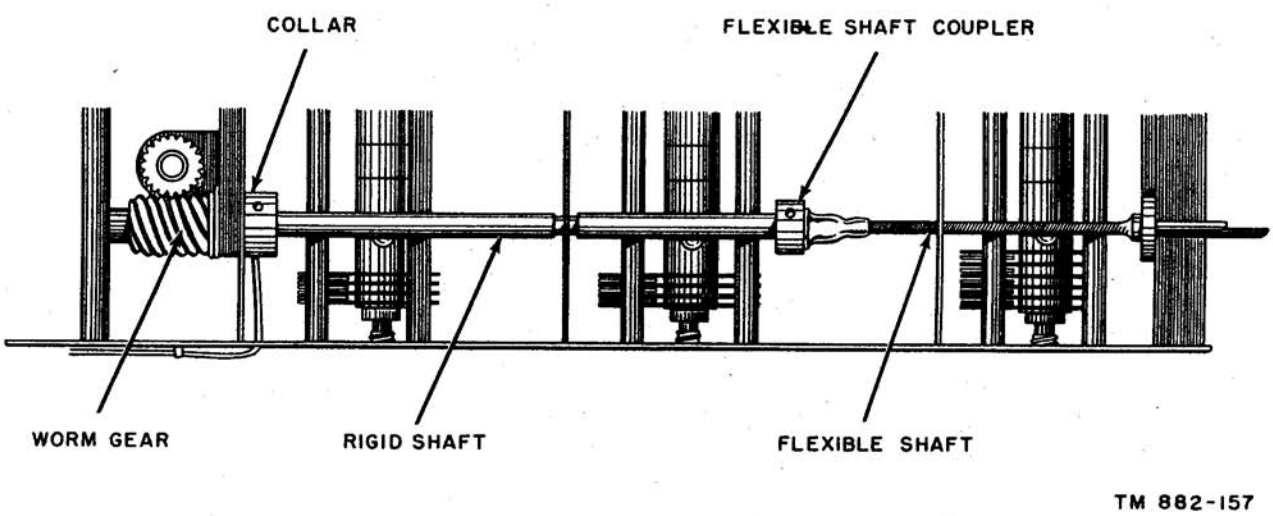


Figure 109. Antenna trimmer shaft removal.

coupler. Pull the flexible shaft back so that the collar slides off the rigid shaft. Remove the flexible shaft by pulling it forward through the hole in the subassembly plate (fig. 110).

(6) To remove subassemblies A112 or Z172, loosen the two setscrews on the shaft collar. Remove the worm gear and pull the rigid shaft out through the holes in the subassembly plates (fig. 110).

(7) Subassemblies A112 or Z172 may now be removed from the frame.

(8) When the subassemblies are removed from the subchassis, do not change the setting of the variable capacitors or realinement will be necessary.

(9) To replace the subassemblies, reverse the instructions given above.

96. Disassembly of Main Unit

a. General. Before repairing or replacing any parts in the main unit, other than tubes, remove power supply and rf unit. Refer to paragraph 92.

b. Removal of Front Panel.

(1) Remove all front panel control knobs (fig. 12).

(2) Unsolder the two wires attached to meter M301 (fig. 71). When resoldering the wires, be sure that the red wire is soldered to the terminal marked "+".

(3) Unsolder the wires attached to the AUDIO OUTPUT jacks (fig. 71). Tag each wire or make a pencil sketch of the wiring so that the proper connections will be made when the panel is replaced.

(4) Place blocks of wood at each corner of the chassis so that the front panel does not touch the bench.

(5) Remove the six Phillips head screws that hold the panel to the chassis (fig. 2).

(6) Remove the four Allen head cap screws that hold the two handles to the panel.

(7) The panel may now be removed from the chassis.

(8) To replace the panel, reverse the instructions given above.

c. Disassembly of BAND SELECTOR Knob. Figure 113 shows an exploded view of the BAND SELECTOR control knob. Reference numbers are assigned to parts on the illustration as an aid in disassembly. A cross-reference chart *d* below lists the reference number and name of parts shown in figure 113. To disassemble the control knob, proceed as follows:

(1) Loosen setscrews 1 from main knob 10. Do not remove the setscrews from the knob.

(2) Remove the band switch knob assembly, consisting of items 2 through 10, from band switch sleeve and pinion assembly 16.

(3) Remove machine screw 2 and lockwasher 3 and lift cover plate 4 off knob turn assembly 9.

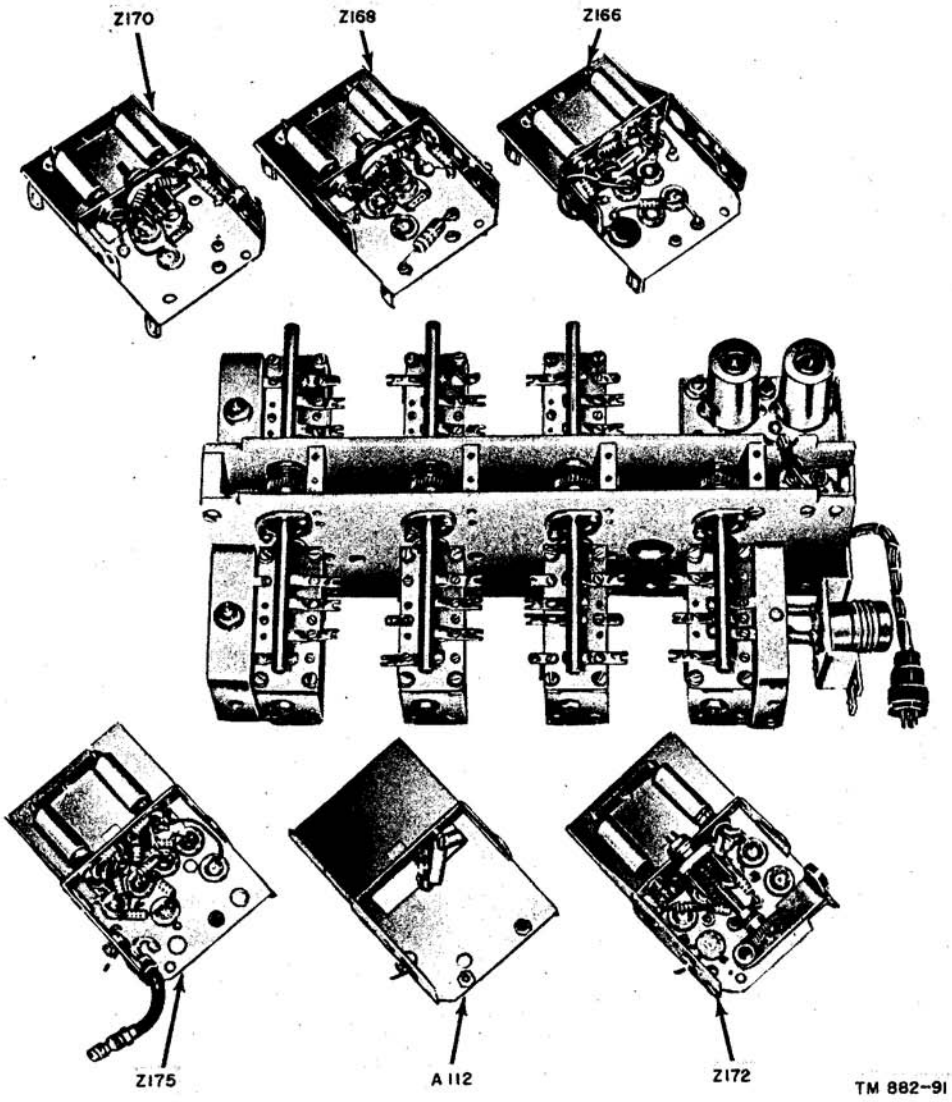


Figure 110. Rf turret partition disassembled.

(4) Push in detent pin 6 from the rear until retaining ring 5 is accessible. Remove the retaining ring.

(5) Push in guide pin 7 from the rear until retaining ring 5 is accessible. Remove retaining ring.

(6) Remove knob turn assembly 9 from main knob 10.

(7) Remove detent pin 6, guide pin 7, and springs 8 from main knob.

(8) Remove detent plate 12 and gasket 15 by removing machine screws 13 and washers 14.

(9) To reassemble the BAND SELECTOR knob, reverse the order of instructions given above. When replacing cover plate 4, place the lettered side over the detent pin.

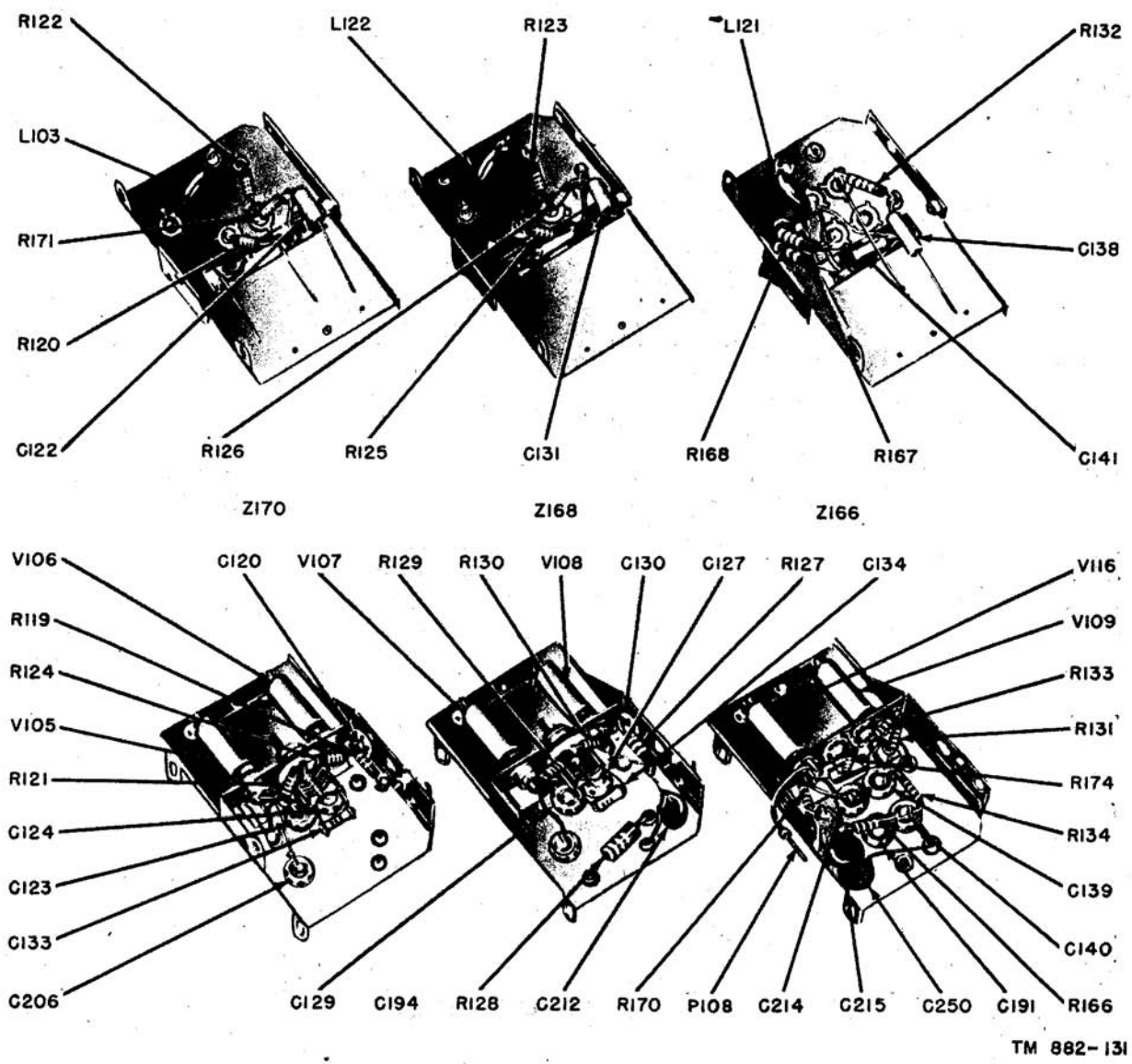


Figure 111. Rf turret partitions, section B.

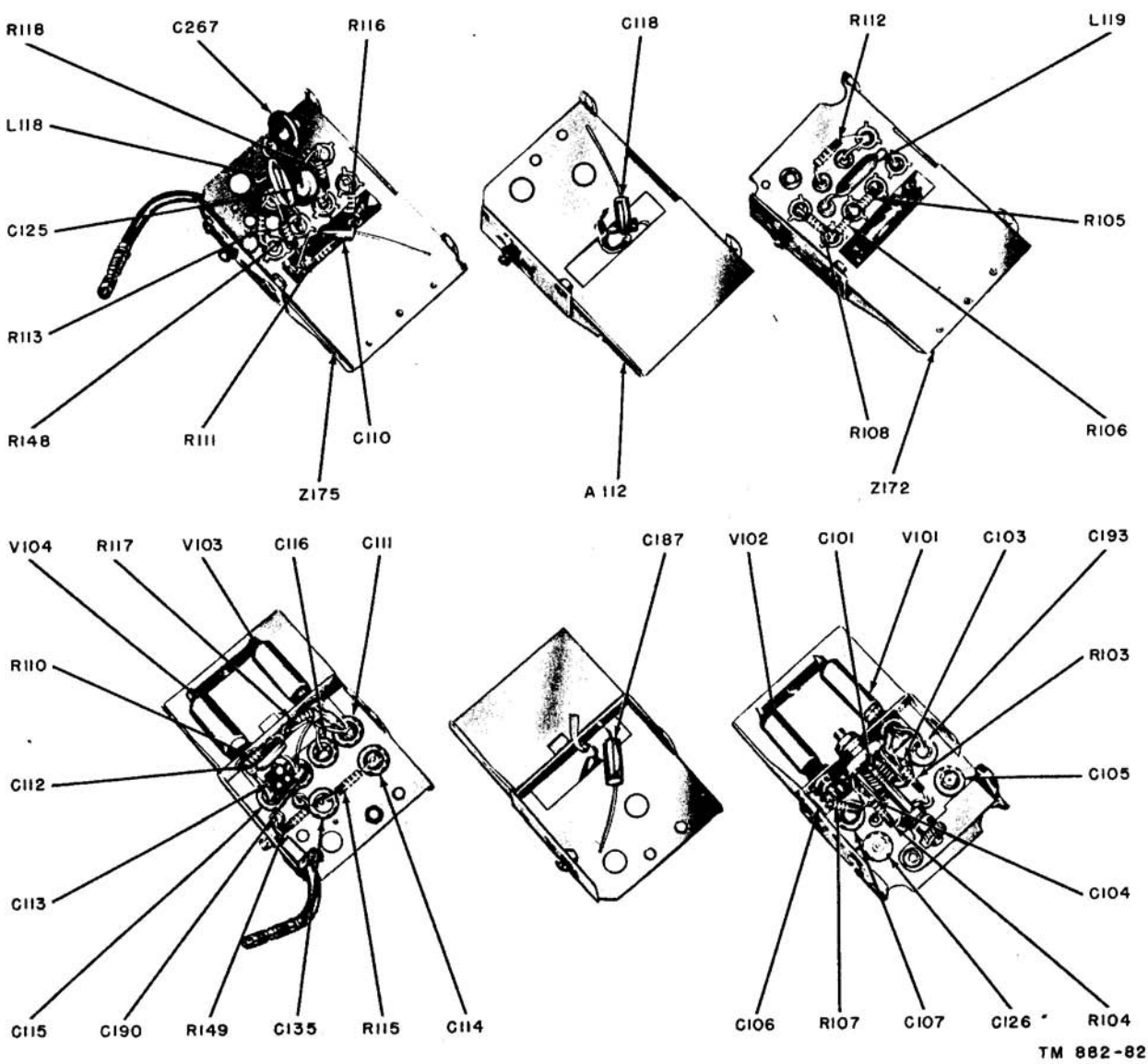


Figure 112. Rf turret partitions, section D.

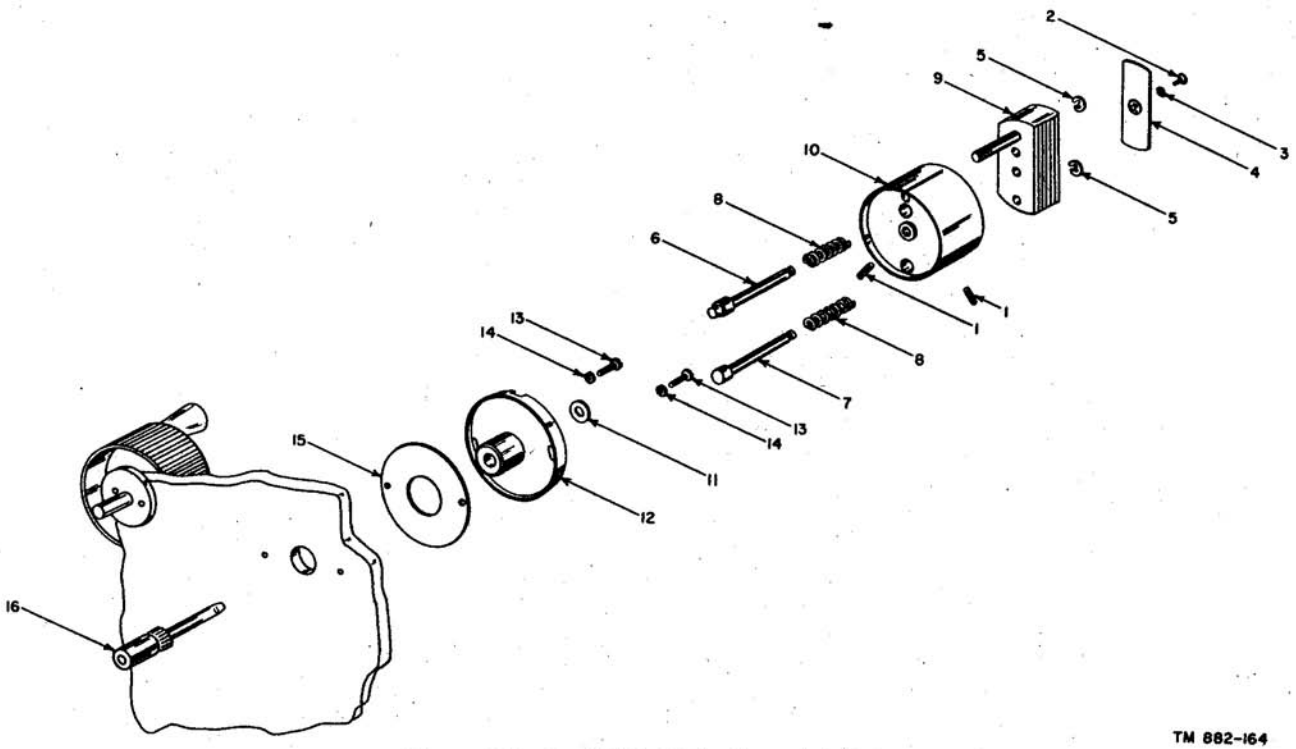


Figure 113. Band Selector knob, exploded view.

d. Cross-Reference Chart.

Ref. No.	Name
1	Setscrew, Allen head (8–32 x 5/16)
2	Machine screw (3–48 x 1/4)
3	Lockwasher
4	Cover plate
5	Retaining ring
6	Detent pin
7	Guide pin
8	Spring
9	Knob turn assembly
10	Main knob
11	Washer
12	Detent plate
13	Machine screw (6–32 x 3/8)
14	Washer
15	Rubber gasket
16	Band switch sleeve and pinion assembly

e. Removal of Bfo Subchassis (fig. 114).

(1) Remove the tube shield and tube from the bfo subchassis.

(2) Unsolder the five wires that are attached to the subchassis. Tag each wire as it is removed.

(3) Loosen the two slotted-head setscrews on the flexible coupling that is nearer the oscillator shield.

(4) Pull the B. F. OSCILLATOR control knob away from the front panel so that the flexible coupling is clear of the shaft.

(5) Remove the two stop nuts that hold the subchassis to the front of the main chassis.

(6) Remove the two screws that hold the rear of the subchassis to the main chassis.

(7) Remove the subchassis by pulling it up and tilting it so that the rear flange clears the wiring on the main chassis.

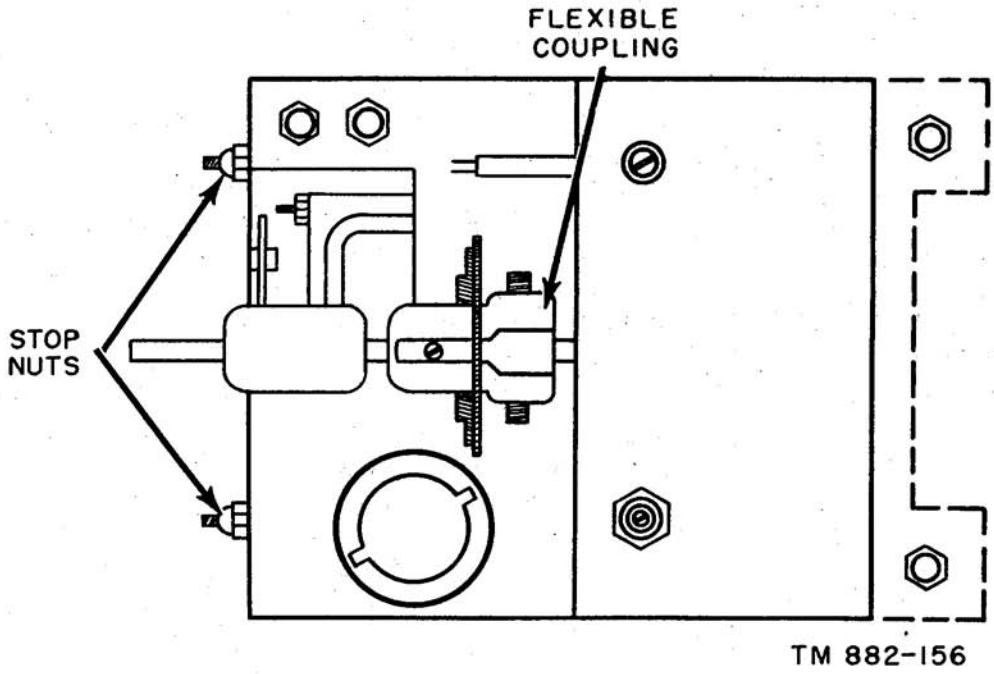


Figure 114. Bfo Subchassis removal.

97. Cable Connections

The following chart lists all the internal cables, their length, terminations, and mating connections in Radio Receiver R–220/URR. This chart will aid in reconnecting the various sections of the receiver.

	Length (in.)	Plug	Mating connection	Plug	Mating connection
1st mixer section coaxial cable	4	P101	J101	(*)	
1st mixer section power cable	7	P103	J103	(*)	
1st hf oscillator section heater power cable	3	P104	J104	(*)	
1st hf oscillator section output cable	3½	P108	J108	(*)	
2d mixer section power cable	2½	P102	J102	(*)	
Main unit coaxial cable	4¾	P308	J308	(*)	
Cable assembly W301	7	P306	J106	P307	J307
Cable assembly W302	22	P105	J105	P304	J304
Cable assembly W304	18	P303	J303	P604	J304

*These cables consist of one or more wires having a plug on one end only; the other end in each case is permanently fastened to the receiver.

98. Special Repair Procedures

a. General. Most of the parts in the main unit of the receiver are readily accessible and can be replaced easily without special instructions. Special repair procedures are required for repairing or replacing the dial masks, filters, tube sockets, and connectors.

b. Dial Masks. To remove the kilocycle dial mask and the megacycle dial mask, the rf unit must be removed from the receiver. Instructions for removal of the rf unit are given in paragraph 92. To remove the dial masks, proceed as follows:

(1) Rotate the BAND SELECTOR control to band 7.

(2) Remove the Phillips head screw that holds the kilocycle dial mask assembly to the front panel (fig. 2).

(3) Pull the dial mask assembly away from the rear of the panel. Do not use force because damage to the gears may result.

(4) The mask may now be removed from the assembly by removing the three binder-head screws (fig. 73).

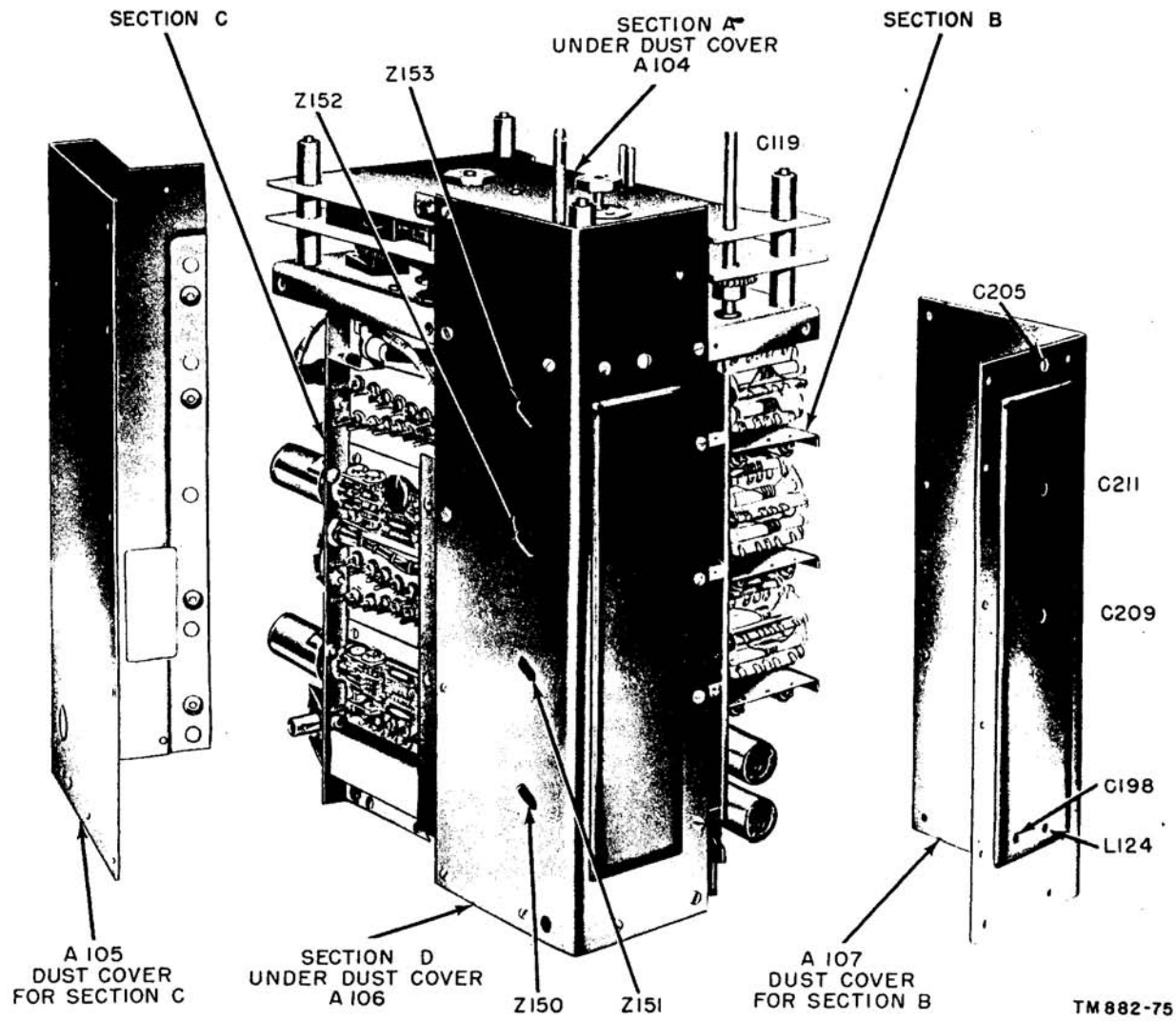


Figure 115. Rf unit, location of sections A through D.

(5) When replacing the mask, be sure that the holes in the hub line up with the holes in the gear.

(6) The megacycle dial mask assembly is removed in the same manner as the kilocycle dial mask assembly.

c. Filters. The 1.75-mc filter, FL301, and the selectivity filters, FL302, FL303, and FL304, are similar in mechanical construction. Follow the instructions below when removing any one of the filters (figs. 15, 82, 85, and 103).

(1) Unsolder the wires attached to the ends of the filter.

(2) Remove the four nuts and lockwashers that secure the filter to the chassis. It may be necessary to move terminal boards TB301 and TB302 slightly to get at the nuts. To do this, loosen the two screws that hold the terminal board in place. Move the terminal board just enough to expose the nuts. Be careful not to damage any of the parts when moving the terminal board.

(3) The filter may now be removed from the chassis by lifting it straight up.

(4) To replace the filter, reverse the procedure given above.

d. Tube Sockets. All sockets are attached to the chassis by rivets or screws. To change a socket, proceed as follows:

(1) Remove the part plugged into the socket.
(2) Unsolder the wires connected to the socket.
(3) Drill out the two rivets or remove the screws that fasten the socket to the chassis.
(4) Substitute a new socket and fasten it with rivets or machine screws, lockwashers, and nuts.
(5) Resolder the wires to the socket.
(6) Clean the unit thoroughly to remove solder drops and metal chips.
(7) Check the new connections with those shown on the schematic for that unit.

e. Connectors.

(1) Tie together all wires and tag each wire to indicate where it connects.
(2) Unsolder the wires.
(3) Remove the two screws holding the connector in place.
(4) Remove the connector and repair or replace it.
(5) Place the new connector in position and push the machine screws in from the outside.
(6) Fasten the connector tightly in place with the original nuts.
(7) Carefully resolder the wires.

99. Lubrication of Equipment at Field Maintenance Level

a. General Lubricating Instructions. Do not use excessive amounts of oil or grease and do not allow electrical connections to become greasy. Be sure that lubricants and points to be lubricated are free from sand, dirt, or grit; abrasives are the chief cause of wear and often cause breakdown of gear assemblies. Before lubrication, clean all surfaces with a lint-free cloth dampened with cleaning compound.

b. Lubrication of Switches. Clean the exposed bearing surfaces of switch detents and switch mechanisms when repairs are being made; sparingly apply Grease, Aircraft and Instruments (GL). Remove excess grease to prevent possible malfunctioning of other parts, especially switch contacts.

100. Refinishing

Instructions for refinishing badly marred panels on the exterior cabinets are given in TM 9–2851.

Section III. RADIO RECEIVER R–220/URR ALINEMENT

101. General

a. Conditions for Alinement. Remove the receiver from its case. For best results, the equipment should be set up on a metal-top bench located in a grounded screen room. All equipment chassis should be bonded to the bench. In many cases, a screen room and a metal-top bench are not available. If the receiver must be alined without them, be sure that there is a good ground connection between the receiver and test equipment. Allow approximately one-half hour for all equipment to warm up before starting the alinement procedure. The input voltage to the receiver and test equipment must be maintained at 115-volts ac during alinement. A coupling unit consisting of a resistive network designed to match the signal generator output impedance and the receiver input impedance should be used.

b. Receiver Controls. Unless otherwise specified, set the receiver front panel controls to the following positions:

(1) BAND SELECTOR to band 2.
(2) TUNING to 30 mc.
(3) B. F. OSCILLATOR to OFF.
(4) SELECTIVITY to 50 K. C.
(5) AUDIO RESPONSE to WIDE.
(6) R. F. GAIN SQUELCH to approximate midposition.
(7) AUDIO GAIN 1 and AUDIO GAIN 2 to approximate midposition.
(8) NOISE LIMITER to OFF.
(9) OPERATION to MGC.
(10) METER switch to CARRIER.
(11) CALIBRATE to OFF.

102. First High-frequency Oscillator Alinement

a. Receiver Tuning-dial Capacitor. Remove the rf unit from the main unit; follow the instructions outlined in paragraph 92*e*. Remove the first hf oscillator dust cover (fig. 101) and replace the rf unit.

(1) Unsolder the lead from the stator of C152 that goes to L107 and C151 (fig. 92). Connect Multimeter TS–297/U between ground and the stator of C152. Place a

small flat-edged metal strip across the bottom of the stator plates of C152. Rotate the receiver TUNING control until C152 is at full mesh (maximum capacitance) position. This occurs when the rotor plates make contact with the flat-edged metal strip across the stator resulting in a zero reading on the TS–297/U. Loosen the setscrews in the coupling shaft so that the C152 rotor will remain fixed when the receiver TUNING control is rotated. Resolder the lead from L107 to C152.

(2) Unsolder the lead from the stator of C155 that goes to L108 and C153 (fig. 92). Connect Multimeter TS–297/U between ground and the stator of C155. Place a small flat-edged metal strip across the bottom of the stator plates of C155. Rotate the receiver TUNING control until C155 is at full mesh position (indicated in the same manner as for C152). Loosen the setscrews in the coupling shaft so that the C155 rotor will remain fixed when the receiver TUNING control is rotated. Remove the TS–297/U and the flat-edged metal strip. Resolder the lead from L108 to C155.

(3) Rotate the kilocycle dials until the guide dot markers are in line with the notched marker at the top of control bearing plate No. 1 (fig. 116). If the guide dots do not line up with the marker, loosen the dial setscrews and aline them; tighten the setscrews.

(4) Loosen the setscrews on the megacycle dial assembly and aline the solid line at the low-frequency end of the dial with the notched marker at the top of control bearing plate No. 1; tighten the setscrews (fig. 116).

(5) Tighten the setscrews on the coupling shafts to tuning capacitors C152 and C155.

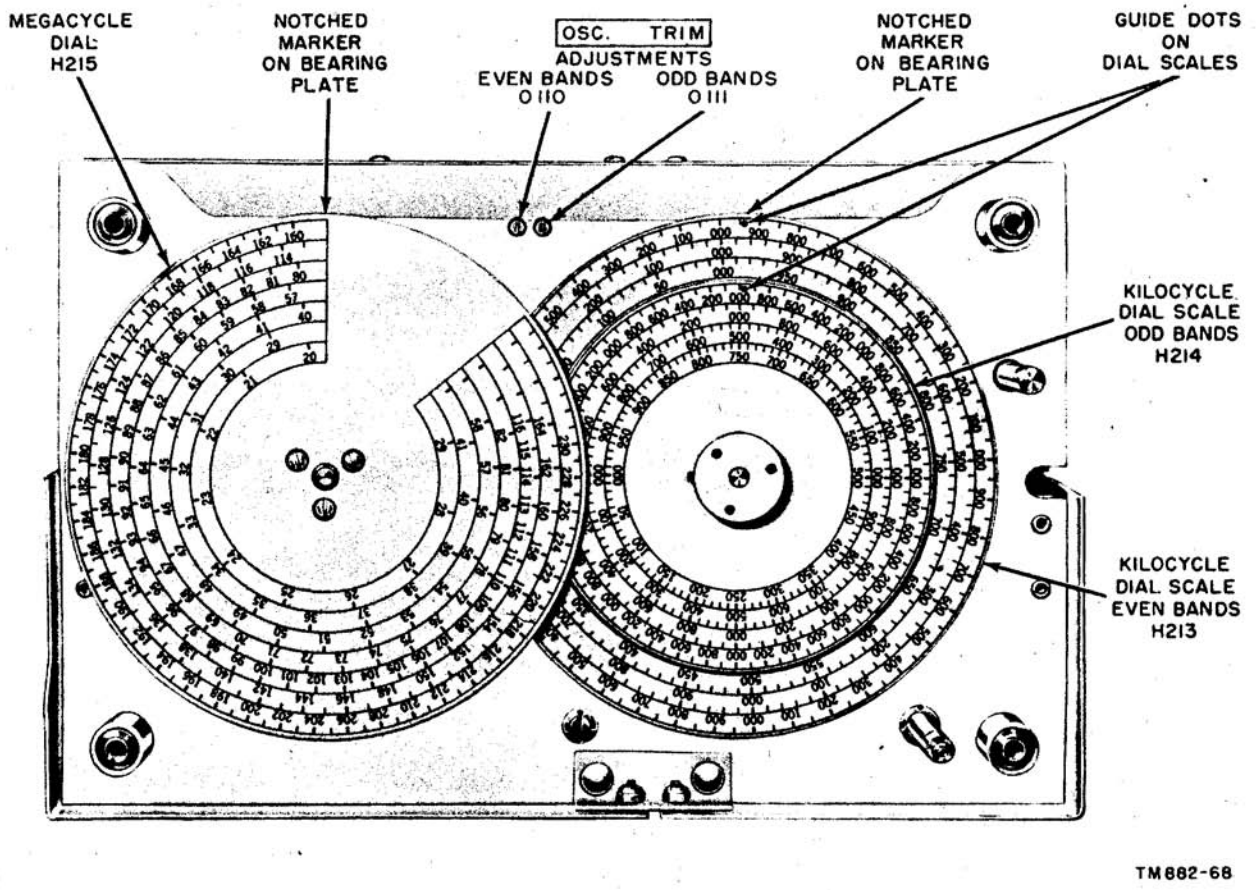


Figure 116. Rf unit, front view, showing dial system and oscillator trimmer adjustments.

b. Odd Band Alinement. Before attempting to aline the first hf oscillator, be sure the filament voltage is 6.3 volts, B+ is 105 volts dc, and the first hf oscillator heater voltage is 115 volts ac. Disconnect P103 from J103 (fig. 102).

(1) Remove the multiplier dust cover (fig. 87). Adjust the shafts of oscillator trimmers C154 and C158 until the slots are in a vertical position. Adjust L107, C108, C156, and C157 to approximately the middle of their ranges. Plug P103 into J103.

(2) Replace the dust cover on the first hf oscillator assembly; first be sure that P104 is connected to J104 (fig. 87). Replace the rf unit in the main chassis.

(3) Rotate the BAND SELECTOR to band 1 position. Loosely couple the lead from Frequency Meter BC–221 to the standoff terminal that connects the lead from P108 to pin 1 of V116 (fig. 103). Rotate the TUNING control to 20.08 mc. This setting results in a 6° rotation of C155 from full mesh. Set the SCR–211 to 13.9856 mc. This is the actual oscillator frequency for a 6° rotation of C155. Adjust L108 for a zero beat in the headset, indicating that the oscillator frequency is the same as that of the BC–221.

(4) Set the receiver TUNING dial to 29.413 mc. This setting results in a 174° rotation of C155 from full mesh. Set the BC–221, to 23.3189 mc (second harmonic of 11.6594 mc on the BC–221). This is the actual oscillator frequency for a 174° rotation of C155. Adjust C156 for a zero beat.

(5) Repeat the process outlined in (3) and (4) above until no further adjustment of L108 and C156 is required to set the oscillator for the proper dial frequency. The chart below lists oscillator frequencies with corresponding dial readings and the allowable error in dial setting. The *Degree* column lists the degree of rotation for C155. The *Oscillator frequency* column lists the corresponding oscillator frequency and the dial frequency column indicates the proper dial setting at the front panel of the receiver. Using the information in the chart below, measure the oscillator frequency with respect to the dial frequency for every 10° rotation of C155. If, at any setting, the actual error is in excess of the allowable error, realine the odd band circuit by following the procedure outlined in (1) through (4) above.

Degree	Oscillator frequency (mc)	Dial frequency (mc)	Allowable error (kc)
0	13. 6523	19. 746	9. 5
6	13. 9856	20. 080	10. 0
10	14. 2078	20. 302	10. 0
20	14. 7634	20. 858	10. 0
30	15. 31896	21. 413	10. 0
40	15. 8745	21. 969	10. 5
50	16. 43008	22. 524	11. 0
60	16. 9856	23. 080	11. 0
70	17. 54118	23. 635	11. 0
80	18. 0967	24. 191	12. 0
90	18. 6523	24. 747	12. 0
100	19. 2078	25. 302	12. 0
110	19. 7634	25. 858	12. 5
120	20. 3189	26. 413	13. 0
130	20. 8745	26. 969	13. 0
140	21. 4301	27. 524	13. 0
150	21. 9856	28. 080	14. 0
160	22. 5412	28. 635	14. 0
170	23. 0967	29. 191	14. 0
174	23. 3189	29. 413	14. 0
180	23. 6523	29. 747	14. 5

c. Even Band Alinement. Rotate the BAND SELECTOR to band 2 position.

(1) Set the receiver dial to 28.458 mc. This is equal to a 6° rotation of C152. Adjust the BC–221 to 9.911 mc. This is the actual oscillator frequency at 6° rotation of C152. Adjust L107 (fig. 117) until a zero beat is obtained.

(2) Set the receiver TUNING dial to 41.686 mc. This is equal to a 174° rotation of C152. Adjust the BC–221 to 16.524 mc. This is the actual oscillator frequency at 174° rotation of C152. Adjust C157 for a zero beat in the headset.

(3) Repeat the process outlined in (1) and (2) above until no further adjustment of L107 and C157 is required to set the oscillator for the proper dial frequency. The following chart lists oscillator frequencies with corresponding dial readings and the allowable error. If, at any setting, the actual error is in excess of the allowable error, realine the even band

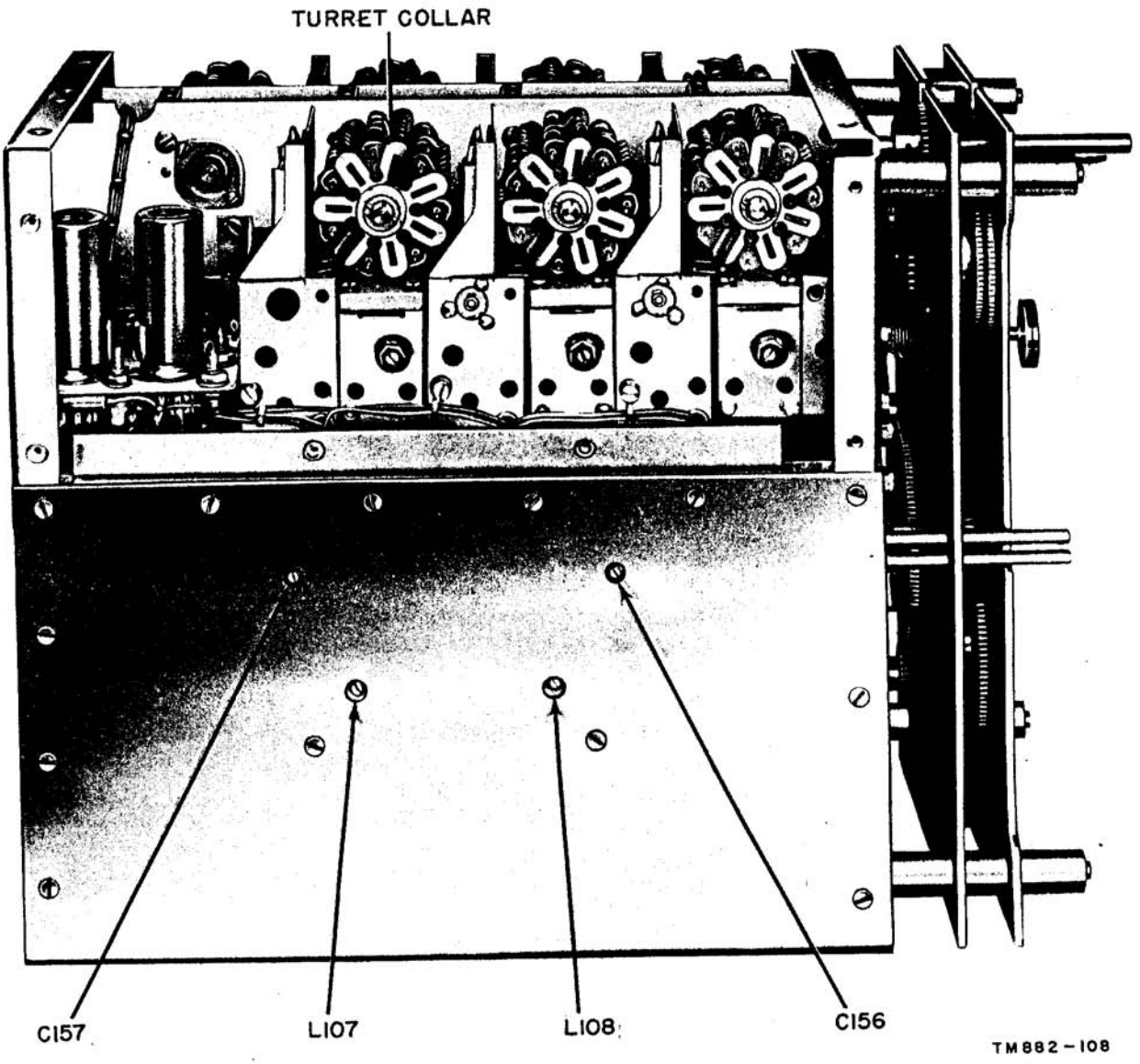


Figure 117. First hf oscillator alinement points.

circuit by following the procedure outlined in (1) and (2) above.

Degree	Oscillator frequency (mc)	Dial frequency (mc)	Allowable error (kc)
0	9. 674	27. 985	13. 5
6	9. 911	28. 458	14. 0
10	10. 068	28. 773	14. 0
20	10. 462	29. 561	14. 0
30	10. 856	30. 348	15. 0
40	11. 249	31. 135	15. 0
50	11. 643	31. 923	15. 5
60	12. 0366	32. 710	16. 0
70	12. 430	33. 497	16. 0
80	12. 824	34. 285	17. 0
90	13. 2176	35. 072	17. 0
100	13. 6113	35. 859	17. 5
110	14. 005	36. 647	18. 0
120	14. 398	37. 434	18. 0
130	14. 792	38. 221	19. 0
140	15. 186	39. 009	19. 0
150	15. 580	39. 796	19. 5
160	15. 973	40. 583	20. 0
170	16. 367	41. 371	20. 0
174	16. 524	41. 686	20. 0
180	16. 761	42. 158	21. 0

(4) Remove the rf unit from the main chassis (fig. 101) and replace the multiplier dust cover. Replace the rf unit in the main chassis.

103. Second High-frequency Oscillator Alinement

a. Set the receiver BAND SELECTOR to band 1. Connect Electronic Multimeter TS–505/U between pin 7 of V112 (fig. 90) and ground (positive lead to ground).

b. Adjust L115 (fig. 118) for a maximum voltage reading. Use alinement tool H379 (fig. 97). Set the BAND SELECTOR to bands 2 through 7; adjust coils L114 through L109 respectively (fig. 118). A minimum injection voltage of .4 volt must be maintained at the cathode (pin 7) of the second mixer (V112) for all bands.

104. Rf and Multiplier Alinement

a. Multiplier Stages. Remove the rf unit from the receiver by following the disassembly procedure in paragraph 101*e*. Remove the second mixer dust covers (fig. 101) and disconnect P101 from J101 (fig. 102). Replace the dust cover. For accurate results, the alinement *must* be performed with the dust covers placed as for normal operation. Figure 15 shows access holes for alinement and figure 70 shows the turrets to be alined.

(1) Rotate the BAND SELECTOR to band 7. Connect the TS–505/U to P101 (fig. 102). Rotate the TUNING dial to 233.5 mc. Adjust trimmers C211, C209, C205, and C119 (fig. 88) and the capacitor on Z128 for a maximum output as shown on the TS–505/U. Rotate the TUNING dial to 162.4 mc. Adjust the coil slugs of Z149, Z142, Z135, and Z128 for maximum output. Paragraph 87*e* lists a cross-reference chart of the subassemblies contained in each turret for each band.) Repeat the above procedure several times or until further adjustments result in negligible variations in meter readings.

Note. If, during the rotation of the TUNING control on any one of the seven bands, an abnormally high output on the TS–505/U is observed, the trouble is self-oscillation within the multiplier unit, usually caused by improper tracking.

(2) Rotate the BAND SELECTOR to band 6. Set the TUNING dial to 165.4 mc and adjust the trimmer on Z127 and the slugs of Z134, Z141, and Z148 for maximum output. Rotating the TUNING dial to 115.1 mc, again adjust the slugs of Z148, Z141, Z134, and Z127 for maximum output. Repeat this procedure several times, or until further adjustment of the trimmer on Z127 results in only a negligible change in output. Make a compromise adjustment of Z134 such that the output readings at both ends of the band are approximately equal.

(3) Rotate the BAND SELECTOR to band 5 and tune to 116.7 mc. Adjust the trimmer on Z126, and the slugs on Z147, Z140, and Z133 for maximum output. Set the TUNING dial to 81.2 mc and readjust the slugs on Z147, Z140, Z133, and Z126 for maximum output. Repeat this procedure several times, or until further adjustment of the trimmer on Z126 results in only a negligible change in output. Make a final adjustment of Z133 for maximum output.

(4) Rotate the BAND SELECTOR to band 4 and tune to 82.7 mc. Adjust Z146, Z139, Z132, and Z125 for maximum output. Rotate the TUNING dial to 57.5 mc and adjust Z146, Z139, Z132, and Z125 for maximum output.

(5) Rotate the BAND SELECTOR to band 3 and tune to 58.4 mc. Adjust Z145, Z138, Z131, and Z124 for maximum output. Rotate the TUNING dial to 40.6 mc and again adjust Z145, Z138, Z131, and Z124 for maximum.

(6) Rotate the BAND SELECTOR to band 2 and tune to 41.4 mc. Adjust Z144, Z137, Z130, and Z123 for maximum output. Rotate the TUNING dial to 28.7 mc and again adjust Z144, Z137, Z130, and Z123.

(7) Rotate the BAND SELECTOR to band 1 and tune to 29.2 mc. Adjust Z143, Z136, Z129, and Z122 for maximum output. Rotate the TUNING dial to 20.3 mc and adjust Z143, Z136, Z129, and Z122 for maximum output.

b. Rf Alinement. Disconnect the TS–505/U from P101, and connect TS–497/URR to P101. Connect the TS–585/U to terminals 1 and 2 of TB308 (fig. 12).

(1) Rotate the BAND SELECTOR to band 1 and tune to 29.191 mc. Adjust the TS–497/URR to 29.191 mc. Adjust the ANTENNA TRIMMER control (C101, fig. 12) and the trimmers on Z101, Z108, and Z115 for maximum output on the TS–585/U. To aline the low end of band 1, tune the receiver and the TS–497/URR to 20.302 mc. Adjust slugs on Z101, Z108, and Z115 for maximum output on TS–585/U.

(2) For alinement of bands 2 through 7, follow the procedure used in *b* (1) above. The frequencies and adjustments are shown in the chart below.

Band	High end		Low end	
	Frequency (mc)	Adjustments	Frequency (mc)	Adjustments
1	29. 191	C101 Z101 Z108 Z115	20. 302	Z101 Z108 Z115
2	41. 371	C101 Z102 Z109 Z116	28. 773	Z102 Z109 Z116
3	58. 382	C101 Z103 Z110 Z117	40. 604	Z103 Z110 Z117
4	82. 742	C101 Z104 Z111 Z118	57. 546	Z104 Z111 Z118
5	116. 764	C101 Z105 Z112 Z119	81. 208	Z105 Z112 Z119
6	165. 484	C101 Z106 Z113 Z120	115. 092	Z106 Z113 Z120
7	220. 192	C101 Z107 *Z114* Z121	170. 192	Z107 *Z114* Z121

(3) Reconnect P101 to J101 and disconnect all test equipment.

105. First If. Alinement

a. Set the receiver panel controls to the positions listed in paragraph 109*b*. Rotate the BAND SELECTOR to band 1. Remove the first mixer dust cover (fig. 101). Remove turret Z152 by first loosening the Allen setscrews on the turret collar (fig. 117). Set the TS–497 to 6.0942 mc with modulation and connect it to the spring wiper nearest the collar. Connect the TS–585 to terminals 1 and 2 of TB308 (fig. 12). Adjust the coil slugs listed below for maximum reading on the TS–585/U.

b. Adjust L146, L147, L160, and L161 (fig. 118) for maximum output.

c. Change the frequency of the TS–497/URR to 8.6369 mc and set the BAND SELECTOR to band 2. Adjust L144, L145, L158, and L159 for maximum output.

d. Follow the procedure outlined in *a* through *c* above when alining the first if. stage. The following chart lists frequencies and alinement points for each band.

Band	Center frequency (mc)	Alinement points
1	6. 0942	L146, L147, L160, L161
2	8. 6369	L144, L145, L158, L159
3	12. 1884	L142, L143, L156, L157
4	17. 2738	L140, L141, L154, L155
5	24. 3767	L138, L139, L152, L153
6	34. 5476	L136, L137, L150, L151
7	48. 7535	L134, L135, L148, L149

106. Discriminator Alinement

a. Set the receiver front panel controls as outlined in paragraph 101*b*. Set the SELECTIVITY control to 200 and the OPERATION control to FM SQUELCH. Connect Electronic Multimeter TS–505/U to the output of the discriminator at the junction of R355 and R356 on TB304 (fig. 81). Set TS–505/U scale to +3 volts dc. Connect the AN/URM–25 to the grid of the third mixer V301 (fig. 82). Remove 2,205-kc crystal Y301 (fig. 15).

b. Adjust the AN/URM–25 for 100 microvolts output at 355 kc. Because accuracy is important, check the frequency of the AN/URM–25 using Frequency Meter Set SCR–211. Adjust Z301 (fig. 72) (using alinement tool provided at the rear of the receiver) for maximum positive dc voltage.

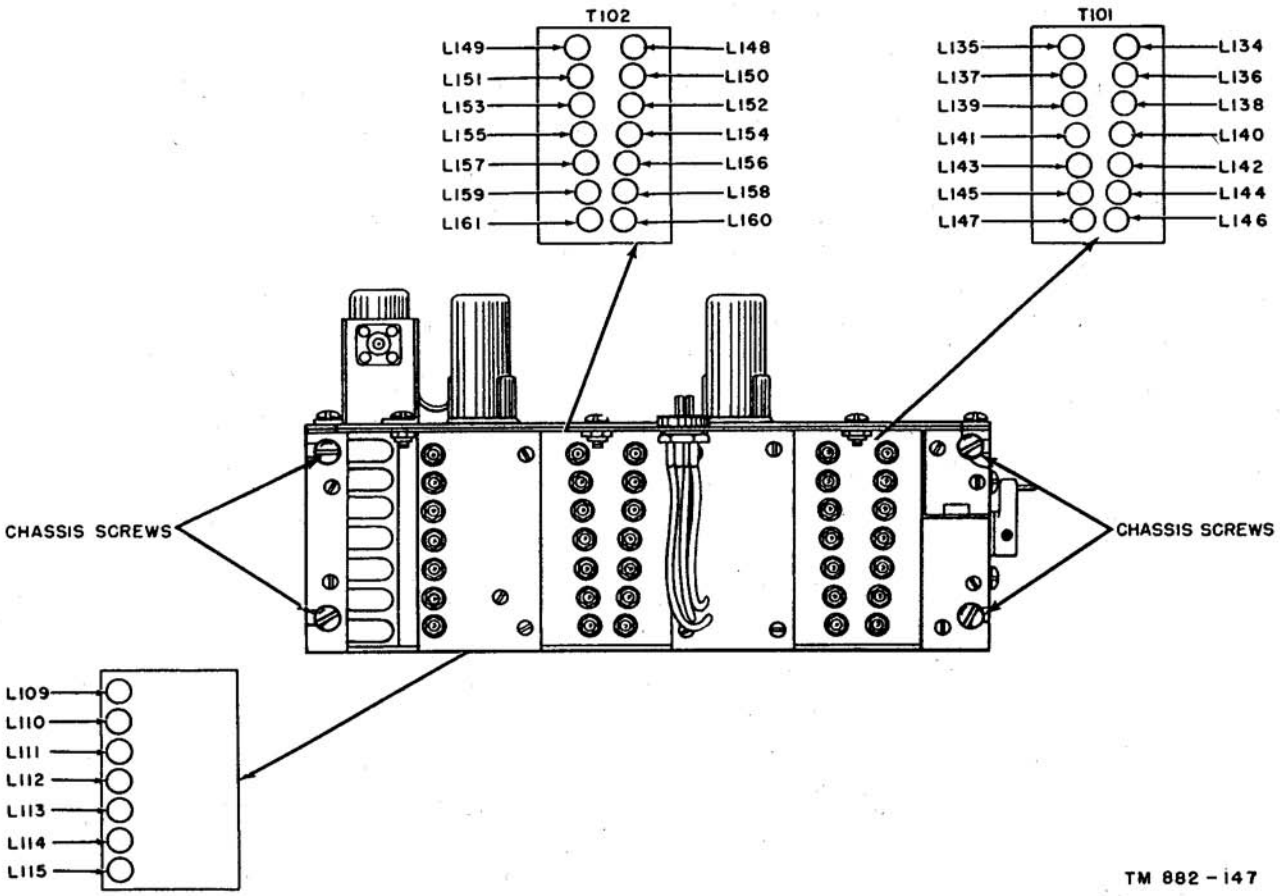


Figure 118. Rf unit, if section alinement points.

c. Change the frequency of the AN/URM–25 to 555 kc. (Check frequency with SCR–211.) Set the TS–505/U scale to −3 volts dc. Adjust Z302 (fig. 72) for maximum negative dc voltage.

d. Change the frequency of the AN/URM–25 to 455 kc and adjust C350 for zero volts on the TS–505/U.

e. Repeat the procedure outlined in *b* through *d* above. Change the frequency of the AN/URM–25 to 380 kc and note the voltage reading. Change the frequency of the AN/URM–25 to 530 kc and note the voltage reading. These readings must be a minimum of 1 volt and be within .3 volt of each other.

f. Replace the 2,205-kc crystal Y301.

107. Beat-Frequency Oscillator Alinement

a. Connect Signal Generator TS–497/URR to the antenna input of the receiver through adapter E101. Set the receiver front panel controls as outlined in paragraph 101*b*. Adjust the TS–497/URR for 30 mc at 50 microvolts, unmodulated. Connect the headset to an AUDIO OUTPUT jack.

b. Set the B.F. OSCILLATOR to *0* position. Adjust C408 (fig. 74) for a zero beat. Rock the B.F. OSCILLATOR control to each side of the *0* position. At the extreme end of the range on each side of the *0* position, the frequency of the audio note should be 3 to 4 kc.

108. Meter Alinement

a. CARRIER Position. Rotate the OPERATION switch to the AGC position. Connect the TS–497/URR to the receiver antenna input through adapter E101. Connect Electronic Multimeter ME–6A/U to terminals 1 and 2 of TB308 (fig. 12). Adjust the TS–497/URR for 50 microvolts (uv) output at 30 mc, amplitude modulated 30 percent at 400 cycles. Adjust the ANTENNA TRIMMER (fig. 12) for maximum output. The receiver panel meter should read 0 db. If the meter reads other than 0, adjust R429 (fig. 72) until the required reading is obtained.

b. OUTPUT LOW Position. Connect Output Meter TS–595/U to terminals 3 and 6 of TB308. Set the input impedance to 600 ohms. Connect the TS–497 to the antenna input through adapter E101 and adjust for a 5-μv output at 30 mc, amplitude modulated 30 per cent at 400 cycles. Set the METER switch to the OUTPUT LOW position. Rotate AUDIO GAIN 1 and AUDIO GAIN 2 controls for an output of 1 milliwatt (mw). Receiver front panel meter reads 0 dbm (decibel referred to 1 milliwatt in 600 ohms).

c. OUTPUT HIGH Position. Follow the same procedure outlined in *b* above. Set the METER switch to OUTPUT HIGH. Receiver front panel meter reads 0 dbm.

d. LIMITER Position. Adjust the TS–497/URR for an output of 5μv at 30 mc, unmodulated. Set the receiver METER switch to LIMITER and the OPERATION switch to FM SQUELCH. With the R. F. GAIN-SQUELCH control set at maximum and AUDIO 1 and AUDIO GAIN 2 controls set at midposition, the front panel meter should indicate grid current. Increasing the output of the TS–497/URR should increase the current reading on the meter.

e. DISC Position. Disconnect the TS–585/U and the TS–497/URR; ground the balanced antenna input. Set the R. F. GAIN SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls to maximum. Set the OPERATION switch to FM SQUELCH and the METER switch to DISC. With a rushing noise heard in the headset, adjust R420 (fig. 72) for a zero (0) reference (midscale deflection) on the front panel meter.

109. Calibrator Oscillator Alinement

Turn the CALIBRATE switch to ON. Connect Electronic Multimeter TS–505/U to pin 1 (grid) of V114 (fig. 103). Adjust L124 (fig. 89) (using the alinement tool supplied with the receiver for maximum grid voltage. Adjust Frequency Meter Set SCR–211 to 5 mc; loosely couple the output of the grid circuit of V115 (fig. 103) to the SCR–211, and adjust C198 (fig. 89) until the frequency matches that of the frequency meter.

110. Mgc Level Control Adjustment R311 (fig. 72)

a. Receiver Controls. Set the receiver front panel controls to the following positions:

(1) BAND SELECTOR to band 7.
(2) TUNING to 230 mc.
(3) B. F. OSCILLATOR to OFF.
(4) SELECTIVITY to 200.
(5) AUDIO RESPONSE to MEDIUM.
(6) R. F. GAIN SQUELCH to maximum.
(7) NOISE LIMITER to OFF.
(8) OPERATION to MGC.
(9) AUDIO GAIN 1 to two-thirds maximum.
(10) AUDIO GAIN 2 to maximum.
(11) CALIBRATE to OFF.

b. Meter Connections. Connect the TS–585/U to terminals 1 and 2 of TB308 (fig. 12). Set the input impedance to 600 ohms. Connect the TS–497/URR, externally modulated by the TS–382A/U, to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the TS–497/URR for a 10 μv output at 230 mc, amplitude modulated 30 per cent at 400 cycles by the TS–382A/U.

c. Tests. Adjust the ANTENNA TRIMMER and AUDIO GAIN 1 controls for maximum output as indicated on the TS–585/U. Loosen the locknut on R311 (fig. 72). Adjust R311 for maximum output without overloading. Tighten the locknut on R311. Decrease the TS–497 output to minimum. Slowly increase the TS–497/URR to 10 μv. The output, as indicated on the TS–585/U should be approximately linear over the input range and show no sign of limiting.

Section IV. FINAL TESTING

111. General

This section is a guide to be used in determining the quality of a repaired Radio Receiver R–220/URR. The minimum test requirements (pars. 112–117) may be performed by maintenance personnel with adequate test equipment and the necessary skills. Repaired equipment meeting these requirements will furnish uniformly satisfactory operation. Equipment not meeting the requirements should be considered as defective and requiring further maintenance.

112. Test Equipment and Preliminary Adjustments

a. General. The test equipment listed in *b* is necessary to complete the final testing. If the

particular type mentioned is not available, an equivalent may be used. When using a substitute, be sure the characteristics, such as input and output impedance, frequency range, etc., are the same. To insure positive results of all final tests, be sure that the source voltage applied to test equipment and Radio Receiver R–220/URR is exactly 115 volts ac, unless otherwise specified. A dummy antenna consisting of a resistive network designed to match the signal generator output impedance and the receiver input impedance should be used.

b. Test Equipment.

(1) Output Meter TS–585/U.
(2) Signal Generator TS–497/URR.
(3) Audio Oscillator TS–382A/U.
(4) Electronic Multimeter ME–6A/U.
(5) Signal Generator AN/URM–70.

c. Receiver Controls. For each test, set the receiver front panel controls to the positions listed in this paragraph. When a test requires a different setting of the controls, the new setting is indicated with the test.

(1) BAND SELECTOR to band 2.
(2) TUNING to 30 mc.
(3) B. F. OSCILLATOR to OFF.
(4) SELECTIVITY to 50 K. C.
(5) AUDIO RESPONSE to WIDE.
(6) R. F. GAIN SQUELCH to approximate midposition.
(7) AUDIO GAIN 1 and AUDIO GAIN 2 to approximate midpositions.
(8) NOISE LIMITER to OFF.
(9) OPERATION to MGC.
(10) METER switch to CARRIER.
(11) CALIBRATE to OFF.

113. Audio Circuits

a. Overall Audio Response.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 112*c*. Set the OPERATION switch to AGC.

(2) *Meter connections.* Connect the TS–585/U to terminals 1 and 2 to TB308 (fig. 12). Set input impedance to 600 ohms. Connect the TS–497/URR, externally modulated by the TS–382A/U to the receiver antenna input through adapter E101 and a dummy antenna. Adjust TS–497/URR for a level sufficient to produce a signal-plus-noise to noise ratio of 40 db (approx. 500 μv) at 30 mc, amplitude-modulated 30 percent at 1,000 cycles by the external audio oscillator.

(3) *Tests.*

(*a*) Adjust the ANTENNA TRIMMER control on the receiver for a maximum output as indicated on the receiver front panel meter.

(*b*) Adjust the R. F. GAIN SQUELCH control until an output of 10 db is indicated on the TS–585/U. If the desired db level cannot be obtained by adjusting the R. F. GAIN SQUELCH control, AUDIO GAIN 1 or AUDIO GAIN 2 may be adjusted to provide the proper db level.

b. Audio Power Output.

(1) *Receiver controls.* Set the receiver front panel controls as outlined in paragraph 112*c*. Rotate the BAND SELECTOR to band 7 and tune to 230 mc. Set the SELECTIVITY control to the 10 position and the AUDIO RESPONSE switch to MEDIUM. Rotate the R. F. GAIN SQUELCH, AUDIO GAIN 1 and AUDIO GAIN 2 controls to maximum.

(2) *Meter connections.* Connect the TS–585/U to terminals 1 and 2 of TB308 (fig. 12). Set the impedance to 600 ohms. Connect the TS–497/URR externally modulated by the TS–382A/U to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the TS–497/URR for a 10-μv output at 230 mc, amplitude modulated 30 percent at 1,000 cycles by the external audio oscillator.

(3) *Tests.*

(*a*) Adjust the ANTENNA TRIMMER control for a maximum output as indicated on the TS–585/U. The power output must be at least 500 mw.

(*b*) Set the SELECTIVITY control to the 50 K. C. position and readjust the ANTENNA TRIMMER control for a maximum output as indicated on the TS–585/U. The power output must be at least 500 mw.

(*c*) Set the SELECTIVITY control to the 200 position and readjust the ANTENNA TRIMMER control for a maximum output as indicated on the TS–585/U. The power output must be at least 500 mw.

(*d*) Return the SELECTIVITY control to the 10 position.

(4) *Audio power output with bfo.* Follow the procedure outlined in *a*(1) and (2) above with the following exceptions:

(*a*) Turn the B. F. OSCILLATOR to ON.

(*b*) Disconnect the TS–382A/U.

(*c*) Reduce the TS–497/URR output from 10 μv to 5 μv. Perform the test outlined in (3) above.

114. If. Circuits

a. Image Rejection Ratio.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 112*c*. Rotate the BAND SELECTOR to band 1 and tune to 20 mc.

(2) *Meter connections.* Connect the TS–585/U to terminals 1 and 2 of TB308 (fig. 12). Set the impedance to 600 ohms. Connect the TS–497/URR to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the signal generator for a 10 μv output at 20 mc, amplitude modulated 30 percent at 400 cycles.

(3) *Tests.*

(*a*) Adjust the ANTENNA TRIMMER control for a maximum output on TS–585/U. Adjust the R. F. GAIN SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls for 10-mw output. Change the frequency of AN/URM–70 to 7.8116 mc (image frequency) and increase the output until a power output of 10 mw is again obtained. The ratio of inputs must be at least 80 db.

Caution: While tuning the AN/URM–70 to the image frequency, the receiver controls must be left untouched at the test frequency.

(*b*) Using the previously outlined procedure, check the image rejection ratio at each of the test frequencies listed in the following chart:

Test frequency (mc)	Image frequency (mc)	Minimum ratio (db)
34	16. 7262	80
48	23. 6232	80
75	40. 4524	80
106	57. 2466	80
150	80. 9048	80
200	102. 4930	80

b. If. Rejection Ratio.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 112*c*. Rotate the BAND SELECTOR to band 1 and tune to 20 mc.

(2) *Meter connections.* Connect Output Meter TS–585/U to terminals 1 and 2 of TB308. Set the impedance to 600 ohms. Connect the AN/URM–25 to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the AN/URM–25 for 10-μv output at 20 mc, amplitude modulated 30 percent at 400 cycles.

(3) *Tests.*

(*a*) Adjust the ANTENNA TRIMMER for a maximum output on TS–585/U. Adjust the R. F. GAIN SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls for an output of 10 mw. Retune the AN/URM–25 to 455 kc, and increase its output until 10 mw is again obtained. The ratio of inputs must be at least 80 db.

(*b*) Retune the AN/URM–25 to 1.75 mc, and increase its output until a power output of 10 mw is again obtained. Again the ratio must be at least 80 db.

(*c*) Retune the AN/URM–25 to 6.0942 mc and increase its output until a power output of 10 mw is obtained. The ratio must be at least 80 db.

(*d*) Using the previously outlined procedure, check the if. rejection ratio at each of the test frequencies listed in the following table. In all cases, the minimum ratio will be 80 db.

Note. At higher frequencies, it will be necessary to use Signal Generator TS–497/URR.

Band	Receiver frequency (mc)	Signal generator frequency (mc)
1	20	.455
1	20	1.75
1	20	6.0942
2	34	.455
2	34	1.75
2	34	8.6369
3	48	.455
3	48	1.75
3	48	12.1884
4	69	.455
4	69	1.75
4	69	17.2738
5	98	.455
5	98	1.75
5	98	24.3767
6	140	.455
6	140	1.75
6	140	34.5476
7	200	.455
7	200	1.75
7	200	48.7535

c. Spurious Response.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 112*c*. Rotate the BAND SELECTOR to band 1 and tune to 24 mc. Set the SELECTIVITY switch to 10 and R. F. GAIN SQUELCH control fully clockwise.

(2) *Meter connections.* Connect the TS–585/U to terminals 1 and 2 of TB308 (fig. 12). Set the impedance to 600 ohms. Connect Signal Generator TS–497/URR to the receiver antenna input through adapter E101 and the dummy antenna. Adjust the TS–497/URR for 2.5 μv at 24 mc, amplitude modulated 30 percent at 400 cycles.

(3) *Tests.*

(*a*) Tune in the signal on the receiver with the ANTENNA TRIMMER adjusted for maximum and the AUDIO GAIN 1 and AUDIO GAIN 2 controls adjusted for a 10-mw output with modulation, and a 1-mw noise output with modulation removed. The output as indicated on the output meter is to be used as a reference in the remainder of this test.

(*b*) Lower the TS–497/URR 0.5 mc and increase the output 60 db. Tune the TS–497/URR slowly until the frequency is 5 mc higher than the test frequency. At each spurious frequency indication, measure the ratio of the input level at the spurious frequency in relation to the reference level of 10 mw.

(*c*) Repeat the above procedure at the following test frequencies: 34 mc, 48 mc, 68 mc, 96 mc, 136 mc, and 192 mc. Increase the TS–497/URR output to 4.0 μv at 136 mc and 6.5 μv at 192 mc for a signal-plus-noise to noise ratio of 10 to 1.

(*d*) The rejection ration of the spurious responses should be at least 60 db.

d. Fm Limiting.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 112*c*. Rotate the SELECTIVITY control to 200 and the R. F. GAIN SQUELCH control to maximum. Set the OPERATION switch to the FM SQUELCH position.

(2) *Meter connections.* Connect the ME–6A/U to terminals 1 and 2 of TB308 (fig. 12). Set impedance to 600 ohms. Connect AN/URM–70 to the receiver antenna input through adapter E101 and a dummy antenna. Adjust AN/URM–70 for 10-μv output at 30 mc, modulated by 400 cycles with 10-kc deviation.

(3) *Test.* Adjust the receiver ANTENNA TRIMMER for maximum output. Adjust the receiver R. F. GAIN SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls for an output of 20 db. Increase the rf output of the AN/URM–70 from 10 μv to 0.1 volt. The receiver output must not rise more than 4 db above the reference level of 20 db.

115. Rf Circuits

a. Overall Selectivity.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 112*c*. Rotate the BAND SELECTOR to band 1 and tune to 24.2 mc. Set the SELECTIVITY switch to 200.

(2) *Meter connections.* Connect the ME–6A/U to terminals A and B of J301 (fig. 15) terminal B is ground. Set the ME–6A/U to read a maximum of −10 volts

dc. Connect the AN/URM–25 to the receiver balanced antenna input through adapter E101 and a dummy antenna. Adjust the AN/URM–25 for an unmodulated output of 10 μv at 24.2 mc.

(3) *Tests.*

(*a*) Adjust the ANTENNA TRIMMER for a maximum output. Adjust the R. F. GAIN SQUELCH control for a reading of −5.0 volts on the vtvm. Increase the AN/URM–25 output to 20 μv and increase the frequency until the reference voltage of −5.0 volts is again obtained. Record the difference in frequency from the initial test frequency.

(*b*) Decrease the AN/URM–25 frequency until the reference voltage of −5.0 volts is again obtained. Record the difference in frequency from the initial test frequency.

(*c*) Perform the test given in *a* for each setting of the SELECTIVITY control and each of the following signal inputs: 10, 20, 100, 1,000, and 10,000 microvolts. Using the procedure in (*a*) and (*b*) above, check the overall selectivity of the receiver for the bandwidth requirements listed in the chart below at the following frequencies: 24.2 mc, 34.5 mc, 48.2 mc, 69.0 mc, 97.5 mc, 138.0 mc, and 196.0 mc.

Response ratio (db)	10 K. C.		50 K. C.		200 K. C.	
	Min (kc)	Max (kc)	Min (kc)	Max (kc)	Min (kc)	Max (kc)
6 (20-μv input)	8. 5	11. 5	42. 5	57. 5	170. 0	230. 0
20 (100-μv input)	17	19. 5	76	87. 4	290	333. 5
40 (1,000-μv input)	27	31. 0	116	133. 4	416	478. 5
60 (10,000-μv input)	36	41. 4	155	178. 2	540	621. 0

b. AGC Characteristic.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 112*c*. Set the OPERATION switch to the AGC position and the AUDIO RESPONSE switch to MEDIUM.

(2) *Meter connections.* Connect Output Meter TS–585/U to terminals 1 and 2 of TB308. Set the impedance to 600 ohms. Connect the AN/URM–25 to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the AN/URM–25 for 4–μv output at 30 mc, amplitude modulated 30 percent at 400 cycles.

(3) *Tests.*

(*a*) Adjust the ANTENNA TRIMMER for maximum output. Adjust the R. F. GAIN SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls for 10-mw output (10 db). Increase the AN/URM–25 output from 4 μv to 1,000 μv. The maximum db rise as shown on the TS–585/U shall not exceed 3 db.

(*b*) Increase the AN/URM–25 output from 4 μv to 0.5 volt. The maximum db rise from the original reference level, shall not exceed 8 db.

c. Frequency Coverage.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 112*c*. Rotate the BAND SELECTOR to band 1 and tune to 20.0 mc. Set the SELECTIVITY control to the 10 position.

(2) *Meter connections.* Connect the AN/URM–25 to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the AN/URM–25 for 50 μv at 20.0 mc, amplitude modulated 30 percent at 400 cycles. Increase the receiver gain controls until the signal is heard at the headset.

(3) *Tests.*

(*a*) Retune the AN/URM–25 to a frequency approximately 1 percent below the lowest frequency indicated on the dial for band 1 (19.8 mc). Retune the receiver until the signal is again heard. (Dial is not calibrated for 19.8 mc.)

(*b*) Retune the AN/URM–25 to a frequency approximately 1½ percent above the highest frequency indicated on the dial for band 1 (28.92 mc). Retune the receiver until the signal is again heard. (Dial is not calibrated for 28.92 mc.)

(*c*) The above outlined procedure checks the dial overlap for band 1 only. The dial overlap for the other six bands is 1½ percent for both the low and high ends of the band. Use the frequencies listed in the following chart:

Band	Low frequency (mc)	High frequency (mc)
1	19. 80	28. 92
2	28. 07	41. 10
3	39. 89	57. 85
4	56. 14	82. 21
5	79. 78	115. 71
6	112. 29	164. 43
7	159. 57	233. 45

116. Sensitivity Tests

a. Am. Sensitivity.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 112*c*. Set the BAND SELECTOR to band 1 and tune to 20.01 mc. Rotate the AUDIO RESPONSE to MEDIUM and the R. F. GAIN SQUELCH control to maximum.

(2) *Meter connections.* Connect Output Meter TS–585/U to pins 1 and 2 of TB308. Set impedance to 600 ohms. Connect the TS–497/URR to the receiver antenna input through adapter E101 and the dummy antenna. Adjust the TS–497/URR for a 2.5-μv output at 20.01 mc, modulated 30 percent at 400 cycles.

(3) *Tests.* Tune in the signal with the ANTENNA TRIMMER adjusted for maximum output and the AUDIO GAIN 1 and AUDIO GAIN 2 controls adjusted for a 10-mw output with modulation, and a 1-mw noise output with modulation removed. Using this procedure, check the sensitivity of the receiver at the frequencies listed in the following chart. The signal input with these conditions should be as indicated in the chart below.

Band	Receiver and generator frequency (mc)	Receiver input (μv)	Band	Receiver and generator frequency (mc)	Receiver input (μv)
1	20. 010	2. 5	4	80. 600	2. 5
1	24. 250	2. 5	5	81. 400	2. 5
1	28. 480	2. 5	5	97. 000	2. 5
2	28. 520	2. 5	5	113. 500	2. 5
2	34. 500	2. 5	6	114. 000	4. 0
2	40. 200	2. 5	6	138. 000	4. 0
3	40. 700	2. 5	6	161. 000	4. 0
3	49. 000	2. 5	7	163. 000	6. 5
3	56. 700	2. 5	7	196. 000	6. 5
4	57. 300	2. 5	7	229. 000	6. 5
4	69. 000	2. 5			

b. Fm Sensitivity.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 112*c*. Set the BAND SELECTOR to band 1 and tune to 21 mc. Rotate the SELECTIVITY switch to 200, AUDIO RESPONSE switch to MEDIUM, and the OPERATION switch to FM SQUELCH. Set the R. F. GAIN SQUELCH control to maximum.

(2) *Meter connections.* Connect the TS–585/U to pins 1 and 2 of TB308. Set the impedance to 600 ohms. Connect the AN/URM–70 to the receiver antenna input through adapter E101 and the dummy antenna.

(3) *Tests.* Adjust the AN/URM–70 for an output of 3 μv unmodulated at 21 mc. Adjust the TUNING control for maximum quieting of the receiver. Decrease the AN/URM–70 output to zero. Adjust AUDIO GAIN 1 and AUDIO GAIN 2 controls for 10-db (10 mw) noise output. Increase the AN/URM–70 output until 20 db of quieting is obtained (0.1 mw). The output of the AN/URM–70 should not exceed 3 μv. Using this

procedure, check the sensitivity of the receiver at the frequencies listed in the following chart.

Band	Receiver and generator frequency (mc)	Receiver input (μv)	Band	Receiver and generator frequency (mc)	Receiver input (μv)
1	21	3	4	80	3
1	24	3	5	84	3
1	28	3	5	100	3
2	30	3	5	112	3
2	34	3	6	120	3
2	40	3	6	142	3
3	42	3	6	160	3
3	49	3	7	168	7.2
3	56	3	7	200	7.2
4	60	3	7	230	7.2
4	70	3			

c. Bfo Sensitivity.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 112*c*. Rotate the BAND SELECTOR to band 1 and tune to 20.01 mc. Set the AUDIO RESPONSE switch to MEDIUM. Rotate the R. F. GAIN SQUELCH control to maximum and the B. F. OSCILLATOR to 0.

(2) *Meter connections.* Connect Output Meter TS–585/U to terminals 1 and 2 of TB308. Set the impedance to 600 ohms. Connect Signal Generator TS–497/URR to the receiver antenna input through adapter E101 and the dummy antenna. Adjust the TS–497/URR for 1–2 μv output at 20.01 mc with no modulation. Adjust the B. F. OSCILLATOR control for a 1,000 cycle tone.

(3) *Tests.* Tune in the signal with the ANTENNA TRIMMER adjusted for maximum output and the AUDIO GAIN 1 and AUDIO GAIN 2 controls adjusted for 10-mw output with the TS–497/URR on and 1-mw noise output with the TS–497/URR off. Using this procedure, check the sensitivity of the receiver at the frequencies listed in the following chart. The signal input with these conditions should be as indicated in the chart below

Band	Receiver and generator frequency (mc)	Receiver input (μv)	Band	Receiver and generator frequency (mc)	Receiver input (μv)
1	20.010	1.2	4	80.600	1.2
1	24.250	1.2	5	81.400	1.2
1	28.480	1.2	5	97.000	1.2
2	28.520	1.2	5	113.500	1.2
2	34.500	1.2	6	114.000	1.7
2	40.200	1.2	6	138.000	1.7
3	40.700	1.2	6	161.000	1.7
3	49.000	1.2	7	163.000	2.2
3	56.700	1.2	7	196.000	2.2
4	57.300	1.2	7	229.000	2.2
4	69.000	1.2			

d. Squelch Circuit.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 112*c*. Rotate the SELECTIVITY switch to 200 and the OPERATION switch to AM SQUELCH.

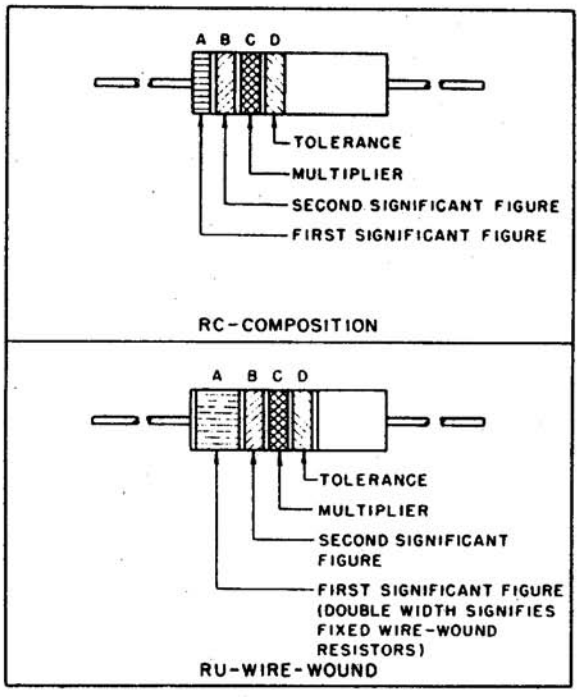
(2) *Meter connections.* Connect a speaker to terminals 1 and 2 of TB308. Connect the TS–497/URR to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the TS–497/URR for 50 μv output at 30 mc, modulated 30 per cent at 400 cycles. Adjust the AUDIO GAIN 1 and AUDIO GAIN 2 controls for a comfortable listening level.

(3) *Tests.* Rotate the R. F. GAIN SQUELCH control counterclockwise until the receiver squelches the incoming signal.

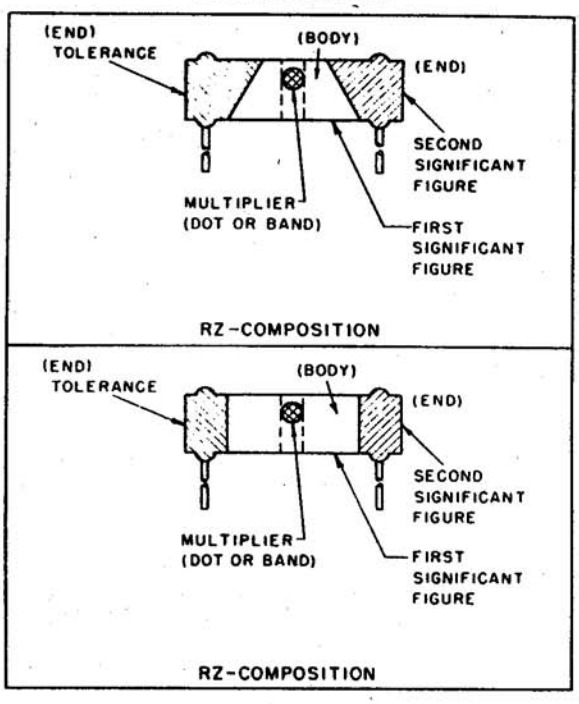
(*a*) Adjust TS–497/URR for 1-μv output and the R. F. GAIN SQUELCH control to the threshold level (point at which the incoming signal just overcomes the squelch). Rotate the R. F. GAIN SQUELCH control counterclockwise until the signal is just squelched. Increase the output of the TS–497/URR to 2 μv and the signal should be heard in the loudspeaker. With the TS–497 output reduced to zero and the R. F. GAIN SQUELCH control rotated completely counterclockwise, the receiver noise should be squelched.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED)



RADIAL-LEAD RESISTORS (UNINSULATED)



RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

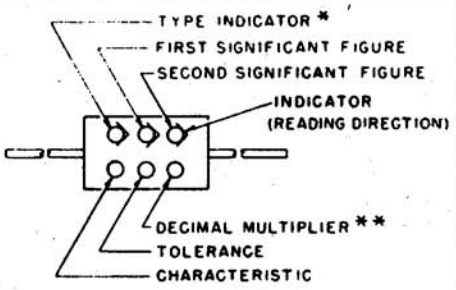
*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

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

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY, BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY, BLACK END, RED DOT OR BAND; SILVER END.

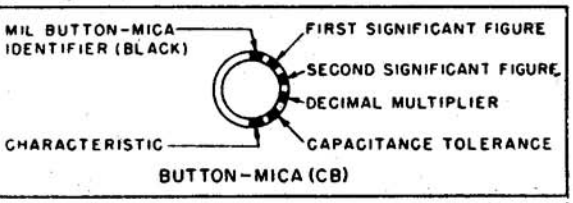
STD-RI

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)

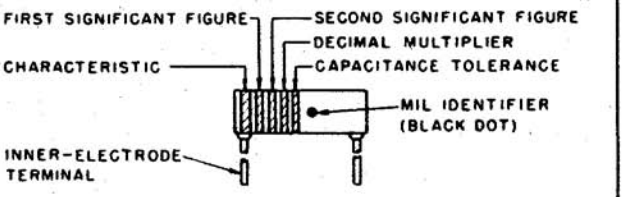


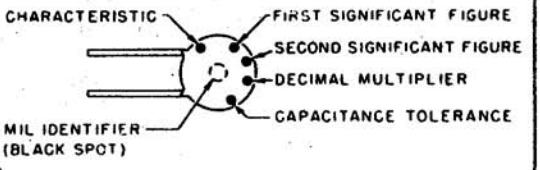
* BLACK DOT: MICA DIELECTRIC
SILVER DOT: PAPER DIELECTRIC
** INDICATES NUMBER OF ZEROS ON PAPER TYPE.

MICA (CM) AND PAPER (CN)



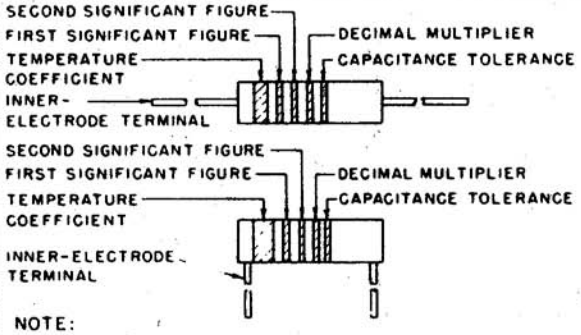
BUTTON-MICA (CB)





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

CERAMIC-GENERAL PURPOSE (CK)



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

CERAMIC-TEMPERATURE COMPENSATING (CC)

CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE [2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	CC
BLACK	0	1	NONE		A			·20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500) [3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-C1

(*b*) Rotate the OPERATION switch to FM SQUELCH. With the R. F. GAIN SQUELCH control completely counterclockwise the receiver noise should be squelched. Adjust the TS-497/URR for 10-μv output at 30 mc, modulated at 400 cycles with 15-kc deviation and, with the R. F. GAIN SQUELCH control rotated completely counterclockwise, the incoming signal should be squelched. Adjust the TS-497/URR output for 2-μv output and the R. F. GAIN SQUELCH control adjusted to the threshold level. Rotate the R. F. GAIN SQUELCH control counterclockwise until the signal is just squelched. The output of the TS-497/URR should increase to 6.5 μv and the signal should be heard in the speaker. With the TS-497/URR output reduced to zero and the R. F. GAIN SQUELCH control rotated completely counterclockwise, the receiver noise should be squelched.

e. Noise Limiter Circuit.

(1) Set the receiver front panel controls as indicated in paragraph 112*c*.

(2) Turn the RF GAIN SQUELCH control to the maximum clockwise position, the AUDIO RESPONSE switch to WIDE, the NOISE LIMITER to OFF, and the AUDIO GAIN 1 and AUDIO GAIN 2 to maximum clockwise positions. Tune in a strong noise signal. Now turn the NOISE LIMITER control to the maximum clockwise position. The noise should be reduced considerably.

117. Auxiliary Circuits

a. Auxiliary If. Output.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 112*c*. Rotate the BAND SELECTOR to band 1 and tune to 24.250 mc. Set the AUDIO RESPONSE switch to MEDIUM. Rotate the R. F. GAIN SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls to maximum.

(2) *Meter connections.* Connect Electronic Multimeter ME-6A/U to the AUX. IF. OUTPUT connector (fig. 12). Connect the TS-497/URR to the receiver antenna input through adapter E101 and a dummy antenna. Adjust the TS-497/URR for 2 microvolts at 24.250 mc, modulated 30 percent at 400 cycles.

(3) *Tests.* Tune the signal in with the ANTENNA TRIMMER adjusted for maximum output and the R. F. GAIN SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls adjusted for 1-mv output with modulation and .33-mv noise output with modulation removed. Using this procedure, check the auxiliary circuit of the receiver at the frequencies listed in the following chart. The signal input with these conditions should be as indicated in the chart below.

Band	Receiver and generator frequency (mc)	Receiver inout (μv)
1	24. 250	2. 5
2	34. 500	2. 5
3	49. 000	2. 5
4	69. 000	2. 5
5	97. 000	2. 5
6	138. 000	4. 0
7	196. 000	6. 5

b. Auxiliary Diode Circuit.

(1) *Receiver controls.* Set the receiver front panel controls as indicated in paragraph 112*c*. Rotate the BAND SELECTOR to band 1 and tune to 24.250 mc. Set the SELECTIVITY switch to 10 and the AUDIO RESPONSE switch to MEDIUM. Rotate the R. F. GAIN SQUELCH, AUDIO GAIN 1, and AUDIO GAIN 2 controls for maximum.

(2) *Meter connections.* Connect the TS-505/U to terminals A and B (B is ground) of J301 (fig. 15). Connect the AN/URM-70 to the receiver antenna input through a dummy antenna and adapter E101. Adjust the AN/URM-70 for an output of 2.5 μv at 24.250 mc,

amplitude modulated 30 percent at 400 cycles.

(3) *Tests.* Tune in the signal. With the ANTENNA TRIMMER adjusted for maximum, the output should be 4 volts with modulation and 1.33 volts with modulation removed. Using this procedure, check the auxiliary diode circuit for the frequencies in the following chart. The signal input with these conditions should be as indicated in the chart below.

Band	Receiver and generator frequency (mc)	Receiver inout (μv)
1	24. 250	2. 5
2	34. 500	2. 5
3	49. 000	2. 5
4	69. 000	2. 5
5	97. 000	2. 5
6	138. 000	4. 0
7	196. 000	6. 5

CHAPTER 7

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

118. Disassembly

The following instructions are recommended as a guide for preparing the radio set for transportation and storage.

a. Disconnect the power cord from the ac line.

b. Disconnect all coaxial cables from the receiving set.

c. Roll up the power cord.

d. Take down the antenna and repack it. Follow instructions given in TM 11–5016.

119. Field Repacking for Shipment or Limited Storage

a. Materials Required. The following chart lists the estimated amount of materials required to prepare Radio Receiving Set AN/URR–29 for shipment:

Materials	Amount
Waterproof barrier	85 sq ft
Pressure-sensitive tape	30 ft
Single-faced, flexible corrugated paper	75 sq ft
Gummed paper tape	10 ft
Flat steel strapping	29 ft
Wooden shipping boxes	3 ea

b. Box Sizes. The dimensions required are given in the chart below:

Box No.	Size (in.)	Board (ft)	Volume (cubic ft)	Packed weight (lb)
1 of 3	25 x 21 x 19	17	5. 77	155
2 of 3	70 x 8 x 10	20	3. 24	85
3 of 3	18 x 12 x 14	9	1. 75	52

c. Manuals. Wrap the manuals in waterproof barrier material. Seal all seams and folds with water-resistant, pressure-sensitive tape.

d. Electrical Spare Parts Items. Package each item individually as follows: Cushion each item by wrapping in single-faced, flexible, corrugated paper. Secure cushioning with gummed paper tape.

e. Construction of Wooden Shipping Boxes. The boxes must be large enough to allow a 2-inch clearance between the packaged components of Radio Receiving Set AN/URR–29 and the sides, ends, and the top of the box. Construct each of the boxes as follows:

(1) Construct the bottom of the box. To determine the dimensions of the bottom, add twice the thickness of the material used for the bracing to the dimensions given in the chart.

(2) Construct the ends of the box. Use the dimensions given in the chart (*b* above).

(3) Construct the two sides. To determine the dimensions of the sides, add twice the thickness of the material used for the bracing to the dimensions given in the chart.

(4) Construct the top. Mount the boards so that they run parallel to the boards forming the bottom. Make the top large enough to extend to the outer edges of the sides and ends.

f. Wrapping Spare Parts and Manuals. Wrap the items as specified in *c* and *d* above within a snug wrap of single-faced, flexible, corrugated paper. Secure all ends and folds with water-resistant, pressure-sensitive tape.

g. Radio Receiver R–220/URR in Receiver Case CY–956/URR. Package each receiver in its case

as follows: Secure all catches and fasteners. Line the case with pads made of flexible, corrugated paper. Wrap the receiver with flexible, corrugated paper. Seal all joints and seams with water-resistant, pressure-sensitive tape.

h. Antenna Assembly AS–574/URR.

(1) *Bag BG–102A with contents.* Place the various items other than mast sections and stakes within Bag BG–102A. Close the bag and secure all fastenings. Wrap the bag with a close-fitting wrap of single-faced, flexible, corrugated paper. Seal all seams with water-resistant, pressure-sensitive tape.

(2) *Bag, long.* Place antenna masts and stakes in the proper compartments of the bag. Close the bag and secure the fasteners.

i. Packing. Pack Radio Receiving Set AN/URR–29 as follows:

(1) *Shipping containers.* Place the package specified in *f* above and one receiver within a nailed wooden box. Fill in all spaces with pads of single-faced flexible corrugated paper. Place one Bag BG–102A and one long bag within a long nailed box.

(2) *Strapping.* Strap the shipping boxes for intertheater shipment only. The strapping should run at right angles to the length of the boards.

(3) *Marking.* Mark the boxes in accordance with the requirements of Section II, SR 55–720–1, Transportation and Travel, Preparation of Oversea Movement of Units (POM).

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

120. General

The demolition procedures outlined in paragraph 121 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 commanding officer.

121. Methods of Destruction

a. Smash. Smash the crystals, controls, tubes, coils, turrets, switches, capacitors, and transformers. Use sledges, axes, handaxes, hammers, crowbars, or other heavy tools.

b. Cut. Cut cords and wiring; use axes, handaxes, or machetes.

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

d. Bend. Bend panels, cabinet, and chassis.

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

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

g. Destroy. Destroy everything.

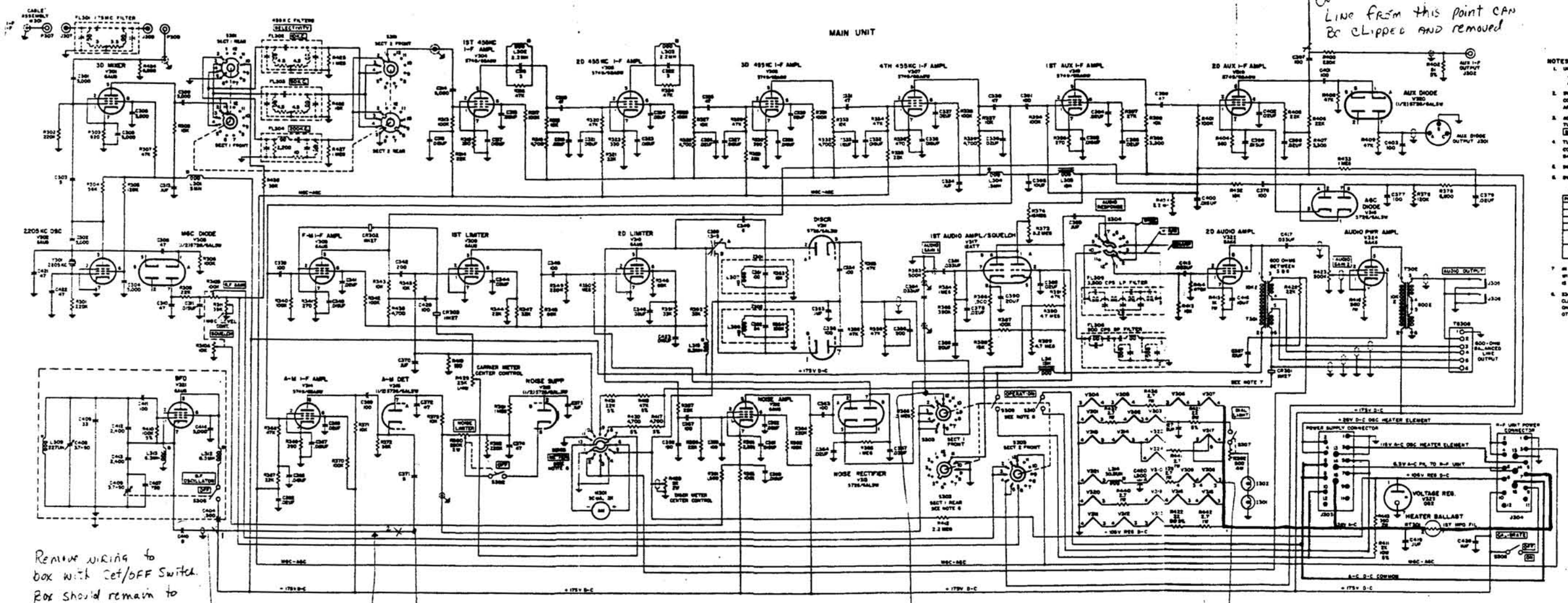


Figure 138. Radio Receiver R-220/URR, schematic diagram.

INDEX

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11-57R, Armd Sig Co (2)
11-127R, Sig Rep Co (2)
11-128R, Sig Depot Co (2)
11-500R (AA-AE), Sig Svc Org (2)
11-557R, Abn Sig Co (2)
11-587R, Sig Base Maint Co (2)
11-592R, Hq & Hq Co, Sig Base Depot (2)
11-597R, Sig Base Depot Co (2)
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32-55R, Comm Recon Bn (2)
32-56R, Hq & Hq Co, Comm Recon Bn (2)
32-57R, Comm Recon Opr Co (2)

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

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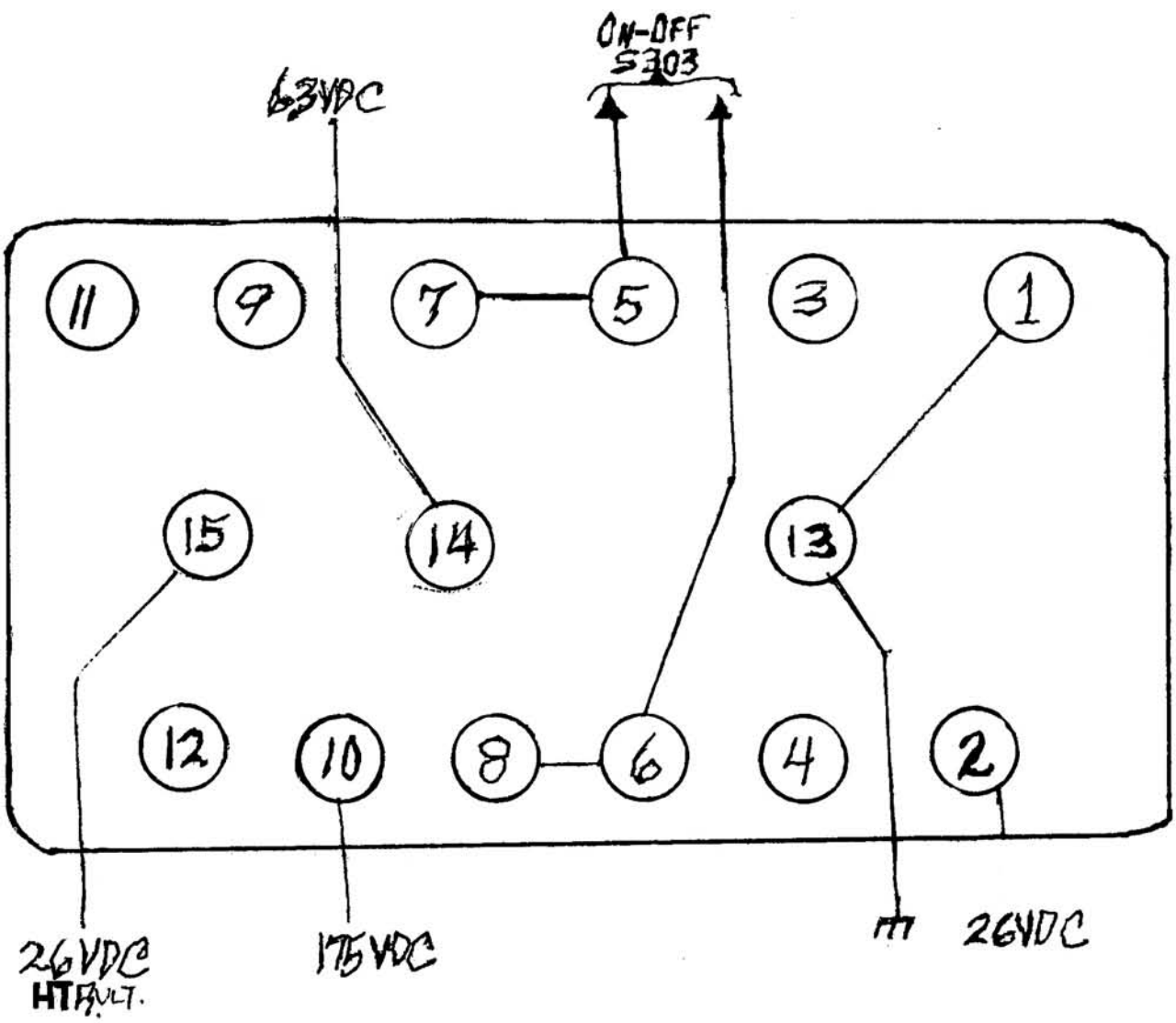
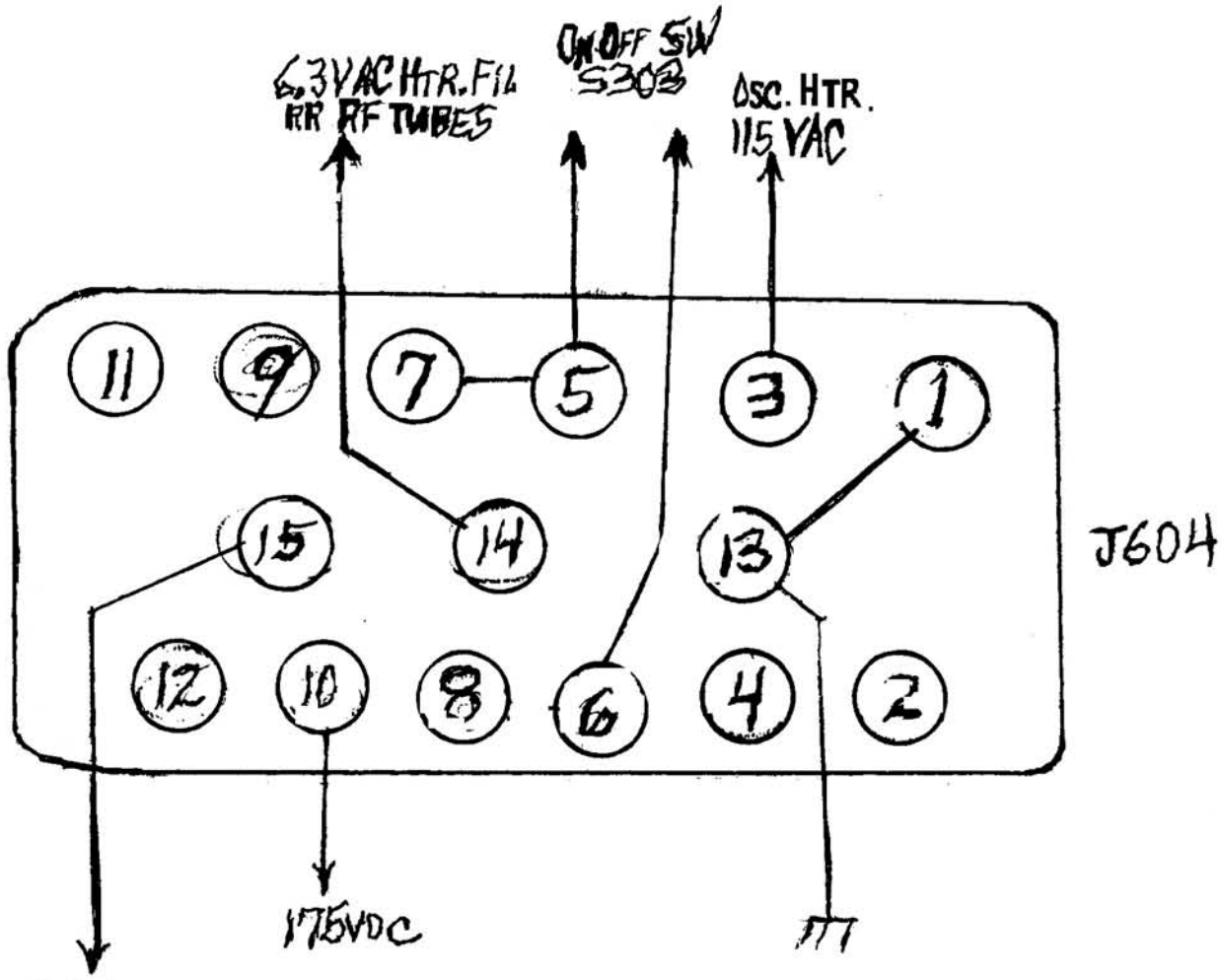




PLUG WIRING
ON PP-660/URR

R-1538 (R-220 Rec'r Modified)

ANT. CONNECTOR (TWIN COAX.)

		Amp. No.	Keyed
UG/421	PLUG	32225	90°
UG/421B	PLUG	6275 (V-GROOVE) CLAMP	90°

PANEL JACK (TWIN COAX)

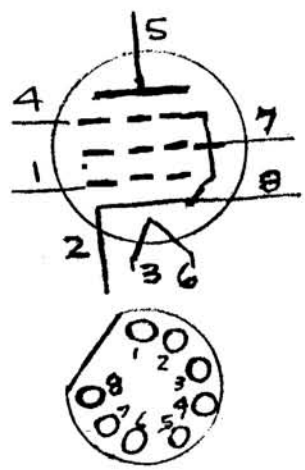
			Keyed
UG-423	/6175		90°
UG-423B	/32200	(V-GROOVE) CLAMP	90°

STRAIGHT JACK (TWIN COAX)
Amp. No. 6975 Keyed 90°

USED WITH COAX

RG-22, 22A, 22B, 108A	100Ω
Belden No. 8227, 8207	100Ω

5840



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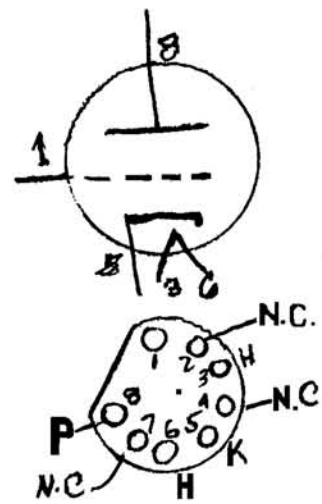

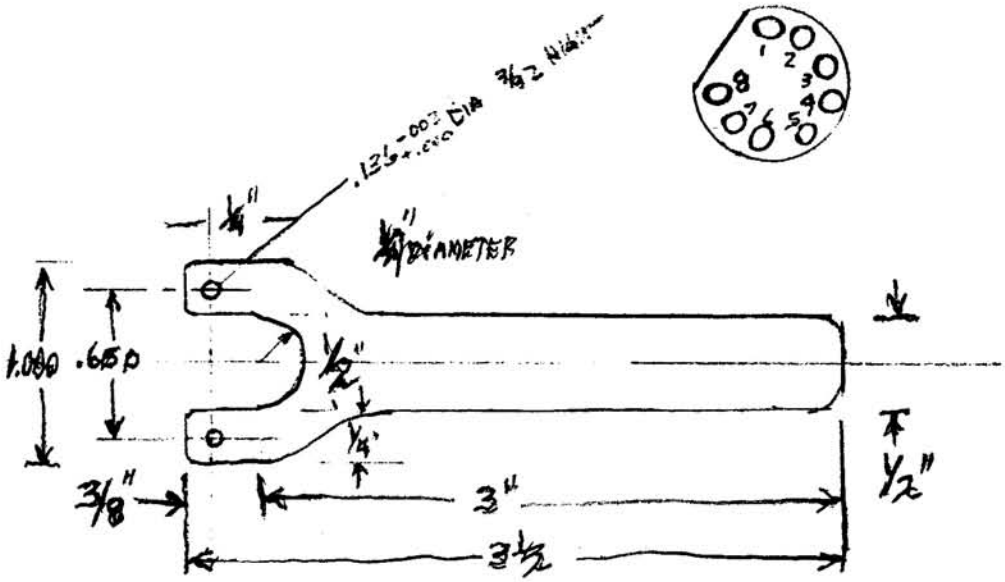

R-220 RECEIVER
SPANNER WRENCH TOOL STEEL